Western Water Constructors, Inc.
license no. 188068

Submittal Cover

Job no. 16-05

CONTRACT NAME:	Manteca WQCF Digester Improvements	**SUB #:**	186
SPEC SECTION:	15552 Hot Water Boiler	**REV #:**	0
SUBMITTAL TITLE:	Boiler O&M	**CODE:**	15552-02
FILE NAME:	186-R0_15552-02_Boiler-OM	**DATE:**	9/15/2017

WWC REVIEW/COMMENTS: ☒ **NO EXCEPTIONS** ☐ **EXCEPTIONS / DEVIATIONS AS NOTED**

REVIEWED BY: ST **SIGNED:**

WWC HAS REVIEWED THIS SUBMITTAL FOR CONFORMANCE WITH THE PROJECT PLANS & SPECIFICATIONS.

OWNER REVIEW:

ITEM	DESCRIPTION	REVIEW STATUS				
		A	B	C	D	E
1	Boiler O&M	☐	☐	☐	☐	☐
2		☐	☐	☐	☐	☐
3		☐	☐	☐	☐	☐
4		☐	☐	☐	☐	☐
5		☐	☐	☐	☐	☐

LEGEND: **A =** No Exceptions Taken **B =** Make Correction Noted **C =** Correct & Resubmit
D = Rejected **E** = Accepted for Record

OWNER COMMENTS:

REVIEWER'S NAME: _____

REVIEWER'S SIGNATURE: _____ **DATE:** _____

707 Aviation Blvd
Santa Rosa, CA 95403

www.westernwater.com
general engineering contractors

p 707.540.9640
f 707.540.9641

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM SO# 294455

2. MANUFACTURER Johnston Boiler Company

3. EQUIPMENT IDENTIFICATION NUMBER(S) DIG-BOL-07-011 DIG-BOL-07-021
(maps equipment number)

4. LOCATION OF EQUIPMENT Digester control building #2

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)

10,000 lbs

6. NAMEPLATE DATA - Horsepower 5 hp
Amperage
Voltage 480 V
Service Factor (S.F.) 1.15
Speed 3600
ENC Type
Capacity
Other

7. MANUFACTURER'S LOCAL REPRESENTATIVE

Name Bay City Boiler

Address 23312 Cabot Blvd Hayward, CA 94545

Telephone Number 510-786-3711

8. MAINTENANCE REQUIREMENTS See O&M

9. LUBRICANT LIST N/A

10. SPARE PARTS (recommendations)

11. COMMENTS

johnson burners

Since 1903

INSTALLATION, OPERATING & MAINTENANCE MANUAL

CUSTOMER:	BAY CITY BOILER
MODEL:	NM100A5V
SHOP ORDER #:	294455 & 294456
P.O. #:	14137
JOB NAME:	MANTECA WWTP
	MANTECA, CA

S.T. Johnson Company
5160 Fulton Drive • Fairfield, CA 94534 • USA • Phone (510) 652-6000 • Fax (510) 652-4302 • www.johnsonburners.com

Table of Contents

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Section 2	Engineering Data Sheet, Bill of Materials, & Parameters
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Section 5	Component Literature & Technical Instructions

Recommended Spare Parts List

NM100A5V

RECOMMENDED SPARE PARTS LIST S.O. # 294455

PART #	DESCRIPTION	CATEGORY
10005	Air Pressure Switch	BURNER COMPONENTS
10020	Air Filter Switch	BURNER COMPONENTS
10026	Burner Latch Switch	BURNER COMPONENTS
20590	O2 Trim Module; Siemens	BURNER COMPONENTS
20605	O2 Sensor; Siemens	BURNER COMPONENTS
20732	Flue Gas Temperature Sensor	BURNER COMPONENTS
20735	Ambient Temperature Sensor	BURNER COMPONENTS
40290	2" Dual Gas Valve Body, Siemens	BURNER COMPONENTS
40314	3" Dual Biogas Valve Body, Siemens	BURNER COMPONENTS
40360	SKP15, Actuator (110v), POC switch, Siemens	BURNER COMPONENTS
40375	SKP25, Press Reg. Actuator (110v), Siemens	BURNER COMPONENTS
40410	3/8" Pilot Gas Pressure Regulator	BURNER COMPONENTS
40565	Vent Valve	BURNER COMPONENTS
40585	Low Gas Pressure Switch	BURNER COMPONENTS
40610	High Air Pressure Switch	BURNER COMPONENTS
40610	High Gas Pressure Switch	BURNER COMPONENTS
40700	Gas Pilot Shut-Off Valve	BURNER COMPONENTS
50006	Ignition Transformer	BURNER COMPONENTS
60045	Blower Motor	BURNER COMPONENTS
21540-SCC	Natural Gas Valve and Actuator	BURNER COMPONENTS
21555-SCC	Digester Gas Valve and Actuator	BURNER COMPONENTS
A-7976-3	Gas Inlet Gasket	BURNER COMPONENTS
A-8123-2-K	Swing Cylinder Gasket (3-pack)	BURNER COMPONENTS
B-6720	Gas Inlet Coupling	BURNER COMPONENTS
C-5512-2	Gas Inlet Flange	BURNER COMPONENTS
C-5659-6	Fan Wheel, 1-1/8" Aluminum Hub	BURNER COMPONENTS
ST-11055	Air Filter, NM80-150A, 25 Micron Element	BURNER COMPONENTS
ST-11059-12	Firing Head, NOXmatic 100-125, 12" Dead Zone	BURNER COMPONENTS
ST-11639-12	Swirler, NM 100-150, 12" Deadzone, 316 SST	BURNER COMPONENTS
ST-12004-12	Ignition Pilot, NOXmatic with 12" Dead Zone	BURNER COMPONENTS
ST-12081	Spark Ignitor	BURNER COMPONENTS
20492	LMV52, Control unit, 110 V 50-60 Hz, Siemens	CONTROL COMPONENTS
20500	AZL52, Prog. display unit for LMV52, Siemens	CONTROL COMPONENTS
20510	Flame detector, side viewing, Siemens	CONTROL COMPONENTS
20570	Rotational sensor and mounting kit, Siemens	CONTROL COMPONENTS
20726	Immersion temp. sensor, 374F, Siemens	CONTROL COMPONENTS
22136	VFD, A-B PowerFlex 40, NEMA 4X, 5 HP	CONTROL COMPONENTS
24881	Panel Light, Green, NEMA 4, 120V	CONTROL COMPONENTS
24885	Panel Light, Red, NEMA 4, 120V	CONTROL COMPONENTS
24900	Panel Light, White, NEMA 4, 120V	CONTROL COMPONENTS

22087	Fuse, 2 Amp
22805	Fuse, 4 Amp
22879	Fuse, 6.25 Amp
70215	Air Filter Cover Knobs
70305	Stationary Sight Glass
G1005	Pilot Gauge
G1129	Burner Gas Pressure Gauge, Digester Gas
G1131	Gas Inlet Gauge
G1132	Inlet Gas Pressure Gauge, Natural Gas
G1159	Burner Gas Pressure Gauge, Natural Gas
G1163	Air Filter Pressure Gauge
G1164	Inlet Gas Pressure Gauge, Digester Gas

NM100A5V

RECOMMENDED SPARE PARTS LIST S.O. # 294456

PART #	DESCRIPTION	CATEGORY
10005	Air Pressure Switch	BURNER COMPONENTS
10020	Air Filter Switch	BURNER COMPONENTS
10026	Burner Latch Switch	BURNER COMPONENTS
20590	O2 Trim Module; Siemens	BURNER COMPONENTS
20605	O2 Sensor; Siemens	BURNER COMPONENTS
20732	Flue Gas Temperature Sensor	BURNER COMPONENTS
20735	Ambient Temperature Sensor	BURNER COMPONENTS
40290	2" Dual Gas Valve Body, Siemens	BURNER COMPONENTS
40314	3" Dual Biogas Valve Body, Siemens	BURNER COMPONENTS
40360	SKP15, Actuator (110v), POC switch, Siemens	BURNER COMPONENTS
40375	SKP25, Press Reg. Actuator (110v), Siemens	BURNER COMPONENTS
40410	3/8" Pilot Gas Pressure Regulator	BURNER COMPONENTS
40565	Vent Valve	BURNER COMPONENTS
40585	Low Gas Pressure Switch	BURNER COMPONENTS
40610	High Air Pressure Switch	BURNER COMPONENTS
40610	High Gas Pressure Switch	BURNER COMPONENTS
40700	Gas Pilot Shut-Off Valve	BURNER COMPONENTS
50006	Ignition Transformer	BURNER COMPONENTS
60045	Blower Motor	BURNER COMPONENTS
21540-SCC	Natural Gas Valve and Actuator	BURNER COMPONENTS
21555-SCC	Digester Gas Valve and Actuator	BURNER COMPONENTS
A-7976-3	Gas Inlet Gasket	BURNER COMPONENTS
A-8123-2-K	Swing Cylinder Gasket (3-pack)	BURNER COMPONENTS
B-6720	Gas Inlet Coupling	BURNER COMPONENTS
C-5512-2	Gas Inlet Flange	BURNER COMPONENTS
C-5659-6	Fan Wheel, 1-1/8" Aluminum Hub	BURNER COMPONENTS
ST-11055	Air Filter, NM80-150A, 25 Micron Element	BURNER COMPONENTS
ST-11059-12	Firing Head, NOXmatic 100-125, 12" Dead Zone	BURNER COMPONENTS
ST-11639-12	Swirler, NM 100-150, 12" Deadzone, 316 SST	BURNER COMPONENTS
ST-12004-12	Ignition Pilot, NOXmatic with 12" Dead Zone	BURNER COMPONENTS
ST-12081	Spark Ignitor	BURNER COMPONENTS
20492	LMV52, Control unit, 110 V 50-60 Hz, Siemens	CONTROL COMPONENTS
20500	AZL52, Prog. display unit for LMV52, Siemens	CONTROL COMPONENTS
20510	Flame detector, side viewing, Siemens	CONTROL COMPONENTS
20570	Rotational sensor and mounting kit, Siemens	CONTROL COMPONENTS
20726	Immersion temp. sensor, 374F, Siemens	CONTROL COMPONENTS
22136	VFD, A-B PowerFlex 40, NEMA 4X, 5 HP	CONTROL COMPONENTS
24881	Panel Light, Green, NEMA 4, 120V	CONTROL COMPONENTS
24885	Panel Light, Red, NEMA 4, 120V	CONTROL COMPONENTS
24900	Panel Light, White, NEMA 4, 120V	CONTROL COMPONENTS

22087	Fuse, 2 Amp
22805	Fuse, 4 Amp
22879	Fuse, 6.25 Amp
70215	Air Filter Cover Knobs
70305	Stationary Sight Glass
G1005	Pilot Gauge
G1129	Burner Gas Pressure Gauge, Digester Gas
G1131	Gas Inlet Gauge
G1132	Inlet Gas Pressure Gauge, Natural Gas
G1159	Burner Gas Pressure Gauge, Natural Gas
G1163	Air Filter Pressure Gauge
G1164	Inlet Gas Pressure Gauge, Digester Gas

Engineering Data Sheet & Bill of Materials

ENGINEERING DATA SHEET ("EDS")

S.O. #:	294455 & 294456	Date:	6/9/2017
Customer:	Bay City Boiler	User:	Manteca WWTP
Vessel Mfr/Application/Type:	Johnston 509 Series 3-pass	Jobsite Location / Elevation:	Manteca CA. 45 FASL
Steam Boiler☐ Water Heater☑	Firetube☑ Watertube☐ Other☐	Boiler Oper Press/Temp:	170 to 200 Deg F
Firing Rate:	4,200 MBH N. Gas / 4200 MBH Digester Gas	Furnace Pressure:	1.25" w.c.
Emissions::	Natural Gas/digester gas; Nox 9 ppm & CO 50 ppm (ref. 3% O2, dry): VOC/PM/PM10/PM2.5 0.018 Lb/MMBtu		

BURNER

Model #:	NM100A5V	Fan:	C-5659-6
Refractory Throat Supplied by:	STJ ☐ Others ☑	Motor HP:	5 HP
Pilot:	Gas Electric	RPM:	3450
		Turndown Rate:	4:1
Gas Fuel Type:	Natural Gas	Gas Fuel Type:	Digester Gas
NG Firing Head:	ST-11059-12	DG Firing Head:	ST-11059-12
NG Pressure@burner:	4.2" w.c.	DG Pressure@burner:	18" w.c.
Natural Gas Nozzles:	(43) 3/16" Orifices	Digester Gas Nozzles:	(43) 3/16" Orifices

PIPING & INSTRUMENTATION

Natural Gas Train Diagram:	B-8981-01-2, 2"	Digester Gas Train Diagram	B-9709-4, 3"
NG Pressure Regulator:	SKP25	DG Pressure Regulator:	SKP25
Natural Gas Control Valve:	VKG10.032U 1.25" Full Port, Siemens	Digester Gas Control Valve	VKG10.065U 2-1/2" F.P., Siemens
NG Supply Pressure (train inlet):	28"w.c. minimum	DG Supply Pressure (train inlet):	28"w.c. minimum
Natural Gas Flow:	71 Cubic ft / min [4294 Cft / hr]	Digester Gas Flow:	116 Cubic ft / min [7,071 Cft / hr]
Natural Gas HHV	978 Btu/SCF	Digester Gas HHV	594 Btu/SCF
Natural Gas S.G.	0.6	Digester Gas S.G.	0.94
Pilot Train:	A-8214		
NG Limit Switch Settings:	LGP: 13.9" w.c.; HGP: 37.2" w.c.	DG Limit Switch Settings:	LGP: 14" w.c.; HGP: 38.1" w.c.

ELECTRICAL

Wiring Diagram:	B-9980-01	Code/Labeling:	UL 508A panel/Cal Code/ CSD-1 / FM
Control Voltage:	120-1-60	Motor Voltage:	460-3-60
BMS/Combustion Control:	LMV 52	Flame Detection:	IR
Panel Size:	36 x 30 x 8 NEMA 4X 304 SST	Location:	Remote Mounted on Boiler
Pushbuttons:	Emergency Shutdown	Remote Control :	Switching DG to NG or NG to DG
Annuncition Lights:	Power, Load Demand, Safety, Low Low Water, Low Water, Limits Complete		
Alarm:	YES	Silencing Switch:	YES
Control XFMR:	YES	Fusing:	YES
VFD:	PowerFlex 40, 5 HP [Allen Bradley] NEMA 4X	Location:	Mounted to Main Panel
Additional Controls:	Boiler Pressure Sensor, Oxygen Trim System with Probe, Contactor and Motor Protector for 1/2 HP Circulation Pump		
	Modbus RTU to Modbus TCP/TP Converter in each burner control panel		
	1/2 HP Circulation Water Pump Controlled by Call to Heat Command from LMV		

SPECIAL CONSTRUCTION

MECHANICAL - Flex Tight Conduit

MECHANICAL - Piping Gas Inlet at Burner is 316 SST and assembled per drawing ST-13907-01

ELECTRICAL - Panel has a special layout to follow for the front - D-2602-06 Rev A.

Project Engineer:	PS	Purchase Order:	14137
Checked By:	SKH	Quote:	STK160801-1A Rev 2

S.T. Johnson Company LLC
Bill of Materials

Shop Order #: 294455

Part #	Service	Description	QTY
294455-NM100A5V - NOXmatic ULN Burner, Size 100			1
NM100A5V	Burner Model	NOXmatic Ultra-Low NOx Burner, Axial Flow, Size 100	1
ST-11059-12	NG and DG Firing Head	Firing Head, NOXmatic 100-125, 12" Dead Zone	1
ST-12004-12	Ignition Pilot	Ignition Pilot, 12" total length, for NOXmatic with 12" Dead Zone	1
ST-11639-12	Swirler	Swirler, NM 100-150, 12" Deadzone, 316 SST	1
ST-11045-02	Digester Gas and Natural Gas Manifold	Gas Manifold Assembly, NM100-150A, 316 SST	1
20726	Load Sensor	QAE2020.001, 3-wire Immersion temp. sensor, Pt, 100 Ohm, RTD, 1/2" NPT, 2.5" insertion well, 374F, Siemens	1
20613	O2 Trim Cable	C8120(35), 35 ft. of 6 Wire Cable for O2 Trim System, Siemens	1
20605	O2 Sensor	QGO20.000D17, Siemens Oxygen Sensor, 110V 50-60Hz, 150W, Siemens	1
20590	O2 Trim Module	PLL52.110A100, Siemens Oxygen Trim Electronic Module, 120V, Siemens	1
20735	Ambient Temperature Sensor	QAC2020U, 2-wire Outdoor temp sensor, Ni1000, Metal housing with M16 connection, Siemens	1
20732	Flue Gas Temperature Sensor	QAM-P210, 2-wire Stack Exhaust Temp. Sensor, Pt1000 RTD, 1/2" NPT x 10" insertion, 900F, Siemens	1
B-9980-01-100-460V	Control Panel	Remote Mounted On Boiler Control Panel, LMV52.4, Natural Gas, Digester Gas, NM100A5V, O2 System	1
C-7012-SST-Prepiped	Digester Gas Train	Siemens Gas Train, Assembled, 3", VRD, UL, CSD-1, FM, 304 SST, Digester Gas	1
C-7013-CS-Prepiped	Natural Gas Train	Siemens Gas Train, Assembled, 2", VGD- Dual Body, GE-GAP, NFPA85, Natural Gas	1
NM100A5V - NOXmatic Ultra-Low NOx Burner, Axial Flow, Size 100			1
A-8214	Pilot Train	Gas Pilot Train, Standard UL	1
Actuators - LMV5	LMV52 Actuator Set	Actuator Set for Siemens LMV5	1
NM-A 100	Mechanical Assembly	NOXmatic Mechanical Assembly, Size 100	1
A-8214 - Gas Pilot Train, Standard UL			1

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Bill of Materials

Shop Order #: 294455

Part #	Service	Description	QTY
40410	Press. Regulator	325-3, 3/8" Pilot Gas Pressure Regulator, 4"-12" w.c. spring	1
G1005	Pressure Gauge	Gauge, 0-35" w.c., 2.5" dial, 1/4" NPT bottom connection	1
70040	Manual Valve	Ball Valve, 3/8" Brass	1
40700	Pilot Shutoff Valve	8262H078, Solenoid Valve, 1/4", N.C., 120/60, 110/50 AC, ASCO	1
Actuators - LMV5 - Actuator Set for Siemens LMV5			1
21540-SCC	Natural Gas Valve and Actuator	VA45.2-NF-125, VA Assembly, SQM45.2 to 1-1/4" Full Port Butterfly Valve, 25 PSID Max, Siemens	1
21555-SCC	Digester Gas Valve and Actuator	VA45.2-NF-250, VA Assembly, SQM45.2 to 2-1/2" Full Port Butterfly Valve, 25 PSID Max, Siemens	1
20522	Conduit Adapters	ADP-M16xE500, Conduit Adapter, Metal, M16-1/2" NPSM, Siemens	6
NM-A 100 - NOXmatic Mechanical Assembly, Size 100			1
C-6338-NM	Housing	Housing Assembly, NOXmatic 100-150	1
ST-11057	Adapter Plate	Firing Head Adapter Plate, NM100-150A	1
60045	Blower Motor	Prem. Eff. Motor, 5 HP/3 HP, 60/50 Hz, 3600/2900 RPM, 184T, 3 Ph, 208, 230/460V, 380V, ODP	1
C-5659-6	Fan Wheel	Fan Wheel, Design 16, 15-5/8" Diameter, 3-3/4" Blade Height, SPUN Front Ring, 6-9/16" Approx. O'All, AL Hub, 1-1/8" Bore - STRAIGHT	1
ST-11226	Pilot Cover Plate	Boxed Pilot Cover Plate, NM100-150A	1
G1131	Gas Inlet Gauge	Gauge, Ashcroft Type 1188, 0-30" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L30IW	1
70077-SST	Inlet Gas Gauge Snubber	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	1
70006	Inlet Gas Gauge Valve	Ball Valve, 1/4" SST, Apollo 76F	1
C-5512-2	Gas Inlet Flange	Gas Inlet Flange, FD68 150-250	1
A-7976-3	Gas Inlet Gasket	Gas Inlet Gasket, 150-250	1
B-6720	Gas Inlet Coupling	Gas Inlet Coupling, FD68 150-250	1

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Bill of Materials

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Part #	Service	Description	QTY
50006	Ignition Transformer	1092-SG, Ignition Transformer for Webster Burner, 120V, 6000 V Secondary	1
70082-SS	Ignition Transformer Junction Box	Enclosure, 12" H x 12" W x 6" D, NEMA 4X, 304 Stainless Steel	1
70083	Ignition Transformer Junction Box Back Panel	Back Panel, 12" x 12" Enclosure, NEMA 4	1
B-6771-1	Swing Cylinder Junction Box	Swing Cylinder Junction Box, FD68 050-400	1
70305	Stationary Sight Glass	Sight Glass, 1" Window, for 1-1/4" hole	2
A-6845	Burner Latch Handle	Latch Handle Assembly, FD68 Sizes 50-1000	1
A-3706	Burner Latch Lug	Latch Lug	1
A-3964	Burner Latch Switch Body	Latch Switch Body	1
A-6855	Burner Latch Lock	Latch Lock	1
10026	Burner Latch Switch	BZ-2RL5551-A2, Microswitch, Environmentally Sealed	1
10005	Blower Air Pressure Switch	JD-2R, Air Proving Switch, 0-24" Red Spring	1
40610	High Burner Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
10020	Air Filter Pressure Switch	1823-2, Vacuum Switch, 0.5"-2" w.c.	1
A-8466-01	Air Filter Pressure Switch Bracket	Bracket, Vacuum Switch, All NOXmatics	1
ST-11053	Air Filter Support Assembly	Air Filter Support Assembly, NM100-150A	1
ST-11055	Air Filter	Air Filter, NM80-150A, 377UP, 25 Micron Element, No Handles	1
G1163	Air Filter Pressure Gauge	Magnehelic Differential Pressure Gauge, range 0-2.0" w.c., minor divisions .10, Signal Flag, 2002-ASF	1
70215	Air Filter Cover Knobs	57715K740, Knobs, NOXmatic Air Filters, 5/16-18	4
A-6805-1	Manifold Mounting Bracket, Slotted	Mounting Strap, Slotted, Firing Head/Manifold, 4.25" OAL	3
A-6805-4	Manifold Mounting Bracket	Mounting Strap, Firing Head/Manifold, 7" OAL	3
ST-11046-16	Extension Tube	Extension Tube, NM100-150A, 316 SST	1
20570	Speed Sensor	AGG5.310, Rotational sensor and mounting kit, required for LMV52 VFD applications, Siemens	1
ST-11255	Speed Sensor Bracket	Bracket for Siemens AGG5.310 Speed Sensor, NM-A	1
20510	Flame Detector	QRI2B2.B180B, Flame detector, side viewing, Siemens, requires AGG90.U(20854) adapter	1

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Bill of Materials

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Part #	Service	Description	QTY
20854	Flame Detector Mounting Adapter	AGG90.U, Right angle adapter for QRI2B2.B180B flame detector, Siemens	1
B-9980-01-100-460V - Remote Mounted On Boiler Control Panel, LMV52.4, Natural Gas, Digester Gas, NM100A5V, O2 System			1
70220-SS	Enclosure	Enclosure, 36" H x 30" W x 8" D, NEMA 4X, 304 Stainless Steel	1
70225	Enclosure Back Panel	Back Panel, 36"H x 30" Enclosure	1
20575	AZL to LMV5: Connector Set	AGG5.635, 9' pre-assembled Can Bus connection cable to connect the LMV5 to the AZL, Siemens	1
20500	AZL: Display	AZL52.40B1, unit with MODBUS interface for LMV52 & LMV51 controls, Siemens	1
22068	AH: Alarm Horn	Alarm Horn, 120VAC, NEMA 4, Auer Signaling ESG, 105 dba	1
24090	CB-1: Circuit Breaker	S201U-K10, Mini Circuit Breaker, 10 Amp, 1 Pole, K Trip Char, 240VAC	1
22092	T-1	Stepdown Transformer, Open Mount, 3/4 kVA, 240/480 V to 120V, 50/60 Hz	1
22097	Finger Guard Kit	Finger Guard Kit, for (FB# 22092)Stepdown Transformer, Open Mount, 3/4 kVA	2
20565	T-2	AGG5.210, Power supply for LMV51 Can Bus circuit, 120 Vac primary: 12-0-12 Vac secondary, Siemens	1
20565	T-3: Extra Power Supply	AGG5.210, Power supply for LMV51 Can Bus circuit, 120 Vac primary: 12-0-12 Vac secondary, Siemens	1
20492	LMV52.4	LMV52.440B1, Control Unit with PID control, 6 actuator, VFD and high performance O2 functions, 110 V 50-60 Hz, Siemens	1
20580	LMV: Connection Plug	AGG5.720, Standard connection plug set for LMV5 for three motor system layout, Siemens	1
20585	LMV: Connection Plug for O2 system	AGG5.721, Extended connection plug set for additional motor, transformer or VFD system layout, Siemens	1
20560	LMV: Can Bus Strain Relief Adaptor	AGG5.110, Can Bus connector, 90 deg. Offset with strain relief, Siemens	1
24900	LT-1: "POWER ON"	Panel Light, LED, NEMA4, 120V, White	1
24881	LT-2: "LIMITS COMPLETE"	Panel Light, LED, NEMA4, 120V, Green	1
24881	LT-3: "DIGESTER GAS SELECT"	Panel Light, LED, NEMA4, 120V, Green	1

S.T. Johnson Company LLC
Bill of Materials

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Part #	Service	Description	QTY
24881	LT-4: "NATURAL GAS SELECT"	Panel Light, LED, NEMA4, 120V, Green	1
24900	LT-5: "LOAD DEMAND"	Panel Light, LED, NEMA4, 120V, White	1
24881	LT-6: "NAT.GAS VALVE OPEN"	Panel Light, LED, NEMA4, 120V, Green	1
24881	LT-7: "DIG. GAS VALVE OPEN"	Panel Light, LED, NEMA4, 120V, Green	1
24885	LT-8: "LOW WATER"	Panel Light, LED, NEMA4, 120V, Red	1
24885	LT-9: "LOW LOW WATER"	Panel Light, LED, NEMA4, 120V, Red	1
24885	LT-10 "SAFETY"	Panel Light, LED, NEMA4, 120V, Red	1
21955	CR-1: Digester Gas Select Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21955	CR-2: Natural Gas Select Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21965	CR-3: Local Start / Stop Relay	RH3B-UAC120V, 3PDT RELAY, 120VAC	1
21955	CR-4: Remote Start / Stop Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21940	CR-5: Alarm Silence Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-6: Low Water Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-7: Alarm Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-8: Low Dig. Gas Press. Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-9: Low Nat Gas Press. Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21950	CR-1 Base	SH2B, 2PDT BASE	1
21950	CR-2 Base	SH2B, 2PDT BASE	1
21960	CR-3 Base	SH3B, 3PDT BASE	1
21950	CR-4 Base	SH2B, 2PDT BASE	1
21935	CR-5 Base	SH1B, 1PDT BASE	1
21935	CR-6 Base	SH1B, 1PDT BASE	1
21935	CR-7 Base	SH1B, 1PDT BASE	1
21935	CR-8 Base	SH1B, 1PDT BASE	1
21935	CR-9 Base	SH1B, 1PDT BASE	1
22865	NFD	M633, Disconnect Switch, Non-Fused, 63A	1
22036	SS-1: "LOCAL - OFF - REMOTE"	Switch Assembly, 3 Position Maintained with 2 NO Contacts	1
22034	SS-2: "DIG. GAS - REMOTE - NAT. GAS"	Switch Assembly, 3 Position Maintained with 2 NO contacts, 2 NC contacts	1
22805	F-1	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1

S.T. Johnson Company LLC
Bill of Materials

Shop Order #: 294455

Part #	Service	Description	QTY
22801	F-1 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-1A	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-1A Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22087	F-2	Fuse, 2 Amp, FNQ-R-2 or ATQ-R-2	1
22801	F-2 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22879	F-3	Fuse, 6.25 Amp, FNQ-R-6-1/4 or ATQ-R-6-1/4	1
22801	F-3 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-4	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-4 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-5	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-5 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22051	PB-1: Emergency Stop	Emergency Stop Switch, Red Button, 1 NO and 1 NC Contact	1
22056	PB-1: Emergency Stop Shroud	HW9Z-KG3, Shroud for 40 mm HW Emergency Stop Switch	1
22059	PB-2: "BURNER STOP"	Pushbutton Assembly, Red, ABW101-R, with NC contact	1
22053	PB-3: "BURNER START"	Pushbutton Assembly, Black, ABW110, with NO contact	1
22049	PB-4: "ALARM SILENCE"	Pushbutton Assembly, Red, ABW110, with NO contact	1
22935	PDB	Power Distribution Block, 3 Pole, Open Style, 175A, Edison PB1043	1
22936	PDB Cover	Power Distribution Block Cover, for FB# 22935 (Edison PB1043), Edison PBC23	1
24056	MP-1: MS Protector	MS132-1.6, Motor Starter Protector, FLA Setting 1.0 - 1.6	1
24075	MP-1: MS Aux Contact	HKF1-11, Auxiliary Contact for MS132 Motor Starter Protectors	1
24085	MP-1: MS Link Module	BEA16-4, Link Module	1
24000	C-1: Contactor	AF09-30-10-13, Contactor, NO Aux Contact, 100-250V Coil, 9 Max Amp	1
24062	MP-2: VFD Motor Protector	MS132-16, Motor Starter Protector, FLA Setting 10 - 16	1
20585	Extended Plug Kit	AGG5.721, Extended connection plug set for additional motor, transformer or VFD system layout, Siemens	1
20524	RS232 to RS485 Converter	K3SC-10-AC100-240 Converter, RS-232C/USB to RS-422/485, 100-240 VAC, Siemens	1

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Part #	Service	Description	QTY
22136	VFD	VFD, A-B PowerFlex 40, NEMA 4X, 5 HP: 480V, 22B-D010C104	1
A-8671	VFD Enclosure Bracket	Bracket, PowerFlex 40 VFD to Enclosure, 316 SST NEMA 4X, 5 HP: 480V, 22B-D010C104	1
20697	Protocol Converter	TS-PX4-X, Modbus RTU to Modbus TCP/IP Converter for LMV5, Siemens	1
C-7012-SST-Prepiped - Siemens Gas Train, Assembled, 3", VRD, UL, CSD-1, FM, 304 SST, Digester Gas			1
70034	Manual Shutoff Valve	Ball Valve, 3" NPT Stainless Steel, Apollo 76F-100-01A, 150 PSI	1
G1164	Inlet Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-60" w.c., 4.5" Dial, SST Bellows, SST Socket, 1/4" NPT lower Connection, 451188SS02L60IW	1
40610	High Gas Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
40314	Dual Valve Body	VRD40.080UF, 3" Dual Biogas Valve Body, ANSI 150# Flanged, Siemens	1
40345	Set Spring	AGA22, Set point spring for SKP2... (6-48" wc)/(1.5psi to 10psi), color natural gold, Siemens	1
40360	Blocking Actuator	SKP15.011U1, Actuator (110v), POC switch, Siemens	1
40375	Main Actuator w/ Governor	SKP25.013U1, Press Regulating Actuator (110v), Siemens	1
40406	Nema 4 Gaskets	AGA66, NEMA 4 Gasket Kit for SKP-VG gas train valve bodies, Siemens	2
40585	Low Gas Pressure Switch	QPL31.140M00, 7-55" W.C. Low Pressure Manual Reset, Siemens	1
70034	Leak Test Gas Cock	Ball Valve, 3" NPT Stainless Steel, Apollo 76F-100-01A, 150 PSI	1
70006	Gauge Cocks	Ball Valve, 1/4" SST, Apollo 76F	2
70077-SST	Gauge Snubbers	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	2
40740	Flame Arrester	5010-3-2-S, Flame Arrester, 3", Horizontal, Aluminum Body, SS Sheets, SS Hardware, Varec 5010 Series	1
70132	Junction Box	Enclosure, 8" x 6" x 5", NEMA 4X, 316L SST, (4) Screw Cover, Hoffman (Pentair)	1

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Part #	Service	Description	QTY
70133	JB Back Panel	Back Panel, 8"H x 6"W Enclosure for LSC201512 Hoffman	1
G1129	Burner Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-30" w.c., 4.5" Dial, SST Bellows, SST Socket, 1/4" NPT Lower Connection, 451188SS02L30IW	1
C-7013-CS-Prepiped - Siemens	Gas Train, Assembled, 2", VGD- Dual Body, GE-GAP, NFPA85, Natural Gas		1
70033	Manual Shutoff Valve	Ball Valve, 2" NPT Carbon Steel, Apollo 489-108-01, Gas or Steam UL	1
G1132	Inlet Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-60" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L60IW	1
40610	High Gas Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
40290	Dual Valve Body	VGD20.503U, 2." Dual Gas Valve Body, Siemens	1
40345	Set Spring	AGA22, Set point spring for SKP2... (6-48" wc)/(1.5psi to 10psi), color natural gold, Siemens	1
40335	Valve Body Flanges	AGF10.50U, Threaded flange for VGD20, 2" NPT, Siemens (repl AGA51U)	2
40360	Blocking Actuator	SKP15.011U1, Actuator (110v), POC switch, Siemens	1
40375	Main Actuator w/ Governor	SKP25.013U1, Press Regulating Actuator (110v), Siemens	1
40406	NEMA 4 Gaskets	AGA66, NEMA 4 Gasket Kit for SKP-VG gas train valve bodies, Siemens	1
40565	Vent Valve	8215C53, Solenoid Gas Valve, 1", N.O., 120V, ASCO	1
40585	Low Gas Pressure Switch	QPL31.140M00, 7-55" W.C. Low Pressure Manual Reset, Siemens	1
70033	Leak Test Gas Cock	Ball Valve, 2" NPT Carbon Steel, Apollo 489-108-01, Gas or Steam UL	1
70075	Gauge Cocks	A14, Gauge Cock, 1/4" FNPT x 1/4" FNPT, Brass	2
70077-SST	Gauge Snubbers	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	2
70132	Junction Box	Enclosure, 8" x 6" x 5", NEMA 4X, 316L SST, (4) Screw Cover, Hoffman (Pentair)	1
70133	JB Back Panel	Back Panel, 8"H x 6"W Enclosure for LSC201512 Hoffman	1

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Part #	Service	Description	QTY
G1159	Burner Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-20" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L20IW	1

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Part #	Service	Description	QTY
294455-NM100A5V - NOXmatic ULN Burner, Size 100			1
NM100A5V	Burner Model	NOXmatic Ultra-Low NOx Burner, Axial Flow, Size 100	1
ST-11059-12	NG and DG Firing Head	Firing Head, NOXmatic 100-125, 12" Dead Zone	1
ST-12004-12	Ignition Pilot	Ignition Pilot, 12" total length, for NOXmatic with 12" Dead Zone	1
ST-11639-12	Swirler	Swirler, NM 100-150, 12" Deadzone, 316 SST	1
ST-11045-02	Digester Gas and Natural Gas Manifold	Gas Manifold Assembly, NM100-150A, 316 SST	1
20726	Load Sensor	QAE2020.001, 3-wire Immersion temp. sensor, Pt, 100 Ohm, RTD, 1/2" NPT, 2.5" insertion well, 374F, Siemens	1
20613	O2 Trim Cable	C8120(35), 35 ft. of 6 Wire Cable for O2 Trim System, Siemens	1
20605	O2 Sensor	QGO20.000D17, Siemens Oxygen Sensor, 110V 50-60Hz, 150W, Siemens	1
20590	O2 Trim Module	PLL52.110A100, Siemens Oxygen Trim Electronic Module, 120V, Siemens	1
20735	Ambient Temperature Sensor	QAC2020U, 2-wire Outdoor temp sensor, Ni1000, Metal housing with M16 connection, Siemens	1
20732	Flue Gas Temperature Sensor	QAM-P210, 2-wire Stack Exhaust Temp. Sensor, Pt1000 RTD, 1/2" NPT x 10" insertion, 900F, Siemens	1
B-9980-01-100-460V	Control Panel	Remote Mounted On Boiler Control Panel, LMV52.4, Natural Gas, Digester Gas, NM100A5V, O2 System	1
C-7012-SST-Prepiped	Digester Gas Train	Siemens Gas Train, Assembled, 3", VRD, UL, CSD-1, FM, 304 SST, Digester Gas	1
C-7013-CS-Prepiped	Natural Gas Train	Siemens Gas Train, Assembled, 2", VGD- Dual Body, GE-GAP, NFPA85, Natural Gas	1
NM100A5V - NOXmatic Ultra-Low NOx Burner, Axial Flow, Size 100			1
A-8214	Pilot Train	Gas Pilot Train, Standard UL	1
Actuators - LMV5	LMV52 Actuator Set	Actuator Set for Siemens LMV5	1
NM-A 100	Mechanical Assembly	NOXmatic Mechanical Assembly, Size 100	1
A-8214 - Gas Pilot Train, Standard UL			1

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Part #	Service	Description	QTY
40410	Press. Regulator	325-3, 3/8" Pilot Gas Pressure Regulator, 4"-12" w.c. spring	1
G1005	Pressure Gauge	Gauge, 0-35" w.c., 2.5" dial, 1/4" NPT bottom connection	1
70040	Manual Valve	Ball Valve, 3/8" Brass	1
40700	Pilot Shutoff Valve	8262H078, Solenoid Valve, 1/4", N.C., 120/60, 110/50 AC, ASCO	1
Actuators - LMV5 - Actuator Set for Siemens LMV5			1
21540-SCC	Natural Gas Valve and Actuator	VA45.2-NF-125, VA Assembly, SQM45.2 to 1-1/4" Full Port Butterfly Valve, 25 PSID Max, Siemens	1
21555-SCC	Digester Gas Valve and Actuator	VA45.2-NF-250, VA Assembly, SQM45.2 to 2-1/2" Full Port Butterfly Valve, 25 PSID Max, Siemens	1
20522	Conduit Adapters	ADP-M16xE500, Conduit Adapter, Metal, M16-1/2" NPSM, Siemens	6
NM-A 100 - NOXmatic Mechanical Assembly, Size 100			1
C-6338-NM	Housing	Housing Assembly, NOXmatic 100-150	1
ST-11057	Adapter Plate	Firing Head Adapter Plate, NM100-150A	1
60045	Blower Motor	Prem. Eff. Motor, 5 HP/3 HP, 60/50 Hz, 3600/2900 RPM, 184T, 3 Ph, 208, 230/460V, 380V, ODP	1
C-5659-6	Fan Wheel	Fan Wheel, Design 16, 15-5/8" Diameter, 3-3/4" Blade Height, SPUN Front Ring, 6-9/16" Approx. O'All, AL Hub, 1-1/8" Bore - STRAIGHT	1
ST-11226	Pilot Cover Plate	Boxed Pilot Cover Plate, NM100-150A	1
G1131	Gas Inlet Gauge	Gauge, Ashcroft Type 1188, 0-30" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L30IW	1
70077-SST	Inlet Gas Gauge Snubber	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	1
70006	Inlet Gas Gauge Valve	Ball Valve, 1/4" SST, Apollo 76F	1
C-5512-2	Gas Inlet Flange	Gas Inlet Flange, FD68 150-250	1
A-7976-3	Gas Inlet Gasket	Gas Inlet Gasket, 150-250	1
B-6720	Gas Inlet Coupling	Gas Inlet Coupling, FD68 150-250	1

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Part #	Service	Description	QTY
50006	Ignition Transformer	1092-SG, Ignition Transformer for Webster Burner, 120V, 6000 V Secondary	1
70082-SS	Ignition Transformer Junction Box	Enclosure, 12" H x 12" W x 6" D, NEMA 4X, 304 Stainless Steel	1
70083	Ignition Transformer Junction Box Back Panel	Back Panel, 12" x 12" Enclosure, NEMA 4	1
B-6771-1	Swing Cylinder Junction Box	Swing Cylinder Junction Box, FD68 050-400	1
70305	Stationary Sight Glass	Sight Glass, 1" Window, for 1-1/4" hole	2
A-6845	Burner Latch Handle	Latch Handle Assembly, FD68 Sizes 50-1000	1
A-3706	Burner Latch Lug	Latch Lug	1
A-3964	Burner Latch Switch Body	Latch Switch Body	1
A-6855	Burner Latch Lock	Latch Lock	1
10026	Burner Latch Switch	BZ-2RL5551-A2, Microswitch, Environmentally Sealed	1
10005	Blower Air Pressure Switch	JD-2R, Air Proving Switch, 0-24" Red Spring	1
40610	High Burner Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
10020	Air Filter Pressure Switch	1823-2, Vacuum Switch, 0.5"-2" w.c.	1
A-8466-01	Air Filter Pressure Switch Bracket	Bracket, Vacuum Switch, All NOXmatics	1
ST-11053	Air Filter Support Assembly	Air Filter Support Assembly, NM100-150A	1
ST-11055	Air Filter	Air Filter, NM80-150A, 377UP, 25 Micron Element, No Handles	1
G1163	Air Filter Pressure Gauge	Magnehelic Differential Pressure Gauge, range 0-2.0" w.c., minor divisions .10, Signal Flag, 2002-ASF	1
70215	Air Filter Cover Knobs	57715K740, Knobs, NOXmatic Air Filters, 5/16-18	4
A-6805-1	Manifold Mounting Bracket, Slotted	Mounting Strap, Slotted, Firing Head/Manifold, 4.25" OAL	3
A-6805-4	Manifold Mounting Bracket	Mounting Strap, Firing Head/Manifold, 7" OAL	3
ST-11046-16	Extension Tube	Extension Tube, NM100-150A, 316 SST	1
20570	Speed Sensor	AGG5.310, Rotational sensor and mounting kit, required for LMV52 VFD applications, Siemens	1
ST-11255	Speed Sensor Bracket	Bracket for Siemens AGG5.310 Speed Sensor, NM-A	1
20510	Flame Detector	QRI2B2.B180B, Flame detector, side viewing, Siemens, requires AGG90.U(20854) adapter	1

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Part #	Service	Description	QTY
20854	Flame Detector Mounting Adapter	AGG90.U, Right angle adapter for QRI2B2.B180B flame detector, Siemens	1
B-9980-01-100-460V - Remote Mounted On Boiler Control Panel, LMV52.4, Natural Gas, Digester Gas, NM100A5V, O2 System			1
70220-SS	Enclosure	Enclosure, 36" H x 30" W x 8" D, NEMA 4X, 304 Stainless Steel	1
70225	Enclosure Back Panel	Back Panel, 36"H x 30" Enclosure	1
20575	AZL to LMV5: Connector Set	AGG5.635, 9' pre-assembled Can Bus connection cable to connect the LMV5 to the AZL, Siemens	1
20500	AZL: Display	AZL52.40B1, unit with MODBUS interface for LMV52 & LMV51 controls, Siemens	1
22068	AH: Alarm Horn	Alarm Horn, 120VAC, NEMA 4, Auer Signaling ESG, 105 dba	1
24090	CB-1: Circuit Breaker	S201U-K10, Mini Circuit Breaker, 10 Amp, 1 Pole, K Trip Char, 240VAC	1
22092	T-1	Stepdown Transformer, Open Mount, 3/4 kVA, 240/480 V to 120V, 50/60 Hz	1
22097	Finger Guard Kit	Finger Guard Kit, for (FB# 22092)Stepdown Transformer, Open Mount, 3/4 kVA	2
20565	T-2	AGG5.210, Power supply for LMV51 Can Bus circuit, 120 Vac primary: 12-0-12 Vac secondary, Siemens	1
20565	T-3: Extra Power Supply	AGG5.210, Power supply for LMV51 Can Bus circuit, 120 Vac primary: 12-0-12 Vac secondary, Siemens	1
20492	LMV52.4	LMV52.440B1, Control Unit with PID control, 6 actuator, VFD and high performance O2 functions, 110 V 50-60 Hz, Siemens	1
20580	LMV: Connection Plug	AGG5.720, Standard connection plug set for LMV5 for three motor system layout, Siemens	1
20585	LMV: Connection Plug for O2 system	AGG5.721, Extended connection plug set for additional motor, transformer or VFD system layout, Siemens	1
20560	LMV: Can Bus Strain Relief Adaptor	AGG5.110, Can Bus connector, 90 deg. Offset with strain relief, Siemens	1
24900	LT-1: "POWER ON"	Panel Light, LED, NEMA4, 120V, White	1
24881	LT-2: "LIMITS COMPLETE"	Panel Light, LED, NEMA4, 120V, Green	1
24881	LT-3: "DIGESTER GAS SELECT"	Panel Light, LED, NEMA4, 120V, Green	1

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Part #	Service	Description	QTY
24881	LT-4: "NATURAL GAS SELECT"	Panel Light, LED, NEMA4, 120V, Green	1
24900	LT-5: "LOAD DEMAND"	Panel Light, LED, NEMA4, 120V, White	1
24881	LT-6: "NAT.GAS VALVE OPEN"	Panel Light, LED, NEMA4, 120V, Green	1
24881	LT-7: "DIG. GAS VALVE OPEN"	Panel Light, LED, NEMA4, 120V, Green	1
24885	LT-8: "LOW WATER"	Panel Light, LED, NEMA4, 120V, Red	1
24885	LT-9: "LOW LOW WATER"	Panel Light, LED, NEMA4, 120V, Red	1
24885	LT-10 "SAFETY"	Panel Light, LED, NEMA4, 120V, Red	1
21955	CR-1: Digester Gas Select Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21955	CR-2: Natural Gas Select Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21965	CR-3: Local Start / Stop Relay	RH3B-UAC120V, 3PDT RELAY, 120VAC	1
21955	CR-4: Remote Start / Stop Relay	RH2B-UAC120V, 2PDT RELAY, 120VAC	1
21940	CR-5: Alarm Silence Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-6: Low Water Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-7: Alarm Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-8: Low Dig. Gas Press. Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21940	CR-9: Low Nat Gas Press. Relay	RH1B-UAC120V, 1PDT RELAY, 120VAC	1
21950	CR-1 Base	SH2B, 2PDT BASE	1
21950	CR-2 Base	SH2B, 2PDT BASE	1
21960	CR-3 Base	SH3B, 3PDT BASE	1
21950	CR-4 Base	SH2B, 2PDT BASE	1
21935	CR-5 Base	SH1B, 1PDT BASE	1
21935	CR-6 Base	SH1B, 1PDT BASE	1
21935	CR-7 Base	SH1B, 1PDT BASE	1
21935	CR-8 Base	SH1B, 1PDT BASE	1
21935	CR-9 Base	SH1B, 1PDT BASE	1
22865	NFD	M633, Disconnect Switch, Non-Fused, 63A	1
22036	SS-1: "LOCAL - OFF - REMOTE"	Switch Assembly, 3 Position Maintained with 2 NO Contacts	1
22034	SS-2: "DIG. GAS - REMOTE - NAT. GAS"	Switch Assembly, 3 Position Maintained with 2 NO contacts, 2 NC contacts	1
22805	F-1	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1

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Part #	Service	Description	QTY
22801	F-1 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-1A	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-1A Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22087	F-2	Fuse, 2 Amp, FNQ-R-2 or ATQ-R-2	1
22801	F-2 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22879	F-3	Fuse, 6.25 Amp, FNQ-R-6-1/4 or ATQ-R-6-1/4	1
22801	F-3 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-4	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-4 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22805	F-5	Fuse, 4 Amp, FNQ-R-4 or ATQ-R-4	1
22801	F-5 Block	Fuse block, USCC1, 600V, 30A, 1 pole, Ultrasafe	1
22051	PB-1: Emergency Stop	Emergency Stop Switch, Red Button, 1 NO and 1 NC Contact	1
22056	PB-1: Emergency Stop Shroud	HW9Z-KG3, Shroud for 40 mm HW Emergency Stop Switch	1
22059	PB-2: "BURNER STOP"	Pushbutton Assembly, Red, ABW101-R, with NC contact	1
22053	PB-3: "BURNER START"	Pushbutton Assembly, Black, ABW110, with NO contact	1
22049	PB-4: "ALARM SILENCE"	Pushbutton Assembly, Red, ABW110, with NO contact	1
22935	PDB	Power Distribution Block, 3 Pole, Open Style, 175A, Edison PB1043	1
22936	PDB Cover	Power Distribution Block Cover, for FB# 22935 (Edison PB1043), Edison PBC23	1
24056	MP-1: MS Protector	MS132-1.6, Motor Starter Protector, FLA Setting 1.0 - 1.6	1
24075	MP-1: MS Aux Contact	HKF1-11, Auxiliary Contact for MS132 Motor Starter Protectors	1
24085	MP-1: MS Link Module	BEA16-4, Link Module	1
24000	C-1: Contactor	AF09-30-10-13, Contactor, NO Aux Contact, 100-250V Coil, 9 Max Amp	1
24062	MP-2: VFD Motor Protector	MS132-16, Motor Starter Protector, FLA Setting 10 - 16	1
20585	Extended Plug Kit	AGG5.721, Extended connection plug set for additional motor, transformer or VFD system layout, Siemens	1
20524	RS232 to RS485 Converter	K3SC-10-AC100-240 Converter, RS-232C/USB to RS-422/485, 100-240 VAC, Siemens	1

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Part #	Service	Description	QTY
22136	VFD	VFD, A-B PowerFlex 40, NEMA 4X, 5 HP: 480V, 22B-D010C104	1
A-8671	VFD Enclosure Bracket	Bracket, PowerFlex 40 VFD to Enclosure, 316 SST NEMA 4X, 5 HP: 480V, 22B-D010C104	1
20697	Protocol Converter	TS-PX4-X, Modbus RTU to Modbus TCP/IP Converter for LMV5, Siemens	1
C-7012-SST-Prepiped - Siemens Gas Train, Assembled, 3", VRD, UL, CSD-1, FM, 304 SST, Digester Gas			1
70034	Manual Shutoff Valve	Ball Valve, 3" NPT Stainless Steel, Apollo 76F-100-01A, 150 PSI	1
G1164	Inlet Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-60" w.c., 4.5" Dial, SST Bellows, SST Socket, 1/4" NPT lower Connection, 451188SS02L60IW	1
40610	High Gas Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
40314	Dual Valve Body	VRD40.080UF, 3" Dual Biogas Valve Body, ANSI 150# Flanged, Siemens	1
40345	Set Spring	AGA22, Set point spring for SKP2... (6-48" wc)/(1.5psi to 10psi), color natural gold, Siemens	1
40360	Blocking Actuator	SKP15.011U1, Actuator (110v), POC switch, Siemens	1
40375	Main Actuator w/ Governor	SKP25.013U1, Press Regulating Actuator (110v), Siemens	1
40406	Nema 4 Gaskets	AGA66, NEMA 4 Gasket Kit for SKP-VG gas train valve bodies, Siemens	2
40585	Low Gas Pressure Switch	QPL31.140M00, 7-55" W.C. Low Pressure Manual Reset, Siemens	1
70034	Leak Test Gas Cock	Ball Valve, 3" NPT Stainless Steel, Apollo 76F-100-01A, 150 PSI	1
70006	Gauge Cocks	Ball Valve, 1/4" SST, Apollo 76F	2
70077-SST	Gauge Snubbers	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	2
40740	Flame Arrester	5010-3-2-S, Flame Arrester, 3", Horizontal, Aluminum Body, SS Sheets, SS Hardware, Varec 5010 Series	1
70132	Junction Box	Enclosure, 8" x 6" x 5", NEMA 4X, 316L SST, (4) Screw Cover, Hoffman (Pentair)	1

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Part #	Service	Description	QTY
70133	JB Back Panel	Back Panel, 8"H x 6"W Enclosure for LSC201512 Hoffman	1
G1129	Burner Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-30" w.c., 4.5" Dial, SST Bellows, SST Socket, 1/4" NPT Lower Connection, 451188SS02L30IW	1
C-7013-CS-Prepiped - Siemens	Gas Train, Assembled, 2", VGD- Dual Body, GE-GAP, NFPA85, Natural Gas		1
70033	Manual Shutoff Valve	Ball Valve, 2" NPT Carbon Steel, Apollo 489-108-01, Gas or Steam UL	1
G1132	Inlet Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-60" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L60IW	1
40610	High Gas Pressure Switch	QPH31.150M00, 10-60" W.C. High Pressure Manual Reset, Siemens	1
40290	Dual Valve Body	VGD20.503U, 2." Dual Gas Valve Body, Siemens	1
40345	Set Spring	AGA22, Set point spring for SKP2... (6-48" wc)/(1.5psi to 10psi), color natural gold, Siemens	1
40335	Valve Body Flanges	AGF10.50U, Threaded flange for VGD20, 2" NPT, Siemens (repl AGA51U)	2
40360	Blocking Actuator	SKP15.011U1, Actuator (110v), POC switch, Siemens	1
40375	Main Actuator w/ Governor	SKP25.013U1, Press Regulating Actuator (110v), Siemens	1
40406	NEMA 4 Gaskets	AGA66, NEMA 4 Gasket Kit for SKP-VG gas train valve bodies, Siemens	1
40565	Vent Valve	8215C53, Solenoid Gas Valve, 1", N.O., 120V, ASCO	1
40585	Low Gas Pressure Switch	QPL31.140M00, 7-55" W.C. Low Pressure Manual Reset, Siemens	1
70033	Leak Test Gas Cock	Ball Valve, 2" NPT Carbon Steel, Apollo 489-108-01, Gas or Steam UL	1
70075	Gauge Cocks	A14, Gauge Cock, 1/4" FNPT x 1/4" FNPT, Brass	2
70077-SST	Gauge Snubbers	Pulsation-Damping Snubber, .008, 303 SST, 1/4 NPT, 4000 PSI	2
70132	Junction Box	Enclosure, 8" x 6" x 5", NEMA 4X, 316L SST, (4) Screw Cover, Hoffman (Pentair)	1
70133	JB Back Panel	Back Panel, 8"H x 6"W Enclosure for LSC201512 Hoffman	1

S.T. Johnson Company LLC
Bill of Materials

Shop Order #: 294456

Part #	Service	Description	QTY
G1159	Burner Gas Pressure Gauge	Gauge, Ashcroft Type 1188, 0-20" w.c., 4.5" Dial, Bronze Bellows, Brass Socket, 1/4" NPT Bottom Connection, 451188AS02L20IW	1

S. T. JOHNSON

SEQUENCE OF OPERATIONS

March 10, 2017

BURNER CONTROL PANEL AND BURNER SYSTEM

MANTECA WQCF DIGESTER IMPROVEMENTS PROJECT

1. With burner off engage the on button.
2. The BMS system will start the burner using the purge and light off sequence per the Siemens LMV5 Operating Manual. Lockout Phase, Safety Phase, Home Run Position, Burner Standby, Safety Relay ON, Release of startup ON, Combustion Fan ON, Drive to Purge Position, Prepurge, Drive to Ignition Position, Pre-ignition spark, Pilot Valve ON, Ignition OFF, Pilot Stabilization, Drive to Low Fire Position, Operation, Post Purge after burn, Post purge.
3. Beyond these required standard start up and shutdown this burner also has specific features as described here:
4. This burner can be switched from Natural Gas to Digester gas with local or remote control.
5. The logic in the panel external to the LMV control is performed with relays. Such as LOCAL-OFF-REMOTE, START - STOP, OFF, ON, DIGESTER GAS – NATURAL GAS can be performed locally or through the Modbus RTU to Modbus TCP/IP converter in the control panel.
6. The following signals can communicate over the network: Local-Off-Remote, Local or Remote, Fuel Low Pressure, Burner Run, Common Shutdown, SCADA Boiler Start, Burner Firing Rate, and fuel changeover. It should be noted that on fuel start up and shut down this can be done remotely as well as at the panel front as many times as needed on either gas.
7. System is equipped with an O2 Control System within the LMV 52 controller. Hardware supplied include: O2 Sensor, Flue Gas Temperature Sensor, Flue Gas Collector and Ambient Temperature Sensor. The system will sense O2 and compare Air to Fuel ratios and influence the air and fuel to achieve the optimal percentage O2 in the stack. See section 6 of the complete O2 Trim system details sent separately.

johnson burners

SIEMENS LMV52 PARAMETER LIST

SO#	294455 294456
BURNER MODEL	NM100A5V
CUSTOMER	BAY CITY BOILER & ENGINEERING CO., INC.
END USER / LOCATION	CITY MANTECA
ELECTRICAL DRAWING	B-9980-01
NOTES	WITH POWERFLEX 40

This is a guide to the parameters that are set by S.T. Johnson. Always use the Siemens factory manual as the master reference. S.T. Johnson sets operating parameters to general values that will minimize potential start-up difficulties. However, several parameters may need to be modified once the equipment is installed. It is the responsibility of the commissioning technician to ensure that all parameters and settings are set for the safe operation of the specific installation.

* If diffe

MENU PATH			*PARAMETER*	*DEFAULT*	*SUGG*	*ACTUAL**
Operational Stat			NormalOperation			status only
			Status/Reset			status only
			FaultHistory			status only
			LockoutHistory			status only
			Alarm act/deact	activated	(default)	
Operation	Boiler Setpoint		SetpointW1	-	(default)	
			SetpointW2	-	(default)	
	UserMaxload		UserMaxLoadMod	100%	(default)	
			UserMaxLoadStg	S3	(default)	
	Fuel		CurrentFuel			status only
			FuelSelect	Gas or Oil	(default)	
	Date/TimeOf Day	Display Clock	Date			status only
			TimeOfDay			status only
			Weekday			status only
		Set Clock	Date	-	set	
			TimeOfDay	-	set	
			Weekday	-	set	
	Hours Run		GasFiring			status only
			OilStage1/Mod			status only
			OilStage2			status only
			OilStage3			status only
			TotalHoursReset			status only

Operation	Hours Run			TotalHours			status only
				SystemOnPower			status only
	Start Counter			GasStartCount			status only
				OilStartCount			status only
				TotalStartCountR			status only
				TotalStartCount			status only
	Fuel Meter			Curr Flow Rate			status only
				Volume Gas			status only
				Volume Oil			status only
				Volume Gas R			status only
				Volume Oil R			status only
				Reset DateGas			status only
				Reset DateOil			status only
				LockoutCounter			status only
	O2 Module			Current O2 Value			status only
				O2 Setpoint			status only
				SupplyAirTemp			status only
				FlueGasTemp			status only
				CombEfficiency			status only
				BurnerID			status only
	OptgMode Select			InterfacePC	disabled	(default)	
				GatewayBASon	-	(default)	
				GatewayBASoff	-	(default)	
				Type of Gateway	Modbus	(default)	
				O2Ctrl activate	deactivated	(default)	
Manual Operation				SetLoad	-	(default)	
				Autom/Manual/Off	Automatic	(default)	
Params & Display	BurnerControl	Times	Times Startup1	MinTmeStartRel	1 sec	(default)	
				FanRunupTme	2 sec	(default)	
				PrepurgeTmeGas	120 sec	30	
				PrepurgeTmeOil	120 sec	30	
				MinT_PrepurgeGas	20 sec	(default)	
				MinT_PrepurgeOil	15 sec	(default)	
				PrepurgeSafeGas	20 sec	(default)	
				PrepurgeSafeOil	15 sec	(default)	
				PrepurgePt1Gas	0.2 sec	(default)	
			Times Startup1	PrepurgePt3Gas	0.2 sec	(default)	
				PrepurgePt1Oil	0.2 sec	(default)	
				PrepurgePt3Oil	0.2 sec	(default)	

Params & Display	BurnerControl	Times	Times Startup1	PreIgnitionTGas	2 sec	(default)	
				PreIgnitionTOil	2 sec	(default)	
				MinOnTmeOilPump	5 sec	(default)	
			Times Startup2	SafteyTme1Gas	5 sec	(default)	
				SafteyTme1Oil	5 sec	(default)	
				Interval1Gas	2 sec	(default)	
				Interval1Oil	2 sec	(default)	
				SafetyTme2Gas	5 sec	(default)	
				SafetyTme2Oil	5 sec	(default)	
				Interval2Gas	2 sec	(default)	
				Interval2Oil	2 sec	(default)	
				PressReacTme	2 sec	(default)	
			Times Shutdown	MaxTmeLowFire	45 sec	(default)	
				AfterburnTme	8 sec	(default)	
				PostpurgeT1Gas	30 sec	(default)	
				PostpurgeT1Oil	30 sec	(default)	
				PostpurgeT3Gas	5 sec	(default)	
				PostpurgeT3Oil	5 sec	(default)	
				MinTmeHomeRun	1 sec	(default)	
				DelayLackGas	10 sec	(default)	
			TimesGeneral	AlarmDelay	10		
				DelayStartPrev	0.4		
				PostpurgeLockout	120	30	
				MaxTmeStartRel	120		
		Configuration	ConfigGeneral	AlarmStartPrev	deactivated		
				ShutdwnStbyOnErr	deactivated		
				NormDirectStart	NormalStart		
				OilPumpCoupling	Magnetcoupl		
				IgnOilPumpStart	on in Ph22		
				ForcedIntermit	activated	deactivated	
				Skip Prepurge Gas	deactivated		
				Skip Prepurge Oil	deactivated		
				ContinuousPurge	deactivated		
				DriveLowFire Gas	LowFire P54		

Params & Display	BurnerControl	Configuration	ConfigGeneral		DriveLowFire Oil	LowFire P54		
					FuelTrainGas	Pilot GP2	Pilot GP2	
					FuelTrainOil	HO w Gasp	LO w Gasp	
				FuelTrainReset	FuelTrainGas	-		
					FuelTrainOil	-		
					ContPilotGas	deactivated		
					ContPilotOil	deactivated		
					MainsFrequency	60		
			ConfigIn/Output		StartReleaseGas	StartRelGas	CPI OIL	
					StartReleaseOil	activated	deactivated	
					AirPressureTest	activated	activated	
					PS-VP/CPI	CPI gas	CPI GAS	
					FGR-PS/FCC	FCC	deactivated	
					InputController	activated	activated	
					GasPressureMin	activated	activated	
					GasPressureMax	activated	activated	
					OilPressureMin	activated	activated	
					OilPressureMax	activated	activated	
					HeavyOilDirStart	activated	deactivated	
					Start/PS-Valve	StartSignal	StartSignal	
			Config FlameDet		ReacExtranLight	Lockout		
					ExtranLightTest	activated		
				FlameSignal	Standardize	deactivated		
					StandardFactor	100%		
					FlameSig QRI_B	0.00%		
					FlameSigION	0.00%		
					SensExtranlGas	1 sensor	(default)	
					SensPilotPhGas	1 sensor	(default)	
					SensOperPhGas	1 sensor	(default)	
					SensExtranlOil	1 sensor	(default)	
					SensPilotPhOil	1 sensor	(default)	
					SensOperPhOil	1 sensor	(default)	
			RepititCounter		LossOfFlame	1		
					HeavyOil	1		
					StartRelease	1		
					SafetyLoop	1	1	
		ValveProving			ValveProvingType	No VP		
					Config_PM-VP/CPI	PS-VP	CPI GAS	
					VP_EvacTme	3.0 s		

Params & Display	BurnerControl	ValveProving			VP_TmeAtmPress	10		
					VP_FillTme	3		
					VP_Tme_GasPress	10		
		Product ID			ASN	status only		
					ProductionDate	status only		
					SerialNumber	status only		
					ParamSet Code	status only		
					ParamSet Vers	status only		
					SW Version	status only		
	RatioControl	Gas Settings	Special Positions	HomePos	HomePosGas	0	0	
					HomePosAir	0	(default)	
					HomePosAux1	0	(default)	
					HomePosAux2	0	(default)	
					HomePosAux3	0	(default)	
					HomePosVSD	0	0	
				PrepurgePos	PrepurgePosAir	90	(default)	
					PrepurgePosAux1	90	(default)	
					PrepurgePosAux2	90	(default)	
					PrepurgePosAux3	90	(default)	
					PrepurgePosVSD	100	100	
				IgnitionPos	IgnitionPosGas	0	0	
					IgnitionPosAir	0	(default)	
					IgnitionPosAux1	0	(default)	
					IgnitionPosAux2	0	(default)	
					IgnitionPosAux3	0	(default)	
					IgnitionPosVSD	0	30	
				PostpurgePos	PostpurgePosGas	15	(default)	
					PostpurgePosAir	15	(default)	
					PostpurgePosAux1	25	(default)	
					PostpurgePosAux2	25	(default)	
					PostpurgePosAux3	25	(default)	
					PostpurgePosVSD	50	(default)	
					ProgramStop	deactivated		
			ResetIgnitPos		IgnitionPosGas	-		
					IgnitionPosAir	-		
			ResetIgnitPos		IgnitionPosAux1	-		
					IgnitionPosAux2	-		
					IgnitionPosAux3	-		
					IgnitionPosVSD	-		

Params & Display	RatioControl	Gas Settings			Curve Params	-		
			LoadLimits		MinLoad	0		
					MaxLoad	100		
			Load mask out		LoadMaskLowLimit	0		
					LoadMaskHighLimit	0		
					Air Actuator	air influenc	deactivated	
					AuxActuator 1	air influenc	deactivated	
					AuxActuator 2	deactivated	deactivated	
					AuxActuator 3	deactivated	deactivated	
					VSD	air influenc	air influenc	
					STARTPOINT Op	1	1	
					GasActuator	activated	activated	
		Oil Settings	Special Positions	HomePos	HomePosOil	0	0	
					HomePosAir	0	(default)	
					HomePosAux1	0	(default)	
					HomePosAux2	0	(default)	
					HomePosAux3	0	(default)	
					HomePosVSD	0	0	
				PrepurgePos	PrepurgePosAir	90	(default)	
					PrepurgePosAux1	90	(default)	
					PrepurgePosAux2	90	(default)	
					PrepurgePosAux3	90	(default)	
					PrepurgePosVSD	100	100	
				IgnitionPos	IgnitionPosOil	0	(default)	
					IgnitionPosAir	0	(default)	
					IgnitionPosAux1	0	(default)	
					IgnitionPosAux2	0	(default)	
					IgnitionPosAux3	0	(default)	
					IgnitionPosVSD	0	30	
				PostpurgePos	PostpurgePosOil	0	15	
					PostpurgePosAir	15	(default)	
					PostpurgePosAux1	25	(default)	
					PostpurgePosAux2	25	(default)	
			Special Positions	PostpurgePos	PostpurgePosAux3	25	(default)	
					PostpurgePosVSD	50	(default)	
					ProgramStop	deactivated		
			ResetIgnitPos		IgnitionPosOil	-		
					IgnitionPosAir	-		
					IgnitionPosAux1	-		

			Reset ignition	IgnitionPosAux2	-		
				IgnitionPosAux3	-		
				IgnitionPosVSD	-		
			Curve Params	CurveSettings			
				Operation Mode	modulating		
		Oil Settings	LoadLimits	MinLoad	0		
				MaxLoad	100		
			Load mask out	LoadMaskLowLimit	0		
				LoadMaskHighLimit	0		
				Air Actuator	air influenc	deactivated	
				AuxActuator 1	air influenc	deactivated	
				AuxActuator 2	deactivated	deactivated	
				AuxActuator 3	deactivated	deactivated	
				VSD	air influenc	air influenc	
				Oil Actuator	activated	activated	
				STARTPOINT Op	1	1	
				Autom/Manual/Off	Automatic		
		Times		OperatRampMod	30	60	
				OperatRampStage	10		
				TimeNoFlame	10	60	
				NumFuelActuators	2		
				ShutdownBehav	HomePos		
				ProgramStop	deactivated		
				OptgMode			
				O2 Control			
				O2 Monitor			
			Control Param	P Low-Fire			
				I Low-Fire			
				Tau Low-Fire OEM			
				Tau Low-Fire			
				P High-Fire			
			Control Param	I High-Fire			
				Tau High-Fire OEM			
				Tau Low-Fire			
				O2 CtrlThreshold			
				LowfireAdaptPtNo			
				Type of Fuel			
				V_Lnmin			
				V_afNmin			

Params & Display

RatioControl

Oil Settings

O2ContrGuard

Gas/Oil Settings

Params & Display	O2ContrGuard	Gas/Oil Settings	Fuel User Def	V_atrNmin			
				A2			
				B / 1000			
				O2 Content Air			
				Type ofAirChange			
				O2 OffsetGas			
				O2 OffsetOil			
				LoadCtrlSuspend			
				FilterTimeLoad			
			Process Data	CombEfficiency	status only		
				ManVar O2 Ctrl	status only		
				State O2 Ctrl	status only		
				Air-related Load	status only		
				Diag Reg State	status only		
	Load Controller	Controller Param	ContrlParam List	StandardParam	very slow		
				P-Part	15%		
				I-Part	320 s		
				D-Part	40 s		
				MinActuatorstep	1		
				SW_FilterTmeCon	3 s		
				SetpointW1	32	170	
				SetpointW2	32		
				SD_ModOn	1.00%		
				SD_ModOff	10%		
				SD_Stage1On	-2%		
				SD_Stage1Off	10%		
				SD_Stage2Off	8%		
				SD_Stage3Off	6%		
				ThreshStage2On	300		
		Controller Param		ThreshStage3On	600		
		TempLimiter		TL_Thresh_Off	203	380	
				TL_SD_On	-5%		
		ColdStart		ColdStartOn	deactivated	activated	
				ThresholdOn	20%		
				StageLoad	15%		
				StageSetp_Mod	5%		
				StageSetp_Stage	5%		
				MaxTmeMod	3 min		
				MaxTmeStage	3 min		

Params & Display	Load Controller			ThresholdOff	80%		
				AdditionalSens	deactivated		
				Temp ColdStart	32		
				Setp AddSensor	140		
				Release Stages	release		
		Configuration		LC_OptgMode	IntLC	IntLC	
				Sensor Select	Pt100	PT100	
				MeasureRangePtNi	302	(default)	
				Var. RangePtNi	1562	374	
				Ext Inp X61 U/I	0..10V	0..10V	
				MRange TempSens	194	(default)	
				MRange PressSens	29	(default)	
				Ext Inp X62 U/I	4..20mA	(default)	
				Ext MinSetpoint	0		
				Ext MaxSetpoint	60		
			AnalogOutput	OutValueSelection	Load		
				CurrMode 0/4mA	0..20mA		
				Scale20mA perc	100%		
				Scale20mA temp	1562		
				Scale20mA press	29		
				Scale20mA angle	90		
				Scale 0/4mA	0		
		Adaption		StartAdaption	-		
				AdaptionLoad	100		
				SW Version			status only
	AZL	Times		PasswordTime	120 min		
				Sum/WinterTime	Automatic		
	AZL	Times		Time EU/US	S/W time US		
				Language	English		
				DateFormat	MM-DD-YY		
				PhysicalUnits	F/psi		
		Ebus		Address	1		
				SendCycleBU	30 s		
		ModBus		Address	1		
				Baudrate	19200		
				Parity	no		
				Timeout	30 s		
				Lokal / Remote	local		
				Remote Mode	Automatic		

Params & Display				W3	0		
				Display Contrast	-		
		ProductID		ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
				SW Version	status only		
	Actuators	Addressing		1 AirActuator	-	(default)	
				2 GasActuat(Oil)	-	set	
				3 OilActuator	-	Set	
				4 AuxActuator1	-	(default)	
				5 AuxActuator2	-	(default)	
				6 AuxActuator3	-	(default)	
		DirectionRot		DeleteCurves	-		
				1 AirActuator	standard	(default)	
				2 GasActuat(Oil)	standard	CHECK	
				3 OilActuator	standard	CHECK	
				4 AuxActuator1	standard	(default)	
				5 AuxActuator2	standard	(default)	
				6 AuxActuator3	standard	(default)	
		ProductID	1 Air Actuator	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
			1 Air Actuator	ParamSet Vers	status only		
			2 Gas Actuator(Oil)	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
			3 Oil Actuator	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
		ProductID	4 Aux Actuators 1	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		

Params & Display	Actuators			ParamSet Code	status only		
				ParamSet Vers	status only		
			5 Aux Actuators 2	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
			6 Aux Actuator 3	ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
		SW Version		1 Air Actuators	status only		
				2 Gas Actuator(Oil)	status only		
				3 Oil Actuators	status only		
				4 Aux Actuators 1	status only		
				5 Aux Actuators 2	status only		
				6 Aux Actuators 3	status only		
	VSD Module	Configuration		ReleaseContctVSD	closed		
				TolQuickShutdown	10%		
			Speed	Num Puls per R	3	(default)	
				Standardization	deactivated	set	
				StandardizedSp	status only		
	VSD Module	Configuration	Speed	Absolute Speed	status only		
				Setpoint Output	4..20mA		
				Settling Time	16		
			Fuel Meter	PulseValueGas	1.0000		
				PulseValueOil	1.0000		
		Process Data		Max Stat Dev	status only		
				Max Dyn Dev	status only		
				Num Dev >0.3%	status only		
				Num Dev >0.5%	status only		
				Absolute Speed	status only		
		Product ID		ASN	status only		
				ProductionDate	status only		
				SerialNumber	status only		
				ParamSet Code	status only		
				ParamSet Vers	status only		
				SW Version	status only		

Params & Display	O2 Module	Configuration	O2 Sensor			
			SupAirTempSens			
			FlueGasTempSens			
			MaxTempFlGasGas			
			MaxTempFlGas/Oil			
		Displayed Values	Actual O2 Value	status only		
			O2 Setpoint	status only		
			SupplyAirTemp	status only		
			CombEfficiency	status only		
			FlueGasTemp	status only		
			QGO SensorTemp	status only		
			QGO HeatingLoad	status only		
			QGO Resistance	status only		
		ProductID	ASN	status only		
			ProductionDate	status only		
			SerialNumber	status only		
			ParamSet Code	status only		
			ParamSet Vers	status only		
			SW Version	status only		
	Flue Gas Recirc		FGR-Mode	Aux3onCurve		
			FGR-Sensor	X86PtNi1000		
	Flue Gas Recirc		ActTmpFGR-sensor	32		
			ThresholdFGR Gas	752		
			DelaytimeFGR Gas	300 s		
			Factor FGR Gas	10%		
			ThresholdFGR Oil	752		
			DelaytimeFGR Oil	300 s		
			Factor FGR Oil	10%		
	System Config		LC_OptgMode	IntLC		
			Ext Inp X62 U/I	4..20mA		
		Temp Limiter	TL_Thresh_Off	203		
			TL_SD_On	-5%		
			Sensor Select	PressSensor		
			MeasureRangePtNi	302		
			O2Ctrl/LimitrGas	man deact		
			O2Ctrl/LimitrOil	man deact		
			LC Analog Output	Load		
			Allowed Pot. Diff	15		
			GasFiring	0		

Params & Display	Hours Run			OilStage1/Mod	0		
				OilStage2	0		
				OilStage3	0		
				TotalHoursReset	0		
				TotalHours			status only
				SystemOnPower			status only
		Reset		GasFiring	-		
				OilStage1/Mod	-		
				OilStage2	-		
				OilStage3	-		
				TotalHoursReset	-		
	System Config	Start counter		GasStartCount	0		
				OilStartCount	0		
				TotalStartCountR	0		
				TotalStartCount			status only
			Reset	GasStartCount	0		
				OilStartCount	0		
				TotalStartCountR	0		
	Fuel Meter			Curr Flow Rate			status only
Params & Display	Fuel Meter			Volume Gas			status only
				Volume Oil			status only
				Volume Gas R			status only
				Volume Oil R			status only
				Reset DateGas			status only
				Reset DateOil			status only
Updating	Passwords			ServicePassword	-		
				OEM Password	-		
				Burner ID	(blank)	294455 & 456	
	ParamsBackup	BackupInfo		Date	-		
				TimeOfDay	-		
				BU included?	-		
				AZL included?	-		
				LC included?	-		
				ACT1 included?	-		
				ACT2 included?	-		
				ACT3 included?	-		
				ACT4 included?	-		
				ACT5 included?	-		
				ACT6 included?	-		

			VSD included?	-	
			O2 included?	-	
			LMV5x -> AZL	-	
			AZL -> LMV5x	-	
			Load_SW_from_PC	-	
PW Login			Access w-out PW	-	
			Access Serv	-	
			Access OEM	-	
			Access SBT	-	
PW Logout			PW Logout	-	
SafetyCheck Funct			LossFlameTest	-	
			SLT Test	-	
			SLT-Testload Mod	-	
			SLT-Testload Stg	-	

S.T. JOHNSON COMPANY

ALLEN BRADLEY POWERFLEX 40 PARAMETER LIST

SO# 294455 & 294456
BURNER MODEL NM100A5V
CUSTOMER Bay City Boiler
END USER / LOCATION City of mantica
ELECTRICAL DRAWING B-9980-01
NOTES with LMV52

This is a guide to the parameters that are set by S.T. Johnson. Always use the Allen Bradley factory manual as the master reference. S.T. Johnson sets operating parameters to general values that will minimize potential start-up difficulties. However, several parameters may need to be modified once the equipment is installed. It is the responsibility of the commissioning technician to ensure that all parameters and settings are set for the safe operation of the specific installation.

* If different than suggested.

PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
d001	Output Freq			status only	Hertz.
d002	Commanded Freq			status only	Hertz.
d003	Output Current			status only	Amps.
d004	Output Voltage			status only	AC Volts.
d005	DC Bus Voltage			status only	DC Volts.
d006	Drive Status			status only	x000-decelerating, 0x00-accelerating, 00x0-forward, 000x-running.
d007	Fault 1 Code			status only	
d008	Fault 2 Code			status only	
d009	Fault 3 Code			status only	
d010	Process Display			status only	
d012	Control Source			status only	00x0-speed command source, 000x-start command source.
d013	Contrl In Status			status only	x000-brake on, 0x00-stop input, 00x0-dir/run reverse, 000x-start/run forward.
d014	Dig In Status			status only	x000-DI4, 0x00-DI3, 00x0-DI2, 000x-DI1.
d015	Comm Status			status only	x000-error, 0x00DSI connnected, 00x0-transmitting, 000x-receiving.
d016	Control SW Ver			status only	
d017	Drive Type			status only	
d018	Elapsed Run Time			status only	Hours. (Multiply by 10 to get actual value.)
d019	Testpoint Data			status only	
d020	Analog In 0-10V			status only	%.
d021	Analog In 4-20mA			status only	%.
d022	Output Power			status only	kW.

PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
d023	Output Power Factor			status only	Angular degrees.
d024	Drive Temp			status only	Degrees Centigrade.
d025	Counter Status			status only	
d026	Timer Status			status only	Seconds.
d028	Stp. Logic Status			status only	

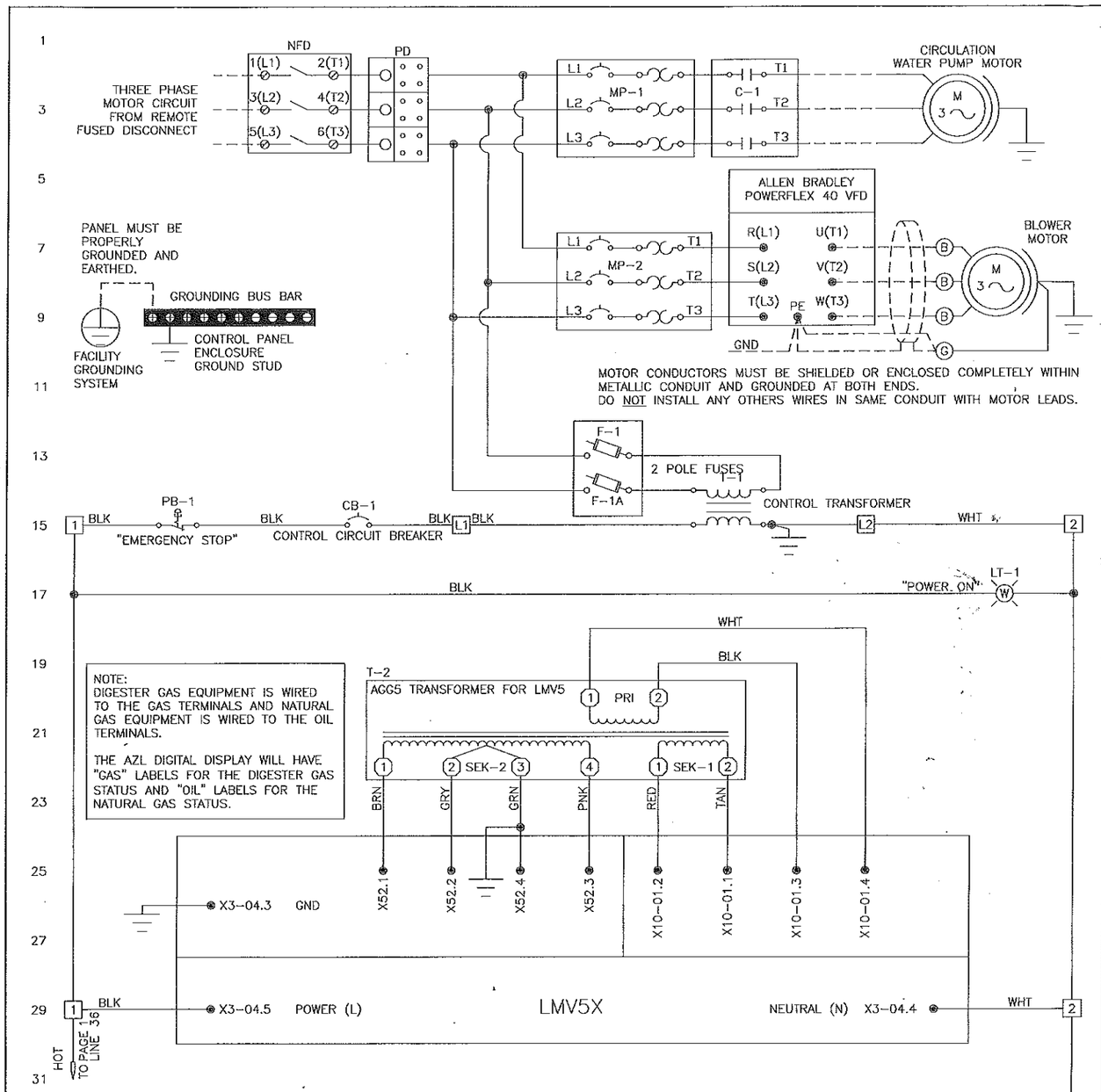
PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
P031	Motor NP Volts	Varies	460		Volts, get from motor nameplate.
P032	Motor NP Hertz	60.0	60		Hertz, 60 or 50.
P033	Motor OL Current	Varies	check	6	Amps, use rated amps from motor nameplate.
P034	Minimum Freq	0.0	(default)		Hertz.
P035	Maximum Freq	60	62		Hertz. Do NOT exceed rated Hertz by more than 2.
P036	Start Source	0	2		2 = "2 wire".
P037	Stop Mode	0	1		1 = "coast to stop".
P038	Speed Reference	0	3		3 = "4-20 ma input".
P039	Accel Time 1	10.0	30		Seconds.
P040	Decel Time 1	10.0	30		Seconds.
P041	Reset To Defalts	0	(default)		
P042	Voltage Class	3	(default)		3 = "600V, high voltage class". This parameter may not show.
P043	Motor OL Ret	0	1		1 = "enable overload counter retention".
A051	Digital In1 Sel	4	0		0 = "not used".
A052	Digital In2 Sel	4	0		0 = "not used".
A053	Digital In3 Sel	5	5		5 = "local"
A054	Digital In4 Sel	11	0		0 = "not used".
A055	Relay Out Sel	0	0		0 = "ready/fault".
A056	Relay Out Level	0.0	(default)		
A058	Opto Out 1 Sel	2	(default)		2 = "motor running".
A059	Opto Out 1 Level	0.0	(default)		
A061	Opto Out 2 Sel	1	(default)		1 = "at frequency".
A062	Opto Out 2 Level	0.0	(default)		
A064	Opto Out Logic	0	(default)		
A065	Analog Out Sel	0	10		10 = "4-20mA represents to 0 to 60 Hz".
A066	Analog Out High	100	(default)		%.
A067	Accel Time 2	20.0	(default)		Seconds.
A068	Decel Time 2	20.0	(default)		Seconds.
A069	Internal Freq	60.0	(default)		Hertz.
A070	Preset Freq 0	0.0	(default)		Hertz.
A071	Preset Freq 1	5.0	(default)		Hertz.
A072	Preset Freq 2	10.0	(default)		Hertz.
A073	Preset Freq 3	20.0	(default)		Hertz.
A074	Preset Freq 4	30.0	(default)		Hertz.
A075	Preset Freq 5	40.0	(default)		Hertz.
A076	Preset Freq 6	50.0	(default)		Hertz.
A077	Preset Freq 7	60.0	(default)		Hertz.
A078	Jog Frequency	10.0	(default)		Hertz.
A079	Jog Accel/Decel	10.0	(default)		Seconds.
A080	DC Brake Time	0.0	(default)		Seconds.

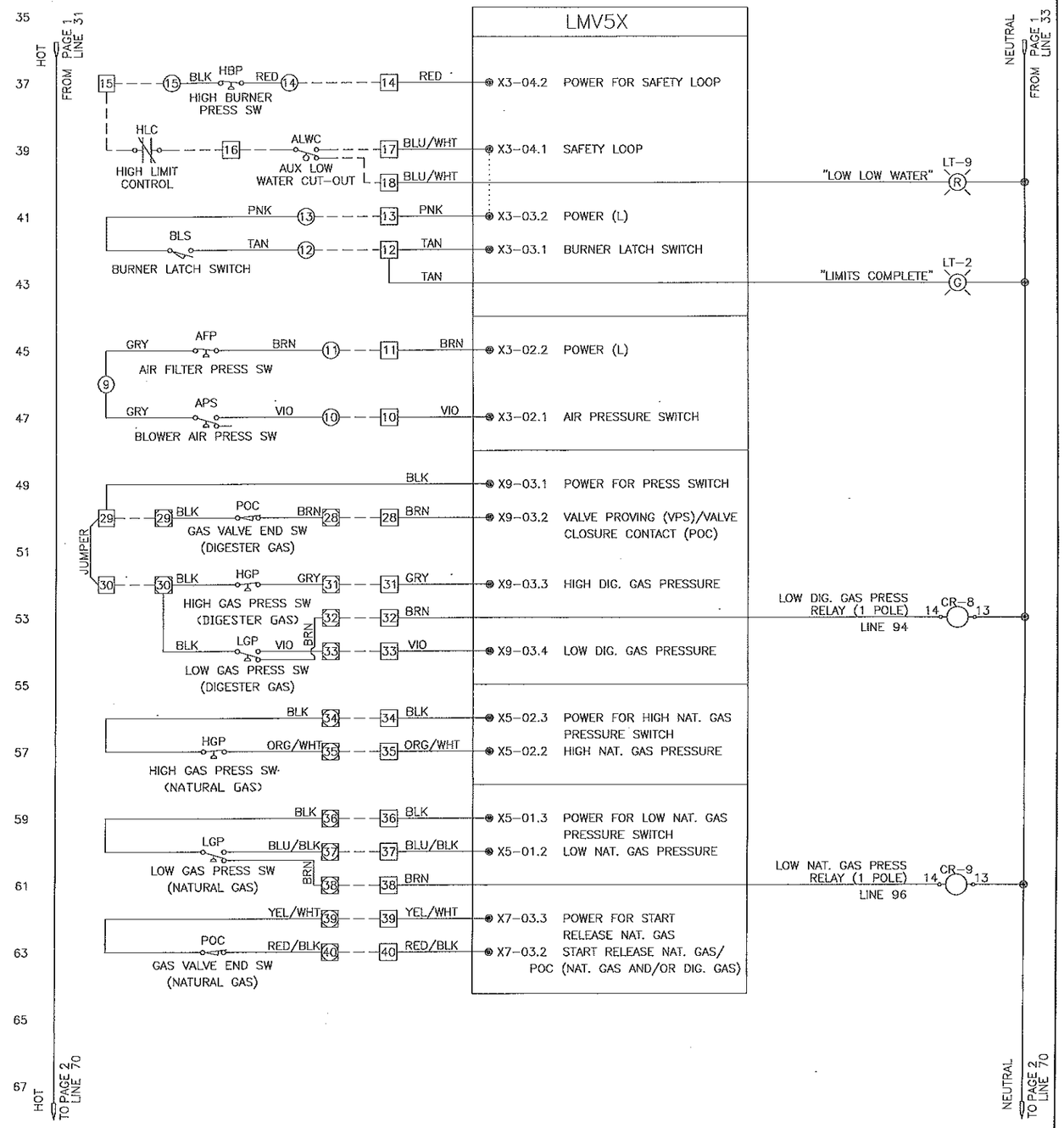
PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
A081	DC Brake Level	Varies	(default)		Amps.
A082	DB Resistor Sel	0	(default)		0 = "disabled".
A083	S Curve	0	(default)		%. 0 = "disabled".
A084	Boost Select	8 or 7	(default)		7 = "2.5, CT" 8 = 5.0, CT".
A085	Start Boost	2.5	(default)		%.
A086	Break Voltage	25	(default)		%.
A087	Break Frequency	15	(default)		Hertz.
A088	Maximum Voltage	Varies	(default)		Volts.
A089	Current Limit	Varies	(default)		Amps.
A090	Motor OL Select	0	(default)		0 = "no I^2t derate".
A091	PWM Frequency	4.0	(default)		kHz.
A092	Auto Rstrt Tries	0	(default)		0 = "no restart retries".
A093	Auto Rstrt Delay	1.0	(default)		Seconds.
A094	Start At PowerUp	0	(default)		0 = "disabled".
A095	Reverse Disable	0	1		1 = "reverse direction disabled".
A096	Flying Start En	0	1		1 = "flying start enabled".
A097	Compensation	1	(default)		1 = "electrical only instability compensation".
A098	SW Current Trip	0.0	(default)		Amps. 0 = "disabled".
A099	Process Factor	30.0	(default)		
A100	Fault Clear	0	(default)		0 = "ready/idle".
A101	Program Lock	0	(default)		1 = "program locked".
A102	Testpoint Sel	400	(default)		
A103	Comm Data Rate	3	(default)		3 = "9600 BAUD".
A104	Comm Node Addr	100	(default)		
A105	Comm Loss Action	0	(default)		0 = "fault".
A106	Comm Loss Time	5.0	(default)		Seconds.
A107	Comm Format	0	(default)		0 = "RTU 8-N-1".
A108	Language	1	(default)		1 = "English".
A109	Anlg Out Setpt	0.0	(default)		%.
A110	Anlg In 0-10V Lo	0.0	(default)		%.
A111	Anlg In 0-10V Hi	100.0	(default)		%.
A112	Anlg In 4-20mA Lo	0.0	(default)		%.
A113	Anlg In 4-20mA Hi	100.0	(default)		%.
A114	Slip Hertz @ FLA	2.0	(default)		Hertz.
A115	Process Time Lo	0.00	(default)		
A116	Process Time Hi	0.00	(default)		
A117	Bus Reg Mode	1	(default)		1 = "enabled".
A118	Current Limit 2	Varies.	(default)		Amps.
A119	Skip Frequency	0	(default)		Hertz. 0 = "disabled".
A120	Skip Freq. Band	0.0	(default)		Hertz. 0 = "disabled".

PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
A121	Stall Fault Time	0	(default)		Seconds.
A122	Analog In Loss	0	(default)		1 = "fault".
A123	10V Bipolar Enbl.	0	(default)		0 = "uni-polar"
A124	Var. PWM Disable	0	(default)		0 = "enabled".
A125	Torque Perf. Mode	1	1		1 = "Sensorless Vector".
A126	Motor NP FLA	Varies.	check	6	Amps, use motor nameplate amps if available, else leave default.
A127	Autotune	0	(default)		0 = "ready/idle".
A128	IR Voltage Drop	Varies.	(default)		Volts.
A129	Flux Current Ref.	Varies.	(default)		Amps.
A130	PID Trim High	60.0	(default)		Hertz.
A131	PID Trim Lo	0.0	(default)		Hertz.
A132	PID Ref Select	0	(default)		0 = "PID disabled".
A133	PID Feedback Sel	0	(default)		0 = "0-10V input".
A134	PID Prop Gain	0.01	(default)		
A135	PID Integ Time	2.0	(default)		Seconds.
A136	PID Diff Rate	0.00	(default)		1/Seconds.
A137	PID Setpoint	0.0	(default)		%.
A138	PID Deadband	0.0	(default)		%.
A139	PID Preload	0.0	(default)		Hertz.
A140	Stp Logic 0	00F1	(default)		
A141	Stp Logic 1	00F1	(default)		
A142	Stp Logic 2	00F1	(default)		
A143	Stp Logic 3	00F1	(default)		
A144	Stp Logic 4	00F1	(default)		
A145	Stp Logic 5	00F1	(default)		
A146	Stp Logic 6	00F1	(default)		
A147	Stp Logic 7	00F1	(default)		
A150	Stp Time 0	30.0	(default)		Seconds.
A151	Stp Time 1	30.0	(default)		Seconds.
A152	Stp Time 2	30.0	(default)		Seconds.
A153	Stp Time 3	30.0	(default)		Seconds.
A154	Stp Time 4	30.0	(default)		Seconds.
A155	Stp Time 5	30.0	(default)		Seconds.
A156	Stp Time 6	30.0	(default)		Seconds.
A157	Stp Time 7	30.0	(default)		Seconds.
A160	EM Brk Off Delay	2.00	(default)		Seconds.
A161	EM Brk On Delay	2.00	(default)		Seconds.
A162	MOP Reset Sel	1	(default)		1 = "save MOP reference".
A163	DB Threshold	100.0	(default)		%.
A164	Comm Write Mode	0	(default)		0 = "save".

PARAM	DESCRIPTION	DEFAULT	SUGGESTED	ACTUAL*	NOTES
A165	Anlg Loss Delay	0.0	0.2		Seconds.
A166	Analog In Filter	0	(default)		0 = "no additional filtering".
A167	PID Invert Error	0	(default)		0 = "PID error not inverted".

Electric Diagrams & Fuel Train Schematics





REV	REVISION DESCRIPTION	BY	DATE
A	CHANGED THE LOAD SENSOR TO TEMP SENSOR, DELETED HIGH WATER LIMIT SWITCH AND LIGHT	SKH	12/20/16
B	ADDED A SIEMENS PROTOCOL CONVERTER KIT AND OTHER OPTIONS PER SPEC	SKH	02/03/17
C	ADDED A MOTOR STARTER FOR THE CIRCULATION WATER PUMP AND RS232 TO RS485 CONVERTER	SKH	02/17/17
D	ADDED AN INDEPENDENT FUEL SELECTION SWITCH	SKH	04/11/17
E	CORRECTED THE POWER SOURCE OF THE PROTOCOL CONVERTER, TO BE EXTERNAL (120VAC/60HZ)	SKH	05/31/17
F	SWITCHED TO ONE PROTOCOL CONVERTER ON EACH PANEL, DELETED THE COMMUNICATION PANEL.	SKH	06/13/17

S.T.JOHNSON CO.
FAIRFIELD, CA USA
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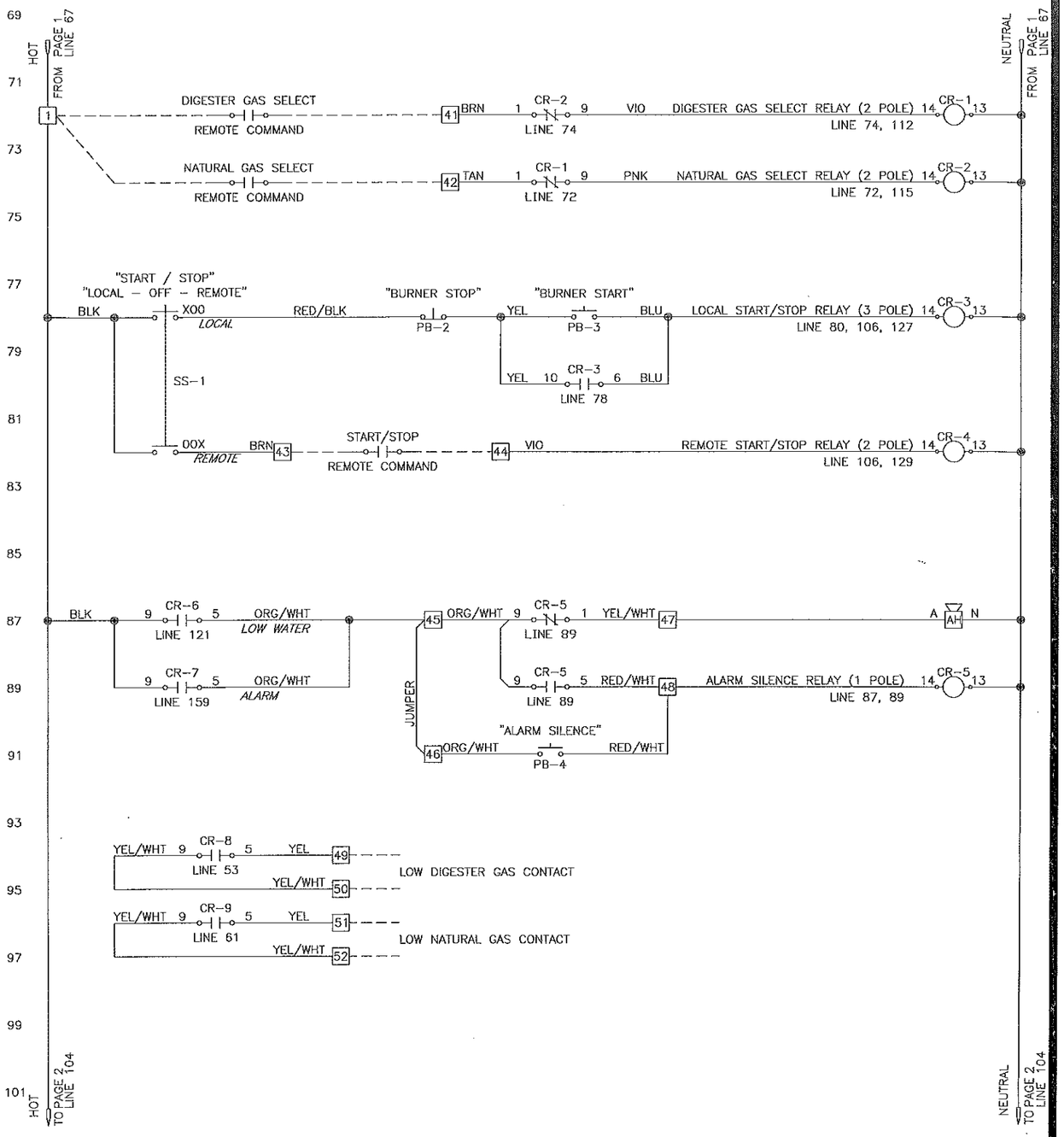
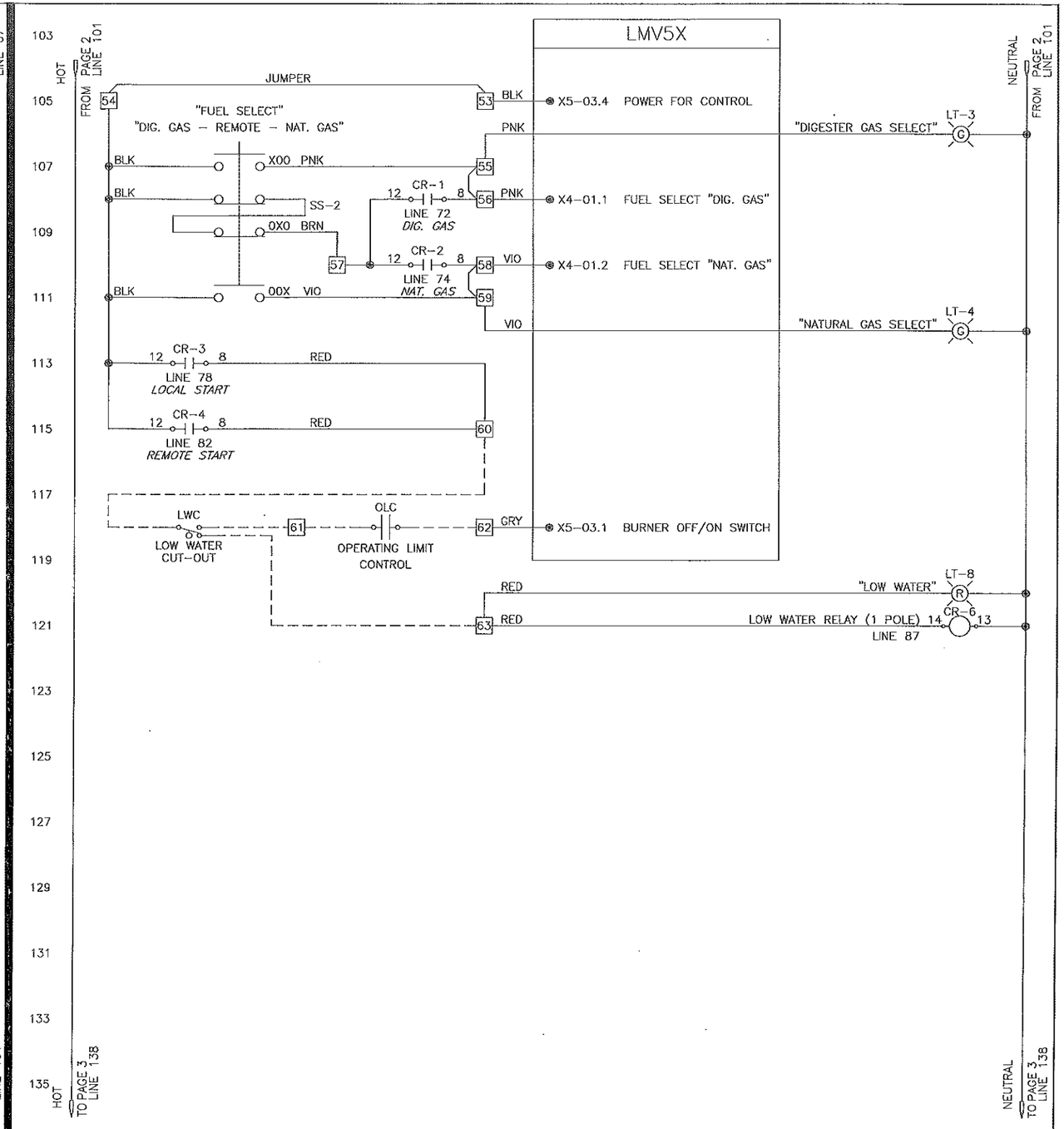
FAX: 510-652-4302
www.johnsonburners.com

FOR UL508A MODULATING CONTROL SYSTEM FOR NM100A5S DUAL GAS BURNER W/ SIEMENS LMV52 BMS, O2 TRIM AND POWERFLEX 40 VFD

NEXT ASSY	TOP LEVEL ASSY	MATERIAL
SHEET 1 OF 4	DRWN BY SKH	DATE 12/01/2016
		DRWG NO. B-9980-01 REV F





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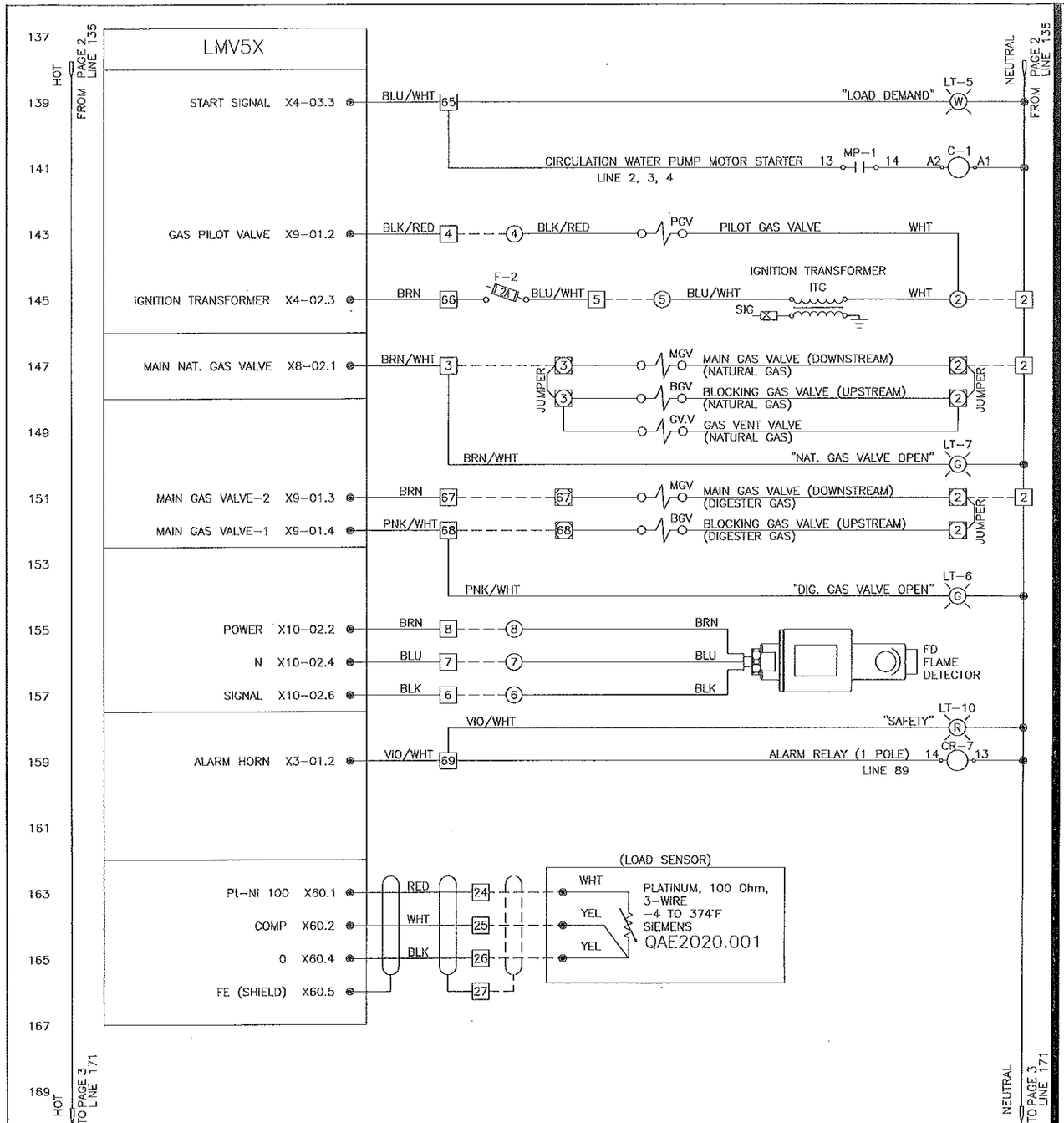
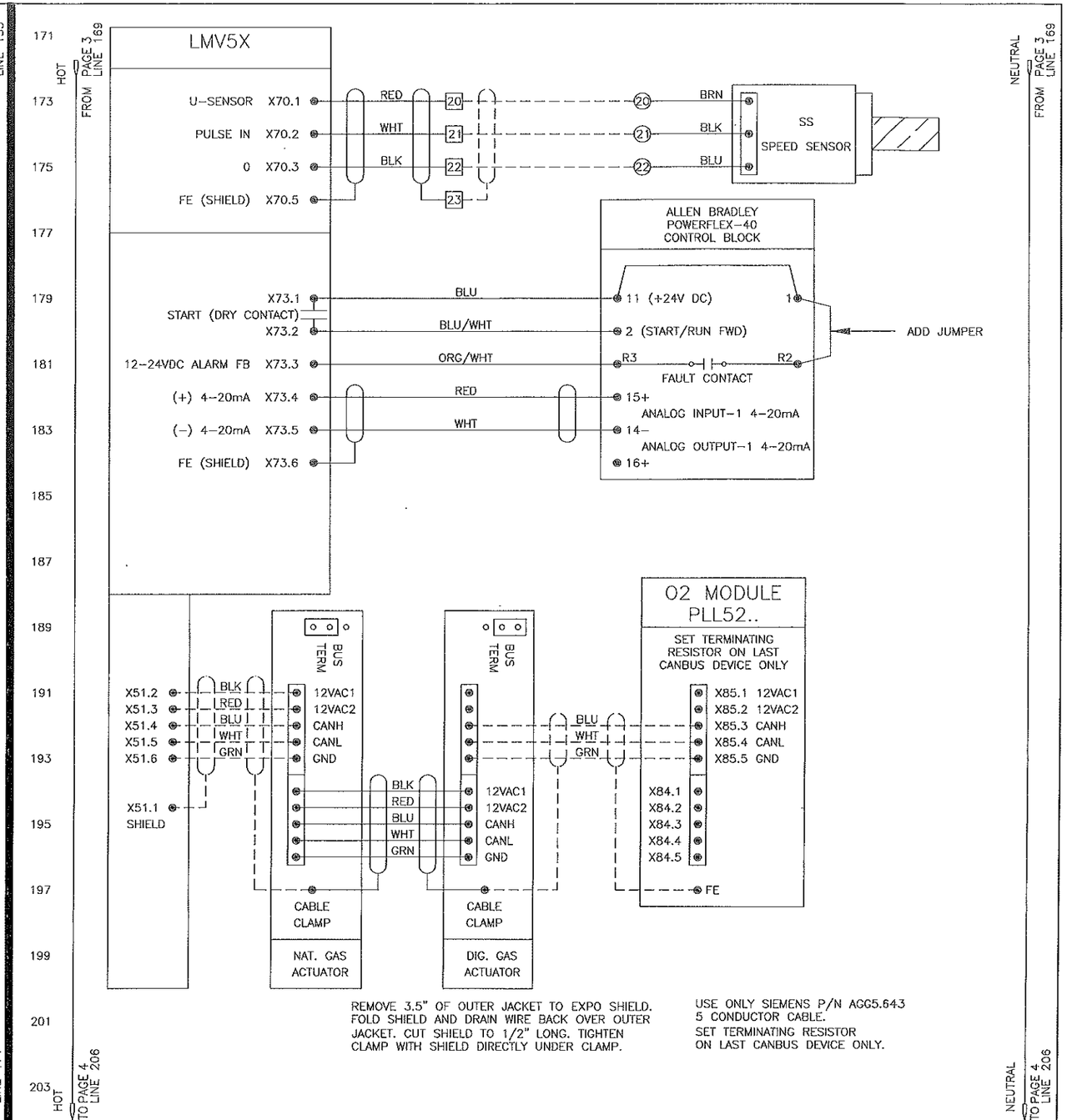
FOR UL508A MODULATING CONTROL SYSTEM FOR NM100A5S DUAL GAS BURNER W/ SIEMENS LMV52 BMS, O2 TRIM AND POWERFLEX 40 VFD

NEXT ASSY	TOP LEVEL ASSY	MATERIAL
SHEET 2 OF 4	DRWN BY SKH	DATE 12/01/2016
		DRWG NO. B-9980-01 / REV F





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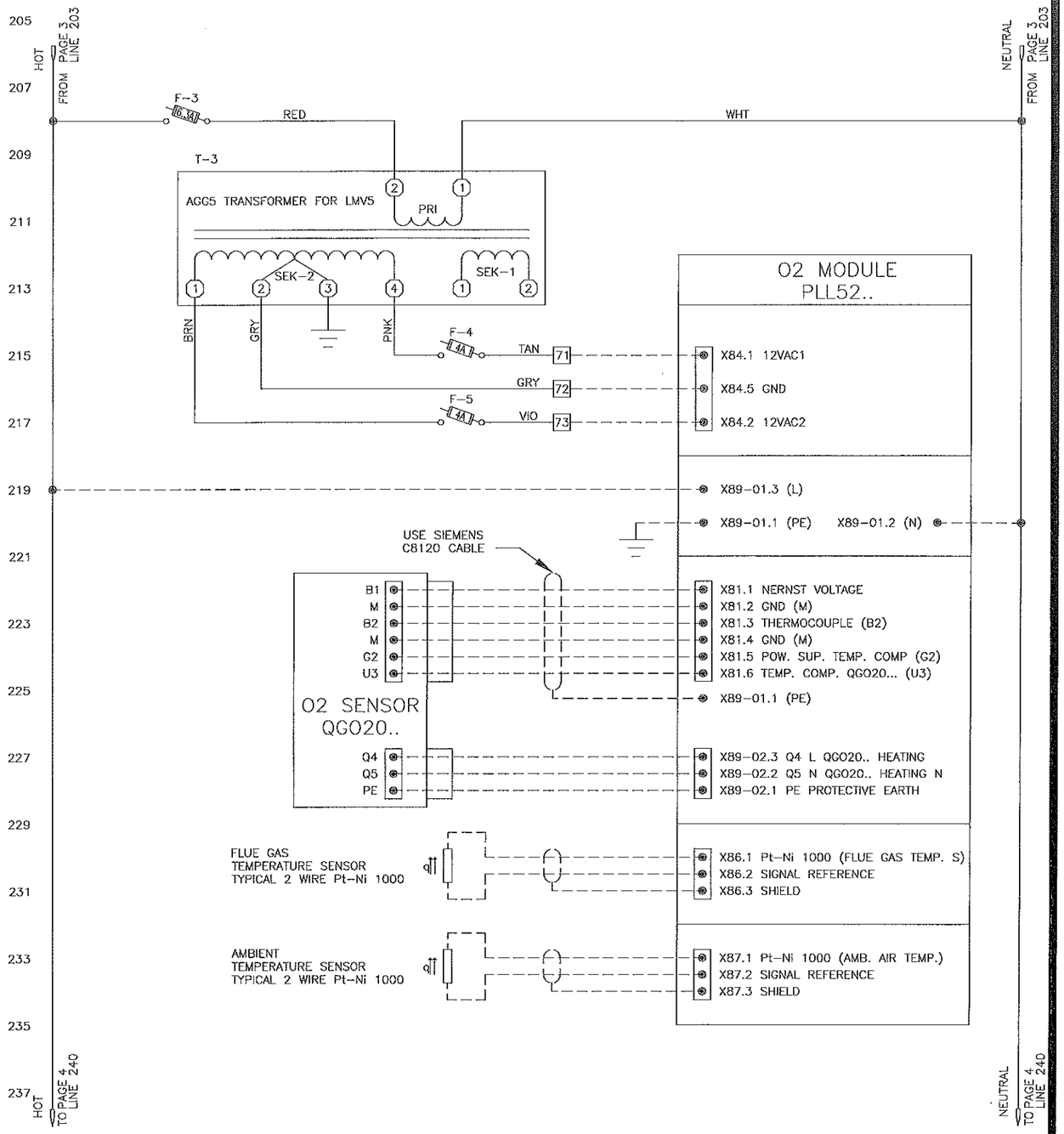
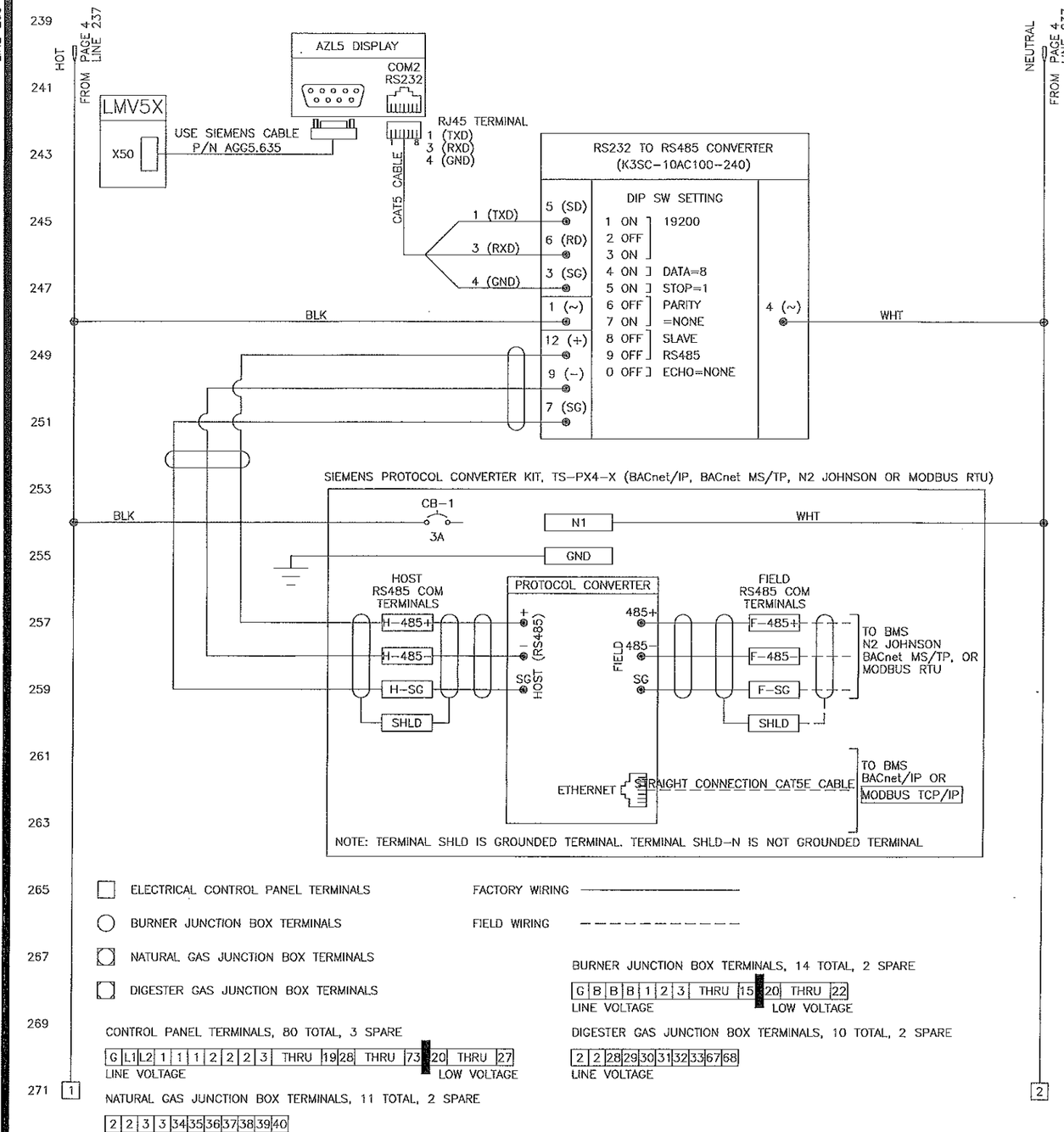
FOR UL508A MODULATING CONTROL SYSTEM FOR NM100A5S DUAL GAS BURNER W/ SIEMENS LMV52 BMS, O2 TRIM AND POWERFLEX 40 VFD

NEXT ASSY	TOP LEVEL ASSY	MATERIAL	
SHEET 3 OF 4	DRWN BY SKH	DATE 12/01/2016	
		DRWG NO. B-9980-01	REV F





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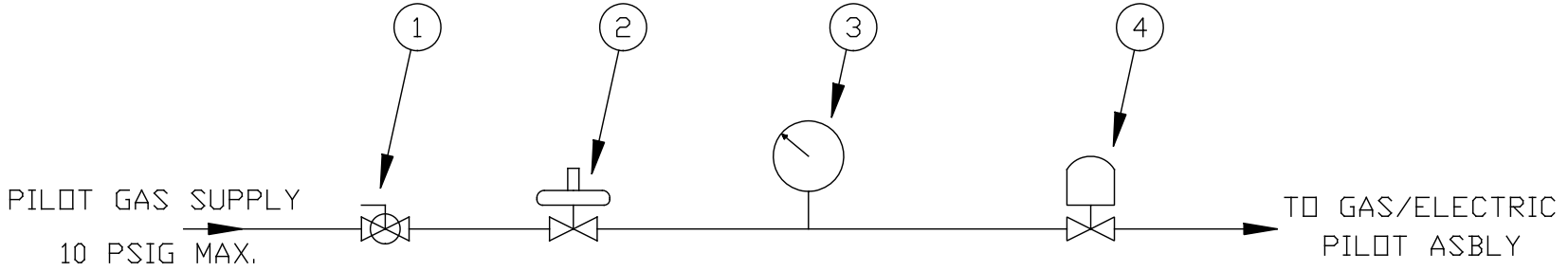
FOR UL508A MODULATING CONTROL SYSTEM FOR NM100A5S DUAL GAS BURNER
W/ SIEMENS LMV52 BMS, O2 TRIM AND POWERFLEX 40 VFD

NEXT ASSY	TOP LEVEL ASSY	MATERIAL
SHEET 4 OF 4	DRWN BY SKH	DATE 12/01/2016
		DRWG NO. B-9980-01 / REV F

COMPONENTS

1. 3/8" BALL VALVE
2. 3/8" MAXITROL 325-3 REGULATOR
3. 0 - 35"w.c. GAUGE
4. 1/4" ASCO 8262H078 SOLENOID VALVE

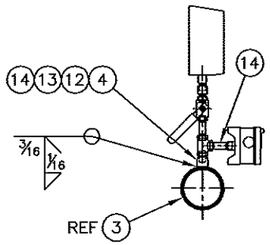


MAXIMUM PILOT CAPACITY FOR
ANY SERIES BURNER = 150,000 BTU/HR

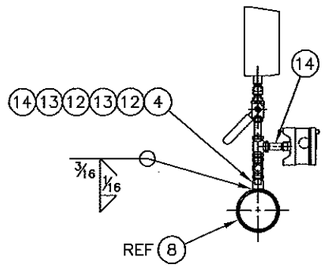
REV	REVISION DESCRIPTION	BY	DATE
A	CHANGED 8262G13 TO 8262H078	WMD	04/06/12

S.T.JOHNSON CO.
OAKLAND, CA USA
TEL: 510-652-6000
FAX: 510-652-4302
www.johnsonburners.com

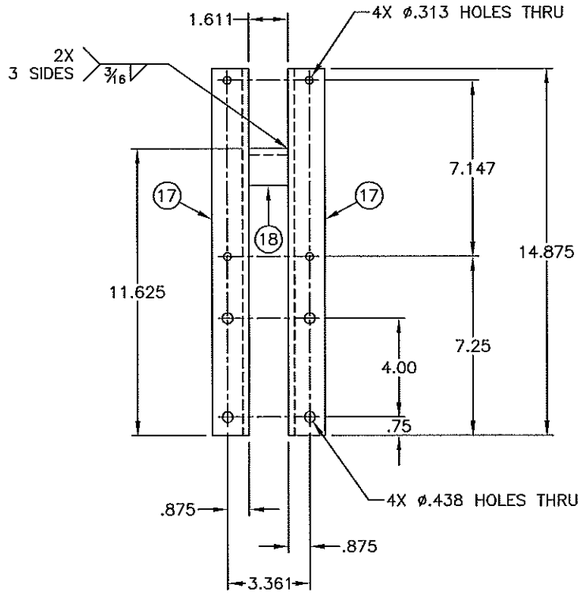
TITLE: STANDARD PILOT GAS TRAIN	NEXT ASSY	TOP LEVEL ASSY	MATERIAL
	SCALE: NONE	DRWN BY: DLW	DATE: 03/12/68
FOR: ALL MODELS OF S.T. JOHNSON BURNERS			DRWG NO.: A-8214 / REV: A



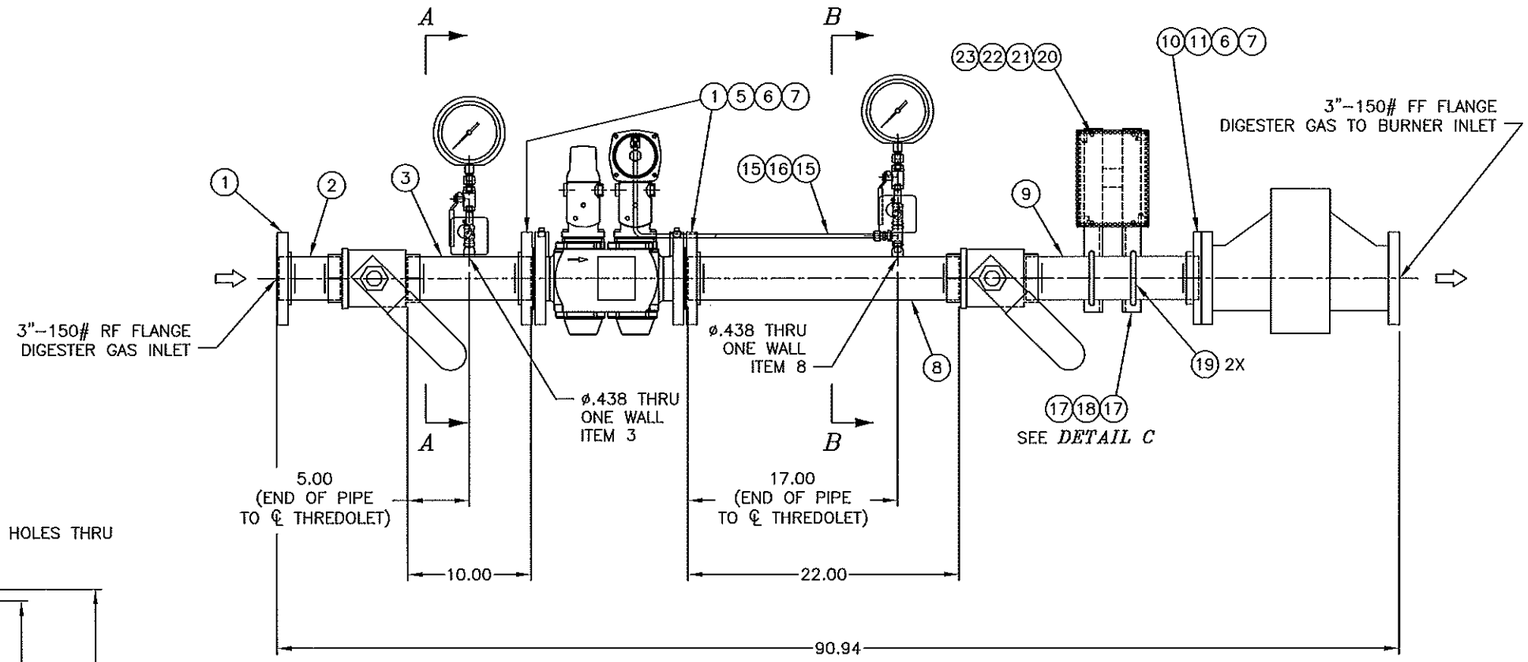
SECTION A–A



SECTION B–B



DETAIL C
SCALE: 1/4



NOTES:

1. DEBURR AND BREAK ALL SHARP EDGES.
2. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
   .XX = ±.02
   .XXX = ±.010
   ANGLE = ±.5°

PARTS LIST

ITEM	QTY	PART/DWG No.	DESCRIPTION
1	3	.	FLANGE 3"–150# RF THREADED FORGED 304/304L SST, McMASTER–CARR P/N 44685K18
2	1	.	PIPE NIPPLE, 3" NPS SCH. 40 X 5.00 LG. WELD 304/304L SST, TBE
3	1	.	PIPE NIPPLE, 3" NPS SCH. 40 X 10.00 LG. WELD 304/304L SST, TBE
4	2	.	THREDOLET, ¼" NPT X 3" PIPE 304/304L SST, McMASTER–CARR P/N 4565T312
5	2	.	GRAFOIL FLANGE GASKET, 3"–150# RF (RING) GRAPHITE 1/16" THK. McMASTER–CARR P/N 93245K48
6	12	.	BOLT, HEX HD. 5/8–11UNC X 3.00 LG. 316 SST, McMASTER–CARR P/N 93190A854
7	12	.	NUT, HEAVY HEX 5/8–11UNC 316 SST, McMASTER–CARR P/N 91850A220
8	1	.	PIPE NIPPLE, 3" NPS SCH. 40 X 22.00 LG. WELD 304/304L SST, TBE
9	1	.	PIPE NIPPLE, 3" NPS SCH. 40 X 14.00 LG. WELD 304/304L SST, TBE
10	1	.	FLANGE 3"–150# FF THREADED CAST 304 SST, McMASTER–CARR P/N 43505K358
11	1	.	GRAFOIL FLANGE GASKET, 3"–150# FF (RING WITH BOLT HOLES) GRAPHITE 1/16" THK. McMASTER–CARR P/N 93245K78
12	3	.	PIPE NIPPLE, (CLOSE) ¼" NPT SCH 40 X .875 LG. SMLS 304/304L SST, McMASTER–CARR P/N 4830K131
13	3	.	TEE, STRAIGHT ¼" NPT 304 SST CLASS 150, McMASTER–CARR P/N 4464K48
14	4	.	PIPE NIPPLE, ¼" NPT SCH 40 X 2.00 LG. WELD 304/304L SST, McMASTER–CARR P/N 4830K133
15	2	.	CONN–M–STR ¼" NPT X .313 O.D. TUBING 316 SST, McMASTER–CARR P/N 5182K809
16	1	.	TUBING, .313 O.D. X .035 WALL X 36.00 LG. WELD 304 SST, McMASTER–CARR P/N 8989K741
17	2	.	ANGLE 1½" X 1½" X ¼" X 14.875 LG. ASTM A–36, SBE
18	1	.	ANGLE 1½" X 1½" X ¼" X 1.611 LG. ASTM A–36, SBE
19	2	.	U–BOLT, ⅜"–16 X 3" PIPE 304 SST WITH FOUR HEX NUTS, McMASTER–CARR P/N 8889T78
20	4	.	BOLT, HEX HD. ¼–20UNC X 1.00 LG. 316 SST
21	4	.	LOCKWASHER, SPLIT ¼" 316 SST
22	4	.	FLATWASHER, STD. SAE ¼" 316 SST
23	4	.	NUT, HEX ¼–20UNC 316 SST

REV	REVISION DESCRIPTION	BY	DATE
A	REVISED PARTS LIST MATERIALS.	LPJ	06/13/17

S.T.JOHNSON CO.
FAIRFIELD, CA USA
TEL: 510–652–6000
FAX: 510–652–4302
www.johnsonburners.com

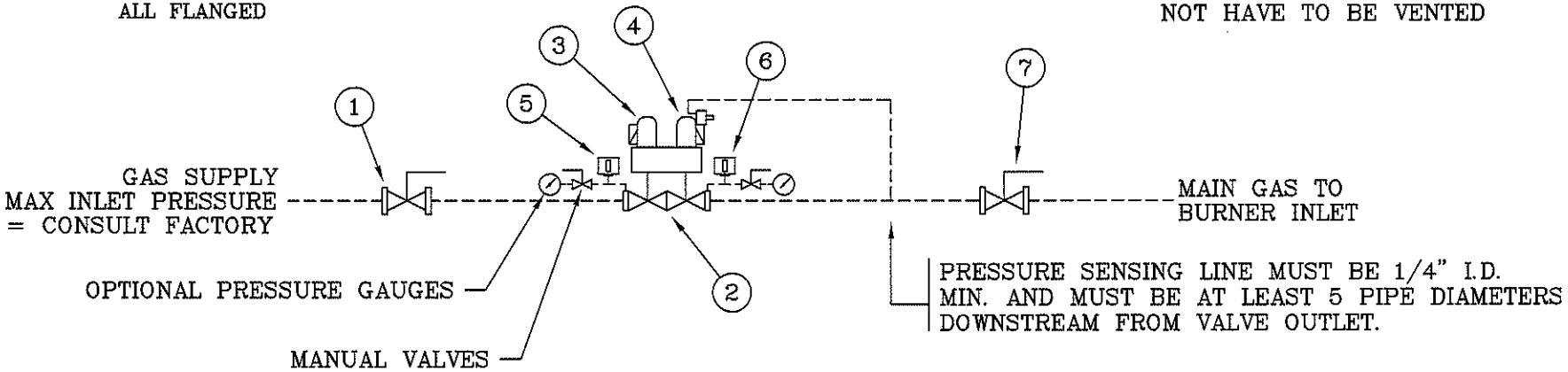
TITLE: GAS PIPING ASSEMBLY
DIGESTER GAS (B–9709–4) – SO# 294455 & 294456

NEXT ASSY:
SCALE: 1/8
TOP LEVEL ASSY:
DRWN BY: LPJ
MATERIAL: AS NOTED
DATE: 05/22/2017
DRWG NO.: C–7012
REV: A

		①	②	③	④	⑤	⑥	⑦
ASSEMBLY	SIZE	INLET GAS COCK	DUAL VALVE BODY	BLOCKING ACTUATOR	MAIN ACTUATOR	LOW PRESSURE SWITCH *	HIGH PRESSURE SWITCH *	LEAK TEST COCK
B-9709-1	1-1/2"	BALL VALVE	VRD40.040	SKP15.011U1	SKP25.013U1 w/ AGA22	ASHCROFT B400	ASHCROFT B400	BALL VALVE
B-9709-2	2"	BALL VALVE	VRD40.050	SKP15.011U1	SKP25.013U1 w/ AGA22	ASHCROFT B400	ASHCROFT B400	BALL VALVE
B-9709-3	2-1/2"	BALL VALVE	VRD40.065	SKP15.011U1	SKP25.013U1 w/ AGA22	ASHCROFT B400	ASHCROFT B400	BALL VALVE
B-9709-4	3"	BALL VALVE	VRD40.080	SKP15.011U1	SKP25.013U1 w/ AGA22	ASHCROFT B400	ASHCROFT B400	BALL VALVE
B-9709-5	4"	BALL VALVE	VRD40.100	SKP15.011U1	SKP25.013U1 w/ AGA22	ASHCROFT B400	ASHCROFT B400	BALL VALVE

PIPING CONNECTIONS:
ALL FLANGED

* PRESSURE SWITCHES DO NOT HAVE TO BE VENTED



PIPING OPTIONAL,
OR BY OTHERS

DATE	LTR	REVISION
4/18/14	A	CHANGED PLUG VALVES TO BALL VALVES (WMD)

S.T. JOHNSON CO
OAKLAND, CA USA
www.JOHNSONBURNERS.com
TEL: 510 652 6000
FAX: 510 652 4302

DATE 03-28-13

SCALE

DRWN BY WMD

TITLE: SIEMENS INTEGRATED GAS TRAIN COMPONENTS w/ STAINLESS STEEL DUAL VALVE BODY UL/CSD-1

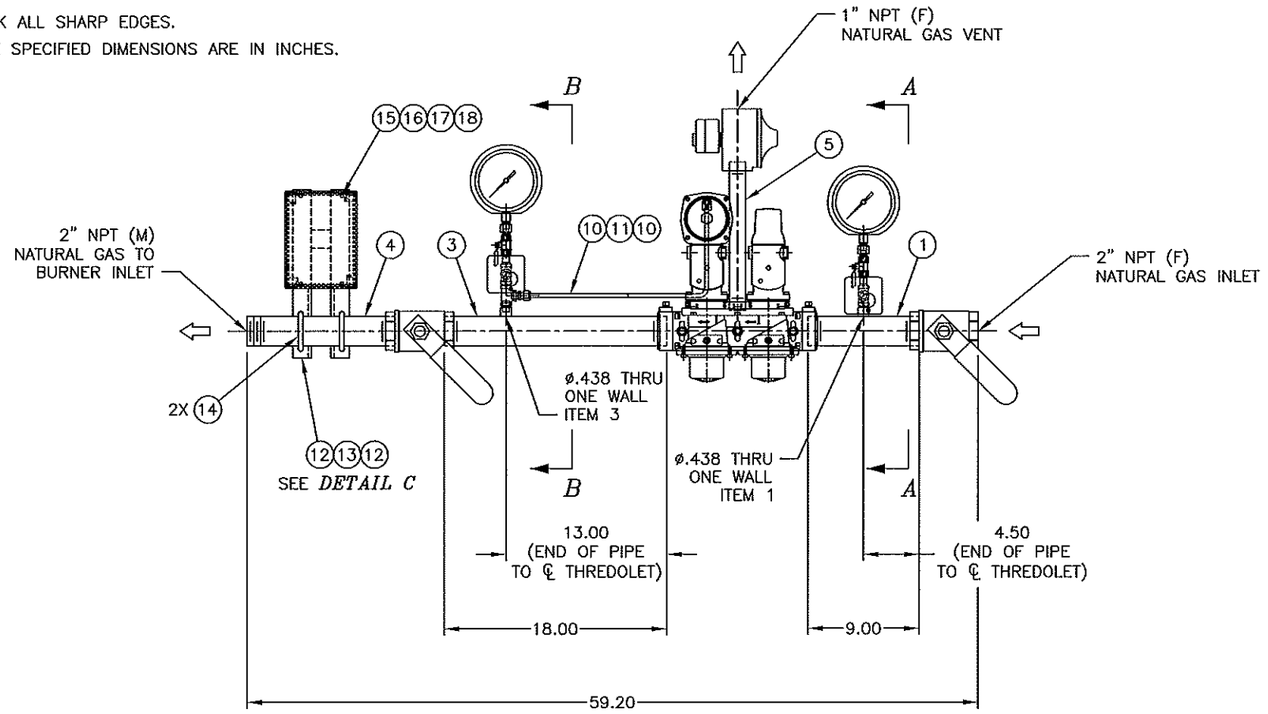
FOR: FIRING CAPACITY 5,001 < Q > 12,500 MBTU/HR

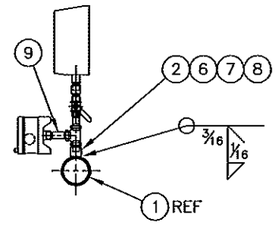
DRWG # B-9709

REV A

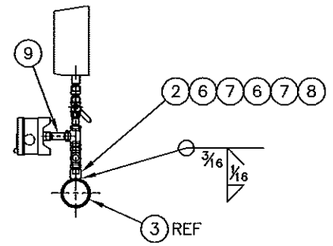
NOTES:

1. DEBURR AND BREAK ALL SHARP EDGES.
2. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
   TOLERANCES ARE:
   .XX = ±.02
   .XXX = ±.010
   ANGLE = ±.5°

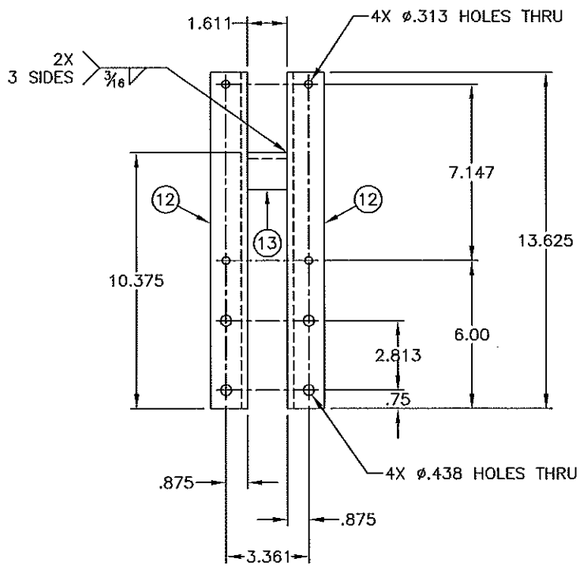




SECTION A–A



SECTION B–B



DETAIL C
SCALE: 1/4

PARTS LIST			
ITEM	QTY	PART/DWG No.	DESCRIPTION
1	1	.	PIPE NIPPLE, 2" NPS SCH. 40 X 9.00 LG. WELD CS, TBE
2	2	.	THREDOLET, ¼" NPT X 2" PIPE 3000# FS, McMASTER–CARR P/N 4587K21
3	1	.	PIPE NIPPLE, 2" NPS SCH. 40 X 18.00 LG. WELD CS, TBE
4	1	.	PIPE NIPPLE, 2" NPS SCH. 40 X 12.00 LG. WELD CS, TBE
5	1	.	PIPE NIPPLE, 1" NPS SCH. 40 X 12.00 LG. WELD CS, TBE
6	3	.	PIPE NIPPLE, (CLOSE) ¼" NPT SCH 40 X .875 LG. WELD CS
7	3	.	TEE, STRAIGHT ¼" NPT BLACK MALLEABLE IRON CLASS 150
8	2	.	PIPE NIPPLE, ¼" NPT SCH 40 X 1.50 LG. WELD CS
9	2	.	PIPE NIPPLE, ¼" NPT SCH 40 X 2.00 LG. WELD CS
10	2	.	CONN–M–STR ¼" NPT X .313 O.D. TUBING 316 SST, McMASTER–CARR P/N 5182K809
11	1	.	TUBING, .313 O.D. X .035 WALL X 30.00 LG. WELD 304 SST, McMASTER–CARR P/N 8989K741
12	2	.	ANGLE 1½" X 1½" X ¼" X 13.625 LG. ASTM A–36, SBE
13	1	.	ANGLE 1½" X 1½" X ¼" X 1.611 LG. ASTM A–36, SBE
14	2	.	U–BOLT, ⅜"–16 X 2" PIPE STL ZINC PLATED WITH FOUR HEX NUTS, McMASTER–CARR P/N 8875T859
15	1	.	BOLT, HEX HD. ¼–20UNC X 1.00 LG. 316 SST
16	1	.	LOCKWASHER, SPLIT ¼" 316 SST
17	1	.	FLATWASHER, STD. SAE ¼" 316 SST
18	1	.	NUT, HEX ¼–20UNC 316 SST

REV	REVISION DESCRIPTION	BY	DATE
A	REVISED PARTS LIST MATERIALS.	LPJ	06/13/17

S.T.JOHNSON CO.
FAIRFIELD, CA USA
TEL: 510–652–6000
FAX: 510–652–4302
www.johnsonburners.com

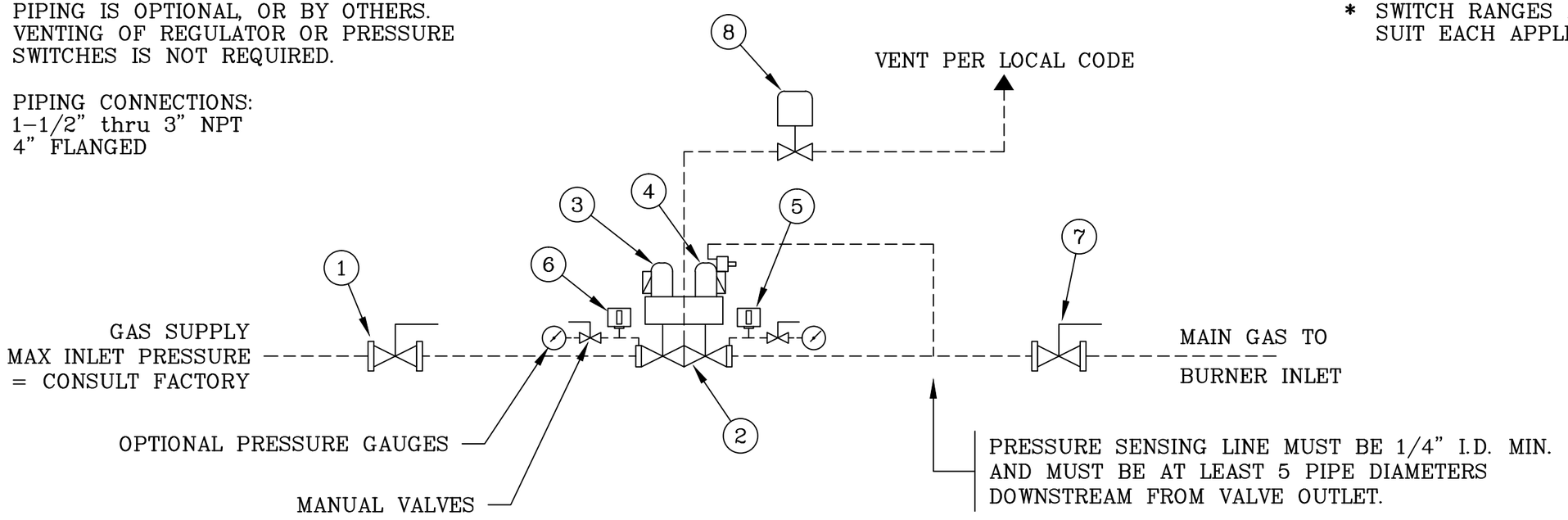
TITLE: GAS PIPING ASSEMBLY
NATURAL GAS (B–8981–01–2) – SO# 294455 & 294456

NEXT ASSY:
SCALE: 1/8
TOP LEVEL ASSY:
DRWN BY: LPJ
MATERIAL: AS NOTED
DATE: 05/22/2017
DRWG NO.: C–7013
REV: A

ITEM #		①	②	③	④	⑤	⑥	⑦	⑧
ASBLY #	SIZE	INLET GAS COCK	DUAL VALVE BODY	BLOCKING ACTUATOR	MAIN ACTUATOR w/GOVERNOR + P.O.C.	HIGH PRESSURE SWITCH *	LOW PRESSURE SWITCH *	LEAK TEST COCK	VENT VALVE / SIZE
B-8981-01-1	1-1/2"	BALL VALVE	VGD20.403U w/(2) AGA41	SKP15.011U1	SKP25.011U1	HGP-G	LGP-G	BALL VALVE	3/4"
B-8981-01-2	2"	BALL VALVE	VGD20.503U w/(2) AGA51	"	"	"	"	BALL VALVE	1"
B-8981-01-3	2-1/2"	BALL VALVE (STD) PLUG VALVE (OPT)	VGD40.065U	"	"	"	"	BALL VALVE	1-1/4"
B-8981-01-4	3"	BALL VALVE (STD) PLUG VALVE (OPT)	VGD40.080U	"	"	"	"	BALL VALVE	1-1/4"
B-8981-01-5	4"	PLUG VALVE	VGD40.100U	"	"	"	"	PLUG VALVE	2"

PIPING IS OPTIONAL, OR BY OTHERS.
VENTING OF REGULATOR OR PRESSURE SWITCHES IS NOT REQUIRED.

PIPING CONNECTIONS:
1-1/2" thru 3" NPT
4" FLANGED



* SWITCH RANGES ARE SELECTED TO SUIT EACH APPLICATION.

REV	REVISION DESCRIPTION	BY	DATE
A	ADDED MANUAL VALVES & OPTIONAL PRESSURE GAUGES.	LPJ	06/19/12
B	ITEM #1, SIZE 2-1/2" & 3": ADDED BALL VALVE (STD) & MADE PLUG VALVE (OPT); REVISED NOTE * AND VENT VALVES (ITEM #8).	LPJ	08/24/15

S.T.JOHNSON CO.
FAIRFIELD, CA USA
TEL: 510-652-6000
FAX: 510-652-4302
www.johnsonburners.com

TITLE: SIEMENS GAS TRAIN WITH VGD DUAL VALVE BODY WITH 2 P.O.C. UL/IRI/NFPA85

FOR: FIRING CAPACITY: NO LIMIT

NEXT ASSY | TOP LEVEL ASSY | MATERIAL .

SCALE NONE | DRWN BY TAC | DATE 10/16/2006

DRWG NO. B-8981-01 | REV B

Equipment Installation, Operation & Maintenance

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Since 1903

Pre-Start Up Check List

The following activities should be completed and confirmed prior to beginning the burner-boiler commissioning properly. We recommend that the installing contractor or plant operator checks and confirms completion of these activities prior to arrival of factory approved service personnel to minimize the time it takes to complete burner-boiler commissioning.

1. Check that boiler and auxiliary equipment installation has been completed in accordance with manufacturer instructions.
   - ☐ Boiler feedwater pumps are installed and operational to specified pressure.
   - ☐ Water level columns and wiring
   - ☐ Fuel pressure regulator installed and operational to specified pressure
   - ☐ Boiler hydrostatic test completed
   - ☐ Fuel valves and components shipped loose are installed and operational
   - ☐ Atomizing air compressor installed and operational
   - ☐ For thermal heaters, thermal fluid system installed and operational

2. Check that fuel and atomizing air/steam lines are clean and free of any debris.
   - ☐ Strainers provided to prevent debris into fuel valves and safety devices
   - ☐ Insulation installed on hot lines. ☐ Fuel oil (if applicable). ☐ Atomizing steam (if applicable)
   - ☐ Atomizing steam line (if applicable) trapped to insure dry steam

3. Check that air fan motor has been properly wired and air fan is operational.
   - ☐ Check proper air fan rotation
   - ☐ If fans are by others, confirm they've been properly balanced

4. Check that the burner control panel has been completely wired per STJ wiring diagrams.
   - ☐ Wiring between STJ control panel and junction box(es) completed and correct per electrical diagrams.
   - ☐ All field devices supplied loose are properly installed and piped.
   - ☐ All field devices are properly wired to control panel and junction box(es) per STJ wiring diagrams.

5. Check flow measuring devices that will be used to check boiler capacity are installed and operable.
   - ☐ Steam flow
   - ☐ Feedwater flow
   - ☐ Gas fuel flow
   - ☐ Fuel oil flow

6. Check that provisions have been made for full load testing or venting.

7. Check there an ample fuel supply to operate burner and pilot to full load.

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8. On gas fired units, check that gas supply pressure to STJ-provided regulator matches required gas pressure on the burner name plate and/or the burner instruction manual.

9. Check any items supplied with the burner that are damaged, missing or defective have been replaced.

10. Check recommended taps and/or indicators are available for following indications.
    - ☐ Gas supply pressure
    - ☐ Gas pressure at burner
    - ☐ Fuel oil supply pressure
    - ☐ Fuel oil pressure at burner
    - ☐ Fuel oil temperature (if applicable)
    - ☐ Atomizing air/steam supply pressure
    - ☐ Atomizing air/steam pressure at burner
    - ☐ Windbox pressure
    - ☐ Furnace pressure
    - ☐ Stack draft pressure
    - ☐ Stack temperature

11. Confirm that qualified boiler operators are available for burner-boiler commissioning.

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CAUTION!

Only factory authorized and trained personnel should attempt to commission or service this burner system.

It is the responsibility of the installer to:

1. Verify the closed position of all actuated devices.
2. Verify proper rotation of all actuated devices.
3. Set the correct servo rotation and span adjustment according to the manufacturers' instructions.

These steps must be followed prior to initial commissioning, and anytime a servo or valve has been serviced, removed, or replaced.

IMPORTANT! All setscrews must be securely tightened and the coupling securely pinned to all gas valve, oil valve, and air damper shafts AFTER FINAL COMMISSIONING.

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NOXMATIC AXIAL FLOW BURNER
INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

CUSTOMER:

JOB NAME:

SHOP ORDER #:

P.O. #:

MODEL:
FIRING RATE:
EMISSIONS TARGET:
FLAME SAFEGUARD:
FUEL AIR CONTROL:
VFD:
MOTOR HP/ VOLTAGE:
ELECTRICAL SCHEMATIC:
GAS TRAIN:
REGULATOR:
ACTUAL DEAD ZONE DIM:
FIRING HEAD DEAD ZONE:
FIRETUBE DIAMETER:

OPTIONS:
VACUUM GAUGE/SWITCH:
OIL BACKUP:

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NOTICE: This manual is provided to supply general information on the installation, operation and maintenance of the NOXMATIC burner system. The burner must be installed and operated by trained personnel, guided by generally accepted industry practice. Do not attempt to operate the burner without familiarizing yourself with these instructions and the manufacturer's instructions for all components in the system. Failure to do so can result in personal injury, loss of life and damage to property.

Specifications and procedures are subject to change without notice. Please consult factory for older unit specifications, or whenever the equipment supplied does not match descriptions in this manual.

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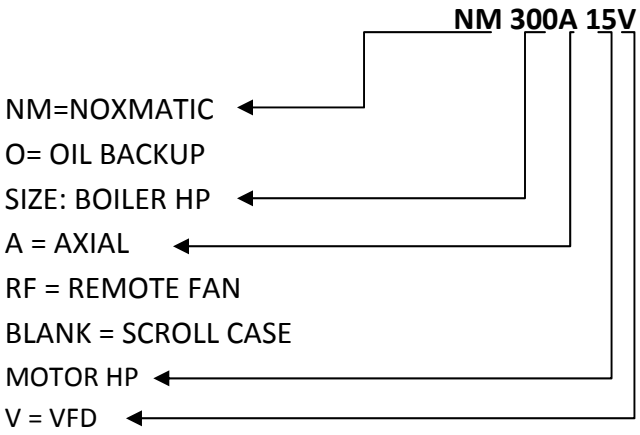
MODEL: NOXmatic type A
Ultra Low NOx
Gas Burners

OVERVIEW

The NOXMATIC A series of burners is based on the trademark Johnson high performance axial flow design. This incorporates a swing open housing that allows easy access and maintenance. The standard configuration uses a variable frequency drive to control air flow, with a gas mixing manifold and metal fiber firing head. The structure of the firing head creates the correct pressure drop to anchor the flame on the outside surface of the fiber material.
With proper maintenance this will easily and reliably give ultra low NOx readings with no FGR.

MODEL DESIGNATIONS



ORDERING INFORMATION

The following information is required to process orders or quotations:

All systems:
Burner Model desired.
Burner capacity of boiler HP.
Type of boiler or furnace.
Furnace pressure to be fired against.
Electrical specifications.
Elevation (if greater than 2,000 ft.)
Insurance or local code requirements.
Control system programmer desired.
Control options desired.
Emissions requirements.

Gas systems:
Type of gas.
Gas supply pressure at burner installation.

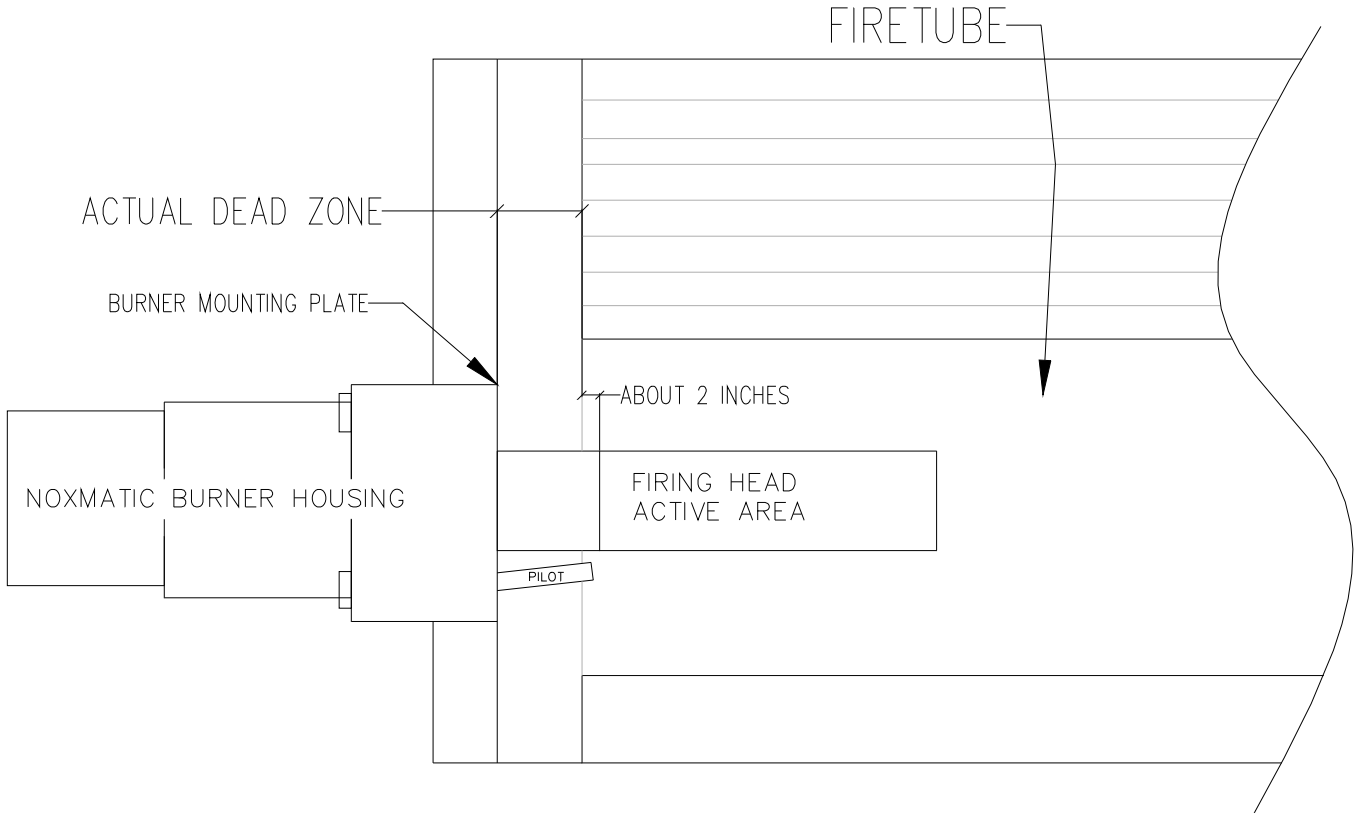
Important Dimensions: The firing head needs to be custom made to fit the boiler. This is the "dead zone" dimension.
For a fire tube boiler: the dimension from the furnace mounting flange to the boiler tube sheet.
For a water tube boiler: the thickness of the front wall.

Contact your sales representative for more information.

IMPORTANT DIMENSIONS:

The firing head needs to be custom made to fit each application.
There will be an inactive zone between where the burner is mounted, and the inside of the fire tube or water tube where the heating area will be. We are calling this the “dead zone”.
As shown on the diagram below, the “actual dead zone” is the measurement from where the burner will be mounted, to the edge of the tube sheet.
The “firing head dead zone”, or the inactive area on the firing head, will be the “actual dead zone” plus 2 inches. This dimension is in whole inches only.

The diameter of the firetube is important as well. There needs to be a minimum of 4-6 inches around the firing head. If the firing head is too close to the side walls there will be flame impingement, and it may not meet emissions. The diameter of the firing head will need to be sized accordingly.



NOXMATIC SERIES
GAS BURNERS
INSTALLATION OVERVIEW

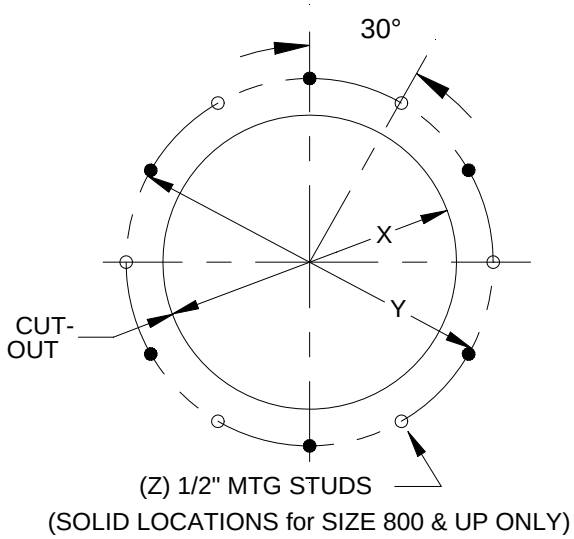
WARNING: LIFTING

Both the windbox (stationary cylinder) and the swing away fan assembly (swing cylinder) have provision for installing a lifting lug, however the burner must always be lifted by placing a lifting eye on the windbox. The entire burner assembly should NEVER be lifted by the swing cylinder only as this will cause unnecessary strain on the hinge assembly.

BURNER MOUNTING DIMENSIONS

Burner Size	X CUT OUT	Y BOLT CIR.	Z BOLTS
100-150	11	21 ¼	6
200-238	13	30 ¼	6
250-300	17	30 ¼	6
350-400	18	35 ¼	6
500-600	22	39 ½	12
700-800	24	39 ½	12
1000-1200	28	51 ¾	16

All dimensions in inches.



(SOLID LOCATIONS for SIZE 800 & UP ONLY)

INSTALLATION GUIDELINES

- The mounting cut out area must be large enough to allow the firing head to pass through easily, and there must be adequate clearance for the pilot tube.

- The area around the firing head must be packed with Kaowool or similar, with a suggested minimum depth of 4". Note that the active area of the firing head is slightly raised compared to the dead area. The insulation should be as tight as possible against the firing head dead zone, but will still allow the firing head to be removed if necessary.

- The area around the pilot tube must be packed with Kaowool or similar.

- The dead zone on the firing head should extend past the insulation by 2"- a minimum of 1".

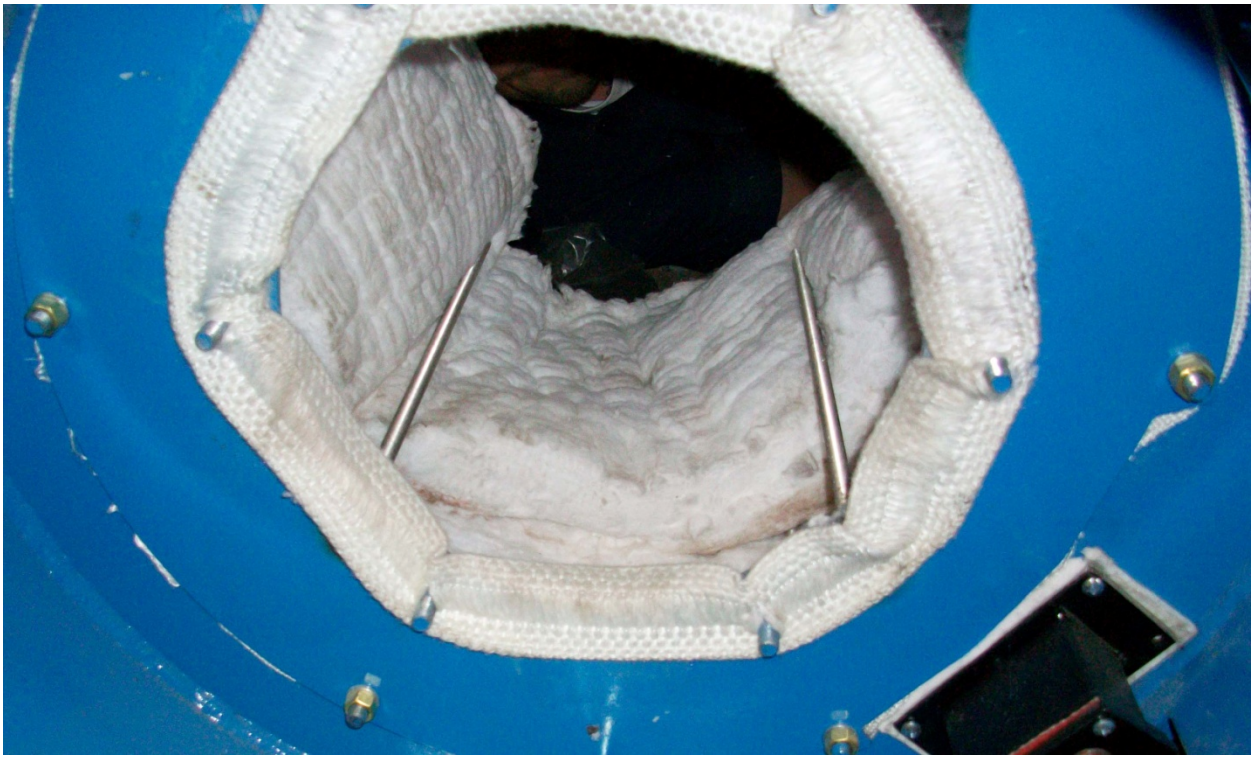
IMPORTANT:
DO NOT DAMAGE THE FIBERMAT FIRING HEAD DURING INSTALLATION.
It is strongly suggested that two or more people be used to install the firing head. On the larger sizes, it is ABSOLUTELY NECESSARY, and is strongly suggested that one person be inside the boiler during installation to help guide and protect the firing head from damage.

WARNING: Damage to the firing head or the metal fibermat surface voids all warranties and could result in damage to property and serious injury.
WARNING: Do not attempt to repair damaged firing heads.
WARNING: Do not attempt to fire damaged firing heads.

- The firing head should have a high temperature gasket between it and the mounting flange. This is installed at the factory. There should be a second gasket between the firing head flange and the firing head extension tube. This is installed in the field.

INSTALLING THE INSULATION

The **actual dead zone dimension** is the area between where the burner/firing head mounts, to where the start of the fire tube is.
On a water tube boiler, this is equal to the thickness of the front wall.
This dimension is going to be different for almost every installation, and the firing head and pilot need to be made custom for each job.
The **firing head dead zone** is the actual dead zone plus 2". This is designed so that the active area will be 2" inside the firetube.
NOTE: This dead zone area needs to be packed with Kaowool (or similar) fiber insulation.
NOTE: There needs to be a way to attach the Kaowool, to prevent it from falling out.



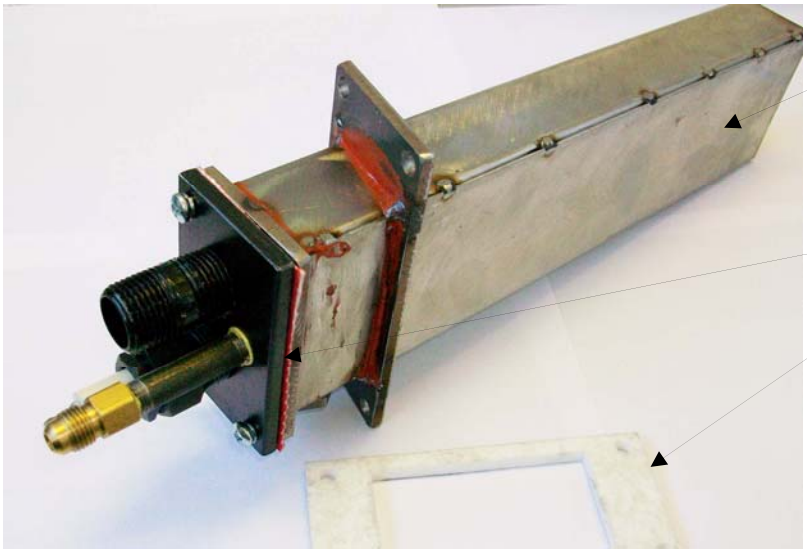
This picture is of an installation on a fire tube boiler. (Note: incomplete by 1 layer of wool.)
The width of the Kaowool is a maximum of 2" and a minimum of 1" shorter than the dead zone dimension on the firing head. The Kaowool should be at least an inch away from the active area on the firing head; otherwise you might get flame impingement and poor emissions.
Note the stainless steel all thread. This is to gently hold the wool in place.

This is the inside view of the same installation with the firing head installed.
The gap in the center of the Kaowool is just large enough to allow the firing head to pass through. If the opening in the center is too large, this will expose the deadzone to excessive heat and may cause premature failure. If the wool is packed tightly against the deadzone, it will make the firing head unnecessarily difficult to remove.

NOTE: The firing head will be shipped with a plastic covering on it. This will protect the firing head when it is being installed, and allow it to slip through the insulation easily and without trouble. It must be removed after the firing head is installed.

This is a picture of a watertube installation.
NOTE: The width of the Kaowool is the thickness of the front wall.
This was anchored into the wall itself, and does not need any all thread as did the firetube installation.

PILOT

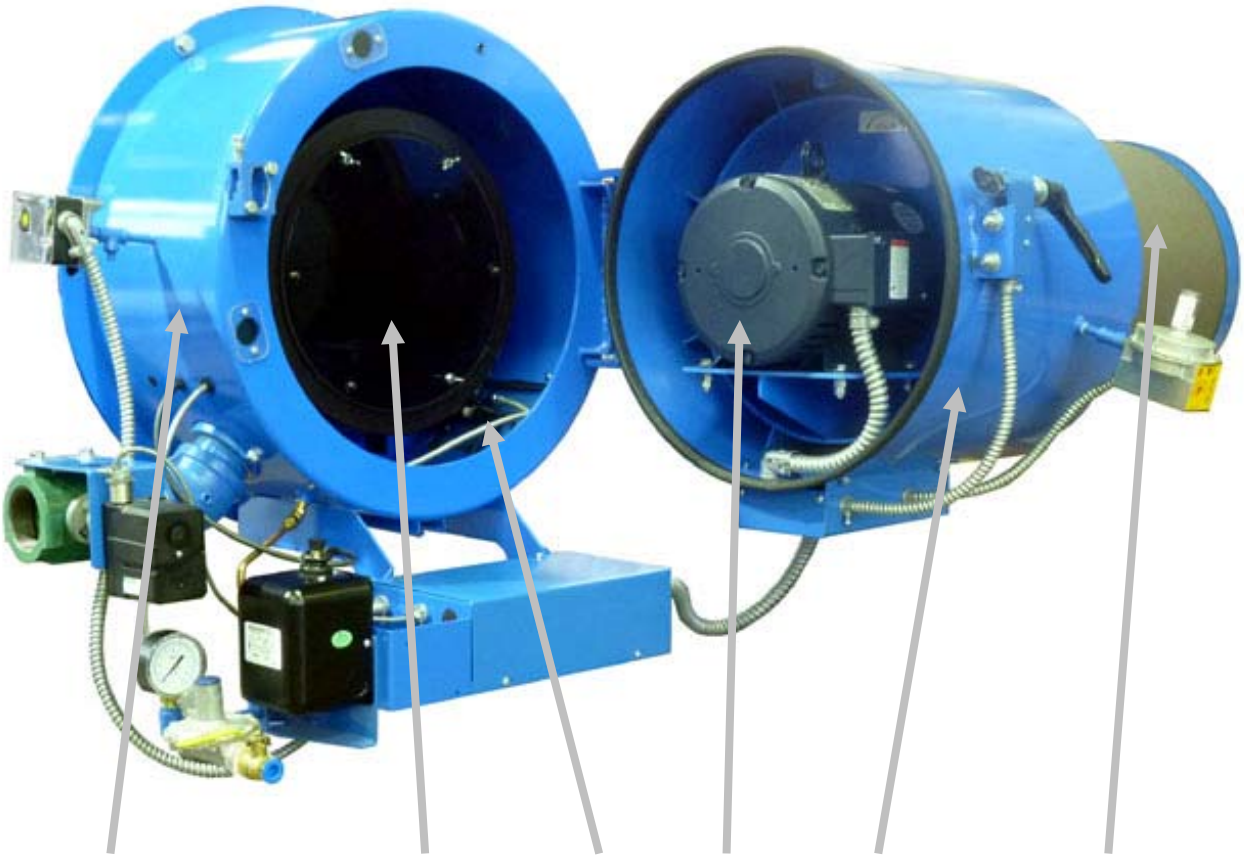


The NOXmatic pilot is a two piece assembly with the pilot and the pilot sleeve. The entire pilot assembly needs to be custom built to match the length of the burner dead zone dimension.

The pilot assembly will be installed with the angle facing towards the firing head, and with the scanner on the top. The pilot sleeve is designed to stay in place with the burner when installed, and the pilot itself can be removed separately through the access hole in the side of the housing.

The ignition electrode forms a spark gap with the edge of the pilot flame retainer, always verify that this spark gap is correct. This should be 1/16” to 1/8”. On installations with a very long pilot it is critical that this spark gap doesn’t change when the pilot is installed.

ASSEMBLY OVERVIEW



STATIONARY CYLINDER GAS MANIFOLD PILOT MOTOR SWING CYLINDER AIR FILTER

SEQUENCE OF INSTALLATION:

Note: The NOXMATIC burner will come from the factory with the gas manifold assembled as complete, with the firing head shipped separately. In all cases, this must be removed in order to install the firing head, BUT in some cases it will be necessary to have the gas manifold and the gas inlet in place in order to plumb the gas supply lines.
It is suggested to leave the gas manifold in place, to correctly locate the gas inlet, which is needed to run the gas supply piping. Once the supply piping is in place, then the gas manifold may be removed, so the firing head can be installed.

WARNING:
DO NOT TRY TO INSTALL THE FIRING HEAD TO THE BURNER, AND MOUNT IT IN ONE PIECE. IF THE FIRING HEAD IS DAMAGED, IT CAN NOT BE REPAIRED.

ASSEMBLING THE GAS MANIFOLD AND FIRING HEAD:
Note: The gas manifold and extension tube will need to be removed to install the firing head. The sequence of components, listed as going from the mounting plate outward:
1. High temp gasket (provided)
2. Firing head
3. Gasket
4. Firing head extension tube

Note: These share the same bolt pattern. The extension tube has one bolt hole cut out for clearance, so that nut can be used to hold the firing head in place during installation. Orient this so that it is towards the bottom of the assembly.
5. Gas manifold. Note: the access plate on the gas manifold should be OFF during installation. The gas manifold has 3 rods that push up against the mounting flange to set the depth. The diameter should be centered on the firing head. The manifold has 3 mounting tabs that line up on center with tabs welded on the inside of the stationary cylinder. The linkage bars can be on either side of these tabs. There is some room for adjustment, but it should be flat against the front and centered.
VERY IMPORTANT: The rubber gasket on the inlet pipe should be tight and properly seated.
6. The swirler goes inside the firing head, the arms attach with two bolts that screw into the sides of the extension tube. The depth is adjustable and will be set during commissioning.
7. Gas manifold access plate

SWING CYLINDER HINGE AND LATCH ADJUSTMENT

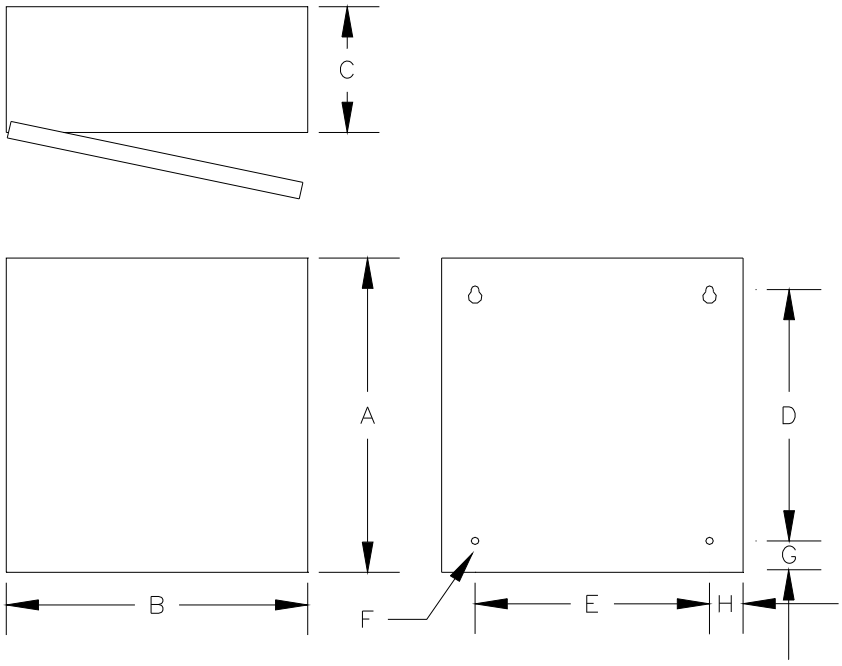
Jarring during shipment can cause misalignment of the swing-away blower assembly to the windbox, or of the latch lug to the latch lock. The blower assembly is aligned to the windbox with adjusting bolts on the hinges; the weight of the blower assembly must be supported should it become necessary to loosen the fastening bolts for readjustment.
The latch assembly can be readjusted in both the horizontal and vertical directions after loosening the mounting screws. The latch lug can also be adjusted to insure tight closure of the blower assembly to the windbox by loosening the jam nut behind the lug and threading the lug closer to, or farther away from the latch lock.
The position of the latch handle relative to the latch lug can be changed by pulling out on the handle while pushing in on the end of the latch shaft and rotating the handle to the desired position.

CONTROL PANEL & SAFETY CONTROLS INSTALLATION

The control panel is furnished as a separate item and should be installed in a location other than immediately next to, or in line with the burner. It should be mounted on an adjacent wall or the side of the appliance. All wiring must comply with, and all branch circuits must be protected according to the national electrical code. Flame detector wiring between the burner and the control panel should be run in separate conduit from high voltage conductors.
All safety controls indicated on the wiring schematic furnished with the burner must be installed and wired in the control system as shown. Any discrepancies, or changes, must be approved by the S.T. JOHNSON CO. prior to initial firing of the burner system.
All signal wiring should be run in separate conduit and shielded according to the wiring schematic supplied with the equipment.

STANDARD CONTROL PANEL MOUNTING DIMENSIONS

The installation dimensions for standard NEMA 1 control panel enclosures follow. Specifications for other than NEMA 1 enclosures, and/or the inclusion of optional control equipment, may result in different installation dimensions. If mounting dimensions are critical, check with the factory for information on specific jobs.



DESIGNATION	A	B	C	D	E	F	G	H
STANDARD	24	24	7.25	22.5	22.5	.38	1.125	1.875
LARGE	30	24	7.25	28.5	22.5	.38	1.25	3.25
X-LARGE	36	30	7.25	34.5	28.5	.38	1.25	3.25

All dimensions in inches.

REQUIRED SAFETY LIMIT CONTROLS FOR ALL MODELS

All burner systems must be installed with a pressure or temperature operating control and high limit control. These controls must be installed on the appliance in a location where they can accurately sense the pressure of the vapor, or temperature of the liquid being heated. Contact the appliance manufacturer if unsure of the correct mounting location. The electrical wiring schematic furnished with the burner indicates where these controls need to be wired into the control system.

The operating control functions to limit the firing of the burner to those pressures, or temperatures, below the set point of the control. Its N.C. contacts break upon rise of the pressure, or temperature. Typical operating controls are:

Honeywell L404A for pressure **Honeywell L4006A** for temperature

The high limit control functions to shut off the burner system at a pressure, or temperature slightly above the set point of the operating control. The set point of the high limit control must be less than the maximum pressure, or temperature, or the appliance the burner is applied to. The N.C. contacts of this control break on a rise in pressure, or temperature, and must result in manual reset of the control to resume operation of the burner system. Typical high limit controls are:

Honeywell L404C for pressure **Honeywell L6006E** for temperature

If safety limit controls were not furnished with the burner system, or with the appliance on which the burner is being installed, contact S.T. JOHNSON CO. or the appliance manufacturer to obtain the proper controls for installation prior to initial firing of the system.

CONTROL SYSTEM OVERVIEW

The Noxmatic series burners may be furnished with almost any brand of controller requested. The preferred configuration will use a variable frequency drive to control the blower motor, and almost any brand of VFD can be used. The scope of this is beyond what may be covered in this manual, and one should refer to the individual manufacturer's documentation.

A typical system as shown in the photo would be a Fireye YB110 flame safeguard, Fireye PPC6000 fuel/air controller, and Allen Bradley variable frequency drive.

WARNING:
START UP AND TUNING SHOULD BE PERFORMED BY TRAINED PERSONNEL ONLY.

VERY IMPORTANT!
MAKE SURE EVERYTHING IS DUST AND DEBRIS FREE BEFORE STARTING THE BURNER.
Wipe down all surfaces. Make sure there is no construction dust anywhere inside the system.

WARNING:
Most Variable Frequency Drives cannot withstand ambient temperatures above 120 F (50 C). If you expect ambient boiler room temperatures to exceed 120 F, appropriate cooling must be installed.

GAS TRAIN INSTALLATION

SELECTION AND SIZING:
Gas trains are selected according to local code and insurance requirements. Components are sized according to available gas supply pressure, burner capacity, and furnace pressure. As a guide standard sizes are listed in the catalog bulletin along with the required outlet pressure of the main pressure regulator. Installation manuals for each job include drawings of the gas train furnished with the burner system.

LOCATION:
Gas trains should be located as close to the burner assembly as possible, preferably on the left side of the burner to facilitate easy connection to the gas control valve. Temperature limitations of all the components should be taken into account when mounting directly on the heating appliance. (Refer to the specifications and installation instructions furnished with the operating manual).

FIELD PIPING:
The piping should contain as few direction changes as possible between the main pressure regulator and the burner inlet to minimize the pressure drop. Proper sizing of components often results in a main pressure regulator with a smaller pipe size than the shut-off valves; this transition in pipe size should be made with a "bell type" reducer at least 4 pipe diameters downstream of the regulator outlet. Gas shut-off valves and regulators are all uni-directional and must be installed accordingly.

VENT CONNECTIONS:
Gas train assemblies to meet IRI code, and all gas trains for capacities greater than 12500 MBTU/hr, include a N.O. vent valve for installation between the (2) shut-off valves. This valve should be installed in a horizontal run of piping with the solenoid coil on the top. The pipe size of the vent line must be no smaller than the valve furnished with the burner system. Vent connections from all pressure regulators and pressure switches should also be vented to the outside of the building using 1/4" OD tubing as a minimum. All vent lines may be connected together but the size of the common vent line must be at least equal in area to the largest vent plus 50% of the area of the remaining vent lines.

WARNING:

All piping and gas train components must be leak tested prior to the initial start up of the burner system. The manual gas cock installed downstream of the shut-off valves is provided for this testing. Gas shut-off valves should be leak tested periodically to insure there is no leakage through the valve seats. It is recommended this leak testing be performed monthly.

GENERAL GUIDELINES:

Note the location of the high and low gas pressure switches.
The Low Gas Pressure switch goes on the supply side, before any regulator. This is to safeguard against a failure in the supply pressure. This is a normally open switch that closes on a high pressure. The pressure should be set at an amount over what is required, such that if the supply drops below that, the switch will open. Most Noxmatic installations require around 1 psi.
NOTE: Some literature suggests that the low gas pressure switch may be set as low as ½ of what is required for high fire. This will not work with the Noxmatic burner. The low pressure switch must be set to the minimum required for high fire, taking into account the pressure drops of the valve train.

The High Gas Pressure switch goes in line after the regulator. This is to safeguard against regulator failure. This is a normally closed switch that opens on a high pressure. This pressure should be set at an amount over what is required, such that if the regulator fails, the pressure will go high and the switch will open.

IMPORTANT:

If a Siemens SKP style regulator is used, the sensing line must be ¼" **I.D**., and as short and straight as possible. The sensing tap must be located at least 5 pipe diameters downstream. Do not install the sensing line with unnecessary bends. This is a common error that will result in poor pressure regulation.

Regulator pressure will be set by the commissioning technician.

GAS SUPPLY REQUIREMENTS:

Low NOx burners in general are more sensitive to changes in fuel supply than non-low NOx burners, and the Noxmatic is no exception. This type of burner operates within a very specific range, and fluctuations in the gas supply- either flow or pressure- will cause problems. In some cases there may be existing problems with the gas supply that were not noticed with an older, non-low NOx burner. It is suggested to pay special attention to the fuel supply and to make sure that there is enough flow and pressure to meet *all* the needs of the location.
Note that standard Siemens valves can only handle 10 psi typically, and if the pressure is too high a step down regulator will be needed.

BURNER START UP NOTES:

Burner commissioning requires that manometer readings must be taken for windbox pressure, gas manifold pressure, and air filter vacuum. The start-up process for the NOXmatic is not that different from other burner types, but one difference is that as a pre-mixed burner, a gas manifold 'pressure drop' figure is given for high fire reference rather than a gas manifold 'pressure'. This is done because furnace backpressures will vary from installation to installation. But this does mean that the manifold dP must be added to the burner dP (which includes the furnace backpressure) to get an expected figure for the gas manifold pressure at high fire. The process for determining this, and the subsequent steps, is outlined below:

1) The pressure measurement at the gas manifold inlet at purge will approximate the burner and furnace back pressure at HF, with the VFD at full Hz. The provided gas manifold dP is then added to this measured figure, with the combined total being approximately the expected gas manifold pressure at HF. Final HF settings should be based on a measured gas meter flow rate, of course, but this can be an initial figure to use for commissioning. It will also indicate at what level to set the outlet pressure from the regulator. A pressure that is roughly 50 percent higher pressure than this figure determined to be needed at the burner manifold should be supplied out of the gas valves, to account for gas control valve and other downstream component pressure drops, while still supplying adequate pressure at the burner. But if this initial setting needs to be adjusted due to inadequate gas capacity, it must be done.

2) The other two points to establish is the light off and low fire levels. They may be but aren't necessarily the same. The initial light off level will be either 1) one inch of air manifold pressure, or 2) the lowest VFD setting that can be achieved. Whichever occurs first can be the initial light off rate. The percent O2 in the stack should be approximately 8 percent, so note that an emissions analyzer is required for commissioning.

3) The light off rate can be used for low fire, but low fire can be adjusted – lower or higher - depending on repeatability and emissions performance. Turndown can be increased as long as the burner is operating well and the burner conditions and measurements are reliably repeatable. If the emissions, particularly the percent O2 level, are not consistently repeatable as the firing rate goes up and then back down, then low fire settings should be raised until it does become consistent.

4) With these reference points, a burner curve can be established. The general excess air (or percent O2) level for NOXmatic operation is 7.5-8 percent O2, and which should be fairly flat across the firing range. It might be somewhat higher than 8 percent at low fire, if emissions dictate, and lower (7.5 percent) at HF. Note that the higher the O2 level, the lower the NOx emissions will be. But O2 levels can be set based on local emissions requirements, with some margin for variation. Care should be taken to avoid going much less than about 5.5-6 percent O2 in the stack, as the flame begins to turn from blue flame to radiant as the O2 goes decreases, and the burner is not designed for radiant flame operation. This operating condition that will damage the head.

MAINTENANCE:

A simplification of the main principle of operation of the Johnson NOXMATIC Gas burner is that one is blowing premixed air and gas through a type of metal fiber mat (the firing head). So it is important that the firing head doesn't get clogged. This problem is solved by using an air filter on the intake. It is also important that the air filter doesn't get clogged. If the air intake filter and firing head are kept clean, the burner will give years of easy, trouble free, ultra low emissions performance.

WARNING: The control system is based on measurements taken during the pre-purge cycle. The burner must be cycled on and off at least once a day to insure all switches are working properly.

WARNING: After initial burner commissioning, maintenance and service personnel should not change the system configuration, including logic, set points, and sensing hardware, without a detailed engineering review and documentation. Failure to do so can result in damage to property, personal injury or death.

WARNING: After a safety shutdown, the burner should not be restarted until a trained operator determines the cause of the shutdown and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting. Failure to do so can result in damage to property, personal injury or death.

The purge setting manometer readings - windbox pressure, gas manifold pressure, and air filter vacuum - taken at commissioning provide the baseline measurements to determine if the head or air filter are getting clogged.

Also note the visual appearance of the flame and head surface. There should have uniform distribution of flame, with robust blue tips. When the firing head or air filter becomes clogged, the air flow drops, and it will run rich, and the flames will become more radiant – burning back into the fiber material and glowing orange, then yellow. A bit of orange spots on the surface is normal. If the whole surface it starts to become orange, or even yellow it means maintenance is needed. A yellow flame operating condition is dangerous and will drastically shorten the life of the firing head. If left for too long, the firing head will fail, creating an unsafe condition.
DANGER: Never let the firing head go radiant. This will severely shorten the life of the firing head and may cause catastrophic failure.

Note: Being able to look at the flame is an important safety and maintenance issue. Many installations have a poor or nonexistent sight glass. This must be fixed.

- The air filter foam pre-filter must be cleaned once a week at a minimum. It is standard to provide a second pre-filter, so one can be washed and dried, while one is in use.
WARNING: Do not change the pre-filter while burner is in operation.
WARNING: Do not install a wet pre-filter.

- The main air filter should be cleaned on a regular basis. It is suggested to do this once a month, but a site with much dust or particles in the air would need more frequent cleaning. This is done by blowing it out, from the inside out, with compressed air.
Depending on conditions, the air filter element may need to be washed. This should be done only as necessary, as the manufacturer recommends that a filter not be washed more than 2 or 3 times before replacement. If you keep the pre-filter and the air filter clean, you may never have to wash the air filter.

- It is suggested to have a second filter on hand as a replacement.

- An air filter vacuum switch is provided. This is there to provide notification that the air filter is dirty and needs to be cleaned. An increase in 0.5“ wc from a new, clean filter vacuum

condition, at purge, would be the maximum increase to allow for in setting the vacuum filter switch.

- The firing head should be cleaned at a pre-determined interval. As a baseline reference, once a month vacuum out the firing head. Cleaning may need to be more or less frequent depending on boiler site conditions.

The condition of the firing head is monitored by windbox pressure. A 1 "wc increase at full flow (purge cycle) indicates a clogging condition, and the firing head should be cleaned promptly. A simple vacuuming and gentle blow out should be sufficient. If this doesn't improve conditions, it will require that the head be repaired or replaced.
NOTE: Some sizes of firing head have a long manufacturing lead time, if boiler downtime is a serious concern it is recommended to purchase a second firing head to have on hand as a backup.

CONTROLS THEORY:

At purge (full air flow, gas off), manometer readings are taken on the windbox and gas inlet connection. This is the baseline measurement.

As the firing head gets clogged it creates more resistance to flow and the pressure at purge will RISE. A 1" rise in windbox pressure indicates that the firing head needs maintenance.
As the air filter gets clogged it can't draw enough air and the windbox pressure at purge will DROP. A 1" drop in windbox pressure indicates a problem with the air filter.
An alternate method is to measure vacuum at the air filter. When vacuum INCREASES by 0.5" from the initial, new filter condition purge measurement, the air filter needs to be cleaned or replaced.

IMPORTANT:

EQUIPMENT WILL NOT BE COVERED BY WARRANTY UNLESS THIS FORM IS COMPLETELY FILLED OUT AND A COPY RETURNED TO THE MANUFACTURER.

COMMISSIONING DATA: GAS

DATE:		TIME:	
MODEL:		S.O. #:	
CUSTOMER:		TECHNICIAN:	
LOCATION:			

Boiler Data	MAKE:	
	SIZE:	
	SETPOINT:	
	MAX. PRESSURE:	

	SETPOINT	PURGE	IGNITION	1	2	3	4	5	6	7	8	9	10
Curve Data	VFD HZ												
	AIR												
	FUEL												
	FGR												
Flows	FUEL: GAS												
	TYPE:												
Pressures	GAS MANIFOLD												
	MAIN GAS												
	WINDBOX												
	FURNACE												
Emissions	O2												
	CO												
	NOx												
	CO2												
	WB O2												
Temps	STACK												
	WINDBOX												
	AMBIENT												
Flame Signal													
Motor	VOLTAGE												
	AMPERAGE												

Gas Supply	MAIN PRESSURE	
	REGULATED PRESS	
	LINE SIZE	

Gas Switch Settings	LOW	
	HIGH	

Air Switch Settings	LOW	
	HIGH	
	VACUUM	

NOTES:

Component Literature & Technical Instructions

SIEMENS

Technical Instructions July 10, 2015

LMV5... Linkageless Burner Management System

Combustion Controls

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Section 1 **Overview**

Section 2 Wiring

Section 3 Parameters

Section 4 Commissioning

Section 5 VSD

Section 6 O_2 Trim

Section 7 Troubleshooting

Section 8 Modbus

Section 9 ACS450

Section 10 Revision History

Appendix A Application Guide

Appendix B* Complimentary Products Guide

*Can be found at www.scccombustion.com.

Section 1 **Overview**

Section 2 Wiring

Section 3 Parameters

Section 4 Commissioning

Section 5 VSD

Section 6 O_2 Trim

Section 7 Troubleshooting

Section 8 Modbus

Section 9 ACS450

Section 10 Revision History

Appendix A Application Guide

Appendix B* Complimentary Products Guide

*Can be found at www.scccombustion.com.

1-1: Introduction

The LMV5 Burner / Boiler Management System (BMS) is ideally suited for use with steam boilers, hot water boilers, thermal fluid heaters, and industrial burners. The LMV5 is extremely flexible, and encompasses the following features:

- Flame safeguard (independent processor)
- Fuel-air ratio control
- Load control / full PID control for pressure or temperature
- Integrated O_2 trim
- Variable Frequency Drive (VFD) control
- Fuel usage monitoring
- Efficiency monitoring
- Simultaneous operation of up to 5 rotary actuators (up to 6 connected)
- Dual setpoints
- Modbus communication
- Remote setpoint or remote firing rate from building automation or external controller
- Flue gas recirculation hold functions (LMV52)
- Thermal shock protection
- Valve proving / valve leak testing
- Dual flame scanner options

Figure 1-1.1: The Main Components of an LMV5 System

1-2: LMV5 System Builder

The LMV5 Linkageless Burner Management System is comprised of many components in addition to the LMV5 itself. Use the following pages to choose the components needed for your specific application. See pages 19-21 for an LMV5 system order sheet. For additional technical information about any of the products listed, refer to Appendix B.

Control Panel Components

Base Unit – Qty (1) Required

Choose one of the following LMV5 options. See page 23 for mounting information.

LMV51.040C1	Dual fuel burner control with electronic fuel-air ratio control of up to 3 actuators (4 connected). Requires an external PID controller
LMV51.140C1	Same features as LMV51.040C1. Includes a PID load controller capable of temperature and / or pressure control and a programmable analog output
LMV52.240B1	Same features as LMV51.140C1 for up to 5 actuators (6 connected**)**. Includes a closed loop VFD control, integrated O_2 trim, fuel meter reading (gas and oil), and temperature / time based FGR hold
LMV52.440B1	Same features as LMV52.240B1 as well as enhanced O_2 trim control designed for low NO_x mesh-style pre-mix burners and high percentage FGR (>25%) applications

Transformer – Qty (1) or (2) Required

At least one transformer is required per LMV5. A second transformer may be necessary depending on the size and number of actuators present in the system (see Section 2 – Wiring). Refer to page 25 of this section for mounting information.

AGG5.210	120 VAC to 12 VAC transformer (three secondaries)

Control Panel Components (continued)

Display – Qty (1) Required

Each LMV5 must be equipped with one AZL52.40B1 display. See page 24 for mounting information and panel cutout dimensions.

	AZL52.40B1	Display with Modbus port, PC port, backlight, six languages available

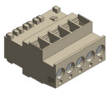
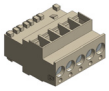
Display Cable – Qty (1) Required

Each LMV5 must be equipped with a cable to connect the AZL52 display to the LMV5.

	AGG5.635	Pre-made 9 foot cable for connecting the AZL52 display to the LMV5

Base Plug Set – Qty (1) Required

The terminal plug sets for the LMV5 are sold separately. Each LMV5 needs one base plug set. Additional plug sets are available (see "Control Panel Spare Parts").

	**AGG5.720**	Plug set containing all terminals for a typical LMV5 system. Will accommodate a system with O_2 trim, three actuators, one transformer, and no fuel meters
	**AGG5.7COMPLETE**	Plug set containing all terminals necessary for a maximum LMV5 system. Will accommodate a system with a VFD, O_2 trim, six actuators, two transformers, and two fuel meters

Strain Relief – Qty (1) Required

A strain relief is required to ground the CANbus shield to the LMV5.

	AGG5.110	Strain relief and actuator CANbus grounding

Control Panel Components (continued)

Touchscreens – Optional

Touchscreen kits are available to provide a human machine interface for the LMV5. Kits come with a touchscreen and a plate kit with all necessary inputs and outputs. Standard communication is via Modbus TCP/IP. Other communication types are available. For more technical information about touchscreens, refer to Document No. TS-1000.

	TS…	Touchscreen kits with 6” or 10” touchscreen, power supply, interconnect terminals, and optional PLC

LMV5 Mounting Brackets – Qty (2) Recommended But Not Required

Recommended brackets for mounting the LMV5 in an electrical enclosure to offset the base unit from the subpanel, allowing easy access to plugs. Two brackets are needed per LMV5.

	BR-LMV5	Brackets for mounting an LMV5 in an electrical enclosure

Control Panel Spare Parts – Not Required

The LMV5 has three replaceable fuses: one main power fuse and two secondary CANbus fuses. Each LMV5 comes with spares for each fuse. Additional spare fuses are available if necessary.

	FUSE6.3A-SLOW	5 pack of LMV5 primary fuses - 6.3A, 250V, 5x20mm, slow blow, for 120 VAC power
	FUSE4.0A-SLOW	5 pack of LMV5 secondary CANbus fuses – 4.0A, 250V, 5x20mm, slow blow, for 12 VAC power

Replacement green connectors are available if necessary. 4-pin connectors are for terminals X52, X71, and X72. 5-pin connectors are for terminals X60, X61, X62, X70, and on each actuator and O_2 module. 6-pin connectors are for terminals X50, X51, and X73.

	1840382(5)	5 pack of spare 4-pin green connectors
	1840395(5)	5 pack of spare 5-pin green connectors
	1840405(3)	3 pack of spare 6-pin green connectors

Control Panel Components (continued)

An extra set of transformer terminals is required if using a second transformer.

	AGG5.2PLUGS	Extra set of terminals for a second transformer (PRI, SEK1, SEK2)

An optional spark quencher is available to reduce voltage spikes typically caused by closing a normally open vent valve.

	XEB0471	Spark quencher for reducing voltage spikes

An optional converter is available to allow communication between RS-485 devices and the LMV5 which utilizes the RS-232 communication protocol.

	TS-X4CX-XXXXX	RS232 to RS485 DIN rail converter kit

Air Damper Assembly

Actuator – Qty (1) Required

Choose one of the following actuators for the air damper. For more information, refer to Document No. N7814 (SQM4… actuators) or Document No. N7818 (SQM9… actuators).

SQM45.295A9	27 in-lb torque, 10mm “D” shaft, 10-120 seconds
SQM48.497A9	177 in-lb torque, 14mm keyed shaft, 30-120 seconds
SQM48.697A9	310 in-lb torque, 14mm keyed shaft, 60-120 seconds
SQM91.391A9	600 in-lb torque, 25mm keyed shaft, 30-120 seconds

Coupling – Qty (1) Required (Provided With Some Mounting Brackets – See Below)

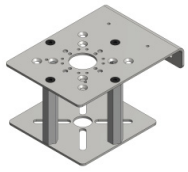
Zero-lash, flexible couplings are available for each actuator. For more information, refer to Document No. CPBK-1000.

CCM10DCA…	Flexible couplings for SQM45… actuators
CFM14KCB…	Flexible couplings for SQM48… actuators
CJM25KCA…	Flexible couplings for SQM91… actuators

Air Damper Assembly (continued)

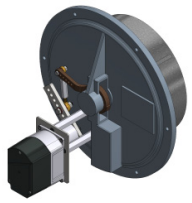
Mounting Bracket Kits - Optional

Modular bracket kits are available to assist in mounting any SQM… actuator to a variety of valves or air dampers. A coupling is necessary when using a modular bracket kit. For more information, refer to Document No. CPBK-2000.



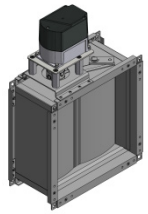
BR-AS…	Modular bracket kits for mounting SQM… actuators to a variety of valves or dampers

When retrofitting a Cleaver Brooks boiler, the following kits are available for the rotary air damper. No additional couplings are needed with these retrofit kits. Refer to Document No. CPBK-4000 for technical information or Document No. CPBK-4100 for installation instructions.



BR-48CBAIR	Bracket for mounting an SQM48… actuator to a Cleaver Brooks rotary air damper
BR-3345CBAIR	Bracket for mounting an SQM45… actuator to a Cleaver Brooks rotary air damper

When using a Lucoma air damper, the following actuator mounting kits are available. No additional couplings are needed with these mounting kits. Refer to Document No. CPBK-3000 for technical information or Document No. CPBK-3100 for installation instructions.



BR-SQM48-LUC	Bracket for mounting an SQM48… actuator to an 8x8 through 28x28 Lucoma air damper
BR-SQM3345-LUC	Bracket for mounting an SQM45… actuator to an 8x8 through 28x28 Lucoma air damper

Gas Firing Rate Control Valve

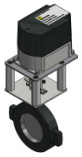
Valve Actuator Assemblies – Qty (1) Required if Firing Gas

Pre-built valve actuator assemblies are available that mount an SQM45… actuator to a VKG… gas butterfly valve. A variety of VKG… valves are available from 1/2" to 4". For more information about VKG… valves, refer to Document No. CVLV-2000. For more information about valve actuator assemblies using VKG… valves, refer to Document No. VA-1000.

VA45.2-NF-050	SQM45 to 1/2" full port firing rate valve
VA45.2-NF-075	SQM45 to 3/4" full port firing rate valve
VA45.2-NF-100	SQM45 to 1" full port firing rate valve
VA45.2-NM-100	SQM45 to 1" medium port firing rate valve
VA45.2-NF-125	SQM45 to 1-1/4" full port firing rate valve
VA45.2-NM-125	SQM45 to 1-1/4" medium port firing rate valve
VA45.2-NF-150	SQM45 to 1-1/2" full port firing rate valve
VA45.2-NM-150	SQM45 to 1-1/2" medium port firing rate valve
VA45.2-NR-150	SQM45 to 1-1/2" reduced port firing rate valve
VA45.2-NF-200	SQM45 to 2" full port firing rate valve
VA45.2-NM-200	SQM45 to 2" medium port firing rate valve
VA45.2-NR-200	SQM45 to 2" reduced port firing rate valve
VA45.2-NF-250	SQM45 to 2-1/2" full port firing rate valve
VA45.2-NM-250	SQM45 to 2-1/2" medium port firing rate valve
VA45.2-NR-250	SQM45 to 2-1/2" reduced port firing rate valve
VA45.2-NF-300	SQM45 to 3" full port firing rate valve
VA45.2-NM-300	SQM45 to 3" medium port firing rate valve
VA45.2-NR-300	SQM45 to 3" reduced port firing rate valve
VA45.2-NF-400	SQM45 to 4" full port firing rate valve
VA45.2-NM-400	SQM45 to 4" medium port firing rate valve
VA45.2-NR-400	SQM45 to 4" reduced port firing rate valve

Gas Firing Rate Control Valve (continued)

Pre-built valve actuator assemblies are available that mount an SQM45… or SQM48… actuator to a VKF… gas butterfly valve. A variety of VKF… valves are available from 1-1/2" to 8". The most common assemblies are listed below. For more information about VKF… valves, refer to Document No. CVLV-1000. For more information about valve actuator assemblies using VKF… valves, refer to Document No. VA-3000.

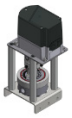


VA45.2-3.0VKF	SQM45 to 3" VKF butterfly valve
VA45.2-4.0VKF	SQM45 to 4" VKF butterfly valve
VA45.2-6.0VKF	SQM45 to 6" VKF butterfly valve

Oil Firing Rate Control Valve

Valve Actuator Assemblies – Qty (1) Required if Firing Oil (Not Using a Cleaver Brooks Oil Valve)

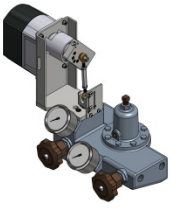
Pre-built valve actuator assemblies are available to mount an SQM45… or SQM48… actuator to a Hauck S, AS, B, F, G, or K series oil valve. For more information about valve actuator assemblies using Hauck oil valves, refer to Document No. VA-4000.



VA…	Valve actuator assemblies mounting an SQM45… or SQM48… actuator to a Hauck oil valve

Cleaver Brooks Oil Valve Retrofit Kit - Optional

When retrofitting a Cleaver Brooks boiler, the following kits are available for the oil metering valve. Refer to Document No. CPBK-5000 for technical information or Document No. CPBK-5100 for installation instructions.

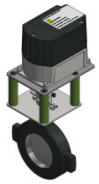


BR-48CBOIL	Bracket for mounting an SQM48… actuator to a Cleaver Brooks oil metering valve
BR-45CBOIL	Bracket for mounting an SQM45… actuator to a Cleaver Brooks oil metering valve

FGR Control Valve

Valve Actuator Assemblies – Qty (1) Required if Using FGR

Pre-built FGR valve actuator assemblies are available to mount an SQM45… or SQM48… actuator to a high-temperature VKF… butterfly valve. The most commonly used assemblies are listed below. For a list of all assembly options, see Document No. VA-3000. For more information on VKF valves, refer to Document No. CVLV-1000. Contact SCC if an FGR valve actuator assembly larger than 8" is required.



VA48.4-3.0VKF-HT	SQM48 to 3" high-temp VKF valve assembly
VA48.4-4.0VKF-HT	SQM48 to 4" high-temp VKF valve assembly
VA48.4-6.0VKF-HT	SQM48 to 6" high-temp VKF valve assembly
VA48.4-8.0VKF-HT	SQM48 to 8" high-temp VKF valve assembly

Actuator Accessories

CANbus Cable – Qty (1) Required

Special cable is used to connect the actuators and O_2 module to the LMV5. This cable may be purchased in 100' or 500' rolls.

AGG5.643(100)	100' roll of CANbus cable
AGG5.643	500' roll of CANbus cable

Electrical Cable Cord Grips and Conduit Adapters – Qty (2) Required Per Actuator

SQM45…, SQM48…, and SQM91… actuators come with two M16 threaded electrical connections. Various adapters are available to convert these connections to an English thread. One short and one long adapter are recommended per actuator to offset conduit connections.

ADP-M16XE500(5)	5-pack of short M16 to 1/2" NPSM metal conduit adapters, compatible with liquid tight or EMT fittings
ADP-M16XE500-LONG(5)	5 pack of long M16 to 1/2" NPSM metal conduit adapters, compatible with liquid tight or EMT fittings
7466201040	M16 to 1/2" NPSM nylon conduit adapter, compatible with liquid tight or EMT conduit fittings
7466200470	M16 nylon cord grip

Flame Scanners

Infrared Flame Scanners – Qty (1) Required Unless Using a QRA75.A17 Flame Scanner

Two infrared flame scanners are available: one side viewing and one forward viewing. For technical information about QRI… flame scanners, refer to Document No. N7719.

	QRI2A2.B180B	Self-check infrared flame scanner, forward viewing
	QRI2B2.B180B	Self-check infrared flame scanner, side viewing

Ultraviolet Flame Scanners – Qty (1) Required Unless Using a QRI… Flame Scanner

One ultraviolet flame scanner is available for use with the LMV5. For technical information about the QRA75… flame scanner, refer to Document No. N7712.

	QRA75.A17	Self-check ultraviolet flame scanner, side viewing, supplied with mounting clamp

Flame Scanner Accessories

QRA75 Wiring Cable – Qty (1) Required per QRA75.A17 Flame Scanner

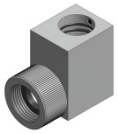
A pre-made 12 foot cable is required when using the QRA75 flame scanner. For more information, refer to Document No. N7712.

	AGM23U	Pre-made 12 foot cable for use with the QRA75… flame scanner, supplied with 1/2” NPSM conduit adapter.

Flame Scanner Accessories (continued)

QRI… Accessories - Optional

Mounting accessories are available for both the forward viewing and side viewing QRI… flame scanners. For more information, refer to Document No. N7719.

	AGG2.110	Kit for mounting forward viewing scanner QRI2A2.B180B on a flame tube. Comes with clamp, mounting sleeve, thermal barrier with 3/4” NPSM connection, and heat insulation lens
	AGG2.120	Pg9 thread to 1/2” NPSM conduit connection adapter for use with any QRI… flame scanner
	**AGG90.U**	Right angle adapter for mounting side viewing scanner QRI2B2.B180B on a flame tube. Comes with 3/4” NPSM female thread connection

QRA75… Accessories - Optional

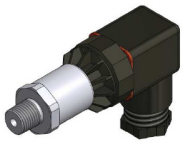
Mounting accessories are available for the QRA75… flame scanner. For more information, refer to Document No. N7712.

	AGG16.U	Right angle adapter for mounting a QRA75 flame scanner. Comes with a 1” NPSM female thread connection
	THERMAL-1X75	Thermal barrier for use with the QRA75 flame scanner along with accessory AGG16.U. Adapts a 1” NPSM thread to a female 3/4” NPT connection
	AGG02	Heat insulating lens with spring washer and O-ring, for applications where the temperature at the scanner will exceed 176 °F, to be mounted inside thermal barrier THERMAL-1X75
	AGG03	Magnifying lens with spring washer and O-ring for increased sensitivity, to be mounted inside thermal barrier THERMAL-1X75

Sensors

Pressure Sensors – Qty (1) Required for Steam Boilers

A wide range of pressure sensors is available for steam boilers. All sensors have a 1/4" NPT process connection and a 1/2" NPT conduit connection. Sensors are available with either a 4-20 mA or 0-10 Vdc output signal. All available 4-20 mA sensors are listed below. To order a 0-10 Vdc sensor, change the underlined digit to a 1. The 0-100 PSI sensor is only available with a 4-20 mA signal. For more information on 7MF pressure sensors, refer to Document No. SEN-2000.



7MF1565-4BB00-5EA1	0-15 PSI range, 4-20 mA signal
7MF1565-4BE00-5EA1	0-30 PSI range, 4-20 mA signal
7MF1565-4BF00-5EA1	0-60 PSI range, 4-20 mA signal
7MF1565-4BG00-5EA1	0-100 PSI range, 4-20 mA signal
7MF1565-4CA00-5EA1	0-150 PSI range, 4-20 mA signal
7MF1565-4CB00-5EA1	0-200 PSI range, 4-20 mA signal
7MF1565-4CD00-5EA1	0-300 PSI range, 4-20 mA signal
7MF1565-4CE00-5EA1	0-500 PSI range, 4-20 mA signal
7MF1565-4CF00-5EA1	0-750 PSI range, 4-20 mA signal

Sensors (continued)

Temperature Sensors – Qty (1) Required for Hot Water Boilers, Optional for Other Applications

One temperature sensor is needed to measure water temperature on hot water boilers. Additionally, one may be needed for low fire hold on a steam boiler, hot standby on a steam boiler, or ambient and stack temperatures for efficiency calculations or FGR hold features. The most commonly used temperature sensors are listed below. For a list of all temperature sensor options as well as technical instructions for all available temperature sensors, refer to Document No. SEN-1000.

	QAE2020.001	100 Ohm, 3-wire, platinum RTD used to measure water temperature on hot water boilers Range: -4 to 374 °F
	QAE2012.001	1000 Ohm, 2-wire, platinum RTD used to measure water temperature for low fire hold or hot standby on steam boilers. Also recommended to measure ambient air temperature for LMV52.4 applications Range: -4 to 374 °F
	QAE2012.9002	1000 Ohm, 2-wire, platinum RTD used to measure water temperature on hot oil heaters and steam boilers operating over 150 PSI Range: -50 to 900 °F
	QAC22	1000 Ohm, 2-wire, nickel RTD used to measure ambient air temperature (required for efficiency calculations) Range: -58 to 158 °F
	QAM-P210	1000 Ohm, 2-wire, platinum RTD used to measure flue gas temperature (required for efficiency calculations and FGR low temperature hold features) Range: -50 to 900 °F

Variable Frequency Drive (VFD) Components

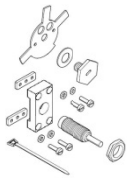
Variable Frequency Drives (VFDs) - Optional

Pre-programmed Variable Frequency Drives (VFDs) are available for use with an LMV52. Braking resistors and line / load reactors are available as accessories.

	DR…	Pre-programmed VFDs with LMV52 programming and wiring instructions

Speed Sensor Mounting Kit – Qty (1) Required per VFD

Because the LMV52 requires speed feedback when using a VFD, one of the following speed sensor kits is required if a VFD is present.

	AGG5.305	Speed sensor and associated mounting kit with connections available for mounting directly to ½" or ¾" conduit. Includes speed sensor, 6 foot cable, 3-finger speed wheel, O-ring for a watertight seal, and necessary mounting hardware Range: 300-6300 RPM
	**AGG5.310**	Speed sensor and associated mounting kit. Includes speed sensor, 6 foot cable, 3-finger speed wheel, and necessary mounting hardware Range: 300-6300 RPM

O2 Trim Components

O2 Module – Qty (1) Required for O2 Trim

For O_2 trim, the following CANbus module is required to connect the O_2 sensor to the LMV52.

	PLL52.110A100	Module to connect O_2 sensor to an LMV52, supplied with (6) M16 to 1/2" NPT conduit adapters compatible with liquid tight conduit fittings

O2 Trim Components (continued)

O2 Sensor – Qty (1) Required for O2 Trim

The following O_2 sensor is necessary for running O_2 trim on an LMV52. For technical information on the O_2 sensor, see Document No. P7842.

	QGO20.000D17	O_2 sensor, internally heated, zirconium dioxide measuring cell, supplied with (2) M16 to 1/2" NPT conduit adapters compatible with liquid tight fittings Max. flue gas temperature: 575 °F

Flue Gas Collector – Qty (1) Required for O2 Trim

A flue gas collector is required to mount the O_2 sensor in the stack. Four options are available as described below.

	AGO20.001SDS-KT	Weldless flue gas collector, 7.25" long, to be mounted into stacks 12-16" in diameter, not to be used on rectangular stacks
	AGO20.002LDS-KT	Weldless flue gas collector, 10.5" long, to be mounted into stacks 18-36" in diameter, not to be used on rectangular stacks
	AGO20.001A	Flue gas collector, 7.25" long, to be welded into stacks up to 16" in diameter
	AGO20.002A	Flue gas collector, 10.5" long, to be welded into stacks larger than 16" in diameter

O2 Sensor Cable – Qty (1) Recommended But Not Required

An optional cable is available to easily connect the O_2 sensor (QGO…) to the O_2 module (PLL…).

	C8120(35)	6-conductor, 18 AWG, shielded cable to connect the O_2 sensor to the O_2 module, 35 feet long

ACS450 Software for Laptop (Optional)

The ACS450 software for the LMV5 offers many features including parameter backups, startup reports, AZL software updates, and trending. The software may be downloaded at www.scccombustion.com.

Cables - Optional

To use the ACS450 software, cables are necessary to connect the AZL display to a PC.

	P454-006	Null modem cable, 6 feet long, 9-pin male to 9-pin female DB9 connection, connects AZL to PC serial port
	ACS-AC-FTDIUSB1	USB-to-serial adapter with FTDI chipset, used in conjunction with null modem cable to connect AZL to PC USB port for PCs with no DB9 serial port

Typical LMV52 System for a Cleaver Brooks Retrofit

Components for a typical LMV52 retrofit on a Cleaver Brooks boiler are listed below:

Control Panel Components

1	LMV52.240B1	Dual fuel burner control, fuel-air ratio control, VFD control, O_2 trim
1	AGG5.210	120 VAC to (3) 12 VAC transformer
1	AZL52.40B1	Display with Modbus port, PC port, six languages available
1	AGG5.635	Pre-made 9 foot cable connecting an LMV5 to the AZL display
1	AGG5.720	Base plug set with all terminals for a typical LMV5 system
1	AGG5.110	Strain relief and actuator CANbus grounding
2	BR-LMV5	Brackets for mounting an LMV5 in an electrical enclosure

Air Damper Assembly

1	SQM48.497A9	Actuator, 177 in-lb torque, 14mm keyed shaft, 30-120 sec running time
1	BR-48CBAIR	CB air damper bracket retrofit kit for SQM48 actuator

Gas Firing Rate Control Valve

1	VA45.2-NF-300	SQM45.295A9 to 3” full port VKG butterfly valve assembly

Oil Firing Rate Control Valve

1	SQM45.295A9	Actuator, 27 in-lb torque, 10mm “D” shaft, 10-120 sec running time
1	BR-45CBOIL	CB fuel oil controller bracket retrofit kit for SQM45 actuator

Actuator Accessories

1	AGG5.643(100)	100’ roll of CANbus cable
1	ADP-M16XE500(5)	5-pack of M16 to 1/2” NPSM metal conduit adapters
1	ADP-M16XE500-LONG(5)	5-pack of long M16 to 1/2” NPSM metal conduit adapters

Flame Scanner

1	QRI2A2.B180B	Self-check infrared flame scanner, forward viewing

Flame Scanner Accessories

1	AGG2.110	Kit for mounting forward viewing QRI… flame scanner on a flame tube
1	AGG2.120	Pg9 to 1/2” NPSM conduit connection adapter for QRI… flame scanner

Sensors

1	7MF1565-4BE00-5EA1	Pressure sensor, 0-30 PSI, 4-20 mA signal
1	QAC22	1000 Ohm, 2-wire, nickel RTD for ambient air temperature
1	QAM-P210	1000 Ohm, 2-wire, platinum RTD for flue gas temperature

Variable Frequency Drive (VFD) Components

1	AGG5.305	Speed sensor and associated mounting kit for VFD control

O_2 Trim Components

1	PLL52.110A100	CANbus module to connect QGO O_2 sensor to LMV52
1	QGO20.000D17	O_2 sensor with zirconium dioxide measuring cell
1	AGO20.002LDS-KT	Weldless flue gas collector for stacks 18-36” in diameter
1	C8120(35)	6-conductor shielded cable to connect the O_2 module and O_2 sensor

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LMV5 SYSTEM ORDER SHEET

Email: customerservice@scccombustion.com Fax: (224) 366-8455

Company Name				**PO#**	
Required Ship Date		**Ship To Address**			
Shipping Method					

	Description		Part Number	Qty
Control Panel Components	**Base Unit** *(Qty 1 Required)*	Float/bump	LMV51.040C1	
		Load control	LMV51.140C1	
		VFD/O_2 trim/fuel meter	LMV52.240B1	
		Advanced O_2 trim	LMV52.440B1	
	Transformer *(Qty 1 or 2 Required)*	120V to (3) 12V transformer	AGG5.210	
	Display Unit *(Qty 1 Required)*	Display unit w/ Modbus	AZL52.40B1	
	Display Cable (*Qty 1 Required)*	9' AZL to LMV5 cable	AGG5.635	
	Plug Set *(Qty 1 Required)*	Typical base plug set	AGG5.720	
		Maximum system plug set	AGG5.7COMPLETE	
	Strain Relief *(Qty 1 Required)*	For CANbus grounding	AGG5.110	
	Touchscreen Kit *(Optional)*	Write in part number (see Doc. No. TS-1000)		
	LMV5 Mounting Brackets *(Qty 2 Recommended)*	For electrical enclosure	BR-LMV5	
	Control Panel Spare Parts *(Optional)*	120V main fuse	FUSE6.3A-SLOW	
		12V CANbus fuse	FUSE4.0A-SLOW	
		5 pack of 4-pins	1840382(5)	
		5 pack of 5-pins	1840395(5)	
		3 pack of 6-pins	1840405(3)	
		Transformer plugs	AGG5.2PLUGS	
		Spark quencher	XEB0471	
		RS-232 to RS-485 converter kit	TS-X4CX-XXXXX	
Air Damper Assembly	**Actuator** *(Qty 1 Required)*	27 in-lb, 10mm "D"	SQM45.295A9	
		177 in-lb, 14mm keyed	SQM48.497A9	
		310 in-lb, 14mm keyed	SQM48.697A9	
		600 in-lb, 25mm keyed	SQM91.391A9	
	Coupling *(Qty 1 Required)*	Write in part number (see Doc. No. CPBK-1000)		
	Mounting Bracket Kits *(Optional)*	Write in part number (see Doc. No. CPBK-2000)		
	Cleaver Brooks Retrofit Kits *(Optional)*	Kit for SQM48	BR-48CBAIR	
		Kit for SQM45	BR-3345CBAIR	
	Lucoma Air Damper Mounting Brackets *(Optional)*	Kit for SQM48	BR-SQM48-LUC	
		Kit for SQM45	BR-SQM3345-LUC	
Gas Firing Rate Valve	**Valve Actuator Assemblies** *(Qty 1 Required if Firing Gas)*	Write in part number (see Doc. No. VA-1000 or VA-3000)		

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	Description		Part Number	Qty
Oil Firing Rate Control Valve	**Valve Actuator Assemblies** *(Qty 1 Required if Firing Oil and Not Using a Cleaver Brooks Oil Valve)*	Write in part number (see Doc. No. VA-4000)		
	Cleaver Brooks Retrofit Kits *(Optional)*	Kit for SQM48	BR-48CBOIL	
		Kit for SQM45	BR-45CBOIL	
FGR Control Valve	**Valve Actuator Assemblies** *(Qty 1 Required if Using FGR)*	3" high temp assembly	VA48.4-3.0VKF-HT	
		4" high temp assembly	VA48.4-4.0VKF-HT	
		6" high temp assembly	VA48.4-6.0VKF-HT	
		8" high temp assembly	VA48.4-8.0VKF-HT	
		Write in part number (see Doc. No. VA-3000)		
Actuator Accessories	**CANbus Cable** *(Qty 1 Required)*	100' roll	AGG5.643(100)	
		500' roll	AGG5.643	
	Electrical Cable Adapters *(Optional)*	Short M16 to 1/2" metal (5)	ADP-M16XE500(5)	
		Long M16 to 1/2" metal (5)	ADP-M16XE500-LONG(5)	
		M16 to 1/2" nylon	7466201040	
		M16 cord grip	7466200470	
Flame Scanners	**Flame Scanners** *(Qty 1 Required)*	IR forward view	QRI2A2.B180B	
		IR side view	QRI2B2.B180B	
		UV side view	QRA75.A17	
Flame Scanner Accessories	**QRA75 Cable** *(Qty 1 Required per QRA75)*	12' cable	AGM23U	
	QRI Accessories *(Optional)*	Mount for forward view	AGG2.110	
		1/2" conduit adapter	AGG2.120	
		Mount for side view	AGG90.U	
	QRA Accessories *(Optional)*	Mount for side view	AGG16.U	
		Thermal barrier	THERMAL-1X75	
		Heat insulating lens	AGG02	
		Magnifying lens	AGG03	
Sensors	**Pressure Sensors** *(Qty 1 Required for Steam Boilers)*	Write in part number (see Doc. No. SEN-2000)		
	Temperature Sensors *(Qty 1 Required for Hot Water Boilers, Optional for Other Applications)*	Pt100, 3-wire, -4...374°F	QAE2020.001	
		Pt1000, 2-wire, -4...374°F	QAE2012.001	
		Pt1000, 2-wire, -50...900°F	QAE2012.9002	
		Ambient air -58...158°F	QAC22	
		Flue gas -50...900°F	QAM-P210	
		Write in part number (see Doc. No. SEN-1000)		
VFDs	**Variable Frequency Drives, Brake Resistors, Line / Load Reactors** *(Optional)*	Write in part number		
	Speed Sensor *(Qty 1 Required per VFD)*	Speed sensor kit for conduit	AGG5.305	
		Speed sensor kit w/o conduit	AGG5.310	
O_2 Trim Components	**O_2 Module** *(Qty 1 Required for O_2 Trim)*	Connects QGO to LMV52	PLL52.110A100	
	O_2 Sensor *(Qty 1 Required for O_2 Trim)*	Max temp 575°F	QGO20.000D17	
	Flue Gas Collector *(Qty 1 Required for O_2 Trim)*	Weldless, up to 16" stack	AGO20.001SDS-KT	
		Weldless, over 16" stack	AGO20.002LDS-KT	
		Weld, up to 16" stack	AGO20.001A	
		Weld, over 16" stack	AGO20.002A	
	O_2 Cable *(Qty 1 Required for O_2 Trim)*	6-conductor, 35' length	C8120(35)	
ACS 450	**Cables** *(Optional)*	Null modem	P454-006	
		USB-to-serial	ACS-AC-FTDIUSB1	

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1-3: Mounting

LMV5 Controller

The LMV5 must be mounted inside an enclosure that will protect it from dirt and moisture. The unit is mounted by four screws (M5 x 0.8mm thread, #2 Phillips drive) that are captive in each corner. The panel, which the unit sits on, should be drilled and tapped to accommodate these screws. Alternatively, two mounting brackets are available that use clearance holes to mount the LMV5 into the panel and space the LMV5 approximate 1.25" off the back of the panel.

It should be noted that the mounting screws do not have excessive play, so the spacing of the mounting holes must be accurate. This can be achieved by clamping or securing the LMV5 in the desired position. Then use the captive screws to score (4) circles into the panel. Do this by turning each of the mounting screws clockwise while applying pressure to the screwdriver.

During the mounting process, consideration should also be given to the various plugs and wires that must be attached to the LMV5. Electrical connections are made via plugs that are located in the face, top and bottom of the unit. A space of at least (2) inches is recommended above and below the LMV5. The recommended total space to leave for the LMV5 is 12" x 12" x 4" because the overall dimensions of the LMV5 are 9.84" x 7.87" x 3.25".

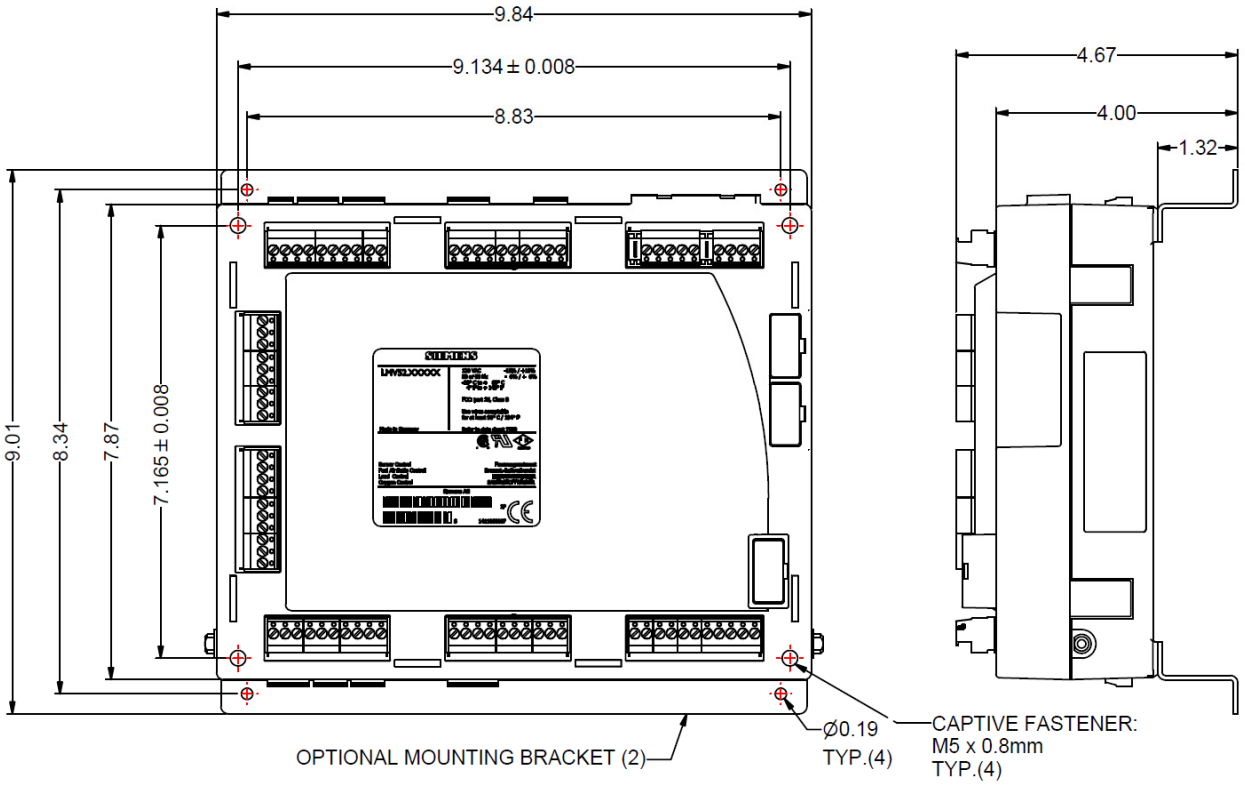

Figure 1-3.1: LMV5 Dimensions (inches)

AZL5 Display

The AZL5 is designed to be mounted in a rectangular cutout through the face / door of an electrical enclosure. It has one screw on the top and another on the bottom that engage small plastic tabs which will swing out when the screw is tightened clockwise; the screw can be loosened to retract the tab and increase clearance before tightening. The tab will pinch the sheet metal of the enclosure door between itself and the AZL5 gasket. This facilitates easy removal and replacement of the AZL5 since it is designed to be taken out of the enclosure face and held in the hands for setup and commissioning.

The AZL5 connects (via the CANbus port on its bottom end) to the LMV5 at terminal X50 with CANbus cable **AGG5.635**. The 9-pin CANbus connector requires a clearance of approximately 2.5” below the bottom of the AZL5 on the inside of the door of the enclosure.

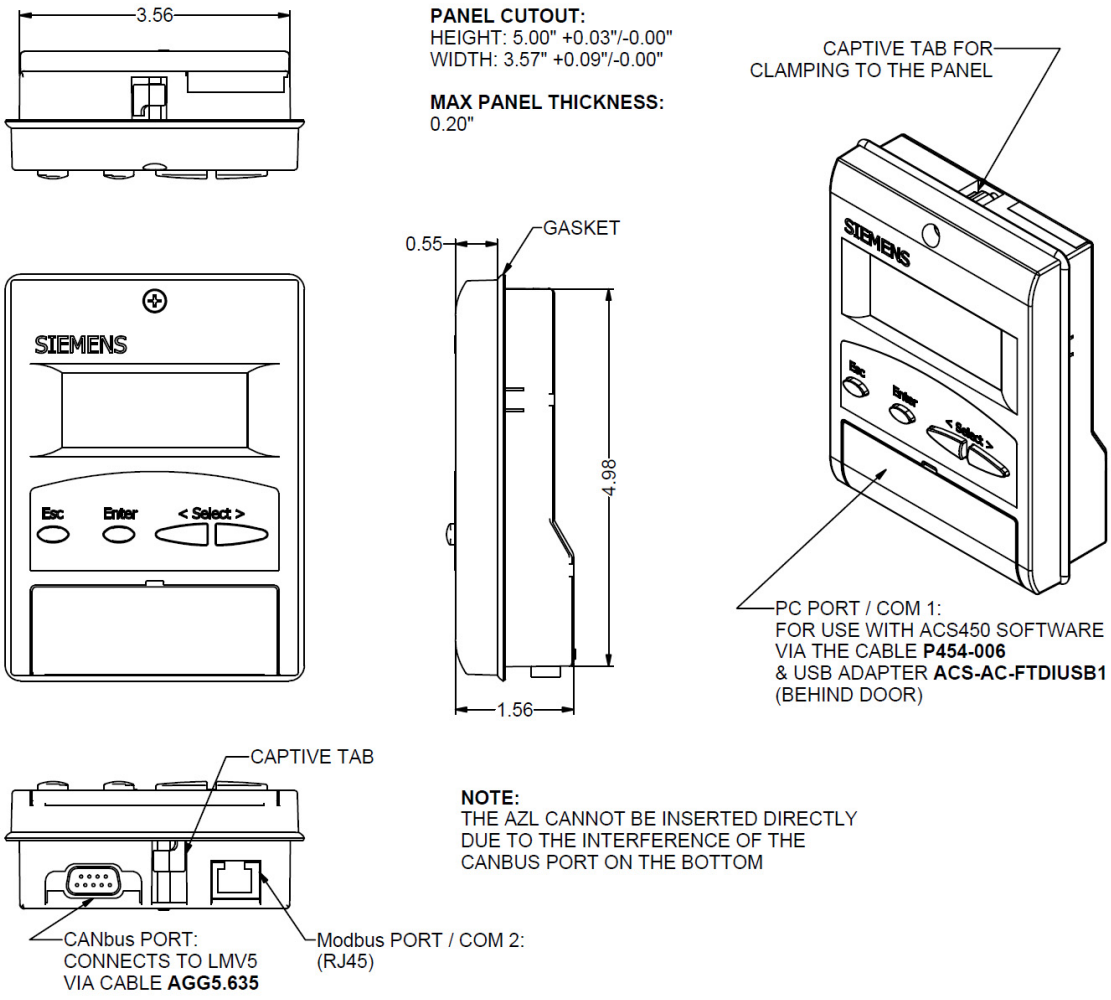

Figure 1-3.2: AZL5 Dimensions (inches)

AGG5.210 Transformer

The AGG5.210 transformer supplies 12 VAC power to the LMV5 base unit, AZL5, actuators, and PLL52 (if equipped). This transformer should also be mounted in an enclosure that shields the transformer from dirt and water. At least one transformer is necessary for each LMV5 base unit. Depending upon how many devices are connected to the CANbus (actuators, PLL52 module, etc.), two AGG5.210 transformers may be necessary.

Note: If a second transformer is used, locate it as close as possible to the actuators / PLL52 module that it powers. Do not connect 12VAC1 and 12VAC2 from each transformer together.

Figure 1-3.3 gives the dimensions of an AGG5.210 transformer. Slotted holes are provided for ease of mounting in tapped holes; a #10 machine screw and SAE washer are recommended.

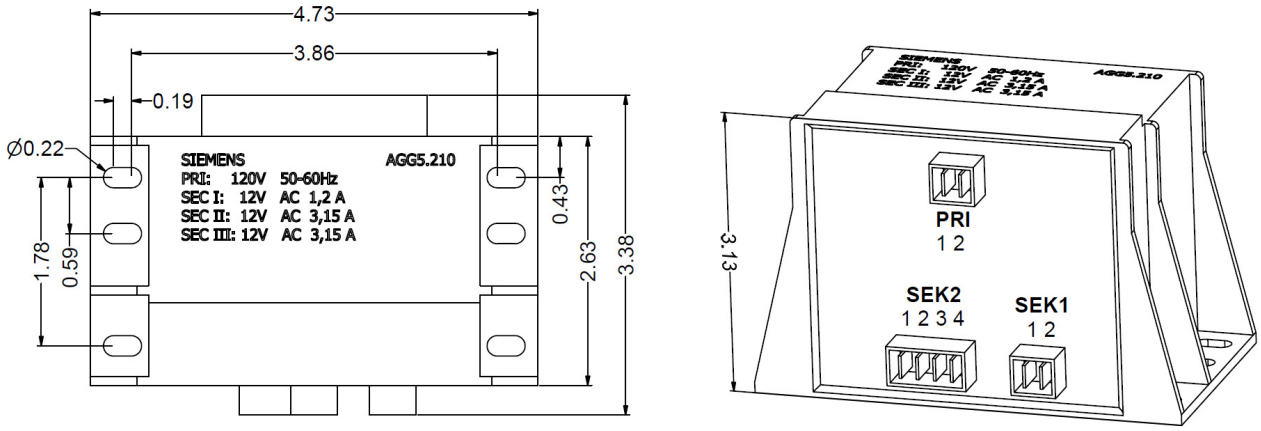

Figure 1-3.3: AGG5.210 Dimensions (inches)

1-4: Important Safety Notes

- The LMV5 is a safety device. Under no circumstances should the unit be modified or opened. SCC Inc. will not assume responsibility for damage resulting from unauthorized modification of the unit.

- After commissioning, and after each service visit, the flue gas values should be checked across the firing range.

- All activities (mounting, installation, service work, etc.) must be performed by qualified staff.

- Before performing any work in the connection area of the LMV5, disconnect the unit from the main supply (all-polar disconnection).

- Protection against electrical shock hazard on the LMV5 and all other connected electrical components must be ensured through good wiring and grounding practices.

- Fall or shock can adversely affect the safety functions of an LMV5. Such units must not be put into operation, even if they do not exhibit any apparent damage.

- The coupling that is used between the actuator and the driven valve / damper is safety related, and must be of a robust and flexible design. Should this coupling fail during operation, the LMV5 will no longer have control of the burner's combustion, bringing about a hazardous condition.

- Condensation and the entry of water into the unit must be avoided.

1-5: Approvals

The LMV5 and its various system components have the following standards and approvals:

CE

Conformity to EEC directives

- Electromagnetic compatibility EMC (immunity)	2004/108/EC
- Directive for gas-fired appliances	2009/142/EC
- Low-voltage directive	2006/95/EC
- Directive for pressure devices	97/23/EEC
- Safety limit thermostats	EN 14597:2005

Safety and control devices for gas and/or oil burners and gas and/or oil appliances - Particular requirements -
Part 1: Fuel-air ratio controls, electronic type — ISO 23552-1:2007

ISO 9001: 2008
Cert. 00739

ISO 14001: 2004
Cert. 38233

	Europe				USA			Australia	Ships	
Type	TÜV	TÜV CERT	DIN Geprüft	DVGW	UL	CSA	FM APPROVED		Lloyd's Register	plant in 2013 GL
LMV50.320B2	---	---	---	---	---	---	---	---	---	---
LMV51.000C2	●	●	●	●	---	---	---	●	●	●
LMV51.040C1	---	---	---	---	●	●	●	●	●	●
LMV51.100C1	●	●	●	●	---	---	---	●	●	●
LMV51.100C2	●	●	●	●	---	---	---	●	●	●
LMV51.140C1	---	---	---	---	●	●	●	●	●	●
LMV51.300B1	●	●	●	●	---	---	---	●	●	●
LMV51.300B2	●	●	●	●	---	---	---	●	●	●
LMV51.340B1	---	---	---	---	●	●	●	●	●	●
LMV52.200B1	●	●	●	●	---	---	---	●	●	●
LMV52.200B2	●	●	●	●	---	---	---	●	●	●
LMV52.240B1	---	---	---	---	●	●	●	●	●	●
LMV52.240B2	---	---	---	---	---	---	---	●	●	●
LMV52.400B2	●	●	●	●	---	---	---	●	●	●
LMV52.440B1	---	---	---	---	●	●	●	●	●	●
LMV5... system components:										
AZL52…	●	●	●	●	●	●	●	---	●	●
SQM45.../48...	●	●	●	●	●	●	●	●	●	●
SQM9…	●	●	●	●	●	●	●	---	---	---
QRI2…	●	●	●	●	●	●	●	●	●	●
QRA7…	●	●	●	●	●	●	●	---	●	●
PLL52…	●	●	●	●	●	●	●	●	---	---
QGO20…	●	●	●	●	●	●	●	---	---	---

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Section 10	Revision History
Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

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2-1: Wiring Introduction

The LMV5 is a very flexible burner control. As such, there are many different ways to wire it. The specific application will dictate the wiring required. This section details the most common applications.

The parameter settings outlined in Section 3 can enable, disable or change the functionality of many terminals on the LMV5. Thus, wiring and parameter settings work together to make the LMV5 an extremely versatile BMS.

This section includes terminal descriptions (Section 2-2) and extensive wiring diagrams (Section 2-3) that detail the many applications of the LMV5.

Terminals

The connection terminals of the LMV5 are RAST 5 and RAST 2.5 connectors (plugs). Line voltage plugs are keyed so that they will only fit into one socket of the LMV5, eliminating the possibility of inserting a plug into an incorrect socket.

Each plug is designed to connect one external device or a small group of external devices, such as gas valves, to the LMV5. Each group of plugs on the front of the LMV5 provides line voltage and grounds so that an additional terminal strip is not necessary.

Note: All protective earth grounds (PE), neutrals (N) and lines (L) are common inside the LMV5.

X9-	01.	04
Plug Group	Plug Number in Group	Pin Number on Plug

Figure 2-1.1: Numbering Scheme on *Line Voltage* (RAST 5) Terminals of the LMV5

Note: Dashes or dots can be used interchangeably between the numbers shown above.

X62.	2
Plug Number	Pin Number

Figure 2-1.2: Numbering Scheme on *Low Voltage* (RAST 2.5) Terminals of the LMV5

Terminal descriptions (Section 2-2) provide a map outlining exactly where the line and low voltage plugs are located.

For each plug, Pin 1 is marked on the casing of the LMV5 as well as on the PLL52 module.

Grounds

The LMV5 has three different types of grounds:

- Protective Earth (marked as **PE** on the LMV5)
- Functional Earth (marked as **FE** on the LMV5)
- Reference Ground (marked as **0**, **M** or **GND** on the LMV5, hereafter referred to as **0**)

Protective Earth

Protective Earth (PE) or chassis ground must always be connected to the control panel grounding lug. The purpose of PE is to provide a ground for all 120 VAC connections. One wire from the secondary side of the control panel's main step-down transformer should also be connected to the control panel grounding lug, as well as a PE on LMV5 transformer terminal SEK2.

All of the PE terminals on the front of the LMV5 casing are common.

Functional Earth

Functional Earth (FE) connections are found on the CANbus terminals as well as other low voltage connections. The sole purpose of the FE is for termination of low voltage cable shields.

The FE is bonded to the Reference Ground through capacitors on the LMV5 circuit board with the exception of the CANbus where it is bonded directly.

Reference Ground

The last type of ground is the Reference Ground (0). These are found on the low voltage connections. The purpose of the Reference Ground is to serve as a datum to measure other voltages.

The Reference Ground is bonded to the FE on the CANbus circuit board through SEK2 pins 2 and 3 on the AGG5.210 transformer.

Note: AGG5.210 transformer SEK2, pins 2 and 3, are also connected to the control panel grounding lug (PE), so that all three grounds are eventually bonded together.

Summary:

- 0 & PE are bonded together at the transformer (connect SEK2 pin 3 to panel ground).
- For the CANbus only, FE is bonded to 0 & PE directly on the circuit board.
- Everywhere else, FE is bonded to 0 & PE through a capacitor on the circuit board.

CANbus

The CANbus is a data bus similar to a computer network. The CANbus is used to connect the actuators, AZL5, and PLL52 module to the LMV5 base unit. Special shielded cable is used to connect all devices on the CANbus to the LMV5 base unit. This cable carries five wires and a braided shield that is located underneath the plastic cable sheathing.

The two heavier gauge wires (16 AWG) are used for power transmission to the connected devices. These power wires are labeled 12VAC1 and 12VAC2, and carry 12 VAC each. These wires are powered by SEK2 Pin 1 and Pin 4 of the AGG5.210 transformer's 4-pin plug, and are fused by FU2 and FU3. These fuses are located under black covers on the right hand side of the LMV5. If measured, 12VAC1 and 12VAC2 should have a potential of approximately 12 VAC to reference ground and 24 VAC between 12VAC1 and 12VAC2.

The two lighter gauge (24 AWG) wires are a shielded, twisted pair to help reduce noise on the line. They carry the digital CANbus data signals and are labeled CANL and CANH. The signal on these wires consists of 5 VDC pulses.

Note: These data wires should never contact the 12VAC wires when the system is powered. LMV5 damage may result.

The termination jumper located on each actuator and PLL52 module is used to terminate CANH and CANL and should be moved to the bus termination position on the last CANbus device.

The last wire in the cable is the reference ground and is marked GND. This is also connected to each device on the CANbus so that the LMV5 can monitor for voltage drops that might affect actuator operation.

Note: It is extremely important that the shield of the CANbus cable is properly terminated.

The shield of the CANbus cable is terminated to the LMV5 by using a special strain relief (part number AGG5.110). This strain relief also has a wire that should be connected to the shield terminal on the LMV5, terminals X50 and X51. The installation of this clip is shown in Figure 2-1.3.

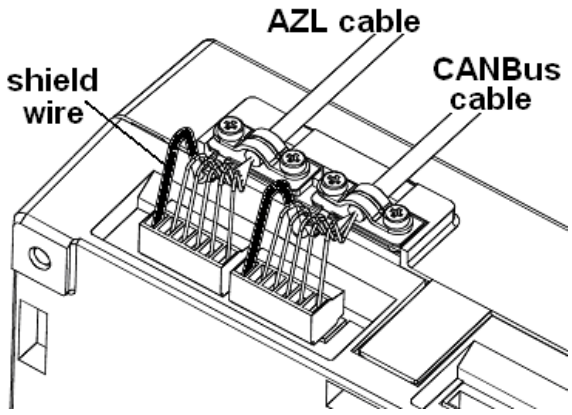


Figure 2-1.3: Installation of CANbus Strain Relief

CANbus (continued)

The shield of the CANbus cable must be connected on each cable segment (between the LMV5 and the actuators or PLL52 module) so that the entire shield has continuity with terminal X51.1 which is the shield connection on the LMV5. This is achieved by clamping the shield on both cable segments with the metal clamps provided on the cable entry of each actuator. Clamps for the CANbus shield are also provided on the PLL52 module.

The current provided by one AGG5.210 transformer is usually sufficient to meet the demands of the LMV5 base unit, AZL5 and actuators on a typical burner / boiler without a PLL52 module. However, situations occur when one AGG5.210 transformer is not sufficient, and a second transformer must be used. The figure below outlines the number of transformers that should be used for different situations.

<table>
<tr><td colspan="2" rowspan="2">Number and type of actuators wired on the CANbus moving concurrently.</td><td colspan="2">Permissible total CANbus cable length including AZL5 (feet).
Single Transformer</td></tr>
<tr><td>Actuators at 100% rated torque.</td><td>Actuators at 80% rated torque.</td></tr>
<tr><td>2 SQM45</td><td rowspan="4">0 SQM48</td><td>115</td><td>125</td></tr>
<tr><td>3 SQM45</td><td>85</td><td>95</td></tr>
<tr><td>4 SQM45</td><td>70</td><td>80</td></tr>
<tr><td>5 SQM45</td><td>2nd Transformer Req.</td><td>2nd Transformer Req.</td></tr>
<tr><td>1 SQM45</td><td rowspan="3">1 SQM48</td><td>85</td><td>95</td></tr>
<tr><td>2 SQM45</td><td>70</td><td>80</td></tr>
<tr><td>3 SQM45</td><td rowspan="2">2nd Transformer Req.</td><td>30</td></tr>
<tr><td>4 SQM45</td><td>2nd Transformer Req.</td></tr>
<tr><td>1 SQM45</td><td rowspan="3">2 SQM48</td><td rowspan="3">2nd Transformer Req.</td><td>30</td></tr>
<tr><td>2 SQM45</td><td rowspan="2">2nd Transformer Req.</td></tr>
<tr><td>3 SQM45</td></tr>
<tr><td>1 SQM45</td><td rowspan="2">3 SQM48</td><td rowspan="2">2nd Transformer Req.</td><td rowspan="2">2nd Transformer Req.</td></tr>
<tr><td>2 SQM45</td></tr>
<tr><td>1 SQM45</td><td>4 SQM48</td><td>2nd & 3rd Transformer Req.</td><td>2nd Transformer Req.</td></tr>
<tr><td rowspan="4">0 SQM45</td><td>2 SQM48</td><td>58</td><td>70</td></tr>
<tr><td>3 SQM48</td><td rowspan="2">2nd Transformer Req.</td><td rowspan="2">2nd Transformer Req.</td></tr>
<tr><td>4 SQM48</td></tr>
<tr><td>5 SQM48</td><td>2nd & 3rd Transformer Req.</td><td>2nd & 3rd Transformer Req.</td></tr>
</table>

Figure 2-1.4: CANbus Loading

Notes:

- When two transformers are used, the loading should be divided between the two transformers as equally as possible.
- The second transformer should be placed as close as possible to the actuators / PLL52 module that it powers due to voltage drop considerations.
- When adding a PLL52 module, subtract 20 ft from the cable length on the chart.
- Absolute maximum cable length is 300 ft (CANbus communication limitation).
- Never connect the 12VAC1 / 12VAC2 from one transformer to 12VAC1 / 12VAC2 on any other transformer.

Load Controller

The LMV51.1 and all LMV52 are equipped with a load controller. The load controller is very flexible and can read multiple sensors simultaneously. Typically, either a temperature sensor or pressure sensor is connected for burner modulation. Both a pressure and a temperature sensor can be used in conjunction for certain applications such as cold start (thermal shock protection).

The load controller has six different operational modes that can be changed by opening or closing a connection on X62. These six different modes of operation are outlined in Section 4. By using a dry contact, or switch, between terminals X62.1 and X62.2, the mode and / or setpoint of the internal load controller can be changed.

If the load controller is in "IntLC" (internal load controller), setpoint W1 will be used if X62.1 / X62.2 is open and setpoint W2 will be used if X62.1 / X62.2 is closed. If the load controller is in any other mode and X62.1 / X62.2 is closed, the LMV5 will revert back to "IntLC" and will use setpoint W1. See Section 4 for more information about load controller modes.

This feature is commonly used when switching the LMV5 from "ExtLC X62" (remote modulation via a 4-20mA source wired into terminals X62.3 and X62.4) back to "IntLC" (local, using LMV5 load controller for modulation of the burner).

The load controller also provides power for 4-20 mA or 0-10 VDC sensors, or 4-20 mA or 0-10 VDC externally powered sensors. The wiring of these sensors is covered in Section 2-3.

Floating / Bumping and Multistage Oil

Terminals X5-03.2 and X5-03.3 can be used for floating / bumping control or multistage oil control, also called 3-position control. This option can be done on all models of LMV5, and is required on the LMV51.0 models.

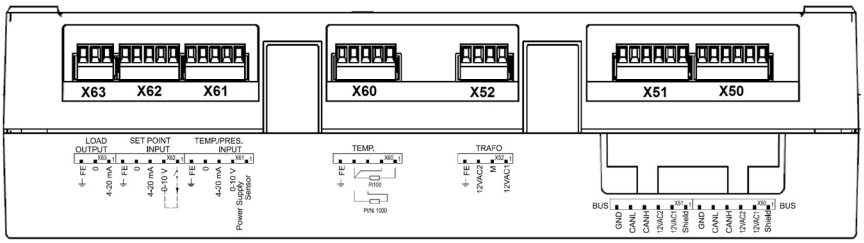
Through the use of floating / bumping, the LMV5 can be driven to a higher firing rate by placing line voltage on terminal X5-03.2 and to a lower firing rate by removing line voltage from X5-03.2 and placing line voltage on X5-03.3. No voltage on X5-03.2 or X5-03.3 keeps the current firing rate. By alternating voltage on these terminals, the firing rate of the LMV5 can be increased, decreased, or kept the same. The floating / bumping type of modulation is typically done with an RWF40/50/55.

A relay can be placed in the line connected to X5-03.2 if a low fire hold is desired.

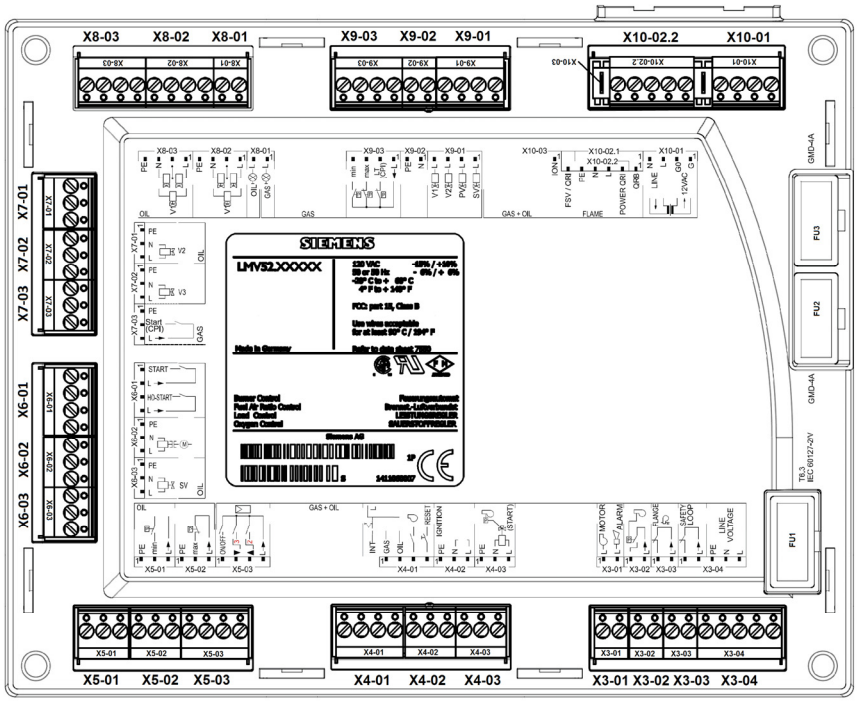
If externally controlled multistage oil is selected, terminal X5-03.1 is energized for stage 1. Terminal X5-03.2 can be energized to put the burner in stage 2, and terminal X5-03.3 can be energized to put the burner in stage 3. De-energizing these terminals takes the burner out of stage 2 or 3.

2-2: Terminal Descriptions

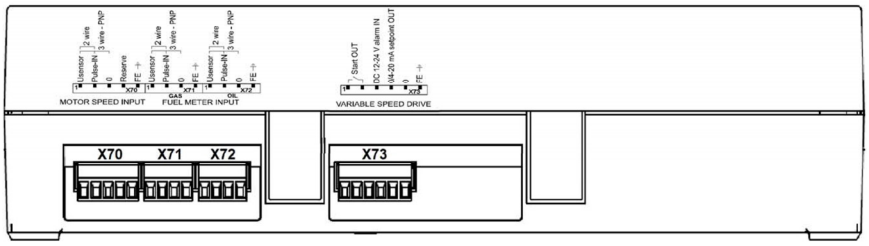
Top



Front

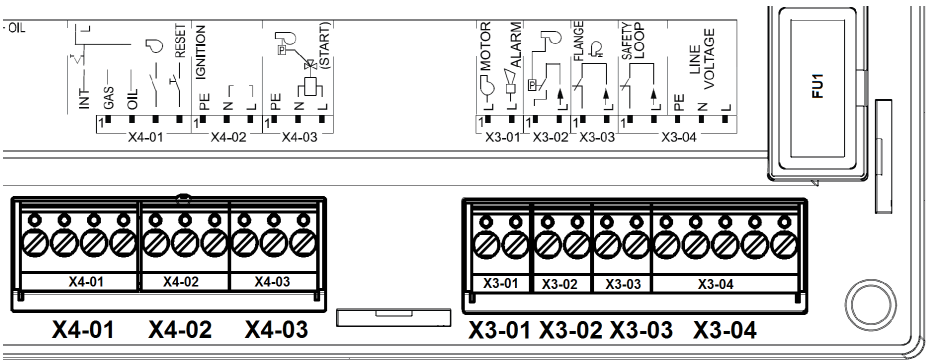


Bottom

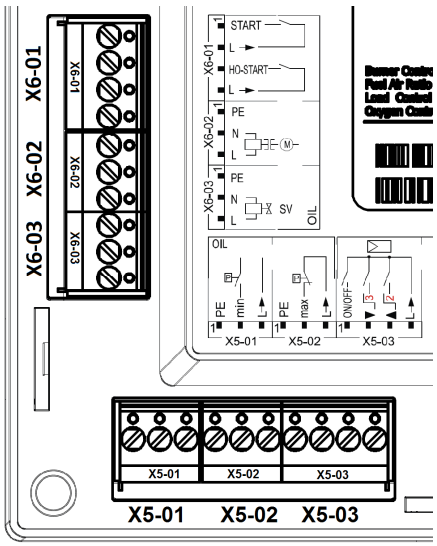


General notes:

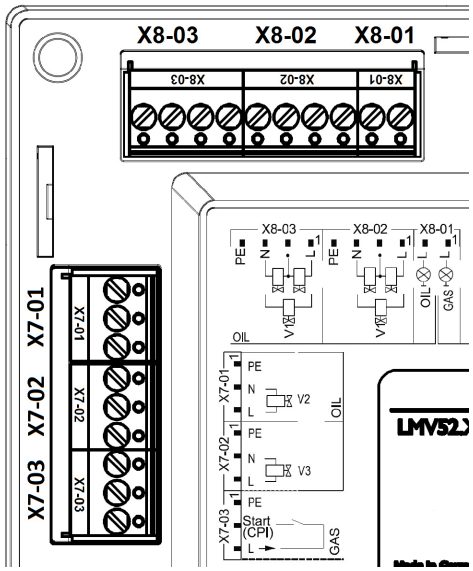
1. Total combined load of all 120VAC outputs cannot exceed 5 Amps.
2. All “Line, fused” terminals are internally connected.
3. All “Neutral” terminals are internally connected.
4. All “PE” terminals are internally connected.
5. All “0” terminals are internally connected.



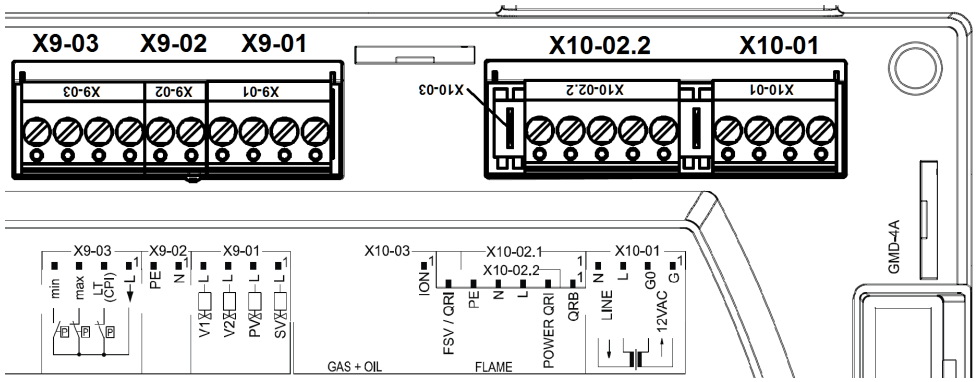
Terminal	Type	Function	*Parameter*	Rating
X3-01.1	Programmable Output	Blower motor starter	***ContinuousPurge PostpurgeLockout***	1A, 120VAC
X3-01.2		Alarm horn	***Alarm act/deact AlarmDelay AlarmStartPrev***	
X3-02.1	Programmable Input	Blower air pressure switch	***AirPressureTest FanRunupTme***	1.5mA, 120VAC
X3-02.2	Line	Line, fused	Not configurable	500mA, 120VAC
X3-03.1	Fixed	Burner flange limit switch	Not configurable	5A, 120VAC
X3-03.2	Jumper	Burner flange limit switch power		
X3-04.1	Programmable Input	Safety loop	***Standby Error***	5A, 120VAC
X3-04.2	Line	Safety loop power	Not configurable	
X3-04.3	PE	Incoming power - Protective Earth		N/A
X3-04.4	Neutral	Incoming power - Neutral		
X3-04.5	Line	Incoming power - Line	***MainsFrequency***	6.3A, 120VAC
X4-01.1	Fixed Input	Fuel 'hardware' select gas	If no power: AZL / Modbus can 'software' select a fuel	1.5mA, 120VAC
X4-01.2		Fuel 'hardware' select oil		
X4-01.3	Programmable Input	Blower motor starter aux. contact -or- FGR pressure switch	***FGR-PS/FCC***	
X4-01.4	Fixed Input	Remote reset and manual lockout	If in alarm: power to reset If no alarm: power to lockout	
X4-02.1	PE	Protective Earth ground	Not configurable	N/A
X4-02.2	Neutral	Neutral		
X4-02.3	Programmable Output	Ignition Transformer	***PrelgnitionTGas/Oil***	1.6A, 120VAC
X4-03.1	PE	Protective Earth ground	Not configurable	N/A
X4-03.2	Neutral	Neutral		
X4-03.3	Programmable Output	Start signal -or- Air pressure switch test	***ContinuousPurge NormDirectStart Start/PS-Valve***	0.5A, 120VAC



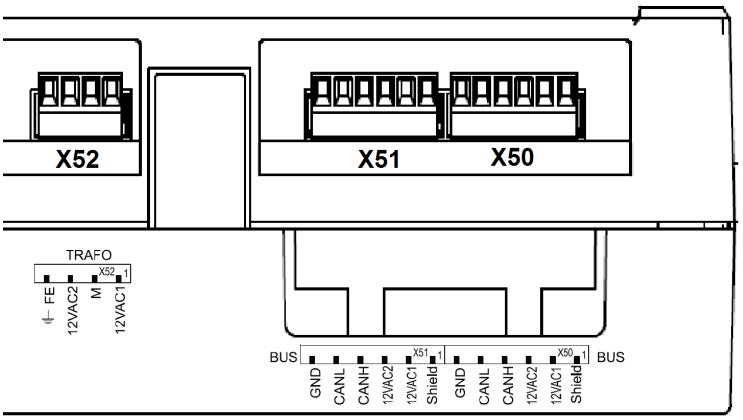
Terminal	Type	Function	*Parameter*	Rating
X5-01.1	PE	Protective Earth ground	Not configurable	N/A
X5-01.2	Programmable Input	Low oil pressure switch	***OilPressureMin***	1.5mA, 120VAC
X5-01.3	Line	Line, fused	Not configurable	500mA, 120VAC
X5-02.1	PE	Protective Earth ground	Not configurable	N/A
X5-02.2	Programmable Input	High oil pressure switch	***OilPressureMax***	1.5mA, 120VAC
X5-02.3	Line	Line, fused	Not configurable	500mA, 120VAC
X5-03.1	Programmable Input	Burner enable (IntLC...) -or- Burner on / off (ExtLC...)	***InputController LC_OptgMode***	1.5mA, 120VAC
X5-03.2		MANY options	***Config X5-03 LC_OptgMode Operation Mode***	
X5-03.3		MANY options		
X5-03.4	Line	Line, fused	Not configurable	500mA, 120VAC
X6-01.1	Programmable Input	Atomizing media pressure switch	***StartReleaseOil***	1.5mA, 120VAC
X6-01.2	Line	Line, fused	Not configurable	500mA, 120VAC
X6-01.3	Programmable Input	Heavy oil stage release	***HeavyOilDirectStart***	1.5mA, 120VAC
X6-01.4	Line	Line, fused	Not configurable	500mA, 120VAC
X6-02.1	PE	Protective Earth ground	Not configurable	N/A
X6-02.2	Neutral	Neutral		
X6-02.3	Programmable Output	Oil pump motor starter	***OilPumpCoupling IgnOilPumpStart***	1.6A, 120VAC
X6-03.1	PE	Protective Earth ground	Not configurable	N/A
X6-03.2	Neutral	Neutral		
X6-03.3	Fixed Output	Outside main oil safety valve (SV)	Typ: Atom. air compressor	1.6A, 120VAC



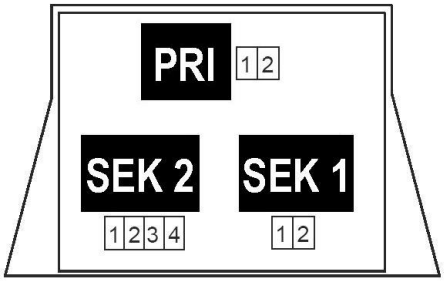
Terminal	Type	Function	*Parameter*	Rating
X7-01.1	PE	Protective Earth ground	Not configurable	N/A
X7-01.2	Neutral	Neutral		
X7-01.3	Programmable Output	Main oil valve V2 (Stage 2)	***Operation Mode***	1.6A, 120VAC
X7-02.1	PE	Protective Earth ground	Not configurable	N/A
X7-02.2	Neutral	Neutral		
X7-02.3	Programmable Output	Main oil valve V3 (Stage 3)	***Operation Mode***	1.6A, 120VAC
X7-03.1	PE	Protective Earth ground	Not configurable	N/A
X7-03.2	Programmable Input	Start release on gas -or- Proof of closure (POC)	***StartReleaseGas***	1.6A, 120VAC
X7-03.3	Line	Line, fused	Not configurable	500mA, 120VAC
X8-01.1	Fixed Output	Firing gas indication light	Not configurable	1A, 120VAC
X8-01.2		Firing oil indication light		
X8-02.1	Programmable Output	Main oil valve V1 (Stage 1)	***Operation Mode***	1.6A, 120VAC
X8-02.2	Tie Point	Use as a tiepoint (EU use only)	Not configurable	N/A
X8-02.3	Neutral	Neutral		
X8-02.4	PE	Protective Earth ground		
X8-03.1	Programmable Output	Main oil valve V1 (Stage 1)	***Operation Mode***	1.6A, 120VAC
X8-03.2	Tie Point	Use as a tiepoint (EU use only)	Not configurable	N/A
X8-03.3	Neutral	Neutral		
X8-03.4	PE	Protective Earth ground		

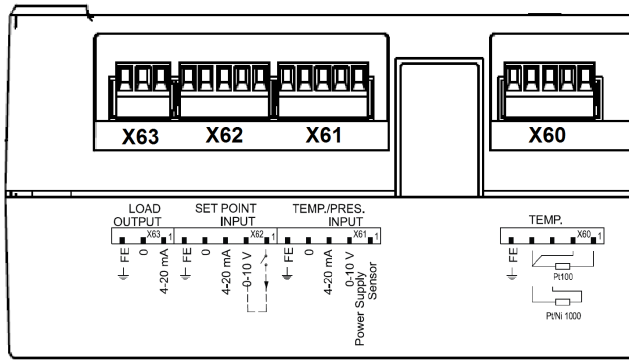


Terminal	Type	Function	*Parameter*	Rating
X9-01.1	Fixed Output	Outside main gas safety valve (SV)	Typ: Gas booster	1.6A, 120VAC
X9-01.2	Programmable Output	Gas pilot valve	***ContPilotGas/Oil*** ***Interval1Gas/Oil*** ***SafetyTme1Gas/Oil***	
X9-01.3		Main gas valve V2 (upstream)	***Interval2Gas/Oil*** ***SafetyTme2Gas/Oil*** ***ValveProvingType***	
X9-01.4		Main gas valve V1 (downstream)		
X9-02.1	Neutral	Neutral	Not configurable	N/A
X9-02.2	PE	Protective Earth ground		
X9-03.1	Line	Line, fused	Not configurable	500mA, 120VAC
X9-03.2	Programmable Input	Proof of closure (POC) -or- Valve proving pressure switch	***Config_PS-VP/CPI***	1.5mA, 120VAC
X9-03.3		High gas pressure switch	***GasPressureMax***	
X9-03.4		Low gas pressure switch	***GasPressureMin***	
X10-01.1	Power	12VAC power - connect to SEK1 pin 2	Not configurable	1.2A, 12VAC
X10-01.2		12VAC power - connect to SEK1 pin 1		
X10-01.3	Line	Line, fused - connect to PRI pin 2		1A, 120VAC
X10-01.4	Neutral	Neutral - connect to PRI pin 1		N/A
X10-02.1	Programmable Input	QRB signal (EU only - no plug)	***ExtranLightTest*** ***ReacExtranLight*** ***ReacTmeLossFlame*** ***StandardFactor*** ***Standardize***	8VDC
X10-02.2	Fixed Output	QRI power supply	Not configurable	100mA, 14-21VDC
X10-02.3	Line	Line, fused		500mA, 120VAC
X10-02.4	Neutral	Neutral		N/A
X10-02.5	PE	Protective Earth ground		
X10-02.6	Programmable Input	QRI signal voltage (IR)	See X10-02.1 above	5VDC nominal
X10-03.1	Programmable Input	Ionization probe signal (flame rod)	See X10-02.1 above	0.5mA

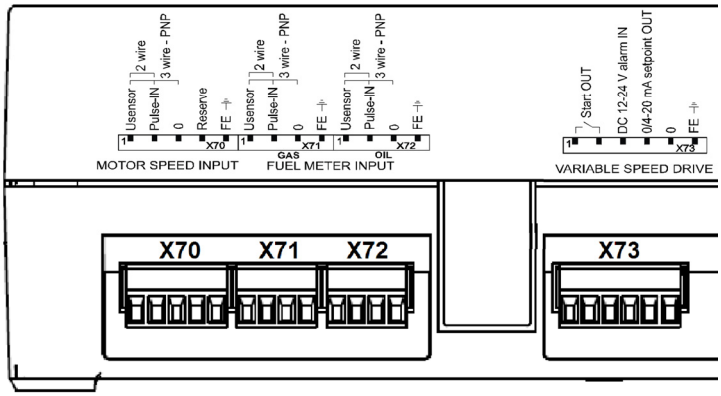


Terminal	Type	Function	*Parameter*	Rating
X50.1	CANbus (AZL)	Shield (FE)	Not configurable	N/A
X50.2		12VAC1 power		4A, 12VAC
X50.3		12VAC2 power		
X50.4		CANH communication signal		5VDC
X50.5		CANL communication signal		
X50.6		Reference ground		N/A
X51.1	CANbus (Actuators, PLL)	Shield (FE)	Not configurable	N/A
X51.2		12VAC1 power		4A, 12VAC
X51.3		12VAC2 power		
X51.4		CANH communication signal		5VDC
X51.5		CANL communication signal		
X51.6		Reference ground		N/A
X52.1	Transformer	12VAC1 from SEK2 pin 1	Not configurable	3.15A, 12VAC
X52.2		Reference ground from SEK2 pin 2		N/A
X52.3		12VAC2 from SEK2 pin 4		3.15A, 12VAC
X52.4		Functional ground from SEK2 pin 3		N/A

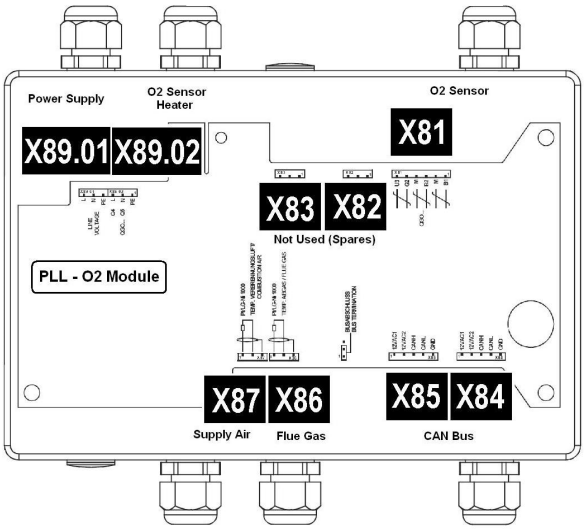




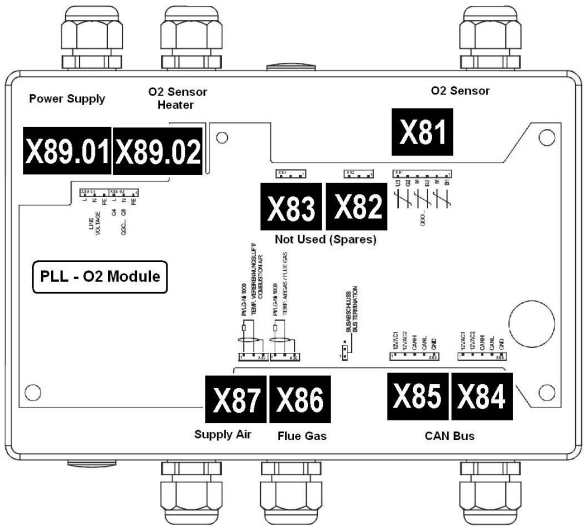
Terminal	Type	Function	*Parameter*	Rating
X60.1	Programmable Input	Pt100 3-wire RTD temperature signal (Input 1)	***AdditionalSens AirTempX60PT1000 FGR-sensor MeasureRangePtNi Sensor Select var. RangePtNi***	N/A
X60.2		Pt100 3-wire RTD line compensation		
X60.3		Pt1000 / Ni1000 2-wire RTD temperature signal (Input 4)		
X60.4	0	Reference ground		
X60.5	FE	Functional ground for shield		
X61.1	Power	Pressure / temperature transducer power supply	***Ext Inp X61 U/I MRange PressSens MRange TempSens Sensor Select***	25mA, 20VDC
X61.2	Programmable Input	0-10VDC (Input 2)		0-10.5VDC
X61.3		4-20mA (Input 2)		0-21mA/3-21mA
X61.4	0	Reference ground		N/A
X61.5	FE	Functional ground for shield		
X62.1	Power	Remote setpoint / remote modulation power supply	***Ext Inp X62 U/I Ext MaxSetpoint Ext MinSetpoint LC_OptgMode User MaxLoadMod/Stg***	25mA, 20VDC
X62.2	Programmable Input	0-10VDC (Input 3)		0-10.5VDC
X62.3		4-20mA (Input 3)		0-21mA/3-21mA
X62.4	0	Reference ground		N/A
X62.5	FE	Functional ground for shield		
X63.1	Programmable Output	MANY options	***CurrMode 0/4mA OutValuSelection Scale 0/4mA Scale20mA angle Scale20mA perc Scale20mA press Scale20mA temp***	0/4-20mA
X63.2	0	Reference ground		N/A
X63.3	FE	Functional ground for shield		



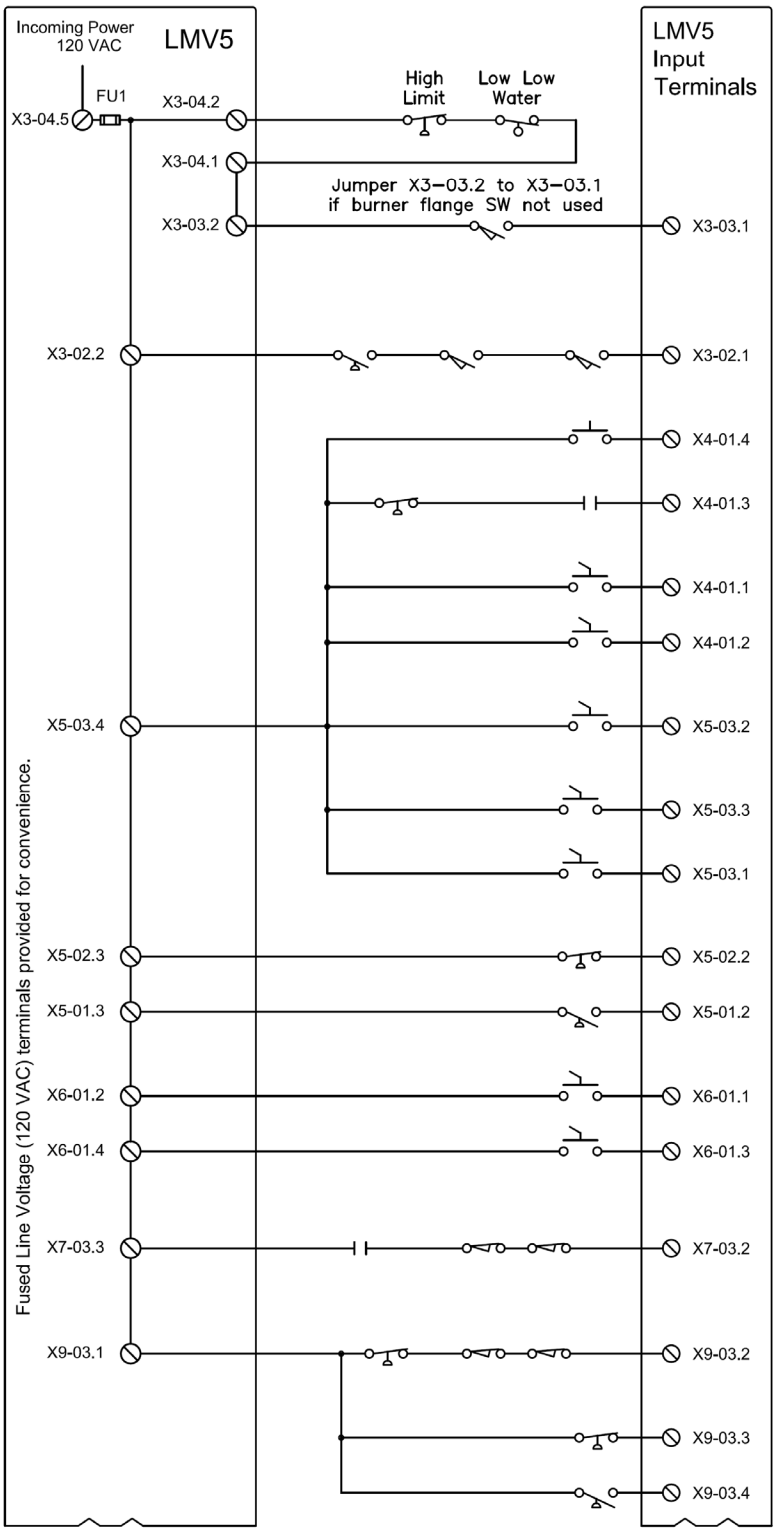
Terminal	Type	Function	*Parameter*	Rating
X70.1	Fixed Output	Speed sensor power supply (BRN)	***Absolute Speed Num Puls per R Standardization StandardizedSp Setteling Time***	45mA, 10VDC
X70.2	Programmable Input	Speed sensor pulse, low 0-1.5VDC, high 3-10VDC (BLK)		0-10VDC
X70.3	0	Reference ground (BLU)		N/A
X70.4	Spare	Spare terminal		
X70.5	FE	Functional ground for shield		
X71.1	Fixed Output	Gas meter pulse power supply	***PulseValueGas***	45mA, 10VDC
X71.2	Programmable Input	Gas meter pulse, low 0-1.5VDC, high 3-10VDC		0-10VDC
X71.3	0	Reference ground		N/A
X71.4	FE	Functional ground for shield		
X72.1	Fixed Output	Oil meter pulse power supply	***PulseValueOil***	45mA, 10VDC
X72.2	Programmable Input	Oil meter pulse, low 0-1.5VDC, high 3-10VDC		0-10VDC
X72.3	0	Reference ground		N/A
X72.4	FE	Functional ground for shield		
X73.1	Programmable Output	VSD dry contact	***ContinuousPurge FGR-PS/FCC ReleasecontctVSD TolQuickShutdown***	2A, 24VAC/DC
X73.2				
X73.3	Fixed Input	VSD alarm		24VDC
X73.4	Programmable Output	0/4-20mA		0-20mA,750ohms
X73.5	0	Reference ground		N/A
X73.6	FE	Functional ground for shield		



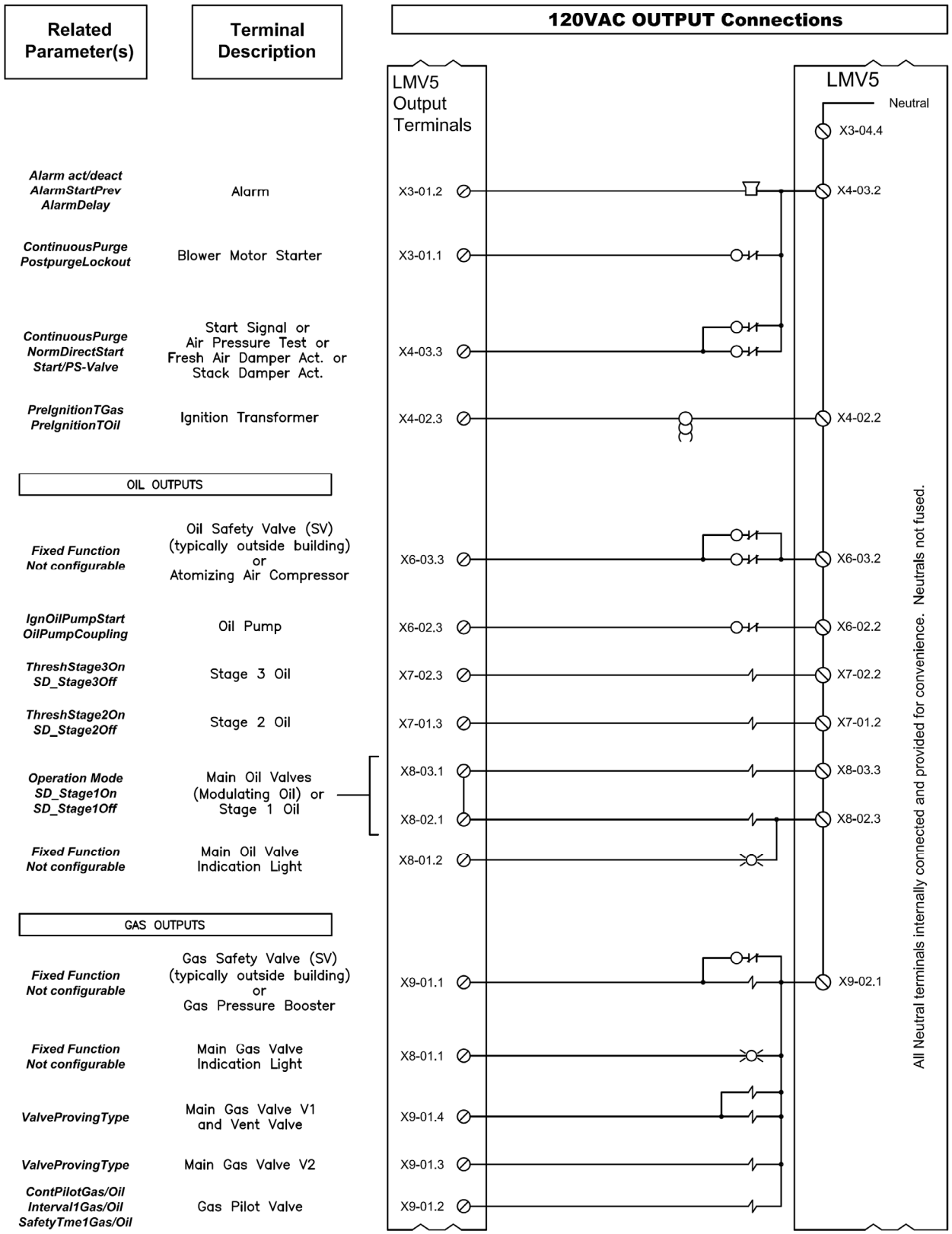
Terminal	Type	Function	*Parameter*	Rating
X81.1	Fixed Input	O_2 signal, Nernst voltage - connect to QGO (B1)	Not configurable	100mVDC
X81.2	0	Ground - connect to QGO (M)		N/A
X81.3	Fixed Input	Thermocouple - connect to QGO (B2)		0 - 33mVDC
X81.4	0	Ground - connect to QGO (M)		N/A
X81.5	Fixed Output	Temp - connect to QGO (G2)		20VDC
X81.6	Fixed Input	Temp compensation - connect to QGO (U3)		4VDC
X82	Spare (not used)			
X83	Spare (not used)			
X84.1	CANbus (PLL)	12VAC1 power for PLL	Not configurable	4A, 12VAC
X84.2		12VAC2 power for PLL		
X84.3		CANH communication signal		5VDC
X84.4		CANL communication signal		
X84.5		Reference ground		N/A
X85.1	CANbus (PLL)	12VAC1 power for PLL	Not configurable	4A, 12VAC
X85.2		12VAC2 power for PLL		
X85.3		CANH communication signal		5VDC
X85.4		CANL communication signal		
X85.5		Reference ground		N/A

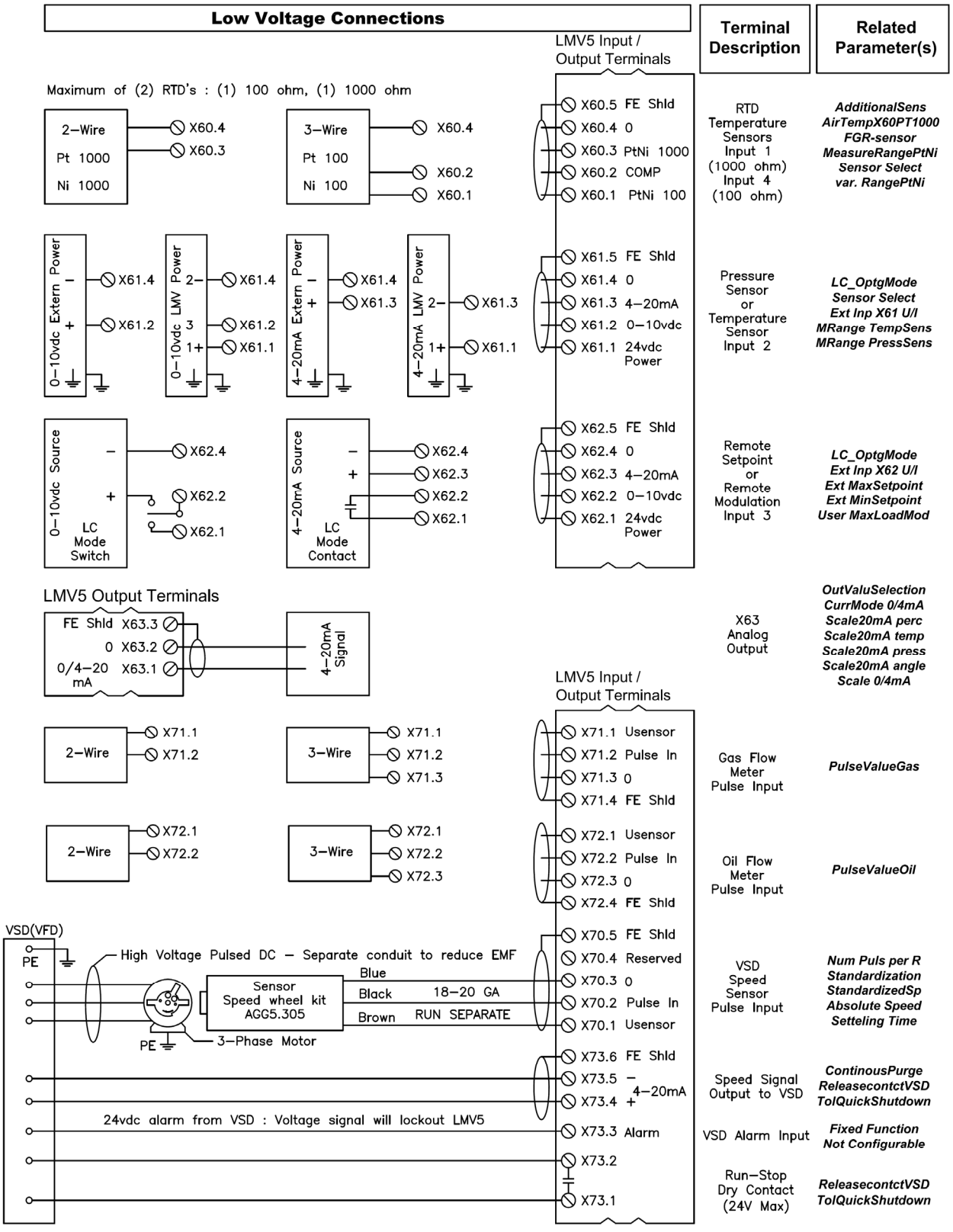


Terminal	Type	Function	*Parameter*	Rating
X86.1	Programmable Input	Flue gas temperature sensor	***FlueGasTemp*** ***FlueGasTempSens*** ***MaxTempFlGasGas/Oil***	N/A
X86.2	0	Reference ground		
X86.3	FE	Functional ground for shield		
X87.1	Programmable Input	Supply air temperature sensor	***AirTempX60PT1000*** ***SupplyAirTemp*** ***SupAirTempSens***	N/A
X87.2	0	Reference ground		
X87.3	FE	Functional ground for shield		
X89-02.1	Fixed Output	To QGO terminal PE - Protective Earth	Not configurable	2.5A, 120VAC
X89-02.2		To QGO terminal Q5 - Neutral (controls QGO heating element)		
X89-02.3		To QGO terminal Q4 - Line (controls QGO heating element)		
X89-01.4	Fixed Input	Supply power to PLL - Protective Earth	Not configurable	2.5A, 120VAC
X89-01.5		Supply power to PLL - Neutral		
X89-01.6		Supply power to PLL - Line (internal 4A fuse)		

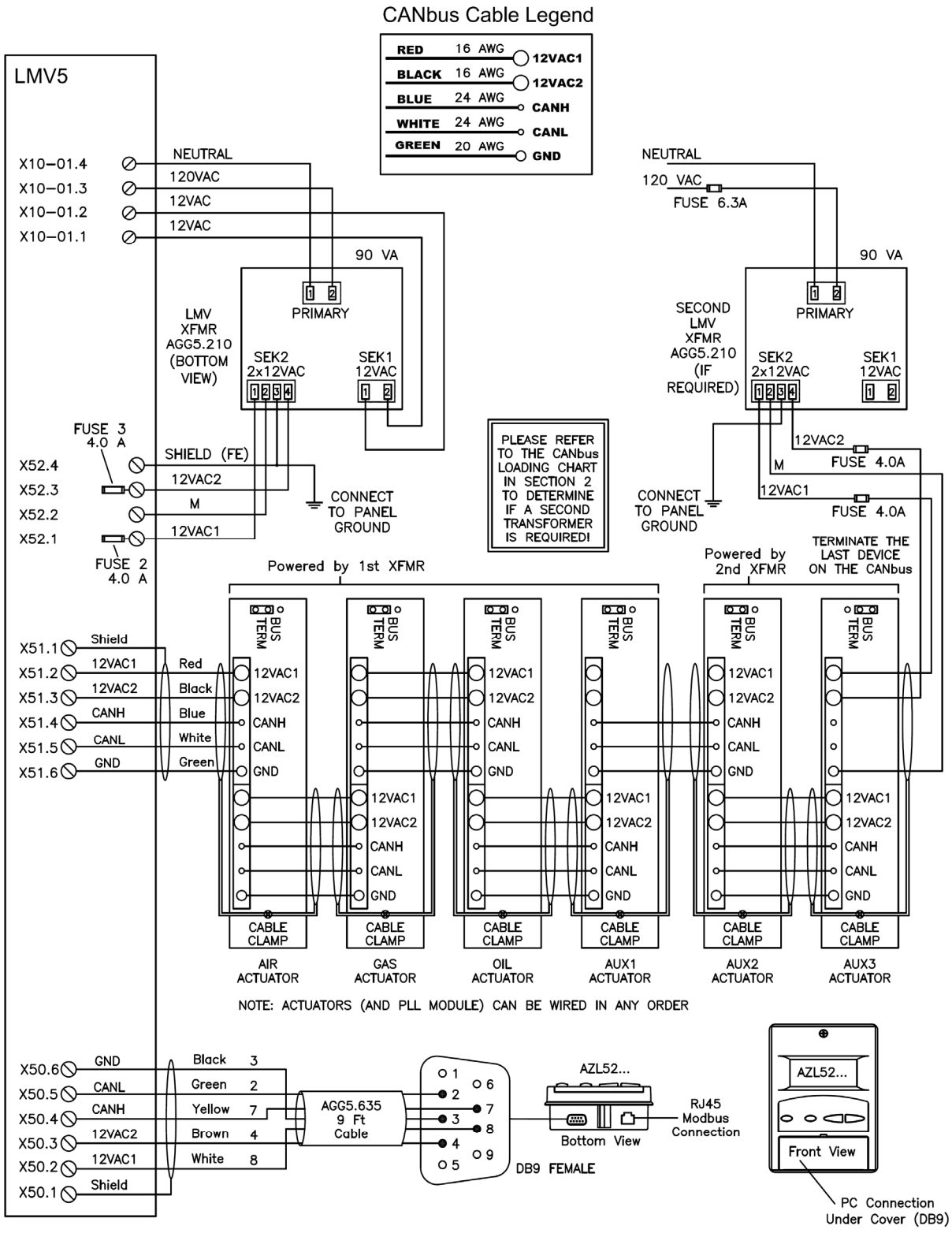


Terminal Description	Related Parameter(s)
Safety Loop (Safety Limits)	*Standby Error*
Burner Flange (End of Safety Limit String)	*Fixed Function Not configurable*
Comb. Air Pressure and Fresh Air damper end SW and Stack Damper end SW	*AirPressureTest FanRunupTme*
Remote Reset and Lockout	*Fixed Function Not configurable*
Blower Starter Aux. (FCC) or FGR Pressure Switch or 2nd Air Pressure SW	*FGR-PS/FCC RotSpeed PS*
Fuel Select Gas	*Fixed Function Not configurable*
Fuel Select Oil	*Fixed Function Not configurable*
Decrease Firing Rate or Enable/Disable 02 Trim	*Config X5-03 LC_OptgMode*
Increase Firing Rate or Program Stop Phase 36	*Config X5-03 LC_OptgMode*
Burner Switch (Operating Limit String)	*InputController LC_OptgMode*
High Oil Pressure SW	*OilPressureMax*
Low Oil Pressure SW	*OilPressureMin*
Atomizing Media Press SW	*StartReleaseOil*
Heavy Oil Temp SW	*HeavyOilDirectStart*
Gas and Oil POC or Gas POC or Oil POC or Start Release Gas	*StartReleaseGas*
Gas and Oil POC or Gas POC or Oil POC or Valve Proving Press SW	*Config_PS-VP/CPI*
High Gas Pressure SW	*GasPressureMax*
Low Gas Pressure SW	*GasPressureMin*

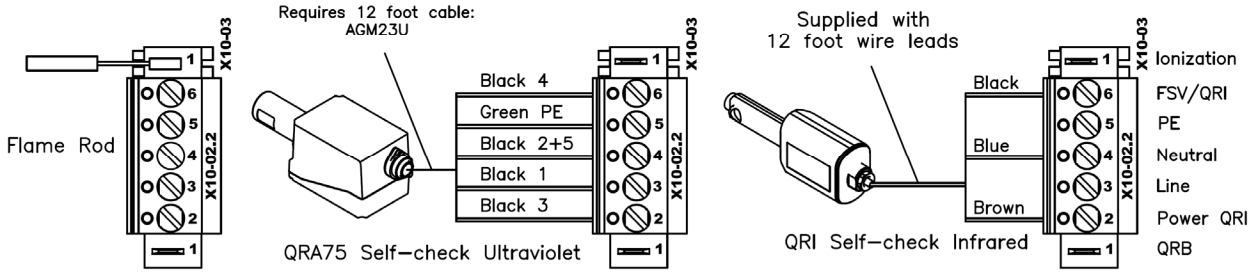

Related Parameter(s)
Terminal Description
120VAC OUTPUT Connections
LMV5 Output Terminals
LMV5
Neutral
X3-04.4
Alarm act/deact
AlarmStartPrev
AlarmDelay
Alarm
X3-01.2
X4-03.2
ContinuousPurge
PostpurgeLockout
Blower Motor Starter
X3-01.1
ContinuousPurge
NormDirectStart
Start/PS-Valve
Start Signal or
Air Pressure Test or
Fresh Air Damper Act. or
Stack Damper Act.
X4-03.3
PreIgnitionTGas
PreIgnitionTOil
Ignition Transformer
X4-02.3
X4-02.2
OIL OUTPUTS
Fixed Function
Not configurable
Oil Safety Valve (SV)
(typically outside building)
or
Atomizing Air Compressor
X6-03.3
X6-03.2
IgnOilPumpStart
OilPumpCoupling
Oil Pump
X6-02.3
X6-02.2
ThreshStage3On
SD_Stage3Off
Stage 3 Oil
X7-02.3
X7-02.2
ThreshStage2On
SD_Stage2Off
Stage 2 Oil
X7-01.3
X7-01.2
Operation Mode
SD_Stage1On
SD_Stage1Off
Main Oil Valves
(Modulating Oil) or
Stage 1 Oil
X8-03.1
X8-03.3
X8-02.1
X8-02.3
Fixed Function
Not configurable
Main Oil Valve
Indication Light
X8-01.2
GAS OUTPUTS
Fixed Function
Not configurable
Gas Safety Valve (SV)
(typically outside building)
or
Gas Pressure Booster
X9-01.1
X9-02.1
Fixed Function
Not configurable
Main Gas Valve
Indication Light
X8-01.1
ValveProvingType
Main Gas Valve V1
and Vent Valve
X9-01.4
ValveProvingType
Main Gas Valve V2
X9-01.3
ContPilotGas/Oil
Interval1Gas/Oil
SafetyTme1Gas/Oil
Gas Pilot Valve
X9-01.2
All Neutral terminals internally connected and provided for convenience. Neutrals not fused.

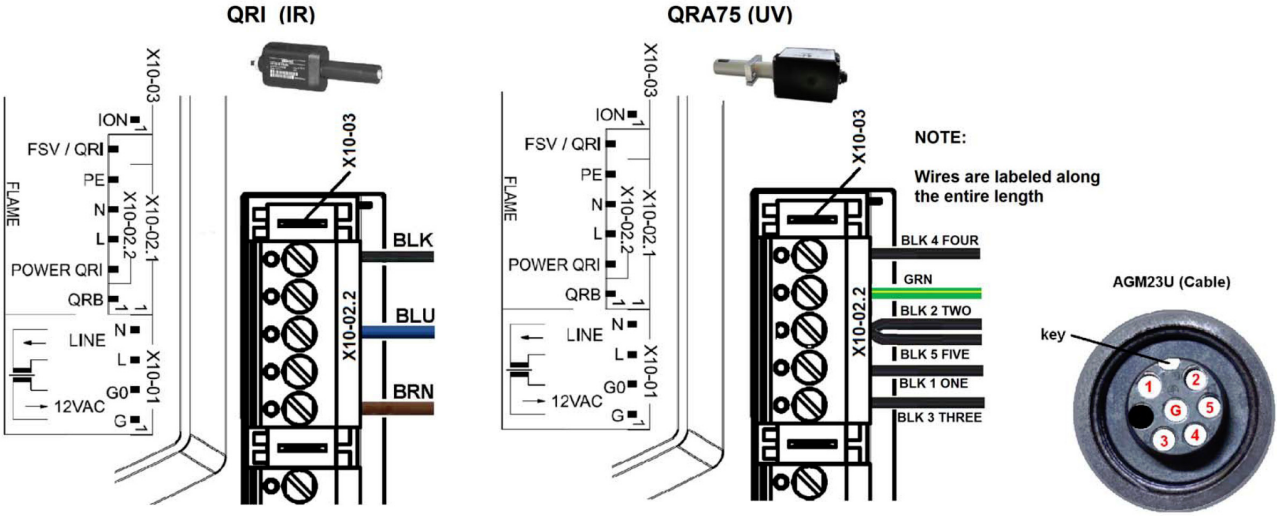

Low Voltage Connections
Terminal Description
Related Parameter(s)
LMV5 Input / Output Terminals
Maximum of (2) RTD's : (1) 100 ohm, (1) 1000 ohm
2–Wire
Pt 1000
Ni 1000
X60.4
X60.3
3–Wire
Pt 100
Ni 100
X60.4
X60.2
X60.1
X60.5 FE Shld
X60.4 0
X60.3 PtNi 1000
X60.2 COMP
X60.1 PtNi 100
RTD Temperature Sensors Input 1 (1000 ohm) Input 4 (100 ohm)
AdditionalSens
AirTempX60PT1000
FGR-sensor
MeasureRangePtNi
Sensor Select
var. RangePtNi
0–10vdc Extern Power
X61.4
X61.2
0–10vdc LMV Power
X61.4
X61.2
X61.1
4–20mA Extern Power
X61.4
X61.3
4–20mA LMV Power
X61.3
X61.1
X61.5 FE Shld
X61.4 0
X61.3 4–20mA
X61.2 0–10vdc
X61.1 24vdc Power
Pressure Sensor or Temperature Sensor Input 2
LC_OptgMode
Sensor Select
Ext Inp X61 U/I
MRange TempSens
MRange PressSens
0–10vdc Source
X62.4
X62.2
X62.1
LC Mode Switch
4–20mA Source
X62.4
X62.3
X62.2
X62.1
LC Mode Contact
X62.5 FE Shld
X62.4 0
X62.3 4–20mA
X62.2 0–10vdc
X62.1 24vdc Power
Remote Setpoint or Remote Modulation Input 3
LC_OptgMode
Ext Inp X62 U/I
Ext MaxSetpoint
Ext MinSetpoint
User MaxLoadMod
LMV5 Output Terminals
FE Shld X63.3
0 X63.2
0/4–20 mA X63.1
4–20mA Signal
X63 Analog Output
OutValuSelection
CurrMode 0/4mA
Scale20mA perc
Scale20mA temp
Scale20mA press
Scale20mA angle
Scale 0/4mA
LMV5 Input / Output Terminals
2–Wire
X71.1
X71.2
3–Wire
X71.1
X71.2
X71.3
X71.1 Usensor
X71.2 Pulse In
X71.3 0
X71.4 FE Shld
Gas Flow Meter Pulse Input
PulseValueGas
2–Wire
X72.1
X72.2
3–Wire
X72.1
X72.2
X72.3
X72.1 Usensor
X72.2 Pulse In
X72.3 0
X72.4 FE Shld
Oil Flow Meter Pulse Input
PulseValueOil
VSD(VFD)
PE
High Voltage Pulsed DC – Separate conduit to reduce EMF
Sensor Speed wheel kit AGG5.305
Blue
Black 18–20 GA
Brown RUN SEPARATE
PE
3–Phase Motor
X70.5 FE Shld
X70.4 Reserved
X70.3 0
X70.2 Pulse In
X70.1 Usensor
VSD Speed Sensor Pulse Input
Num Puls per R
Standardization
StandardizedSp
Absolute Speed
Setteling Time
X73.6 FE Shld
X73.5 –
X73.4 + 4–20mA
Speed Signal Output to VSD
ContinousPurge
ReleasecontctVSD
TolQuickShutdown
24vdc alarm from VSD : Voltage signal will lockout LMV5
X73.3 Alarm
VSD Alarm Input
Fixed Function
Not Configurable
X73.2
X73.1
Run–Stop Dry Contact (24V Max)
ReleasecontctVSD
TolQuickShutdown

CANbus Connections

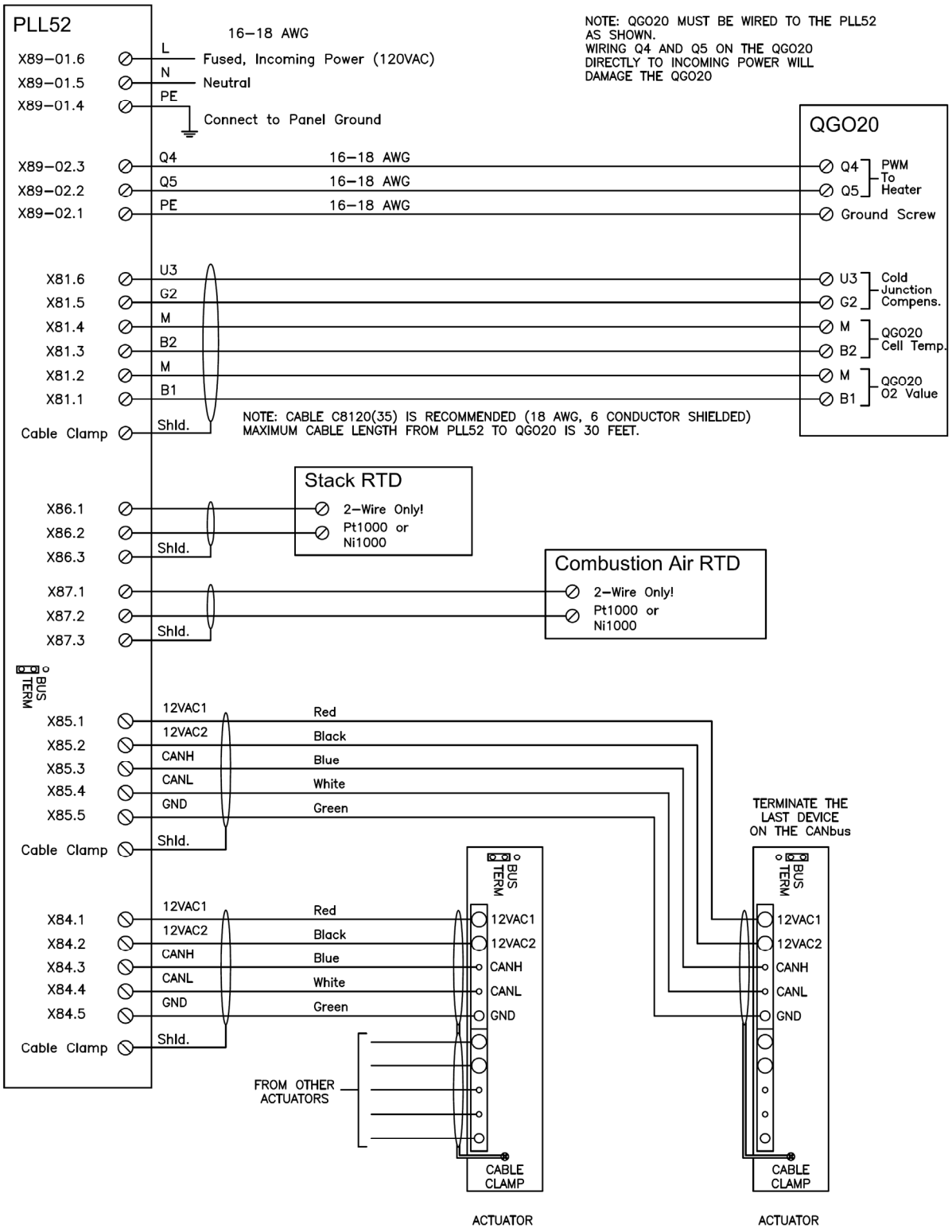


Flame Detector Connections





O2 Trim Connections



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Section 1	Overview
Section 2	Wiring
Section 3	**Parameters**
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Section 5	VSD
Section 6	O_2 Trim
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Section 8	Modbus
Section 9	ACS450
Section 10	Revision History
Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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3-1: Parameters Introduction

The Siemens LMV5 has a number of parameters that can be adjusted to suit the wide variety of applications that exist in the burner / boiler and industrial heating market.

These parameters are broken up into three main groups by password access:

User Level access does not require a password, and encompasses all of the parameters that an end user might have to view or adjust during the life of the burner / boiler.

Service Level access does require a password, and encompasses all of the user level parameters, plus additional parameters that a service technician might need to access to tune or maintain the burner / boiler.

OEM Level access requires a different password than the service level, and enables the OEM to access all available parameters, including safety-related parameters.

The parameters are accessed through the AZL5 in an outline-type structure. This structure is thoroughly illustrated with the LMV5 Parameter List in Section 3-2. An explanation of how to use the LMV5 Parameter List is shown below.

Menu Path	Parameter	Default	Range	Description	51.1	52.2	52.4
States the menu path necessary to access the parameter. Bold indicates the highest menu level.	SafetyTme1Gas (O)	5s	1-10s	When a fuel train with a pilot is used, this setting defines…			
	SafetyTme1Oil (O)	5s	1-15s	States if the parameter is available on an LMV51.1, LMV52.2, or LMV52.4*	x	x	x
Params & Display> BurnerControl> Times> TimesStartup2	Interval1Gas (S)	2s	0.2-63s	When a fuel train is selected that has a pilot, this setting defines…			
	Interval1Oil (S)	2s		States what password level is required to access the parameter.			

*LMV51.0 is not shown in the Parameter List. It has the same parameters as the LMV51.1 with the exception that the LMV51.0 has no “load controller” parameters.

Figure 3-1.1: LMV5 Parameter List Legend

Section 3-3 shows the sequence diagrams for each fuel train available in the LMV5 with the exception of *HeavyOilHO* (heavy oil with direct spark). For an example of what each of these fuel trains looks like, see Section 4.

3-2: Parameter List

A	
Absolute Speed	39, 40
actTmpFGR-sensor	42
Actuator Addressing	37
Actuator/VSD Activation	20
AdaptionLoad	35
AdditionalSens	32
Address	36
Adjust. Temp O2	26
AfterburnTme	9
AirPressureTest	12
Air-related Load	28
AirTempX60PT1000	41, 44
Alarm act/deact	5
AlarmDelay	9
AlarmStartPrev	10
Allowed Pot.diff	44
Autom/Manual/Off	7, 21

B	
Baudrate	36
BurnerID **	6, 45

C	
Calc PI again	23
ColdStartOn	31
CombEfficiency	28, 41
Config X5-03	13
Config_PS-VP/CPI	12, 16
ContinuousPurge	11
ContPilotGas	11
ContPilotOil	11
Curr Flow Rate	6, 45
Current O2 Value	6, 41
CurrentFuel	5
CurrMode 0/4mA	35
CurveParams **	19

D	
Date	5, 45
DateFormat	36
DelayLackGas	9
DelayStartPrev	9
DelaytimeFGR Gas(Oil)	42
DeleteCurves	37
Diag Reg State	28
Direction of rotation	37
Display Contrast	37
D-Part	29
DriveLowfire Gas	11
DriveLowfire Oil	11

E	
Ext Inp X61 U/I	34
Ext Inp X62 U/I	34, 43
Ext MaxSetpoint	34
Ext MinSetpoint	34
ExtranLightTest	14

F	
Factor FGR Gas(Oil)	42
FanRunupTme	7
FaultHistory	5
FGR MaxPos Fact	43
FGR MinPos	43
FGR-Mode	42
FGR-PS/FCC	12
FGR-sensor	42
FlameSig ION	15
FlameSig QRI_B	15
FlueGasTemp	6, 41
FlueGasTempSens	41
ForcedIntermit	10
FuelSelect	5
FuelTrainGas **	11
FuelTrainOil **	11

G	
GasFiring	6, 44
GasPressureMax	13
GasPressureMin	13
GasStartCount	6, 44
Gateway status	6
GatewayBASoff	6
GatewayBASon	6

H	
HeavyOil	16
HeavyOilDirStart	14
HomePos	17

I	
I High-Fire	23
I Low-Fire	23
IgnitionPos **	18
IgnOilPumpStart	10
InputController	13
InterfacePC	6
Interval1Gas	8
Interval1Oil	8
Interval2Gas	8
Interval2Oil	8
I-Part	29

L	
Language	36
LC Analog Output	44
LC_OptgMode	33, 43
Load of Ignition	26
Load_SW_from_PC	46
LoadCtrlSuspend	24
LoadMaskHighLim	20
LoadMaskLowLimit	20
Local / Remote	36
LockoutCounter	6
LockoutHistory	5

L - cont	
LossFlameTest	46
LossOfFlame	16
LowfireAdaptPtNo **	24

M	
MainsFrequency	11
ManVar O2 Ctrl	28
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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
OperationalStat	NormalOperation (U)	Read Only		The normal AZL52 screen. In standby: Setpoint, Actual Value, Fuel and status can be displayed. In run: pertinent information will be displayed. Faults and warnings will always appear on the AZL52. Pressing Enter button will toggle information.	X	X	X
	Status/Reset (U)	Reset		Shows the current fault if there is one, or displays 'No Fault' if there is not. If a fault is present, it can be reset by pressing Esc, then Enter.			
	FaultHistory (U)	Read Only		Shows the last 21 faults. All lockouts are faults, not all faults are lockouts. Format: Class, Fuel, (fault) Code, Phase, Diag(nostic), Lo(a)d and Start No.			
	LockoutHistory (U)	Read Only		Shows the last 9 lockouts. Format : Date, Time of day, C:(code), D:(diagnostic), P:(phase), Start No., Load, and Fuel.			
	Alarm act/deact (U)	activated	activated deactivated	Functions as an alarm silence. Deactivates OUTPUT X3-01.2 which is the alarm output in the event of a lockout. Output will automatically reactivate if another lockout occurs or if system is reset or restarted.			
Operation> BoilerSetpoint	SetpointW1 (U)	Not Set	0-3632 F 0-1449 PSIG	The LMV5 has 2 internal setpoints. ***SetpointW1*** is the normal internal setpoint. ***SetpointW2*** is an alternate internal setpoint. Changeover via dry contact between OUTPUT X62.1 and INPUT X62.2 if ***LC_OptgMode*** is set to IntLC. Contact open = W1, closed = W2. Max setpoint limited by sensor range (parameter ***TL_ThreshOff*** , ***MRange PressSens*** , ***MRange TempSens*** , or ***MeasureRangePtNi***).	X	X	X
	SetpointW2 (U)						
Operation> User Maxload	User MaxLoadMod (U)	100%	***MinLoadGas*** - ***MaxLoadGas***	Used to limit the maximum load (firing rate) without a password. For modulating burners. May be limited by ***MinLoadGas*** and ***MaxLoadGas*** .	X	X	X
	User MaxLoadStg (U)	S3	S1-S3	Used to limit the maximum load (firing rate) without a password. For staged burners.			
Operation> Fuel	CurrentFuel (U)	Gas	Gas Oil	Displays the fuel that is currently selected via hardwire, AZL52 or Modbus	X	X	X
	FuelSelect (U)	Gas	Gas Oil	If INPUT X4-01.1 and INPUT X4-01.2 are not energized, fuel selection is 'internal' (soft) and can be set here or via Modbus. Energize (hard) X4-01.1 for gas or X4-01.2 for oil. Powering both terminals at the same time will cause a lockout.			
Operation> Date/TimeOfDay> DisplayClock	Date (U)	Read Only		Displays the current date.	X	X	X
	TimeOfDay (U)			Display the current time.			
	Weekday (U)			Displays the day of the week.			
Operation> Date/TimeOfDay> SetClock	Date (U)	Set for local date and time at factory location in Europe.		Sets the date. Select U.S. or European format at: *Params & Display > AZL > DateFormat*	X	X	X
	TimeOfDay (U)			Sets the time of day. 24 hour format: HH:MM			
	Weekday (U)			Sets the day of the week.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Operation> HoursRun	GasFiring (U)	Read Only		Hours run firing gas. Reset / adjust: *Params & Display > HoursRun*	X	X	X
	OilStage1/Mod (U)			Hours run on modulating or stage 1 oil. Reset / adjust: *Params & Display > HoursRun*			
	OilStage2 (U)			Hours run on stage 2 oil. Reset / adjust at: *Params & Display > HoursRun*			
	OilStage3 (U)			Hours run on stage 3 oil. Reset / adjust at: *Params & Display > HoursRun*			
	TotalHoursReset (U)			Hours run on all fuels. Reset / adjust: *Params & Display > HoursRun*			
	TotalHours (U)			Displays the number of hours run on all fuels. Not resettable.			
	SystemOnPower (U)			Hours the system has been powered. Not resettable.			
Operation> StartCounter	GasStartCount (U)	Read Only		Number of startups on gas. Reset at: *Params & Display > StartCounter*	X	X	X
	OilStartCount (U)			Number of startups on oil. Reset at: *Params & Display > StartCounter*			
	TotalStartCountR (U)			Number of startups on all fuels. Reset at: *Params & Display > StartCounter*			
	TotalStartCount (U)			Displays the number of startups on all fuels. Not resettable.			
Operation> Fuel Meter	Curr Flow Rate (U)	Read Only		Displays the current flow rate of fuel, gas or oil.			
	Volume Gas (U)			Totalized volume of gas since the last reset.			
	Volume Oil (U)			Totalized volume of oil since the last reset.			
	Volume Gas R (U)	Reset Only		Resets the totalized volume of gas.		X	X
	Volume Oil R (U)			Resets the totalized volume of oil.			
	Reset Date Gas (U)	Read Only		Displays the date when the volume of gas was last reset. Cannot be changed.			
	Reset Date Oil (U)			Displays the date when the volume of oil was last reset. Cannot be changed.			
Operation	LockoutCounter (U)	Read Only		Displays the total number of lockouts that have occurred.	X	X	X
Operation> O2 Module	Current O2 Value (U)	Read Only		Current O2 sensor reading. Wet basis - will be lower than dry O2 reading.			
	O2 Setpoint (U)			O2 target value for the current load can be viewed here.			
	SupplyAirTemp (U)			Current combustion air temperature if equipped with ambient temp sensor.		X	X
	FlueGasTemp (U)			Current flue gas temperature if equipped with flue gas temp sensor.			
	CombEfficiency (U)			The calculated value of the combustion efficiency based on the wet O2 value, combustion air temperature, and flue gas temperature.			
Operation	BurnerID (U)	Read Only		Burner identification. Adjust at: *Updating > BurnerID* (requires OEM password)	X	X	X
Operation> OptgModeSelect	InterfacePC (U)	press Enter to activate, press Esc to deactivate		This activates COM 1, the DB9 connector on the front of the AZL to use with ACS450.	X	X	X
	GatewayBASon (U)	press Enter to activate		This activates or deactivates COM 2, the RJ45 jack on the bottom of the AZL, for Modbus or eBUS communication. This port uses RS-232 communications.			
	GatewayBASoff (U)	press Enter to deactivate					
	Gateway status (U)	Read Only		Displays if the gateway is activated or deactivated.			
	Type of Gateway (U)	Modbus	Modbus eBus Data output	This parameter configures the protocol of Com 2. Select the proper communication protocol (Modbus, eBUS) or select 'Data output' for use with trending software.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Operation	O2Ctrl activate (U)	deact	activated deactivated	Activates the O2 trim system. If control automatically deactivates, can be reactivated here.		X	X
ManualOperation	SetLoad (U)	Not Set	0-100% S1-S3	When in manual mode (see next parameter), this sets firing rate (load). Other parameter settings may limit the maximum achievable load.	X	X	X
	Autom/Manual/Off (U)	Automatic	Automatic Burner off Manual	1) Automatic - Enables the burner allowing it to respond to setpoints and switch on / switch off points. 2) Burner off - Manually turn the burner off. 3) Manual - Enables the load of the burner to be set with ***SetLoad*** . When in manual, setpoints and switch on/ off points are ignored. If INPUT X5-03.1 (burner switch) is enabled, it must be energized for the LMV5 to start, regardless of parameter setting.			
Params & Display> BurnerControl> Times> TimesStartup1	MinTmeStartRel (S)	1s	0.2-63s	When the LMV5 gets a call for heat, this defines the minimum time the LMV5 will hold in phase 21. Start releases could be made, but the LMV5 will still hold in phase 21 for this period of time.	X	X	X
	FanRunupTme (S)	2s	0.2-63s	Time allowed to let the fan accelerate up to speed before the actuators start driving to prepurge.			
NOTE: There are numerous prepurge time parameters to provide options for purging FGR piping. For boilers without FGR, these times should be set the following way. ***PrepurgeTmeGas(Oil)*** should be set for the desired prepurge time after a normal shutdown. ***PrepurgeSafeGas(Oil)*** should be set for the desired prepurge time after a safety shutdown. ***PrepurgePt1Gas(Oil)*** and ***PrepurgePt3Gas(Oil)*** should be set to 0.2 seconds so that they are ignored. See below for more detail on each parameter.							
Params & Display> BurnerControl> Times> TimesStartup1	PrepurgeTmeGas (S)	120s	***MinT_PrepurgeGas(Oil)*** - 63min	Prepurge timing begins when actuators / VSD have reached their specified purge positions. Total prepurge time (phase 30-34) will be equal to this setting or longer (other prepurge time parameters may cause a longer prepurge). This parameter cannot be set less than ***MinT_PrepurgeGas*** or ***MinT_PrepurgeOil*** respectively.	X	X	X
	PrepurgeTmeOil (S)	120s					
Params & Display> BurnerControl> Times> TimesStartup1	MinT_PrepurgeGas (O)	20s	0.2s-63min	Sets the minimum allowable time for ***PrepurgeTmeGas(Oil)*** above. This parameter should be set by the OEM for code-required air exchanges of combustion chamber volume.	X	X	X
	MinT_PrepurgeOil (O)	15s					
	PrepurgeSafeGas (S)	20s	***MinT_PrepurgeGas(Oil)*** - 63min	After a safety shutdown, this time replaces ***PrepurgePt1Gas(Oil)*** and ***PrepurgePt3Gas(Oil)*** . The LMV5 will stay in phase 30 for half of this time. Then the LMV5 will progress to phase 34 for half of this time or longer (if ***PrepurgeTmeGas(Oil)*** is set larger than this parameter). This parameter cannot be set less than ***MinT_PrepurgeGas*** or ***MinT_PrepurgeOil*** respectively. Setting has no effect on startups after a normal shutdown.			
	PrepurgeSafeOil (S)	15s					

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Times> TimesStartup1	PrepurgePt1Gas (S)	0.2s	0.2s-63min	Sets the time the LMV5 stays in phase 30 on startups after a normal shutdown. Setting has no effect on startups after a safety shutdown. If an Aux3 actuator is used, phase 30 is the time when the air actuator / VSD are at purge position and the Aux3 actuator is at home position.	X	X	X
	PrepurgePt1Oil (S)						
	PrepurgePt3Gas (S)	0.2s	0.2s-63min	Sets the minimum time the LMV5 stays in phase 34 on startups after a normal shutdown. Time will be longer if ***PrepurgeTmeGas(Oil)*** is set larger than ***PrepurgePt1Gas(Oil)*** + ***PrepurgePt3Gas(Oil)*** . Setting has no effect on startups after a safety shutdown. If an Aux3 actuator is used, phase 34 is the time when the air actuator / VSD are at purge position and the Aux3 actuator is also at purge position.			
	PrepurgePt3Oil (S)						
Params & Display> BurnerControl> Times> TimesStartup1	PreIgnitionTGas (S)	2s	0.2- 63s	This defines the time the ignition transformer (OUTPUT X4-02.3) alone is energized before the pilot valve (OUTPUT X9-01.2) or main valves (for direct spark fuel trains) become energized. Sets the length of phase 38.	X	X	X
	PreIgnitionTOil (S)	2s	0.2- 44s				
	MinOnTmeOilPump (S)	5s	0.2-63s	When LO w Gasp (Light Oil with Gas pilot) is selected, this is the minimum time the oil pump can run (OUTPUT X6-02.3) before the LMV5 attempts to light the pilot, (OUTPUT X9-01.2). Time starts in phase 22, and will hold in phase 36 until this parameter times out.			
Params & Display> BurnerControl> Times> TimesStartup2	SafetyTme1Gas (O)	5s	1-10s	When a fuel train with a pilot is used, this setting defines the overlap of the spark (OUTPUT X4-02.3) and the pilot valve (OUTPUT X9-01.2). After this time expires, spark is de-energized but the PV remains open if a flame is present. If a flame is not sensed, a lockout occurs. If directly spark igniting the main fuel, this defines the overlap of the spark and the main fuel valves. This time is also known as TSA1. Sets the length of phases 40-42.	X	X	X
	SafetyTme1Oil (O)	5s	1-15s				
	Interval1Gas (S)	2s	0.2-63s	When a fuel train is selected that has a pilot, this setting defines the pilot stabilizing period. This time begins after ***SafetyTme1Gas(Oil***) expires. During this period, only the pilot valve is open. The spark is de-energized. If directly spark igniting the main fuel, this defines the main stabilizing period. Sets the length of phase 44.			
	Interval1Oil (S)	2s					
	SafetyTme2Gas (O)	5s	1-10s	When a fuel train with a pilot is used, this setting defines the overlap of the pilot (OUTPUT X9-01.2) and the main fuel valves. After this time expires the pilot is de-energized if continuous pilot is not selected. Shorter times are more safe. No effect for fuel trains having direct spark ignition of main fuel. This time is also known as TSA2. Sets the length of phase 50.			
	SafetyTme2Oil (O)	5s	1-15s				
	Interval2Gas (S)	2s	0.2-630s	Defines the main flame stabilizing period at ignition position before modulation. This time begins after ***SafetyTme2Gas(Oil)*** expires. During this period, only the main fuel valves are open. The pilot valve is de-energized unless continuous pilot is selected. No effect for fuel trains having direct spark ignition of main fuel. Sets the length of phase 52.			
	Interval2Oil (S)	2s					

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Times> TimesStartup2	PressReacTme (S)	2s	0.2-10s	Sets the time that the LMV5 will ignore the high and low gas pressure switch inputs after the main gas valves open. This is done so that pressure shocks do not cause erroneous alarms on properly adjusted high or low automatic reset gas pressure switches. Does not work with manual reset switches.	X	X	X
Params & Display> BurnerControl> Times> TimesShutdown	MaxTmeLowFire (S)	45s	0.2-630s	The allowable time to let the LMV5 achieve low fire shutdown after a call for heat is removed via internal load controller or INPUT X5-03.1. Setting does not affect fuel valve closing in the event of a safety shutdown.	X	X	X
	AfterburnTme (S)	8s	0.2-63s	Defines the permissible time for a flame to be detected after the main fuel valves are closed without causing a startblock or alarm. Useful for air postpurged oil nozzles.			
	PostpurgeT1Gas (S)	30s	0.2s-63min	Defines the mandatory postpurge period. Even if the direct start option is selected and a call for heat exists, the LMV5 will only go into prepurge after this period times out.			
	PostpurgeT1Oil (S)	30s					
	PostpurgeT3Gas (S)	5s	0.2s-63min	Defines an optional postpurge period. If the direct start option is selected and a call for heat exists, the LMV5 will go directly into prepurge after ***PostpurgeT1Gas(Oil)*** .			
	PostpurgeT3Oil (S)	5s					
	PostpurgeT3long (S)	0min	0-65535min	Defines a postpurge time that is in addition to ***PostpurgeT3Gas(Oil)*** . If the direct start option is selected and a call for heat exists, the LMV5 will go directly into prepurge after ***PostpurgeT1Gas(Oil)*** expires.			X
	MinTmeHomeRun (O)	1s	0.2-63s	The minimum time the LMV5 will wait in phase 10 before proceeding to phase 12.	X	X	X
	DelayLackGas (S)	10s	***MinTmeHomeRun*** -63s	If there is a lack of gas pressure (low gas pressure switch open), then the LMV5 will wait this period of time before attempting to relight, provided that the repetition counter ***RepetitCounter*** for gas is set for more than one (not done in the US). This time period will double after the first relight attempt. This doubling would occur if ***RepetitCounter*** were set to 3 or greater. Cannot be set for a shorter time than ***MinTmeHomeRun*** .			
Params & Display> BurnerControl> Times> TimesGeneral	AlarmDelay (S)	10s	0.4-630s	If a condition exists that does not open the safety loop but does prevent the LMV5 from starting when there is a call for heat, this specifies the period of time that can elapse with this condition before the alarm is energized. If ***AlarmStartPrev*** (alarm in the case of start prevention) is deactivated, setting this time has no effect.	X	X	X
	DelayStartPrev (S)	0.4s	0.4-630s	Period of time before a start prevention is displayed on the AZL. When there is a call for heat, and a start prevention occurs that does not open the safety loop but does prevent the LMV5 from starting, this specifies the period of time that can elapse before the condition is displayed on the AZL.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Times> TimesGeneral	PostpurgeLockout (S)	120s	0.2s-63min	If a lockout condition occurs, and the combustion air fan was running, it will continue running in the lockout phase (phase 00) for this period of time. This time replaces the postpurge time in the event of a lockout. If the combustion air fan was not running, the fan will remain off for the rest of the lockout phase.	X	X	X
	MaxTmeStartRel (S)	120s	0.2s-63min	When the LMV5 gets a call for heat, this is the maximum time the LMV5 will hold in phase 21 waiting for a start release. If this time expires and the start release is not made, the LMV5 will go into alarm. See: *Params & Display > BurnerControl > Times >TimesStartup1 > MinTmeStartRel*			
Params & Display> BurnerControl> Configuration> ConfigGeneral	AlarmStartPrev (S)	deact	activated deactivated	Determines if the alarm OUTPUT X3-01.2 will be energized in the event of a start prevention (an alarm in standby - Phase 12). ***AlarmDelay*** sets how long the LMV5 will wait before going into alarm.	X	X	X
	Standby Error (S)	deact	activated deactivated	If this is set to activated, an alarm will occur if the safety loop is opened in phase 12 (standby). If deactivated, the safety loop can be open when in phase 12 without alarm.			
	NormDirectStart (S)	Normal Start	NormalStart DirectStart	Enables the LMV5 to skip postpurge (T3) time, and go directly into prepurge if there is a call for heat during postpurge T1. If set to DirectStart, a 3-way valve on OUTPUT X4-03.3 must be used to check the air pressure switch.			
	OilPumpCoupling (S)	Magnet-coupl	Magnetcoupl Directcoupl	Combined with IgnOilPumpStart determines the behavior of OUTPUT X6-02.3: 1) Magnetcoupl - the output will energize, in either phase 22 or 38, depending on the setting of ***IgnOilPumpStart*** . Output will de-energize as soon as main oil valves close. 2) Directcoupl - the output will energize at the same time as the blower, and de-energizes 15 seconds after the blower.			
	IgnOilPumpStart (S)	on in Ph22	on in Ph22 on in Ph38	If *Magnetcoupl* is selected above, this determines when OUTPUT X6-02.3 is energized. If a direct spark oil train is selected, spark will occur during prepurge if set to Ph22.			
	ForcedIntermit (S)	activated	activated deactivated	When activated, this setting forces the LMV5 to shut the burner down, every 23 hours 50 minutes. The burner will automatically restart. The purpose of this is to check and cycle safety devices. If a non-self check flame scanner is used, this must be activated.			
	Skip PrepurgeGas (S)	deact	activated deactivated	If activated, prepurge for gas will be skipped. Not recommended for most burners.			
	Skip PrepurgeOil (O)	deact		If activated, prepurge for oil will be skipped. Not recommended for most burners.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigGeneral	ContinuousPurge (S)	deact	activated deactivated off Sloop deac/VSD-SL	Sets the operation of the blower. 1) activated - blower runs in all phases. Typically used to prevent return heat from coming back into the burner. 2) deactivated - blower is called on and off as needed. 3) off Sloop - continuous purge is activated, but the fan will stop if the safety loop is opened. 4) deac/VSD-SL - continuous purge is deactvated and the VSD will be set to zero speed if the safety loop is opened.			
	DriveLowfire Gas (O)	Lowfire P54	LowfireP54 LowfireP50	Controls the action of the actuators when lighting the main burner flame. 1) LowFireP50 - the LMV5 will start driving to ***StartPointOp*** (typically point 1 - low fire) at the beginning of phase 50. This is typically used if a fuel rich light off is needed. 2) LowFireP54 -the LMV5 will not start driving to ***StartPointOp*** until the beginning of phase 54.	X	X	X
	DriveLowfire Oil (O)	Lowfire P54					
	FuelTrainGas (O)**	Not Set	DirectIgniG Pilot Gp1 Pilot Gp2	Selects the fuel train for gas. 1) DirectIgniG - Direct spark ignition gas. 2) Pilot Gp1 - Pilot ignition for European gas burners 3) Pilot Gp2 - Pilot ignition for North American gas burners (See Section 5).			
	FuelTrainOil (O)**	Not Set	LightOilLO HeavyOilHO LO w Gasp HO w Gasp	Selects the fuel train for oil. 1) LightOilLO - Direct spark ignition for light oil. 2) HeavyOilHO - Direct spark ignition for heavy oil. 3) LO w Gasp - Gas pilot ignition for light oil. 4) HO w Gasp - Gas pilot ignition for heavy oil.			
Params & Display> BurnerControl> Configuration> ConfigGeneral> FuelTrainReset	FuelTrainGas (O)	Go into parameter then press Enter to reset		Resets the fuel train to a value of "invalid" (means not set, undefined). This allows removal a previously configured fuel train, if it is no longer being used. Resetting this will also remove the fuel-air ratio curves for the fuel that is reset.	X	X	X
	FuelTrainOil (O)						
Params & Display> BurnerControl> Configuration> ConfigGeneral	ContPilotGas (O)	deact	activated deactivated	Activates or deactivates a continuous pilot. Each fuel can be configured separately. In this case continuous pilot is defined as a pilot from the end of phase 42 (normal pilot light off) to the end of phase 62 (low fire shut down).		X	X
	ContPilotOil (O)	deact					
	MainsFrequency (O)	60 Hz	50 Hz 60 Hz	Set to the freqency of the local AC power grid. For North America select 60 Hz.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigIn/Output	StartReleaseGas (O)	StartRel Gas	deactivated StartRelGas CPI Gas CPI Gas+Oil CPI Oil	Sets the function of INPUT X7-03.2. 1) deactivated - terminal has no function. 2) StartRelGas - input must be energized in phase 21-62. 3) CPI Gas - proof of closure (POC) for gas valves. 4) CPI Gas+Oil - proof of closure (POC) for gas and oil valves wired on the same terminal. 5) CPI Oil - proof of closure (POC) for oil valves.	x	x	x
	StartReleaseOil (O)	activated	activated deactivated HT/FG-RedCo	Sets the function of INPUT X6-01.1. 1) activated - input must be energized in phase 21-62, typically used for an atomizing media pressure switch. 2) deactivated - terminal has no function. 3) HT/FG-RedCo - input for a redundant contact when using an external flame safeguard. This input is inverse of the main contact on terminal X6-01.3. See parameter ***HeavyOilDirStart*** for more information on external flame safeguards (LMV52 only).	/	x	x
	AirPressureTest (O)	activated	activated deactivated deactInStby	Activates or deactivates INPUT X3-02.1, the combustion air pressure switch. Activate for forced or induced draft burners. Can also be set to "deactInStby", so that the status of the air pressure switch is not evaluated in standby. However, the burner will not start until INPUT X3-02.1 is de-energized.	x	x	x
	Config_PS-VP/CPI (O)	CPI Gas	PS-VP CPI Gas CPI Gas+Oil CPI Oil	Sets the function of INPUT X9-03.2. 1) PS-VP - pressure switch for use with automatic valve proving. 2) CPI Gas - proof of closure (POC) for gas valves. 3) CPI Gas+Oil - POC for gas and oil valves on the same terminal. 4) CPI Oil - POC for oil valves. Note: Input can be deactivated by setting to PS-VP and de-activating valve proving at: *Params & Display > BurnerControl > ValveProving > ValveProvingType*	x	x	x
	FGR-PS/FCC (O)	FCC	FCC FGR-PS deactivated PSdeactStby PS VSD	Sets the function of INPUT X4-01.3. 1) FCC - checks the status of the fan motor starter. 2) FGR-PS - checks the status of an FGR pressure switch. 3) deactivated - terminal has no function. 4) PSdeactStby - checks the status of an FGR pressure switch but the pressure switch is not evaluated in standby. 5) PS VSD - checks the status of a second air pressure switch based on VSD speed. See ***RotSpeed PS on*** and ***RotSpeed PS off*** (not available on LMV51.1).	/	x	x

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigIn/Output	RotSpeed PS on (S)	80%	0-100%	If FGR-PS/FCC is set to PS VSD, then INPUT X4-01.3 must be energized from this % VSD and higher. Must be set higher than ***RotSpeed PS off*** .		X	X
	RotSpeed PS off (S)	50%	0-100%	If FGR-PS/FCC is set to PS VSD, then INPUT X4-01.3 must be de-energized from this % VSD and lower. Must be set lower than ***RotSpeed PS on*** .		X	X
	InputController (O)	activated	activated deactivated	Sets the function of INPUT X5-03.1. If activated, X5-03.1 must be energized to permit the LMV5 to fire. This setting is typically used with a hardwired burner on-off switch. On an LMV5 equipped with an internal load controller (LMV51.1 and higher), the internal load controller may remove the call for heat and shut down the burner even if X5-03.1 is energized. If deactivated, X5-03.1 has no function when in any internal load control mode. The LMV5 can also be given permission to fire via Modbus if X5-03.1 is deactivated.	X	X	X
	Config X5-03 (S)	LMV5x std	LMV5x std LMV2/3 std LMV2/3 inv DeaO2/Stp36 CoolFctStby AutoDeactO2	Sets the function of INPUTS X5-03.2 and X5-03.3. 1) LMV5x std - floating bumping load control is retained. 2) LMV2/3 std or LMV2/3 inv - normal or inverted LMV5 2/3 staged oil functionality. 3) DeaO2/Stp36 - energizing terminal X5-03.2 disables O2 trim and de-energizing enables O2 trim (LMV52 only). Also, energizing terminal X5-03.3 allows the LMV5 to progress past phase 36 (de-energizing stops the LMV5 in phase 36 indefinitely). 4) CoolFctStby - only used on an LMV50. 5) AutoDeactO2 - energizing X5-03.2 will deactivate the O2 trim by setting the O2 trim mode to "auto deact". O2 trim mode must be set to "ConAutoDeac" for the AutoDeactO2 to function. De-energizing sets trim mode back to "ConAutoDeac".	/	/	/
	GasPressureMin (O)	activated	activated deactivated deact xOGP	Sets the function of INPUT X9-03.4 for the low gas pressure switch. 1) activated - input is expected to be energized when firing gas, or when using any oil train that requires a gas pilot. 2) deactivated - terminal has no function. 3) deact xOGP - input is expected to be energized only when firing gas.	X	X	X
	GasPressureMax (O)	activated	activated deactivated	Sets the function of INPUT X9-03.3 for a high gas pressure switch. Activate for gas fired installations that use a high gas pressure switch.			
	OilPressureMin (O)	activated	activated deactivated act from ts	Sets the function of INPUT X5-01.2 for a low oil pressure switch. 1) activated - input is expected to be energized by phase 38. 2) deactivated - terminal has no function. 3) act from ts - input is expected to be energized by phase 40.			
	OilPressureMax (O)	activated	activated deactivated	Sets the function of INPUT X5-02.2 for the high oil pressure switch.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigIn/Output	HeavyOilDirStart (O)	38/44..62	38/44..62 act 21..62 HTempGuard ext.FlameGd deactivated activ 38/44	Sets the function of INPUT X6-01.3. 1) 38/44..62 - input must be energized in phase 38 and / or 44, and during phases 50 thru 62. 2) act 21..62 - input must be energized for phase 21 thru 62. This setting is useful for a low oil temperature switch. 3) HTempGuard - only used on an LMV50. 4) ext.FlameGd - input is used for a flame signal from an external flame safeguard. If used, no flame detector may be connected to terminal X10. 5) deactivated - terminal has no function. 6) activ 38/44 - input must be energized in phase 38 or 44.	/	/	/
	Start/PS-Valve (S)	Start Signal	StartSignal PS Relief PS Reli_Inv	Sets the function of OUTPUT X4-03.3. 1) StartSignal - output is energized from phase 21 (before the blower) thru phase 78 (after postpurge), and is suited to open an outside air or stack damper. If ContinuousPurge is activated, this terminal will be energized with the fan. 2) PS Relief - wired to a 3-way valve used to check the action of combustion air pressure switch and is necessary if direct start is used. Energizing vents the combustion air pressure switch to atmosphere during phase 79. 3) PS Reli_Inv - the action is opposite of PS Relief mode, thus de-energizing vents the combustion air pressure switch to atmosphere during phase 79, and the 3-way valve is energized during operation.	X	X	X
Params & Display> BurnerControl> Configuration> ConfigFlameDet	ReacExtranLight (S)	Startblock	Startblock Lockout	If the extraneous light test is activated (see next parameter), this setting determines the response to extraneous light. 1) Startblock - will not permit a start of the lightoff sequence. 2) Lockout - lockout in response to extraneous light.	X	X	X
	ExtranLightTest (O)	activated	activated deactivated	Activates or deactivates the extraneous light check during the start sequence and during standby. NOTE : This setting is intended to be used with applications such as waste incinerators. DO NOT deactivate for boiler burners.			
	ReacTmeLossFlame (O)	0.2s	0.2-3.2s	Sets the flame failure reaction time. The LMV5 has a base flame failure reaction time of approximately 0.8 seconds, so the setting of this parameter will add to the base flame failure reaction time. Max total flame failure reaction time is 4 sec.			

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigFlameDet> FlameSignal	Standardize (O)	Go into parameter then press Enter to start		Sets a datum for a "normal" flame, so that a "normal" flame can be displayed as 100% flame signal on the OperationalStat screen. If an 82.3% flame is present and the flame standardization is performed, what was displayed as 82.3% is now displayed as 100%. This parameter does not affect when a lockout occurs due to low flame signal. This standarization is performed when a normal flame exists in the burner.			
	StandardFactor (O)	XXXX% (Not Set)	0-100%	Can be viewed to see what percent raw flame signal will result in 100% flame signal being displayed on the OperationalStat screen. If the flame signal is not standardized, XXXX % will appear, indicating actual flame strength is displayed.	X	X	X
	FlameSig QRI_B (U)	Read Only		This can be viewed to see the raw flame signal (in %) from the flame scanner (IR or UV). Flame failure at 20%. This signal refers to INPUT terminal X10-02.1 or X10-02.2.			
	FlameSig ION (U)	Read Only		This can be viewed to see what raw flame signal (in %) is being sent to the LMV5 by an ionization probe (flame rod) on terminal X10-03.1. The LMV5 will alarm when this value is less than about 20%.			
NOTE: On an LMV52, it is recommended to set the following six flame scanner parameters for "1 Sensor". These parameters are unavailable on an LMV51.							
Params & Display> BurnerControl> Configuration> ConfigFlameDet	SensExtranlGas (O)	1 Sensor	See Description	For the LMV52, this defines how the combustion chamber will be supervised during the period when the fuel valves are closed (gas firing). The choices for supervision during this phase are as follows: 1) 1 Sensor: Either a flame rod (ION) or scanner can be connected and used. Both cannot be connected. 2) QRI_B | ION: Both sensors can be connected. A flame signal on either will cause a signal to be registered. 3) QRI_B & /ION: Both sensors can be connected. Flame must be detected by QRI_B and not ION. 4) QRI_B: Both sensors can be connected. Only QRI_B is used. 5) ION &/QRI_B: Both sensors can be connected. Flame must be detected by ION and not QRI_B. 6) ION: Both sensors can be connected. Only ION is used.		X	X
	SensPilotPhGas (O)	1 Sensor	See Above	For the LMV52, this defines how the pilot for gas firing is supervised. Options 1 thru 6 as described in parameter ***SenExtranlGas*** also apply to this parameter. Additionally, there is one option added for this parameter. This option is: 7) QRI_B & ION: Both sensors can be connected. Both sensors must detect a flame at the same time or a flame failure will occur.		X	X
	SensOperPhGas (O)	1 Sensor	See Above	For the LMV52, this defines how the main flame for gas firing is supervised. Options 1 thru 7 as described in parameters ***SensExtranlGas*** and ***SensPilotPhGas*** also apply to this parameter.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> Configuration> ConfigFlameDet	SensExtranlOil (O)	1 Sensor	See Above	For the LMV52, this defines how the combustion chamber will be supervised during the period when the fuel valves are closed (oil firing). Options 1 thru 6 as described in parameter ***SensExtranlGas*** apply to this parameter.		X	X
	SensPilotPhOil (O)	1 Sensor	See Above	For the LMV52, this defines how the pilot for oil firing is supervised. Options 1 thru 7 as described in parameters ***SensExtranlGas*** and ***SensPilotPhGas*** also apply to this parameter.		X	X
	SensOperPhOil (O)	1 Sensor	See Above	For the LMV52, this defines how the main flame for oil firing is supervised. Options 1 thru 7 as described in parameters ***SensExtranlGas*** and ***SensPilotPhGas*** also apply to this parameter.		X	X
Params & Display> BurnerControl> Configuration> RepetitCounter	LossOfFlame (S)	1	1-2	Sets the number of times a flame failure is required to cause a lockout. Most US codes require 1.	X	X	X
	HeavyOil (S)	1	1-16	Sets how many times the LMV5 will attempt to proceed past phase 21 if a start release for heavy oil is not met on INPUT X6-01.3. After this number of tries a lockout will occur. A setting of 16 indicates unlimited repetitions.	X	X	X
	StartRelease (S)	1	1-16	Sets how many times the LMV5 will attempt to proceed past phase 21 if a start release is not met, such as low gas pressure on INPUT terminal X9-03.4. After this number of tries, a lockout will occur. A setting of 16 indicates unlimited repetitions.	X	X	X
	SafetyLoop (S)	1	1-16	Sets how many times the LMV5 will attempt to restart without manual reset when the safety loop is opened. This parameter should always be set to 1. A setting of 16 indicates unlimited repetitions.	X	X	X
Params & Display> BurnerControl> ValveProving	ValveProvingType (O)	No VP	No VP VP startup VP shutdown VP stup/shd	This determines if gas valve proving (leak testing) will be performed. Gas valve proving can be performed on startup, shutdown, or both. If 'No VP' is selected, valve proving will not be performed. If 'No VP' is selected, and parameter ***Config_PS-VP/CPI*** is set to PS-VP, then INPUT X9-03.2 is essentially deactivated.	X	X	X
	Config_PS-VP/CPI (O)	PS-VP	PS-VP CPI Gas CPI Gas+Oil CPI Oil	Sets the function of INPUT X9-03.2. Functions: PS-VP (Pressure Switch - Valve Proving) for use with automatic valve proving, proof of closure (POC) for gas valves, POC for oil valves, or POC for gas and oil valves. Note: POC and CPI (Closed Position Indication) are the same function. Input can be deactivated by setting to PS-VP and de-activating valve proving. The same parameter is also available under : *Params & Display > BurnerControl > Configuration*	X	X	X
	VP_EvacTme (O)	3s	0.2-10s	If valve proving is activated, this specifies the time that the downstream valve (V2) is energized, OUTPUT X9-01.3. This will evacuate any gas that might exist between the gas valves. Note: If gas valve proving is used, opening times of the gas valves must be less than the maximum value for this parameter.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> BurnerControl> ValveProving	VP_TmeAtmPress (O)	10s	0.2s-63min	If valve proving is activated, this is the time that both the upstream and downstream valves are closed. If the pressure rises between the valves during this period (enough to open the N.C. pressure switch), then the upstream valve is leaking and the LMV5 will lockout. A longer time period will produce a more sensitive test.	X	X	X
	VP_FillTme (O)	3s	0.2-10s	If valve proving is activated, this specifies the time that the upstream valve (V1) is energized, OUTPUT X9-01.4. This will fill the volume between the main gas valves to line pressure. Note: If gas valve proving is to be used, opening times of the gas valves must be less than the maximum value for this parameter.	X	X	X
	VP_Tme_GasPress (O)	10s	0.2s-63min	If valve proving is activated, this is the time that both the upstream and downstream valves are closed. If the pressure falls between the valves during this period (enough to close the N.C. pressure switch), then the downstream valve is leaking and the LMV5 will lockout. A longer time period will produce a more sensitive test.	X	X	X
Params & Display> BurnerControl> ProductID	ASN (U)	Read Only		Product version identification.	X	X	X
	ProductionDate (U)	Read Only		Date LMV5 unit was produced.	X	X	X
	SerialNumber (U)	Read Only		Serial number of unit.	X	X	X
	ParamSet Code (U)	Read Only		Parameter set code.	X	X	X
	ParamSet Vers (U)	Read Only		Version (revision) of the tagged parameter set.	X	X	X
Params & Display> BurnerControl	SW Version (U)	Read Only		LMV5 software version.	X	X	X
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions> HomePos	HomePosGas or HomePosOil (S)	0 deg	0-90 deg	Sets the home position of the fuel actuator(s). The fuel actuator(s) will also stay in this position during prepurge. Each fuel can have its own setting. Typically set 2 degrees away from closed mechanical stop.	X	X	X
	HomePosAir (S)	0 deg	0-90 deg	Sets the home position of the air actuator. Each fuel can have its own setting. Typically set 2 degrees away from closed mechanical stop.	X	X	X
	HomePosAux1 (S)	0 deg	0-90 deg	Sets the home position of the aux1 actuator. Each fuel can have its own setting. Typically set 2 degrees away from closed mechanical stop.	X	X	X
	HomePosAux2 (S)	0 deg	0-90 deg	Sets the home position of the aux2 actuator. Each fuel can have its own setting. Typically set 2 degrees away from closed mechanical stop.		X	X
	HomePosAux3 (S)	0 deg	0-90 deg	Sets the home position of the aux3 actuator. Each fuel can have its own setting. Typically set 2 degrees away from closed mechanical stop.		X	X
	HomePosVSD (S)	0%	0-100%	Sets the home speed of the VSD. Each fuel can have its own setting.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions> PrepurgePos	PrepurgePosAir (S)	90 deg	0-90 deg	Sets the prepurge position of the air actuator. Be aware of mechancial stops.	X	X	X
	PrepurgePosAux1 (S)	90 deg	0-90 deg	Sets the prepurge position of the aux1 actuator. Be aware of mechancial stops.	X	X	X
	PrepurgePosAux2 (S)	90 deg	0-90 deg	Sets the prepurge position of the aux2 actuator. Be aware of mechancial stops.		X	X
	PrepurgePosAux3 (S)	90 deg	0-90 deg	Sets the prepurge position of the aux3 actuator. Be aware of mechancial stops.		X	X
	PrepurgePosVSD (S)	100%	0-100%	Sets the prepurge speed of the VSD.		X	X
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions> IgnitionPos	IgnitionPosGas or IgnitionPosOil (S)**	Not Set	0-90 deg	Sets ignition position of the fuel actuator(s). If one fuel actuator is connected to both the gas and oil valve, it can still have independent ignition positions for gas and oil. Setting is independent of low fire. Be aware of mechancial stops.	X	X	X
	IgnitionPosAir (S)**	Not Set	0-90 deg	Sets ignition position of the air actuator. Setting is independent of the low fire position. Be aware of mechancial stops.	X	X	X
	IgnitionPosAux1 (S)	Not Set	0-90 deg	Sets ignition position of the aux1 actuator. Setting is independent of the low fire position. Be aware of mechancial stops.	X	X	X
	IgnitionPosAux2 (S)	Not Set	0-90 deg	Sets ignition position of the aux2 actuator. Setting is independent of the low fire position. Be aware of mechancial stops.		X	X
	IgnitionPosAux3 (S)	Not Set	0-90 deg	Sets ignition position of the aux3 actuator. Setting is independent of the low fire position. Be aware of mechancial stops.		X	X
	IgnitionPosVSD (S)	Not Set	0-100%	Sets ignition speed of the VSD. Setting is independent of the low fire position.		X	X
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions> PostpurgePos	PostpurgePosGas or PostpurgePosOil (S)	15 deg	0-90 deg	Sets the postpurge position of the fuel actuator(s). Be aware of mechancial stops.	X	X	X
	PostpurgePosAir (S)	15 deg	0-90 deg	Sets the postpurge position of the air actuator. Be aware of mechancial stops.	X	X	X
	PostpurgePosAux1 (S)	25 deg	0-90 deg	Sets the postpurge position of the aux1 actuator. Be aware of mechancial stops.	X	X	X
	PostpurgePosAux2 (S)	25 deg	0-90 deg	Sets the postpurge position of the aux2 actuator. Be aware of mechancial stops.		X	X
	PostpurgePosAux3 (S)	25 deg	0-90 deg	Sets the postpurge position of the aux3 actuator. Be aware of mechancial stops.		X	X
	PostpurgePosVSD (S)	50%	0-100%	Sets the postpurge speed of the VSD.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions	ProgramStop (S)	deact	See Description	For gas or oil firing, this parameter will stop the sequence in the selected phase. Useful for commissioning and service work. The LMV5 can be held in the following phases: 24 Prepurge, 32 Prepurge FGR, 36 Ignition Position, 44 Interval 1 (pilot stabilize), 52 Interval 2 (main flame stabilize), 72 Postpurge Position, 76 Postpurge FGR. Program Stop can also be deactivated.	X	X	X
Params & Display> RatioControl> Gas/Oil Settings> SpecialPositions> ResetIgnitPos	IgnitionPosGas or IgnitionPosOil (S)	Go into parameter then press Enter to reset		Resets the ignition position of the fuel actuator(s) to an invalid value.	X	X	X
	IgnitionPosAir (S)			Resets the ignition position of the air actuator to an invalid value.	X	X	X
	IgnitionPosAux1 (S)			Resets the ignition position of the aux1 actuator to an invalid value.	X	X	X
	IgnitionPosAux2 (S)			Resets the ignition position of the aux2 actuator to an invalid value.		X	X
	IgnitionPosAux3 (S)			Resets the ignition position of the aux3 actuator to an invalid value.		X	X
	IgnitionPosVSD (S)			Resets the ignition speed of the VSD to an invalid value.		X	X
Params & Display> RatioControl> GasSettings>	CurveParams (S)**	Not Set	Points 1-15	This is where actuator position curves and VSD speed curves are set from low to high fire. These position curves determine the fuel-air ratio for the burner across the firing range. Fifteen points can be set from low to high fire. Typically ten points are set. Colons(:) indicate that the actuator is at the indicated position, (>) indicates the actuator is seeking the indicated position, (#) indicates the aux 3 FGR actuator is being held at position due to an FGR hold. If an O2 sensor is attached and activated (LMV52), the wet O2 value will also be displayed on the screen.	X	X	X
Params & Display> RatioControl> OilSettings> CurveParams	Curve Settings (S)	Not Set		When a specific point is selected (point 2 for example), the LMV5 will prompt if the point is to be 'changed' or 'deleted'. If 'change' is selected, then the LMV5 will prompt the user to select 'followed' or 'not followed'. If 'followed' is selected, the LMV5 will drive the actuators / VSD to the point, and then the point can be changed. If 'not followed' is selected, the LMV5 will not drive to the point, but the point can still be changed. NOTE : When 'not followed' is selected, the effect of actuator changes cannot be seen on a combustion analyzer. If 'not followed' is selected, extreme caution must be used.	X	X	X
	Operation Mode (O)	Mod-ulating	Modulating Two-stage Three-stage	Operation mode for firing oil.	X	X	X
Params & Display> RatioControl> Gas/Oil Settings> LoadLimits	MinLoadGas(Oil) (S)	0%	0-***MaxLoad Gas(Oil)***	Sets the low fire load. During normal operation, the burner will not modulate below this point. Set to reflect low fire fuel input. For a 10:1 turndown burner, set at 10%. Maximum setting limited by ***MaxLoadGas(Oil)*** .	X	X	X
	MaxLoadGas(Oil) (S)	100%	***MinLoadGas (Oil)*** -100%	Sets the high fire load. During normal operation, the burner will not modulate above this point. Minimum setting limited by ***MinLoadGas(Oil)*** .	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> RatioControl> Gas/Oil Settings> Load mask out	LoadMaskLowLimit (S)	0%	0-***LoadMask HighLim***	These settings allow a masking of a particular load range. This is useful for combustion resonances that occur at a particular load (firing rate). For example: if ***LoadMaskLowLim*** is set to 32% and ***LoadMaskHighLim*** is set to 42%, the LMV5 will modulate from 32% to 42% without stopping.	X	X	X
	LoadMaskHighLim (S)	0%	***LoadMask LowLimit*** - 100%		X	X	X
Params & Display> Ratio Control> Gas/Oil Settings	AuxActuator (O)	deact	deactivated damper act VSD active AUX3 VSD+Aux3	Sets the mode of the auxiliary actuator on an LMV51. deactivated - an auxiliary actutor is not being used. damper act - an auxiliary actuator is being used. VSD active - only used on an LMV51.3. AUX3 - only used on an LMV51.3. VSD+Aux3 - only used on an LMV51.3.	/		
	AirActuator (O)	air influen	activated deactivated air influen	Actuators or VSD can be activated, deactivated, or set to air Influenced seperately for each fuel, thus each fuel can have a different setting. The air influenced setting is used to designate which actuators (VSD) will be trimmed if O2 trim is used. The air influenced option is only available on LMV52 for actuators other than the fuel actuator(s). Parameter ***GasActuator*** or ***OilActuator*** will appear based upon which fuel is selected at the time of parameter setting. If an actuator is set to air influenced or activated and is not connected to the LMV5 and addressed, a lockout will occur.	X	X	X
	AuxActuator 1 (O)	air influen				X	X
	AuxActuator 2 (O)	deact				X	X
	AuxActuator 3 (O)	deact				X	X
	VSD (S)	air influen				X	X
	GasActuator (O)	activated	activated deactivated		X	X	X
	OilActuator (O)	activated	activated deactivated		X	X	X
	StartPoint Op (S)	1	1-15	This parameter controls what curve point the LMV5 drives to after main flame ignition. Setting does not affect burner turndown. Typically this is set to low fire (point 1). Some burner designs require a point higher than point 1 after lightoff. Highest possible point is 15 or the highest point that is set.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> RatioControl	Autom/Manual/Off (U)	Automatic	Automatic Burner off Manual	Three options exist: 1) Automatic - Enables the burner allowing it to respond to setpoints and switch on / switch off points. 2) Burner off - Manually turn the burner off. 3) Manual - Enables the load of the burner to be set with ***SetLoad*** . When in manual, setpoints and switching points are ignored. If terminal X5-03.1 (burner switch) is enabled, it must be energized for the LMV5 to start regardless of parameter setting.	X	X	X
Params & Display> RatioControl> Times	OperatRampMod (S)	30s	30-120s	Controls the speed at which the actuators / VSD will ramp during phase 60-62 (fuel valves open). Higher numbers are slower ramps. Set for slowest actuator. (SQM45 - 10s, SQM48.4 - 30s, SQM9 - 30s, SQM48.6 - 60s)	X	X	X
	OperatRampStage (S)	10s	10-60s	Controls the speed at which the LMV5 will ramp in multistage operation.	X	X	X
	TimeNoFlame (S)	10s	10-120s	Controls the speed at which the actuators / VSD will ramp when the fuel valves are closed. Higher numbers are slower ramps. Set for slowest actuator. (SQM45 - 10s, SQM48.4 - 30s, SQM9 - 30s, SQM48.6 - 60s)	X	X	X
Params & Display> RatioControl	NumFuelActuators (O)	2	1-2	Setting is avalable so that a single fuel actuator could be used for a gas and oil valve on a common shaft. Also useful if firing 2 gaseous fuels with the same firing rate control valve.	X	X	X
	ShutdownBehav (S)	HomePos	HomePos PostpurgeP Unchanged	Controls the position of the actuators / VSD when a lockout occurs. Set to the safest option for the burner.	X	X	X
	ProgramStop (S)	deact	See Description	For gas or oil firing, this parameter will stop the sequence in the selected phase. Useful for commissioning and service work. The LMV5 can be held in the following phases: 24 Prepurge, 32 Prepurge FGR, 36 Ignition Position, 44 Interval 1 (pilot stabilize), 52 Interval 2 (main flame stabilize), 72 Postpurge Position, 76 Postpurge FGR. Stop can also be deactivated.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Gas/Oil Settings	OptgMode (S)	man deact	man deact O2 Limiter O2 Control conAutoDeac	Four settings are available for each fuel: 1) man deact - O2 trim controller AND O2 monitor are de-activated. Burner will run on ratio control curve. 2) O2 Limiter - Only the O2 Alarm is activated. Any O2 fault, including low O2 levels in the stack, will cause a burner lockout. O2 Alarm curve must be input for this function. 3) O2 Control - O2 trim controller and O2 Alarm are activated. Any O2 fault will cause a burner shutdown. O2 Alarm curve and O2 setpoint curve must be input for this function. 4) ConAutoDeac - configured to automatically deactivate the O2 trim controller if any O2 fault occurs. Burner runs on ratio curve when O2 control auto deactivates. NOTE: "auto deact" will appear when the O2 control deactivates itself, due to an operating fault or component malfunction. If the control goes into auto deact, choose O2 Limiter, O2 Control, or ConAutoDeac to re-activate. This can also be reactivated under: *Operation > O2Ctrl activate* .		X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings	O2 Control (S)	Not Set	Points 2-15	This is where the O2 ratio control and the O2 control curves are input. An O2 ratio contol point and O2 control point must be set for every point on the position control curve except for point 1. See Section 6 for more detail.		X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings> O2 Alarm	O2 Alarm (S)	Not Set	Points 1-15	This is where the low O2 alarm curve is input. A low O2 alarm point must be set for every point on the position control curve. The position control curves (fuel air ratio curves) must be set before this curve is entered. Points can be set by typing in an O2 value or by probing each point. See Section 6 for more detail.		X	X
	Time O2 Alarm (O)	3s	1-60s	The maximum amount of time the measured %O2 is permitted to be higher than ***O2 MaxValue*** or lower than the ***O2 Alarm*** . Essentially a timer to give the LMV5 time to correct an O2 excursion. Set to the highest value that is safe for the application.		X	X
	Type O2 MaxValue (O)	O2Max Value	O2MaxValue O2MaxCurve	Either the O2 ratio control curve (O2MaxCurve) or a single value (defined by ***O2MaxValue***) can be used to define the maximum allowable %O2 for a given burner. If set to "O2MaxValue", the value (defined below) is used for all firing rates.		X	X
	O2 MaxValue (S)	15%	0-15%	Sets the maximum allowable %O2 for a given burner if parameter ***Type O2 MaxValue*** (see above) is set to "O2MaxValue".		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Gas/Oil Settings> O2 Alarm	NumMinUntilDeact (S)	1	1-5	If the measured %O2 exceeds ***O2 MaxValue*** or goes lower than the ***O2 Alarm*** for a time longer than ***Time O2 Alarm*** (O2 exceedances), then the O2 trim will deactivate. If parameter ***OptgMode*** is set to 'O2 Control' during an exceedance, a lockout will occur. If parameter ***OptgMode*** is set to 'ConAutoDeac' during an exceedance, then the O2 trim will temporarily deactivate (burner keeps running on position control curves). If the measured %O2 comes back between ***O2 MaxValue*** and the ***O2 Alarm*** , then the O2 trim will attempt to reactivate. This parameter determines how many times the O2 trim can deactivate and reactivate. This parameter is valid only if ***OptgMode*** is set to 'ConAutoDeac'. A setting of 1 = no repetitions, a setting of 5 = 4 repetitions.		X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings> Control Param> PI	P Low-Fire (S)	Not Set	3-500%	Proportional band and integral component for O2 trim response. Automatically set based on the Tau (delay time) measured at the ***LowfireAdaptPtNo*** . Both the P and the I can be manually adjusted, but this is typically not necessary.		X	X
	I Low-Fire (S)	Not Set	0-500s			X	X
	Tau Low-Fire OEM (O)	Not Set	1-60s	***Tau Low-Fire*** (delay time at low fire) can be manually adjusted here if necessary, but manual adjustment is typically not necessary.		X	X
	Tau Low-Fire (U)	Read Only		This is the delay time that is automatically measured at ***LowfireAdaptPtNo*** . Delay time is the amount of time that a fuel air ratio change at the burner takes to reach the O2 sensor in the stack. The delay time is shorter at high fire and longer at low fire due to gas velocity through the boiler.		X	X
	P High-Fire (S)	Not Set	3-500%	Proportional band and integral component for O2 trim response. Automatically set based on the Tau (delay time) measured at high fire (the highest point in the curve). Both the P and the I can be manually adjusted, but this is typically not necessary.		X	X
	I High-Fire (S)	Not Set	0-500s			X	X
	Tau High-FireOEM (O)	Not Set	1-60s	***Tau High-Fire*** (delay time at high fire) can be manually adjusted here if necessary, but manual adjustment is typically not necessary.		X	X
	Tau High-Fire (U)	Read Only		This is the delay time that is automatically measured at high fire (the highest point in the curve). See ***Tau Low-Fire*** for explanation.		X	X
	Calc PI again (O)	deact	activated deactivated	If ***Tau High-FireOEM*** or ***Tau Low-FireOEM*** are manually adjusted, then the PI values need to be recalculated based on the new Tau values. Setting this parameter to activated will recalculate the high and low fire PI values.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Gas/Oil Settings> Control Param	LowfireAdaptPtNo (S)**	Not Set	2-15	Sets the point that ***Tau Low-Fire*** is automatically measured. Tau and PI for low fire will be based on this point. A low fire adapt point must be defined before setting up the O2 trim curves. Typically the low fire adapt point is chosen at point 2, but a higher point may be necessary on high-turndown burners and / or oversized stacks.		X	X
	O2 CtrlThreshold (S)	0%	0-100%	This is the minimum load for the O2 trim. If the load drops below this value, the O2 trim automatically de-activates. 5% above this load setting the O2 trim control will automatically reactivate. Typically set to the same load value as the load at LowfireAdaptPtNo.		X	X
	LoadCtrlSuspend (S)	5%	0-25%	During a load change, the O2 trim will lock and will not actively trim. This is necessary due to delay time thru the boiler and also different O2 trim setpoints from low fire to high fire. When locked and not actively trimming, the O2 trim runs on precontrol, meaning that it calculates where to position the air influenced actuators based on burner characteristics learned by the LMV5 during O2 commissioning. This parameter determines how much of a load change will lock the O2 trim and cause it to run on precontrol.		X	X
	O2ModOffset (S)	0%	0-5%	During a load change, this offset temporarily increases the air related load (opens the air influenced actuators). The amount of load change that will trigger ***O2ModOffset*** is determined by the setting of ***LoadCtrlSuspend*** . How much the air related load is increased is determined by the setting of this parameter. A setting of 1% should translate into a 1% increase in measured %O2 during a load change. After active trim is resumed, the offset will be dissolved.		X	X
	O2TrimBehavior (O)	ForcdAir-Add	ForcdAirAdd ForcdAirRed symmetric	Sets the behavior of the O2 trim when active (not locked). This setting only applies if ***StartMode*** is set to standard. Three possibilities exist: 1) ForcedAirAdd - O2 trim will add air faster than it will subtract air. Used when the O2 setpoint is close to the ***O2 Alarm*** . 2) ForcedAirRed - O2 trim will subtract air faster than it will add air. Used when the O2 setpoint is close to ***O2 MaxValue*** . 3) Symmetric - O2 trim will add and subtract air at the same rate. Used when the O2 setpoint is approximately midway between the ***O2 Alarm*** and ***O2 MaxValue*** .		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm>** Gas/Oil Settings>** Control Param	Type Air Change (S)	like theory	like theory like P air LambdaFact1	Influences the behavior of the O2 precontrol (see ***LoadCtrlSuspend***). Setting is determined by whether or not a change in air flow (air pressure in the burner head) impacts the fuel flow. Three possibilites exist: 1) like theory - a change in air flow (pressure) does not impact fuel flow. 2) like P air - a change in air flow (pressure) does impact fuel flow. 3) LambdaFact1 - ignores the learned value and assumes a Lambda factor of 1. This setting is not recommended for most burners. Both 'like theory' and 'like P air' use the Lambda factors learned at each point during O2 control curve commissioning, which is preferred. NOTE: 'like theory' is typical for oil, and 'like P air' is typical for gas. NOTE: The burner behavior discussed above can only be observed if a fuel flow meter is used during commissioning.		X	X
	O2MaxManVariable (S)	35%	1-50%	These settings limit the amount of positive or negative O2 trim that can take place by limiting how much the manipulated variable can be changed. O2MaxManVariable limits how much the air damper can trim open. O2MinManVariable limits how much the air damper can trim closed. These limits must be set so that they are not reached during normal operation with normal variances in ambient conditions. However, they also must be set so that when the limits are reached, an unsafe condition does not occur with the burner. Reaching these limits will cause a deactivation of the O2 trim or lockout depending upon how parameter ***OptgMode*** is set. See Section 6 for more detail.		X	X
	O2MinManVariable (S)	-35%	-50-0%			X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Gas/Oil Settings > Startmode	Startmode (O)	standard	standard Ign Load TC IgnPtWithTC IgnPtWoutTC	Sets how the LMV52.4 transitions from lightoff to operation. Four possibilities exist: 1) standard - after lightoff at set ignition positions, LMV5 is immediately released to modulate on the position control (fuel air ratio) curves. O2 trim will engage after a period of time defined by (***Tau Low-Fire*** x ***NumberTauSuspend***) plus an additional 4x ***Tau Low-Fire*** . This is how past LMV52s have functioned. 2) Ign Load TC - does not use set ignition positions. Varies ignition positions based on ambient temperature and the setting of parameter ***Load of Ignition*** . 3) IgnPtWithTC - uses set ignition positions, but will vary the positions of the air influenced actuators when transitioning from lightoff to low fire based on ambient temperature. 4) IgnPtWoutTC - uses set ignition positions, and will vary the positions of the air influenced actuators when transitioning to low fire based on learned characteristics of the burner. NOTE: Start modes other than standard will all hold the LMV5 at ***StartPointOp*** (low fire) until a time defined by (***Tau Low-Fire*** x ***NumberTauSuspend***) has passed, or the measured %O2 is within +/- 0.2% of setpoint. See Section 6 for more detail.			x
	Load of Ignition (O)	0%	0-100%	When ***Startmode*** is set to "IgnLoadTC", this defines the load at which the burner will be ignited. If another start mode is selected, parameter has no effect.			x
	O2InitOffset (O)	0%	-2-2%	For start modes other than standard, this will bias the manipulated variable so that the transition from lightoff to lowfire can be more rich (negative values) or more lean (positive values). Offset is in %O2, even 1% gives a substantial offset. Can also be used to shorten the release to modulation time (by bringing down the measured %O2 to +/- 0.2% faster) for start modes other than standard.			x
	NumberTauSuspend (S)	10	5-140	After burner ignition, the air inside the boiler and stack is slowly replaced with the products of combustion. Only after this replacement is complete can accurate, representative O2 readings be taken by the O2 sensor. This also determines the low fire waiting time if the ***Startmode*** is not set to "standard". The value of ***NumberTauSuspend*** multiplied by ***Tau Low-Fire*** determines the time at which representative O2 readings can be taken by the O2 sensor mounted in the stack.			x
	Adjust. Temp O2 (U)	Read Only		Temperature as read by the ambient air temperature sensor when the last point of the O2 control curve was commissioned. Used as the basis for the temperature for the compensated (TC) start modes.			x

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Gas/Oil Settings	Type of Fuel (S)	natural GasH	user def naturalGasH naturalGasL propane butane	This enables the user to pick what type of fuel will be burnt with the O2 Control / O2 Alarm when firing gas. Options : User defined (see below), naturalgasH (at or above 960 Btu/SCF), naturalgasL (below 960 Btu/SCF), propane, butane.		X	X
		oil EL	user def oil EL Oil H	This enables the user to pick what type of fuel will be burnt with the O2 Control / O2 Alarm when firing oil. Options : User defined (see below), Oil EL (Light oil #2), Oil H (Heavy oil #6)		X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings> Fuel user-def	V_LNmin (Gas) (S)	9.9	0-40	For user-defined fuels, this represents the volumetric fuel / air ratio needed for stoichiometric combustion of the fuel.		X	X
	V_Lnmin (Oil) (S)	11.2				X	X
	V_afNmin (Gas) (S)	10.93	0-40	For user defined fuels, this represents the quantity of flue gas generated (wet basis) when either one cubic meter (for gases) or one kg (for oil) of fuel is combusted at stoichiometric conditions.		X	X
	V_afNmin (Oil) (S)	12.02				X	X
	V_atrNmin (Gas) (S)	8.89	0-40	For user defined fuels, this represents the quantity of flue gas generated (dry basis) when either one cubic meter (for gases) or one kg (for oil) of fuel is combusted at stoichiometric conditions.		X	X
	V_atrNmin (Oil) (S)	10.53				X	X
	A2 (S)	0.65	0.40-0.80	For user defined fuels, these values are adjustable constants for calculating the combustion efficiency when firing gas or oil.		X	X
	B/1000 (S)	9	1-20			X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings	O2 Content Air (O)	20.9%	0-30%	Defines the O2 content of the combustion air. The LMV52 must see this value +/- 2% during prepurge. This value can be adjusted if O2 enriched air is used.		X	X
Params & Display> O2Contr/Alarm> COx	OptgMode COx Gas (S)	deact	deactivated COx Control COx Limiter	Future functionality. Does nothing at this time.			X
	OptgMode COx Oil (S)	deact					X
	Time COx Alarm (S)	0s	0-600s				X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2Contr/Alarm> Process Data	CombEfficiency (U)	Read Only		Calculated combustion efficiency, based on wet O2 levels in the stack, combustion air temperature, and flue gas temperature.		X	X
	ManVar O2 Ctrl (U)	Read Only		This value represents how much the O2 control is trimming. Values less than 50% indicate that the air-influenced actuators are farther closed than when the O2 was commissioned. Values greater than 50% indicate that the air-influenced actuators are farther open than when the O2 was commissioned. When air temperature decreases (and air density increases), this value should decrease. Conversely, when air temperature increases (and air density decreases), this value should increase.		X	X
Params & Display> O2Contr/Alarm> Gas/Oil Settings> Process Data	State O2 Ctrl (U)	Read Only		This displays the status of the O2 trim control. 1) deactivated - O2 trim is manually or automatically deactivated. System operates on ratio control curve. 2) locked - the manipulated variable (amount of trim) is held at the last value. 3) LockTStart - trim is waiting to engage after lightoff. See ***NumberTauSuspend*** . 4) InitContr - controller is being initialized (preparing to trim) and is still locked. 5) LockTLoad - the O2 trim is engaged but locked due to a load change. See parameter ***LoadControlSuspend*** . 6) active - the O2 trim is active and adjusting the air rate in small steps to achieve the O2 setpoint. 7) LockTCAct - the O2 trim is engaged but locked due to an excursion from O2 setpoint.		X	X
	Air-related Load (U)	Read Only		This is the load-position of the air influenced actuators. If this number is less than the fuel related load at a given point, the air influenced actuators are trimming closed. If greater, than the air influenced actuators are trimming open.		X	X
	Diag Reg State (U)	Read Only		If ***State O2 Ctrl*** reads "locked", this diagnostic code reveals other information. These diagnostic codes are: 0 = load is below load limit set in parameter ***O2 CtrlThreshold*** . 1 = the load controller is in auto-tune or in manual mode. 2 = the O2 sensor is being tested for response (the LMV5 does this periodically during operation). 3 = the fuel air ratio curves or the O2 trim curves are being programmed. 4 = the measured %O2 is below the %O2 set in the Low O2 Alarm curve. 5 = error in the PLL52 module. 6 = error in the precontrol.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
NOTE: For most applications, PID values should be tuned so that the load value does not change more than once every 10 seconds and the actual value trends within 5% of the setpoint.							
Params & Display> LoadController> ControllerParam> ContrlParamList	StandardParam (U)	Not Set	Adaption very slow slow normal fast very fast	These are preset combinations of values for the for the internal load controller PID loop. Adaption (autotune) is not performed with this parameter, but values found by adaption can be used by selecting 'Adaption'. Options are: Adaption: Values set and recorded here when adaption is performed very slow: P = 3.4 % I = 273 s D = 48 s slow: P = 4.7 % I = 250 s D = 44 s normal: P = 6.4 % I = 136 s D = 24 s fast: P = 14.5 % I = 77 s D = 14 s very fast: P = 42.5 % I = 68 s D = 12 s default: P = 14.5 % I = 120 s D = 0 s The labels above refer to the response of the system (boiler, piping, loads) and not to the LMV5 itself. Very slow gives the largest change in firing rate for a given pressure / temperature change and is typically used on very large systems. Very fast gives the smallest change in firing rate for a given pressure / temperature change. The default values work well with most steam boilers.	X	X	X
	P-Part (U)	14.5%	2-500%	P part of the PID loop. P is a type of proportional band around the setpoint, and the units are percent. This % is based on 14.5 PSIG or 212 F, depending upon if the LMV5 is set for pressure or temperature. Low values (2%) give an aggressive response and higher values (100%) give a weak response. Setting this parameter too aggressively will cause the load (firing rate) to hunt.	X	X	X
	I-Part (U)	120s	0-2000s	I part of the PID loop. I is the integral (reset) function. This component serves to eliminate steady state error by looking at the accumulation of error over a period of time and correcting for it. Low values (1s) give an aggressive response and higher values (1000s) give a weak response. Setting this parameter too aggressively will cause overshoot of the setpoint. Setting to 0 is not recommended for most applications since P and I are designed to work together.	X	X	X
	D-Part (U)	0s	0-1000s	D part of the PID loop. D is the derivative function. This component serves to eliminate overshoot caused by the integral value, and also dampen the action of the P and I values. Low values (1s) give a weak response and higher values (1000s) give an aggressive response. Setting this parameter too aggressively will cause the load (firing rate) to hunt. Setting to 0 or to small values (10) works well for many steam boiler applications.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> ControllerParam	MinActuatorStep (U)	1%	0.5-10%	This serves as a deadband on the output of the PID loop to eliminate hunting due to small load changes. If the PID loop requires a load change less than the setting of this parameter, the load will not change. Settings of 5% or above may be counterproductive, not permitting the boiler to closely match the load which may also cause hunting.	X	X	X
	SW_FilterTmeCon (U)	3s	1-10s	This dampens the pressure or temperature that the LMV5 is reading. Higher values increase the damping and will steady small oscillations in the reading.	X	X	X
	SetpointW1 (U)	0	Sensor Range	W1 is the primary setpoint of the boiler, in units of temperature or pressure depending on the sensor attached to the LMV5. Setpoint is changed via the AZL52. Also access at: *Operation > BoilerSetpoint* .	X	X	X
	SetpointW2 (U)	0	Sensor Range	W2 is a secondary setpoint of the boiler, in units of temperature or pressure depending on the sensor attached to the LMV5. Also access at: *Operation > BoilerSetpoint* . If the LMV5 is in internal load controller mode 2 (IntLC), the setpoint can be switched to W2 (from W1) by closing a contact between X62.1 and X62.2.	X	X	X
	SD_ModOn (U)	1%	-50-50%	Determines what temp. / press. a modulating burner will cycle on when LMV5 is in any internal load controller mode. Ignored in external load controller modes. Can be set at a positive or negative %, either above or below the current setpoint respectively. Percentage based on current setpoint.	X	X	X
	SD_ModOff (U)	10%	0-50%	Determines what temp. / press. a modulating burner will cycle off when LMV5 is in any internal load controller mode. Ignored in external load controller modes. Can be set at a positive or negative %, either above or below the current setpoint respectively. Percentage based on current setpoint.	X	X	X
	SD_Stage1On (U)	-2%	-50-50%	Determines what temp. / press. a staged oil burner will engage stage 1. Set at a negative %, so that the burner will turn on stage 1 at a set % below the current setpoint. Percentage based on current setpoint.	X	X	X
	SD_Stage1Off (U)	10%	0-50%	Determines what temp. / press. a staged oil burner will disengage stage 1. Set at a positive % so that the burner will turn off stage 1 oil at a set % above the current setpoint. Percentage based on current setpoint.	X	X	X
	SD_Stage2Off (U)	8%	0-50%	Determines what temp. / press. a staged oil burner will disengage stage 2. Set at a positive % so that the boiler will turn off stage 2 oil at a set % above the current setpoint. Percentage based on current setpoint.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> ControllerParam	SD_Stage3Off (U)	6%	0-50%	Determines what temp. / press. a staged oil burner will disengage stage 3. Set at a positive % so that the boiler will turn off stage 3 oil at a set % above the current setpoint. Percentage based on current setpoint.	X	X	X
	ThreshStage2On (U)	300	0-1000	This value is the integral of a control deviation multiplied by time. This serves to not call on stage 2 unless the pressure / temperature deviates from the desired setpoint for a length of time and/or by a large margin.	X	X	X
	ThreshStage3On (U)	600	0-1000	This value is the integral of a control deviation multiplied by time. This serves to not call on stage 3 unless the pressure / temperature deviates from the desired setpoint for a length of time and/or by a large margin.	X	X	X
Params & Display> LoadController> TempLimiter	TL_ThreshOff (S)	203 F	32-3632 F	Temperature limiter function. If a temperature sensor is used (connected to INPUT X60), this parameter controls at what temperature the burner goes into alarm and shuts down due to an over-temperature situation. The LMV5 faults, but does NOT lockout. LMV5 restarts when temperature goes below ***TL_SD_On*** . Not applicable for steam boilers.	X	X	X
	TL_SD_On (S)	-5%	-50-0%	Creates a negative deadband for the temperature limiter function. If the temperature reaches the threshold off value (***TL_ThreshOff***), the burner will shut off with an alarm. This setting controls what temperature under the threshold off value the burner can be restarted. Not applicable to steam boilers.	X	X	X
Params & Display> LoadController> ColdStart	ColdStartOn (S)	deact	activated deactivated	Activates or deactivates cold start thermal shock protection (low fire hold), based on temp. or press. for a steam boiler, and temp. for a hot water boiler.	X	X	X
	ThresholdOn (S)	20%	0-100%	This is the temp. / press. below which cold start will engage. Above this temp. /press. the cold start will not engage. The value is a percentage of the current setpoint.	X	X	X
	StageLoad (S)	15%	0-100%	This sets the % load of the "load step" for a stepping cold start. If the burner is to be held at low fire (low fire hold) until the ***ThresholdOff*** value is reached, set at 0%.	X	X	X
	StageSetp_Mod (S)	5%	1-100%	For modulating burners, this is how much the temp. / press. must increase before the next load step is triggered. This is a percentage of the current setpoint. Can be set to 100% if a burner is to be stepped by time only.	X	X	X
	StageSetp_Stage (S)	5%	1-100%	For staged burners, this is how much the temp. / press. must increase before the next burner stage is released. This is a percentage of the current setpoint. Can be set to 100% if a burner is to be stepped by time only.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> ColdStart	MaxTmeMod (S)	3min	1-63min	For modulating burners, this is the maximum allowable time for each load step. If the temp. / press. does not increase enough to trigger the next load step before this time expires, the next load step will be taken based on this time. Set to 63 min if to be ramped on temp. / press. only.	X	X	X
	MaxTmeStage (S)	3min	1-63min	For staged oil burners, this is the maximum allowable time for each stage step. If the temp. / press. does not increase enough to trigger the next stage before this time expires, the next stage will be engaged based on this time. Set to 63 min if to be ramped on temp. / press. only.	X	X	X
	ThresholdOff (S)	80%	0-100%	If ***ColdStartOn*** is activated, this is the temp. / press. where the thermal shock protection disengages. The value is a percentage of the current setpoint.	X	X	X
	AdditionalSens (S)	deact	deactivated Pt100 Pt1000 Ni1000	If an additional temp sensor is used on a steam boiler for cold start (recommended), the type of sensor must be selected. Sensor to be wired to INPUT terminal X60. Pt1000 and Ni1000 temperature is updated continuously, PT100 temperature only updated when thermal shock protection is active.	X	X	X
	Temp. ColdStart (U)	Read Only		Displays the temperature being read by the additional sensor. For Pt100 sensor, this is only valid when thermal shock protection is active.	X	X	X
	Setp AddSensor (S)	140 F	32-842 F	If a temperature sensor is used on a steam boiler for cold start, a temperature setpoint must be selected to take the place of the current setpoint. ***ThresholdOn*** , ***ThresholdOff*** , ***StageSetp_Mod*** , and ***StageSetp_Stage*** percentages will be based on this value. Not applicable to hot water boilers.	X	X	X
	Release Stages (S)	release	release no release	For staged burners, this enables or disables stages (other than the first stage) to be released during a cold start.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> Configuration	LC_OptgMode (U)	IntLC	ExtLC X5-03 IntLC IntLC Bus IntLC X62 ExtLC X62 ExtLC Bus	Sets the load controller operating mode of the LMV5. 1) External load controller X5-03 (ExtLC X5-03) - use with a floating bumping type of universal controller on X5-03 pins 2 and 3. Parameters ***SD_ModOn*** and ***SD_ModOff*** ignored. 2) Internal load controller (IntLC) - use with a directly connected pressure or temperature sensor. Setpoint W1 is normally used with this mode. 3) Internal load controller Bus (IntLC Bus) - same as 2 except setpoint W3 can be changed via Modbus connection. 4) Internal load controller X62 (IntLC X62) - same as 2 except setpoint can be changed by using an external analog signal on terminal X62. 5) External load controller X62 (ExtLC X62) - direct firing rate control analog signal on terminal X62. Pressure / temperature sensors ignored. Parameters ***SD_ModOn*** and ***SD_ModOff*** ignored. 6) External load controller Bus (ExtLC Bus) - direct firing rate control via Modbus connection. Pressure / temperature sensors ignored. Parameters ***SD_ModOn*** and ***SD_ModOff*** ignored. NOTE: If "Load Controller not active" is displayed, go to: *SystemConfig > LC_OptgMode* . NOTE: Modes 1 and 3 thru 6 can be switched back to mode 2 by closing a contact between X62.1 and X62.2. When in mode 2, contact closure can be used to switch between setpoint W1 and W2.	X	X	X
	Sensor Select (S)	Pt100	Pt100 Pt1000 Ni1000 TempSensor PressSensor Pt100Pt1000 Pt100Ni1000 NoSensor	Defines the type of sensor that will be used for the internal load controller. 1) Pt100, Pt1000, Ni1000 - Temperature sensor (RTD) wired to terminal X60. Ni1000 is an LG-Ni1000 sensor. 2) TempSensor, PressSensor - Temperature or pressure sensor wired to terminal X61. Can be 0-10VDC, 2-10VDC, 0-20mA or 4-20mA. 3) Pt100Pt1000, Pt100Ni1000 - Redundant temperature sensors wired to terminal X60 for hot water boilers. Reduntant temp sensor for temperature limiter. Ni1000 is an LG-Ni1000 sensor. 4) NoSensor - Selected if LMV5x is being remotely modulated and no sensor is being used for the load controller or the temperature limiter. NOTE: Temperature limiter is only active for hot water boilers (temperature control).	X	X	X
	MeasureRangePtNi (S)	302 F	302 F 752 F 1562 F	Sets the end of measurement range for platinum or LG-nickel temperature sensors (RTDs) connected to terminal X60. Lower settings will detect sensor malfunctions (short circuits) more quickly. Does not affect the scaling (degrees / ohm) for the sensors. Set as low as practical for the application. Also, this serves to scale INPUT X62 if used for remote temperature setpoints. If set for 1562F, remote setpoints are scaled by parameter ***var. RangePtNi*** .	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> Configuration	var. RangePtNi (S)	1562 F	32-1562 F	When ***MeasureRangePtNi*** is set to 1562F, this scales the high end of INPUT X62 for remote temperature setpoints.	X	X	X
	Ext Inp X61 U/I (S)	0..10 V	4..20 mA 2..10 V 0..10 V 0..20 mA	Configuration of terminal X61. Can be 0-10VDC, 2-10VDC, 0-20mA or 4-20mA. NOTE : For 4-20mA signals, signal limits are 3mA to 21mA. For 0-10 VDC signals, signal limit is 10.5 VDC. Signals not in this range will cause an alarm.	X	X	X
	MRange TempSens (S)	194 F	32-3632 F	Sets the end of the scale for a temperature transducer connected to terminal X61. Also, this serves to scale INPUT X62 if used for remote temperature setpoints.	X	X	X
	MRange PressSens (S)	29 PSI	0-1449 PSI	Sets the end of the scale for a pressure sensor connected to terminal X61. Also, this serves to scale INPUT X62 if used for remote pressure setpoints.	X	X	X
	Ext Inp X62 U/I (S)	4..20 mA	4..20 mA 2..10 V 0..10 V 0..20 mA	Configuration of terminal X62. Can be 0-10VDC, 2-10VDC, 0-20mA or 4-20mA. This terminal is usually used for remote setpoint or remote modulation. This input signal is scaled by parameter ***MeasureRangePtNi*** , ***MRange TempSens*** or ***MRange PressSens*** . NOTE : For 4-20mA signals, signal limits are 3mA to 21mA. For 0-10 VDC signals, signal limit is 10.5 VDC. Signals not in this range will cause an alarm.	X	X	X
	Ext MinSetpoint (S)	0%	0-100%	Establishes the minimum external setpoint that can be input via terminals X62 or via Modbus. This is a percentage of the range of the attached sensor.	X	X	X
	Ext MaxSetpoint (S)	60%	0-100%	Establishes the maximum external setpoint that can be input via terminals X62 or via Modbus. This is a percentage of the range of the attached sensor.	X	X	X
Params & Display> LoadController> Configuration> Analog Output	OutValuSelection (S)	Load	See Description	This selects the process value associated with analog OUTPUT X63. The selected process value will be transmitted from X63 with either a 0-20mA or a 4-20mA signal. The 15 choices for this output are: 1) Load - The current load of the burner using 4-20mA. 2) Load 0 - The current load of the burner using 4-20mA or 0-20mA. 3) O2 - The percent O2 currently read by the stack O2 sensor. 4) Pos Air - The current position of the air actuator in angular degrees. 5) Pos Fuel - The current position of the fuel actuator in angular degrees. 6) Pos Aux1 - The current position of the Aux 1 actuator in angular degrees. 7) Pos Aux2 - The current position of the Aux 2 actuator in angular degrees. 8) Pos Aux3 - The current position of the Aux 3 actuator in angular degrees. 9) Speed VSD - The current speed of the VSD motor in percent. 10) Flame - The current raw flame signal. 11) Temp Pt1000 - The temperature read by the Pt1000 sensor on terminal X60. 12) Temp Ni1000 - The temperature read by the Ni1000 sensor on terminal X60. 13) Temp Pt100 - The temperature read by the Pt100 sensor on terminal X60. 14) Temp X61 - The temperature read by the temperature transducer on terminal X61.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> LoadController> Configuration> Analog Output	CurrMode 0/4mA (S)	0..20mA	0..20mA 4..20mA	Selects the output signal of X63 to be either a 0-20mA signal or a 4-20mA signal. NOTE: This has no effect when ***OutValueSelection*** is set to "Load".	X	X	X
	Scale20mA perc (S)	100%	0-999.9%	Scales the analog output for the percent values (other than Load). Specifically, this parameter defines what percentage of Load 0, O2, Speed VSD, or Flame will output 20mA.	X	X	X
	Scale20mA temp (S)	1562 F	32-3632 F	Scales the analog output for the temperature values. Specifically, this parameter defines what temperature (read by Temp Pt1000,Temp Ni1000, etc.) will output 20mA.	X	X	X
	Scale20mA press (S)	2 PSI	0-1449 PSI	Scales the analog output for the pressure value. Specifically, this parameter defines what pressure (read by Press X61) will output 20mA.	X	X	X
	Scale20mA angle (S)	90 deg	0-90 deg	Scales the analog output for the actuators. Specifically, this parameter defines what angular degrees will output 20mA.	X	X	X
	Scale 0/4mA (S)	0%	0-999.9%	Sets the start of the scale for every process value other than "Load". (The start of the scale "Load 0" can be set here, but if "Load" is selected this parameter has no effect.) For example : If parameter ***OutValueSelection*** is set to "Pos Air", ***CurrMode 0/4mA*** is set to 4mA, ***Scale20mA angle*** is set to 90 deg, and ***Scale 0/4mA*** is set to 0%, then 12 mA will be output when the air actuator is at 45 degrees, and 20mA will be output at 90 degrees. If all other values are unchanged and ***Scale 0/4mA*** is now set to 50%, then 4 mA will be output when the air actuator is 45 degrees, and 20mA will be output when the actuator is at 90 degrees.	X	X	X
Params & Display> LoadController> Adaption	StartAdaption (U)	Go into parameter and then press Enter to start adaption		This starts the adaption process. During the adaption process, the LMV5 will determine the thermal response of the system (burner / boiler and attached thermal users). Values for PID will be calculated based on this information. The LMV5 does this by modulating to minimum load and letting the system "settle" to a particular pressure or temperature. After this "settling" period, the LMV5 will modulate up to the ***AdaptionLoad*** and see how long it takes for the system temperature / pressure to respond. Based off of this response, the LMV5 will choose values for P, I, and D. These calculated values are implemented by choosing "Adaption" under ***StandardParam*** . NOTE: Adaption has to be started when the burner is running and a representative load exists on the system.	X	X	X
	AdaptionLoad (U)	100%	40-100%	This load is used to determine the thermal response of the system during adaption only. LMV5 will travel to this load during the heating phase of the adaption.	X	X	X
Params & Display> LoadController	SW Version (U)	Read Only		Software version of the load controller.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> AZL> Times	PasswordTime (O)	120min	10-480min	Sets the length of time before the password times out.	X	X	X
	Sum/WinterTime (U)	Automatic	Manual Automatic	Manual: Daylight savings time disabled. Automatic: Daylight savings time enabled.	X	X	X
	Time EU/US (U)	S/W time US	S/W time US S/W time EU	Daylight savings time schedule. US setting starts the first Sunday in April and ends the last Sunday in October.	X	X	X
Params & Display> AZL	Language (U)	English	See Description	Selects the language for the AZL display. Options are English, Deutsch, Francais, Espagnol, Italiano or Portuguese.	X	X	X
	DateFormat (U)	MM-DD-YY	DD.MM.YY MM-DD-YY	Selects the date format. Choices: MM-DD-YY (US) or DD.MM.YY (European).	X	X	X
Params & Display> AZL	PhysicalUnits (U)	F / psi	F / psi C / bar	Either °C / bar or °F / psi can be chosen.	X	X	X
Params & Display> AZL> eBUS	Address (U)	1	1-8	Sets the LMV5 address for eBUS (job specific).	X	X	X
	SendCycleBU (U)	30s	10-60s	Sets the cycle time for the LMV5 to send data to the BAS (job specific).	X	X	X
Params & Display> AZL> Modbus	Address (U)	1	1-247	Sets the LMV5 address for Modbus (job specific).	X	X	X
	Baudrate (U)	19200 bit/s	9600 bit/s 19200 bit/s	Sets the baud rate of the Modbus port, which is an RJ45 jack located on the underside of the AZL. Also affects data output. NOTE: To use Modbus, it must be activated at: *Operation > OptgModeSelect* .	X	X	X
	Parity (U)	no	no odd even	This sets the parity of the Modbus port. Also affects data output.	X	X	X
	Timeout (U)	30s	0-7200s	If no communication occurs for this period, the AZL considers the Modbus to be unavailable. If the AZL considers the Modbus to be unavailable, then it will make setpoint W1 the current setpoint. Other Modbus values will remain what they were previously and / or be overwritten by input through the AZL.	X	X	X
	Local / Remote (U)	local	local remote	This enables or disables the use of a Modbus conveyed setpoint, setpoint W3. Local - W3 will not be observed. Remote - if there is no timeout condition and the remote operating mode is automatic, then setpoint W3 will be observed.	X	X	X
	Remote Mode (U)	Read Only		View the Modbus remote mode status: Automatic, Manual, Burner off	X	X	X
	W3 (U)	32 F	32-3632 F 0-1449 PSI	W3 is the Modbus conveyed setpoint. Use with operating mode IntLC Bus.	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> AZL	Display Contrast (U)	Adjust as needed		Change with < > keys, store with the Enter key, or cancel with the Esc key.	X	X	X
Params & Display> AZL> ProductID	ASN (U)	Read Only		Information concerning the AZL.	X	X	X
	ProductionDate (U)				X	X	X
	SerialNumber (U)				X	X	X
	ParamSet Code (U)				X	X	X
	ParamSet Vers (U)				X	X	X
Params & Display> AZL	SW Version (U)	Read Only		Software version on the AZL.	X	X	X
Params & Display> Actuators> Addressing	1 AirActuator (S)	1 blink = Air		Enables addressing of the actuators. Select one of the actuators and press Enter. The AZL will then serve as a guide through the rest of the procedure. This procedure involves pressing a red button (hold about 1s) on the selected actuator. The actuators can be wired and addressed in any order. The green LED will be on when the actuator is powered and not addressed, and it will blink after it has been addressed. NOTE: Holding the red button on the actuator down for approx. 10 sec will clear the addressing on that actuator.	X	X	X
	2 GasActuat(Oil) (S)	2 blink = Gas(Oil)			X	X	X
	3 OilActuator (S)	3 blink = Oil			X	X	X
	4 AuxActuator (S)	4 blink = Aux 1			X	X	X
	5 AuxActuator2 (S)	5 blink = Aux 2				X	X
	6 AuxActuator3 (S)	6 blink = Aux 3				X	X
Params & Display> Actuators> DeleteCurves	DeleteCurves (S)	Go into parameter then press Enter to delete		This deletes the ratio control (fuel / air) curves and the ignition positions. Curves must be deleted if the direction of rotation on any actuator is to be changed.	X	X	X
Params & Display> Actuators> DirectionRot	1 AirActuator (O)	standard	standard reversed	Sets the direction of rotation for each actuator, regardless of which fuel is selected. Looking at the actuator with the shaft pointed at eye: **standard** - shaft rotates counterclockwise to open. **reversed** - shaft rotates clockwise to open. These descriptions are opposite if viewed from the cover end of the actuator (shaft pointing away from eye).	X	X	X
	2 GasActuat(Oil) (O)				X	X	X
	3 OilActuator (O)				X	X	X
	4 AuxActuator (O)				X	X	X
	5 AuxActuator2 (O)					X	X
	6 AuxActuator3 (O)					X	X
Params & Display> Actuators> ProductID> 1 AirActuator	ASN (U)	Read Only		Information concerning the currently addressed air actuator.	X	X	X
	ProductionDate (U)				X	X	X
	SerialNumber (U)				X	X	X
	ParamSet Code (U)				X	X	X
	ParamSet Vers (U)				X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> Actuators> ProductID> 2 GasActuat(Oil)	ASN (U)	Read Only		Information concerning the currently addressed gas(oil) actuator.	X	X	X
	ProductionDate (U)				X	X	X
	SerialNumber (U)				X	X	X
	ParamSet Code (U)				X	X	X
	ParamSet Vers (U)				X	X	X
Params & Display> Actuators> ProductID> 3 OilActuator	ASN (U)	Read Only		Information concerning the currently addressed oil actuator.	X	X	X
	ProductionDate (U)				X	X	X
	SerialNumber (U)				X	X	X
	ParamSet Code (U)				X	X	X
	ParamSet Vers (U)				X	X	X
Params & Display> Actuators> ProductID> 4 AuxActuator	ASN (U)	Read Only		Information concerning the currently addressed aux1 actuator.	X	X	X
	ProductionDate (U)				X	X	X
	SerialNumber (U)				X	X	X
	ParamSet Code (U)				X	X	X
	ParamSet Vers (U)				X	X	X
Params & Display> Actuators> ProductID> 5 AuxActuator2	ASN (U)	Read Only		Information concerning the currently addressed aux2 actuator.		X	X
	ProductionDate (U)					X	X
	SerialNumber (U)					X	X
	ParamSet Code (U)					X	X
	ParamSet Vers (U)					X	X
Params & Display> Actuators> ProductID> 6 AuxActuator3	ASN (U)	Read Only		Information concerning the currently addressed aux3 actuator.		X	X
	ProductionDate (U)					X	X
	SerialNumber (U)					X	X
	ParamSet Code (U)					X	X
	ParamSet Vers (U)					X	X
Params & Display> Actuator> SW Version	1 AirActuator (U)	Read Only		Information concerning the software versions of the attached actuators.	X	X	X
	2 GasActuat(Oil) (U)				X	X	X
	3 OilActuator (U)				X	X	X
	4 AuxActuator (U)				X	X	X
	5 AuxActuator2 (U)					X	X
	6 AuxActuator3 (U)					X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> VSD Module> Configuration	ReleasecontctVSD (S)	closed	open closed	This sets the behavior of the run / stop dry contact (terminals X73.1 and X73.2) from postpurge (phase 78) into phase 10 when the VSD is driving to home position (0 RPM). If set to open, the blower will freewheel after phase 78. If set to closed, the blower speed will be ramped down according to parameter ***TimeNoFlame*** . Typically set to open if VSD does not have a braking resistor and closed if VSD has a braking resistor.		X	X
	TolQuickShutdown (O)	10%	0-100%	This sets the percentage of speed deviation from the desired blower speed that will cause an immediate shut down of the burner. Note: 100% means no quick shutdown (function deactivated) and is not recommended.		X	X
Params & Display> VSD Module> Configuration> Speed	Num Puls per R (S)	3	3-6	This sets the expected number of pulses per motor revolution. This setting depends upon what type of speed wheel is used.		X	X
	Standardization (S)	deact	activated deactivated	This starts the standardization process for the motor driven by the VSD. When activated, it will ramp the VSD up and then down with the air damper open. During this time the LMV52 will correlate a milliamp signal to the peak motor RPM.		X	X
	StandardizedSp (S)	1 RPM	1-6300 RPM	Shows the motor speed corresponding to a 95% input signal to the VSD / motor combination. This is automatically set when the VSD / motor is standardized. It can be set manually, but this is not recommended in most circumstances.		X	X
	Absolute Speed (U)	Read Only		This displays the real time speed of the blower motor in RPM (tachometer).		X	X
	Setpoint Output (S)	4..20 mA	0..20 mA 4..20 mA	This sets what the output signal will be to the VSD. It can be set to 4-20mA or 0-20mA.		X	X
	Setteling Time (O)	16 (400ms)	8-200 (200-5000ms)	This sets a filter time or a delay time between when a speed is read from the speed wheel to when the LMV52 attempts to correct the speed. This feature is in effect during modulation. Setting is multipled by 25 milliseconds, so a setting of 16 yields 400ms or 0.4 seconds.		X	X
Params & Display> VSD Module> Configuration> Fuel Meter	PulseValueGas (S)	1	0-999.99999	This sets the number of pulses per unit of gas flow (for use with gas meters having a pulsed output). Can be set for pulses per cubic meter or pulses per cubic foot.		X	X
	PulseValueOil (S)	1	0-9999.9999	This sets the number of pulses per unit of oil flow (for use with oil meters having a pulsed output). Can be set for pulses per gallon or pulses per cubic liter.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> VSD Module> Process Data	Max Stat Dev (U)	Read Only		Records the maximum VSD speed deviation from setpoint during steady state operation (steady load) during a run period. 0 to 100% of standarized speed.		X	X
	Max Dyn Dev (U)	Read Only		Maximum motor speed deviation from setpoint during an acceleration or deceleration of the motor (changing load) during a run period. Range = 0 to 100%		X	X
	Num Dev >0.3% (U)	Read Only		The number of speed deviations exceeding 0.3% of the standardized speed at the end of a modulation event. Max = 255 deviations.		X	X
	Num Dev >0.5% (U)	Read Only		The number of speed deviations exceeding 0.5% of the standardized speed at the end of a modulation event. Max = 255 deviations.		X	X
	Absolute Speed (U)	Read Only		This displays the real time speed of the blower motor in RPM. Max is 6553 RPM.		X	X
Params & Display> VSD Module> ProductID	ASN (U)	Read Only		Information concerning the VSD board (pieces internal to the LMV5).		X	X
	ProductionDate (U)					X	X
	SerialNumber (U)					X	X
	ParamSet Code (U)					X	X
	ParamSet Vers (U)					X	X
Params & Display> VSD Module	SW Version (U)	Read Only		Software version of the VSD control.		X	X
Params & Display> O2 Module> Configuration	O2 Sensor (S)	no sensor	no sensor QGO20 QGO21	Configures the PLL module for the connected O2 sensor.		X	X
	O2SensServTim (S)	0 days	0-65535 days	Sets the service interval for the O2 sensor. The time set here is compared against the total hours run counter. See *Operation > HoursRun* . Upon expiration of service interval, different actions will be taken based on O2 trim operating mode. If in 'conAutoDeac', then O2 trim will auto deactivate. If operating mode is set to 'O2 Control' or 'O2 Alarm', a lockout will occur. If set to 0, feature is deactivated.		X	X
	O2SensServTimRes (S)	deact	activated deactivated	Resets the service interval for the O2 sensor. Reset once service work has been completed.		X	X
	SupAirTempSens (S)	no sensor	no sensor Ni1000 Pt1000	Configures the PLL module for the appropriate ambient air temperature sensor. Sensor is not required for O2 trim, but is required for the efficiency calculation.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2 Module> Configuration	AirTempX60PT1000 (O)	deact	activated deactivated	Configures LMV5 INPUT X60 for a PT1000 ambient air temperature sensor. Sensor is not required for O2 trim, but is required for the efficiency calculation. Ambient air temperature sensor can be wired into terminal X60 of the LMV5 instead of the PLL module if X60 is not being used for other temperature sensors.		X	X
	FlueGasTempSens (S)	no sensor	no sensor Ni1000 Pt1000	Configures the PLL module for the appropriate flue gas temperature sensor. Sensor is not required for O2 trim, but is required for the efficiency calculation.		X	X
	MaxTempFlGasGas (S)	752 F	32-1562 F	Maximum flue temperature setpoint for each fuel. A warning will appear if temperatures exceed this setting. PLL52 module must have a flue gas sensor wired in for this function.		X	X
	MaxTempFlGasOil (S)						
Params & Display> O2 Module> Process Data	Current O2 Value (U)	Read Only		This displays the current O2 value. O2 measured on a wet basis.		X	X
	O2 Setpoint (U)	Read Only		This displays the O2 setpoint at any operating point. This is the target for the O2 trim.		X	X
	SupplyAirTemp (U)	Read Only		This displays the current ambient air temperature.		X	X
	FlueGasTemp (U)	Read Only		This displays the current flue gas temperature.		X	X
	CombEfficiency (U)	Read Only		This displays the current combustion efficiency. If the O2 sensor is deactivated, this number will not be displayed. Also, the flue and ambient temperatures are needed for this number to display.		X	X
	QGO SensorTemp (U)	Read Only		This displays the current O2 sensor internal temperature. Absolute minimum operating temperature = 1202 F. Normal operating temperature for QGO20 is approximately 1292 F.		X	X
	QGO HeatingLoad (U)	Read Only		This displays the current heating load for the O2 sensor. The PLL serves as the temperature control for the QGO20 sensor. Maximum heating load is 60%.		X	X
	QGO Resistance (U)	Read Only		This measures the resistance of the O2 sensor. As a sensor is used, the resistance increases. New sensors have a resistance of approximately 5 ohms. A reading of 0 ohms indicates that a self-test has not been performed after a power off of the LMV5. When this value exceeds 150 ohms, the sensor should be replaced.		X	X
Params & Display> O2 Module> ProductID	ASN (U)	Read Only		Information concerning the currently connected O2 sensor.		X	X
	ProductionDate (U)					X	X
	SerialNumber (U)					X	X
	ParamSet Code (U)					X	X
	ParamSet Vers (U)					X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> O2 Module	SW Version (U)	Read Only		Software version of the O2 module (PLL module).		X	X
Params & Display> Flue Gas Recirc.	FGR-Mode (S)	Aux3on Curve	Aux3onCurve time temperature temp.contr. TCautoDeact deactMinpos auto deact	Sets the mode of the FGR hold for the Aux 3 actuator. Seven seperate operating modes exist. These are: 1) Aux3onCurve- Function deactivated and Aux 3 actuator always operates on its programmed curve. 2) time - Aux 3 actuator stays at ignition position until ***DelayTimeFGR Gas(Oil)*** timer expires. 3) temperature - Aux 3 actuator stays at ignition position until ***ThresholdFGR Gas(Oil)*** temperature is reached. 4) temp.contr. - Position of Aux 3 actuator is based on flue temp, ***Factor FGR Gas(Oil)*** , and the programmed curve for the Aux 3 actuator (LMV52.4 only). 5) TCautoDeact - same as Temp.contr but automatically deactivates if there is a fault with the flue gas sensor (LMV52.4 only). 6) deactMinpos - after ignition position, Aux 3 actuator is held closed (LMV52.4 only). 7) auto deact - do not select this option. It is displayed if the FGR hold was deactivated due to a sensor issue (LMV52.4 only).		/	X
	FGR-sensor (S)	X86PtNi 1000	X86PtNi1000 X60 Pt1000 X60 Ni1000	Selects the type and wiring location of the flue gas sensor for the FGR functions.		X	X
	actTmpFGR-sensor (U)	Read Only		The actual temperature read by the selected FGR sensor can be viewed at this parameter.		X	X
	ThresholdFGR Gas(Oil) (S)	752 F	32-1562 F	This sets the temperature that must be achieved to release the Aux 3 actuator to modulate. Only has an effect if parameter ***FGR-Mode*** is set to "temperature".		X	X
	DelaytimeFGR Gas(Oil) (S)	300s	0-63min	This sets the time that must elapse before the Aux 3 actuator is released to modulate. Only has an effect if parameter ***FGR-Mode*** is set to "time".		X	X
	Factor FGR Gas(Oil) (S)	100%	10-100%	Adjustment of calculated temperature dependent position of the Aux 3 actuator. An adjustment of less than 100% reduces the position of the Aux 3 actuator. 100% means no adjustment. Factor only has an effect when FGR temperature is different than when ratio curves were commissioned.			X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> Flue Gas Recirc.	OperationTempGas(Oil) (S)	Read Only		Displays the recorded flue gas recirculation temperatures for each point. This is recorded when commissioning the ratio control curves.			x
	FGR MinPos (S)	0 deg	0-90 deg	Minimum angular position for the Aux 3 actuator when in temp.contr or TCautoDeact operating modes. Serves as a default position if an auto deact occurs.			x
	FGR MaxPos Fact (S)	10%	0-100%	Maximum value (limit on the Aux 3 actuator) calculated by comparing the current FGR temperature to the stored values.			x
Params & Display> SystemConfig	LC_OptgMode (U)	IntLC	ExtLC X5-03 IntLC IntLC Bus IntLC X62 ExtLC X62 ExtLC Bus	Current operating mode of the LMV5. Can also be changed at: *Params & Display > LoadController > Configuration > LC_OptgMode* . If "Load Controller not active..." message was seen under: *Params & Display > LoadController > Configuration > LC_OptgMode* , adjust this parameter to "IntLC" and return to *Params & Display > LoadController > Configuration > LC_OptgMode* .	x	x	x
	Ext Inp X62 U/I (S)	4..20 mA	4..20 mA 2..10 V 0..10 V 0..20 mA	See: *Params & Display > LoadController > Configuration > Ext Inp X62 U/I*	x	x	x
Params & Display> SystemConfig> TempLimiter	TL_Thresh_Off (S)	203 F	32-3632 F	See: *Params & Display > LoadController > TempLimiter > TL_ThreshOff*	x	x	x
	TL_SD_On (S)	-5%	-50-0%	See: *Params & Display > LoadController > TempLimiter > TL_SD_On*	x	x	x
	Sensor Select (S)	Pt100	Pt100 Pt1000 Ni1000 TempSensor PressSensor Pt100Pt1000 Pt100Ni1000 NoSensor	See: *Params & Display > LoadController > Configuration > Sensor Select*	x	x	x
	MeasureRangePtNi (S)	302 F	302 F 752 F 1562 F	See: *Params & Display > LoadController > Configuration > MeasureRangePtNi*	x	x	x

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> SystemConfig	O2Ctrl/LimitrGas (S)	man deact	See Description	See: *Params & Display > O2Contr/Alarm > GasSettings > OptgMode*		X	X
	O2Ctrl/LimitrOil (S)						
	LC Analog Output (S)	Load	See Description	See: *Params & Display > LoadController > Configuration > Analog Output > OutValuSelection*	X	X	X
	allowed Pot.diff (S)	15	10-15	Sets the allowable difference between channels A and B of the actuator's potentiometer. Units are tenths of a degree, so 10 = 1.0 degrees.	X	X	X
	OptgMode COx Gas (S)	deact	deactivated COx Control COx Limiter	Future functionality. Does nothing at this time.			X
	OptgMode COx Oil (S)	deact					X
	AirTempX60PT1000 (O)	deact	activated deactivated	See: *Params & Display > O2 Module> Configuration > AirTempX60PT1000*		X	X
Params & Display> HoursRun>	GasFiring (U)	0	0-999999 hr	Hours run firing gas. Can be adjusted here. See: *Operation > HoursRun*	X	X	X
	OilStage1/Mod (U)			Hours run on modulating or stage 1 oil. Can be adjusted here. See: *Operation > HoursRun*	X	X	X
	OilStage2 (U)			Hours run on stage 2 oil. Can be adjusted here. See: *Operation > HoursRun*	X	X	X
	OilStage3 (U)			Hours run on stage 3 oil. Can be adjusted here. See: *Operation > HoursRun*	X	X	X
	TotalHoursReset (U)			Hours run on all fuels. Can be adjusted here. See: *Operation > HoursRun*	X	X	X
	TotalHours (U)	Read Only		These values CANNOT be adjusted or reset. See: *Operation > HoursRun*	X	X	X
	SystemOnPower (U)	Read Only			X	X	X
Params & Display> HoursRun> Reset	GasFiring (U)	Reset Only		Hours run firing gas. Can be reset here. See: *Operation > HoursRun*	X	X	X
	OilStage1/Mod (U)			Hours run on modulating or stage 1 oil. Can be reset here. See: *Operation > HoursRun*	X	X	X
	OilStage2 (U)			Hours run on stage 2 oil. Can be reset here. See: *Operation > HoursRun*	X	X	X
	OilStage3 (U)			Hours run on stage 3 oil. Can be reset here. See: *Operation > HoursRun*	X	X	X
	TotalHoursReset (U)			Hours run on all fuels. Can be reset here. See: *Operation > HoursRun*	X	X	X
Params & Display> StartCounter	GasStartCount (U)	0	0-999999 hr	Number of starts for gas. Can be adjusted here. See: *Operation > StartCounter*	X	X	X
	OilStartCount (U)			Number of starts for oil. Can be adjusted here. See: *Operation > StartCounter*	X	X	X
	TotalStartCountR (U)			Total number of starts. Can be adjusted here. See: *Operation > StartCounter*	X	X	X
	TotalStartCount (U)	Read Only		Total number of starts. Cannot be reset.	X	X	X
Params & Display> StartCounter> Reset	GasStartCount (U)	Reset Only		Number of starts for gas. Can be reset here. See: *Operation > StartCounter*	X	X	X
	OilStartCount (U)			Number of starts for oil. Can be reset here. See: *Operation > StartCounter*	X	X	X
	TotalStartCountR (U)			Total number of starts. Can be reset here. See: *Operation > StartCounter*	X	X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Params & Display> Fuel Meter	Curr Flow Rate (U)	Read Only		Current flow rate for the fuel being fired. Gas = cubic meters or cubic feet per hour. Oil = liters or gallons per hour.		X	X
	Volume Gas (U)	Read Only		Totalized volume of gas used since the last reset.		X	X
	Volume Oil (U)			Totalized volume of oil used since the last reset.		X	X
	Volume Gas R (U)	Reset Only		Resets the totalized volume of gas.		X	X
	Volume Oil R (U)			Resets the totalized volume of oil.		X	X
	Reset DateGas (U)	Read Only		This displays the date of the last reset for gas.		X	X
	Reset DateOil (U)			This displays the date of the last reset for oil.		X	X
Updating> Passwords	ServicePassword (O)	9876	3 to 8 characters	The service level password can be changed here.	X	X	X
	OEM Password (O)	START	4 to 8 characters	The OEM level password can be changed here.	X	X	X
Updating	BurnerID (O)**	Not Set	4 to 15 characters	Burner ID must be set here. Typically the burner / boiler serial number is used. Serves as an identifier for the parameter set.	X	X	X
Updating> ParamsBackup> BackupInfo	Date (U)	Read Only		This displays the date of the last backup.	X	X	X
	TimeOfDay (U)			This displays the time of day of the last backup.	X	X	X
	BU included? (U)			This states if the basic unit (LMV5) was included in the last backup.	X	X	X
	AZL included? (U)			This states if the AZL was included in the last backup.	X	X	X
	LC included? (U)			This states if the LC (load controller) was included in the last backup.	X	X	X
	ACT1 included? (U)			This states if the Act 1 (Actuator 1) was included in the last backup.	X	X	X
	ACT2 included? (U)			This states if the Act 2 (Actuator 2) was included in the last backup.	X	X	X
	ACT3 included? (U)			This states if the Act 3 (Actuator 3) was included in the last backup.	X	X	X
	ACT4 included? (U)			This states if the Act 4 (Actuator 4) was included in the last backup.	X	X	X
	ACT5 included? (U)			This states if the Act 5 (Actuator 5) was included in the last backup.		X	X
	ACT6 included? (U)			This states if the Act 6 (Actuator 6) was included in the last backup.		X	X
	VSD included? (U)			This states if the VSD (Variable Speed Drive) was included in the last backup.		X	X
	O2 included? (U)			This states if the O2 module was included in the last backup.		X	X

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Menu Path	**Parameter**	**Default**	**Range**	**Description**	51.1	52.2	52.4
Updating> ParamBackup	LMV5x -> AZL (S)	Go into parameter then press Enter to start		Transfers a parameter set from the LMV5x to the AZL5. Note that the working parameter set is in the LMV5, not the AZL5. Burner ID in LMV5 will overwrite burner ID in the AZL5.	X	X	X
	AZL -> LMV5x (S)	Go into parameter then press Enter to start		Transfers a parameter set from the AZL5 to the LMV5. The burner ID of the LMV5 must be blank (new LMV5) or must match the burner ID of the parameter set in the AZL5. This feature is useful for transferring parameter sets to identical burners. NOTE: When transferring parameter sets from the AZL5 to the LMV5, do not stop the transfer until "Backup Restore Finished Parameter BC : complete or BC : partial" is shown on the AZL screen. This could take up to 5 minutes. Do not disturb the LMV5 while the backup restore is in progress.	X	X	X
Updating	Load_SW_from_PC (S)	Go into parameter then press Enter to start		Enables updating of the AZL5 operating software via the ACS450 software. A .bin file supplies the new software for the AZL5.	X	X	X
PW Login	Access w-out PW (U)	Press Enter for access		Access without password. Also called user level.	X	X	X
	Access Serv (U)	9876	3 to 8 characters	Access with service level password.	X	X	X
	Access OEM (U)	START	4 to 8 characters	Access with OEM level password.	X	X	X
	Access SBT (U)	-	-	Access level not used.	X	X	X
PW Logout	PW Logout (S)	Press Enter to log out		Deactivates all passwords, thus reducing access to user level.	X	X	X
SafetyCheckFunct	LossFlameTest (U)	Go into parameter then press Enter to start		Enables testing of the flame sensor input on the LMV5 by electronically interrupting the flame signal.	X	X	X
	SLT Test (U)	deact	activated deactivated	This enables the safety limit thermostat (SLT) test to check upper safety limits. activated - The internal load controller's setpoint AND switch-off threshold will be ignored, allowing a test of a separate high limit control or pressure relief valve. deactivated - feature is disabled.	X	X	X
	SLT-Testload Mod (U)	100%	0-100%	This sets the load for the SLT test in modulating operation.	X	X	X
	SLT-Testload Stg (U)	S3	S1-S3	This sets the load for the SLT test in staged operation.	X	X	X

3-3: Sequence Diagrams

The Siemens LMV5 BMS can perform a number of different burner sequences based upon how certain parameters are set. Although there are a number of parameters that affect small aspects of the burner sequence, the main parameters that affect the sequence are parameters ***FuelTrainGas*** and ***FuelTrainOil***.

These parameters set the framework of the sequence and are based upon the fuel train diagrams in Section 4. The OEM has the option of selecting one of three different gas trains with their associated sequence diagrams, and one of four different oil trains with their associated sequence diagrams (the sequence diagrams and fuel train diagrams for direct spark ignition with heavy oil have been omitted).

The sequence diagrams in Section 3-3 illustrate when input and output terminals are expected to be energized or de-energized. A legend on the bottom of each page describes the various symbols used in the diagrams. The last diagram describes what positions the attached actuators are expected to achieve at each phase and outlines the method that is used to check the actuators position.

Notes:

1) Only one fuel select terminal can be energized at a time. If both terminals are energized, the LMV5 will go into lockout. If neither terminal is energized, fuel selection is internal through the AZL5 (***FuelSelect***) or via Modbus.

2) The external burner on / off switch can be disabled with parameter ***InputController***. If activated, this terminal needs to be energized to have the LMV5 start its sequence. The function of terminal X5-03.1 becomes “burner on / off” when any external load control mode is selected.

3) The alarm can be silenced through the AZL (***Alarm act/deact***). This alarm silence resets when the LMV5 is reset or restarted.

4) When using an LMV52, continuous pilot is possible (***ContPilotGas*** / ***ContPilotOil***). If continuous pilot is activated, the pilot valve will remain energized through phase 62.

5) If parameter ***GasPressureMin*** is set to *activated*, the low gas pressure switch is expected to remain closed during phases 21-50 of *LO w Gasp* and *HO w Gasp*, ensuring adequate gas pressure for the pilot. If ***GasPressureMin*** is set to *Deact xOGP*, the low gas pressure switch is expected to remain closed only when firing gas and is not checked when firing oil.

6) If parameter ***OilPumpCoupling*** is set to *Magnetcoupl*, the output for the oil pump can be energized in Phase 22 or in Phase 38, depending upon how parameter ***IgnOilPumpStart*** is set. If parameter ***OilPumpCoupling*** is set to *DirectCoupl*, the output will energize with the blower and de-energize 15 seconds after the blower de-energizes.

7) If gas valve proving is performed on startup (immediately after phase 30), the actuators will be in prepurge position. If gas valve proving is performed on shutdown (immediately after phase 62), the actuators will be in the same position as they were in phase 62. The actuators will not move during valve proving.

8) If parameter ***AirPressureTest*** is set to *activated*, the air pressure switch must open after postpurge is complete, causing input terminal X3-02.1 to de-energize. The LMV5 will wait about 30 seconds in phase 10 (driving to home position) for the switch to open before the LMV5 goes into alarm. This is done to check for welded contacts in the air pressure switch. If air pressure switch alarms are encountered in phase 10, increasing the setpoint of the air pressure switch typically cures this problem. If ***AirPressureTest*** is set to *deactInStby*, the air pressure switch is not checked in phase 10 or 12, but the switch must be open or the LMV5 will not start when it receives a call for heat.

9) The LMV5 can be configured for different reactions to extraneous light (a flame signal when there should not be one). Depending on how parameters ***ReacExtranLight*** and ***ExtranLightTest*** are configured, the LMV5 can lockout, block the startup sequence, or ignore it altogether. The extraneous light test should always be enabled for gas / oil fired boilers. The only time parameter ***ExtranLightTest*** should be set to *deactivated* is for applications such as waste incineration.

10) If direct start is enabled and there is a call for heat after phase 62, the LMV5 will omit phase 78 and will go to phase 79. In phase 79, the LMV5 will check the blower air pressure switch with the blower still running by using a three-way solenoid valve (APS checking).
If the switch checks out, the LMV5 will then proceed directly to phase 24 (driving to prepurge position).

11) Safety Time 1 is defined as the overlap of the ignition spark and pilot valve. Safety Time 2 is defined as the overlap of the pilot valve and the main fuel valves. Interval 1 and Interval 2 are stabilization times for the pilot and main flames, respectively.

12) If parameter ***ContinuousPurge*** is set to activated, fan output X3-01.1 will be energized in all phases. Typically this is used in burner applications where return heat may be a problem.

13) Actuator position is checked by using one of three methods. The method used depends upon the phase of the sequence. *Position Required to Proceed* means that the actuators must achieve and hold a certain position for the sequence to proceed. *Dynamic Position Checking* means that the actuator is evaluated by a "time and distance from target" algorithm. The further the actuator is away from its target position, the less time the actuator is permitted to be in that position. *Run-Time Position Checking* means that the actuator is expected to be at a certain point in a certain amount of time (based off of the run-time of the actuator).

14) For direct spark oil fuel trains, spark (ignition) will occur during prepurge if parameter ***OilPumpCoupling*** is set to *Magnetcoupl* and parameter ***IgnOilPumpStart*** is set to *on in Ph22*.

15) If parameter ***FGR-PS/FCC*** is set for *PSdeactStby*, the status of the FGR pressure switch is not checked in phase 10 or 12. The rest of the sequence is the same as setting this parameter to *FGR-PS*. If parameter ***FGR-PS/FCC*** is set for *PS VSD*, input X4-01.3 must be energized anytime the VSD speed is higher than ***RotSpeed PS on*** and de-energized anytime the VSD speed is lower than ***RotSpeed PS off***.

16) Depending on how parameter ***HeavyOilDirStart*** is set, input X6-01.3 has varying sequences. If this parameter is set for *activ 38/44*, input X6-01.3 must be energized in phase 44. If this parameter is set for *38/44..62*, input X6-01.3 must be energized in phases 44-62. If this parameter is set for *act 21..62*, input X6-01.3 must be energized in phases 21-62. If this parameter is set for *deactivated*, energizing input X6-01.3 has no effect.

17) Inputs X5-03.2 and X5-03.3 have many functions depending on how parameter ***Config X5-03*** is set. The settings are as follows:

LMV5x std – If parameter ***LC_OptgMode*** is set to *ExtLC X5-03*, energizing X5-03.2 will decrease the firing rate, while energizing X5-03.3 will increase the firing rate.
LMV2/3 std – If parameter ***LC_OptgMode*** is set to *ExtLC X5-03*, energizing X5-03.3 will achieve stage 2 oil, while energizing X5-03.2 will achieve stage 3 oil.
LMV2/3 inv – If parameter ***LC_OptgMode*** is set to *ExtLC X5-03*, energizing X5-03.2 will achieve stage 2 oil, while energizing X5-03.3 will achieve stage 3 oil.

DeaO2/Stp36 – Energizing input X5-03.2 disables O_2 trim, while de-energizing X5-03.2 enables O_2 trim (LMV52 only). Energizing input X5-03.3 allows the LMV5 to progress past phase 36. If X5-03.3 is de-energized, the LMV5 will remain in phase 36 indefinitely.

CoolFctStby – This setting has no effect (LMV50 only).

AutoDeactO2 – Energizing input X5-03.3 will deactivate O2 trim by setting O2 trim ***OptgMode*** to *auto deact*. O2 trim ***OptgMode*** must be set to *ConAutoDeac* for this function to work. De-energizing X5-03.3 sets the O2 trim ***OptgMode*** back to *ConAutoDeac*. Terminal X5-03.2 has no function with this setting.

Gas Train : DirectIgniG

Parameter *ProgramStop*									PS			PS		PS				PS		PS					PS		PS					
		Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge		Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)		Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1		Optional Postpurge 3	Direct Start		Evacuate	Atmospheric Test	Fill	Pressure Test
	Phase	00	01	10	12	20	21	22	24	30		32	34	36	38	40	42	44	50	52	54	60	62		70	72	74	76	78	79		80	81	82	83
						START-UP																OPER-ATION			SHUTDOWN							GAS VALVE PROVING			
	Terminal	Description	Notes									PURGE				SAFETY TIME 1																			
INPUTS	X4-01.1	Fuel Select Gas	Note 1				M						See sequence diagram phases 80 to 83.																						
	X3-04.1	Safety Loop (Limits)																																	
	X5-03.1	ON / OFF Switch	Note 2																																
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X				M																								
	X4-01.3	Blower Aux. Contact (FCC)				F	X				M																								
		FGR Press. SW (instead of FCC)	Note 15			F	X				M																								
	X9-03.2	POC SW Gas (CPI)																			F	X	X	X	M										
		POC SW Oil (CPI)																																	
		POC SW Gas + Oil (CPI)																			F	X	X	X	M										
		Press. SW Valve Proving																																F	X
	X9-03.4	Low Gas Press SW						M																											
	X7-03.2	POC SW Gas (CPI)																			F	X	X	X	M										
		POC SW Oil (CPI)																																	
		POC SW Gas + Oil (CPI)																			F	X	X	X	M										
		Start Release Gas						M																											
	X9-03.3	High Gas Pressure SW																																	
	X6-01.3	External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X	X	X
	X6-01.1	Ext. Flame SG Red. Contact	Note 9													F	X	X	X	X	X	X	X	M										
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12																															
	X4-02.3	Ignition		X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X4-03.3	Start Signal		X	X	X	X	X																											
		3 Way Valve (APS checking)	Note 10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																						X				
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X9-01.1	Gas Valve SV (Usually Outdoor)		X	X	X	X	X																	X	X	X	X	X	X				
	X8-01.1	Main Fuel Indicator (Gas)		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X	X	X	X		X
	X9-01.4	Gas Valve V1 (Main, upstream)		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X	X	X	X		X
	X9-01.3	Gas Valve V2 (Main, downstream)		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X	X		X	X	X

Shutdown valve proving, if used. See sequence diagram phases 80 to 83.

Start-up valve proving, if used. See sequence diagram phases 80 to 83.

Legend :
- Energized
- Energized or De-energized
- X — De-energized
- M — Must be Energized by end of Phase
- F — Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Gas Train : Pilot Gp1

	Terminal	Description	Notes	Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge	Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)	Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1	Optional Postpurge 3	Direct Start	Evacuate	Atmospheric Test	Fill	Pressure Test
	Parameter *ProgramStop*										PS			PS		PS				PS		PS				PS		PS					
	Phase		00	01	10	12	20	21	22	24	30		32	34	36	38	40	42	44	50	52	54	60	62	70	72	74	76	78	79	80	81	82	83
							START-UP																OPER-ATION		SHUTDOWN						GAS VALVE PROVING			
											PURGE						SAFETY TIME 1																	
INPUTS	X4-01.1	Fuel Select Gas	Note 1				M						See sequence diagram phases 80 to 83.													See sequence diagram phases 80 to 83.								
	X3-04.1	Safety Loop (Limits)																															
	X5-03.1	ON / OFF Switch	Note 2																														
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X				M																						
	X4-01.3	Blower Aux. Contact (FCC)				F	X				M																						
		FGR Press. SW (instead of FCC)	Note 15			F	X				M																						
	X9-03.2	POC SW Gas (CPI)																			F	X	X	X	M								
		POC SW Oil (CPI)					`																										
		POC SW Gas + Oil (CPI)																			F	X	X	X	M								
		Press. SW Valve Proving																														F	X
	X9-03.4	Low Gas Press SW						M																									
	X7-03.2	POC SW Gas (CPI)																			F	X	X	X	M								
		POC SW Oil (CPI)																															
		POC SW Gas + Oil (CPI)																			F	X	X	X	M								
		Start Release Gas						M																									
	X9-03.3	High Gas Pressure SW																															
	X6-01.3	External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X
	X6-01.1	Ext. Flame SG Red. Contact	Note 9														F	X	X	X	X	X	X	X	M								
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12									Start-up valve proving, if used.													Shutdown valve proving, if used.								
	X4-02.3	Ignition		X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X4-03.3	Start Signal		X	X	X	X	X																									
		3 Way Valve (APS checking)	Note 10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																						X			
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X9-01.1	Gas Valve SV (Usually Outdoor)		X	X	X	X	X																	X	X	X	X	X	X			
	X9-01.2	Gas Valve PV (Pilot Valve)	Note 4	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X8-01.1	Main Fuel Indicator (Gas)		X	X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X
	X9-01.4	Gas Valve V1 (Main, upstream)		X	X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X
	X9-01.3	Gas Valve V2 (Main, downstream)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X		X	X	X

Legend :

- Energized
- Energized or De-energized
- X — De-energized
- M — Must be Energized by end of Phase
- F — Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Gas Train : Pilot Gp2

	Parameter *ProgramStop*										PS		PS		PS		PS		PS		PS				PS		PS					
			Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge		Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)		Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1	Optional Postpurge 3	Direct Start		Evacuate	Atmospheric Test	Fill	Pressure Test
		Phase	00	01	10	12	20	21	22	24	30		32	34	36	38	40	42	44	50	52	54	60	62		70	72	74	76	78	79		80	81	82	83
							START-UP																OPER-ATION			SHUTDOWN						GAS VALVE PROVING			
	Terminal	Description	Notes									PURGE					SAFETY TIME 1																		
INPUTS	X4-01.1	Fuel Select Gas	Note 1				M																												
	X3-04.1	Safety Loop (Limits)																																	
	X5-03.1	ON / OFF Switch	Note 2																																
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X				M																								
	X4-01.3	Blower Aux. Contact (FCC)				F	X				M																								
		FGR Press. SW (instead of FCC)	Note 15			F	X				M																								
	X9-03.2	POC SW Gas (CPI)																			F	X	X	X	M										
		POC SW Oil (CPI)					`																												
		POC SW Gas + Oil (CPI)																			F	X	X	X	M										
		Press. SW Valve Proving																																F	X
	X9-03.4	Low Gas Press SW						M																											
	X7-03.2	POC SW Gas (CPI)																			F	X	X	X	M										
		POC SW Oil (CPI)																																	
		POC SW Gas + Oil (CPI)																			F	X	X	X	M										
		Start Release Gas						M																											
	X9-03.3	High Gas Pressure SW																																	
	X6-01.3	External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X	X	X	X	X
	X6-01.1	Ext. Flame SG Red. Contact	Note 9														F	X	X	X	X	X	X	X	M										
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12																															
	X4-02.3	Ignition			X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X4-03.3	Start Signal			X	X	X	X	X																											
		3 Way Valve (APS checking)	Note 10		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																								X			
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X9-01.1	Gas Valve SV (Usually Outdoor)		X	X	X	X	X																		X	X	X	X	X	X				
	X9-01.2	Gas Valve PV (Pilot Valve)	Note 4	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X8-01.1	Main Fuel Indicator (Gas)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X	X	X		X
	X9-01.4	Gas Valve V1 (Main, upstream)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X	X	X		X
	X9-01.3	Gas Valve V2 (Main, downstream)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X		X	X	X	X

Start-up valve proving, if used. See sequence diagram phases 80 to 83.

Shutdown valve proving, if used. See sequence diagram phases 80 to 83.

Legend :
- Energized
- Energized or De-energized
- X De-energized
- M Must be Energized by end of Phase
- F Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Oil Train : LightOilLO HeavyOilHO

	Terminal	Description	Notes	Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge	Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)	Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1	Optional Postpurge 3	Direct Start
	Parameter *ProgramStop*										PS		PS		PS				PS		PS					PS		PS		
	Phase		00	01	10	12	20	21	22	24	30	32	34	36	38	40	42	44	50	52	54	60	62	70	72	74	76	78	79
							START-UP															OPER-ATION		SHUTDOWN					
											PURGE					SAFETY TIME 1														
INPUTS	X4-01.2	Fuel Select Oil	Note 1				M																						
	X3-04.1	Safety Loop (Limits)																											
	X5-03.1	ON / OFF Switch	Note 2																										
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X			M																			
	X4-01.3	Blower Aux. Contact (FCC)				F	X			M																			
		FGR Press. SW (instead of FCC)	Note 15			F	X			M																			
	X9-03.2	POC SW Gas (CPI)																											
		POC SW Oil (CPI)																		F	X	X	X	M					
		POC SW Gas + Oil (CPI)																		F	X	X	X	M					
	X7-03.2	POC SW Gas (CPI)																											
		POC SW Oil (CPI)																		F	X	X	X	M					
		POC SW Gas + Oil (CPI)																		F	X	X	X	M					
	X6-01.1	Start Rel. Oil (Atom. Media PS)						M																					
	X5-02.2	High Oil Press SW						M																					
	X5-01.2	Low Oil Press SW (activated)													M														
		Low Oil Press SW (act from ts)														M													
	X6-01.3	External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X6-01.1	Ext. Flame SG Red. Contact	Note 9													F	X	X	X	X	X	X	X	M					
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12																									
	X4-02.3	Ignition	Note 14	X	X	X	X	X	X	See Note 14							X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-02.3	Oil Pump Motor Starter	Note 6	X	X	X	X	X	X	See Note 6														X	X	X	X	X	X
	X4-03.3	Start Signal		X	X	X	X	X																					
		3 Way Valve (APS checking)	Note 10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																				X
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-03.3	Oil Valve SV (or Atom. Media)		X	X	X	X	X																	X	X	X	X	X
	X8-01.2	Main Fuel Indicator (Oil)		X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X
	X8-02.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X
	X8-03.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X
	X7-01.3	Oil Valve V2 (Staged, load depen.)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
	X7-02.3	Oil Valve V3 (Staged, load depen.)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Legend :

- Energized
- Energized or De-energized
- X — De-energized
- M — Must be Energized by end of Phase
- F — Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Oil Train : LO w Gasp

	Terminal	Description	Notes	Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge	Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)	Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1	Optional Postpurge 3	Direct Start
	Parameter *ProgramStop*										PS		PS		PS				PS		PS					PS	PS		
	Phase		00	01	10	12	20	21	22	24	30	32	34	36	38	40	42	44	50	52	54	60	62	70	72	74	76	78	79
							START-UP															OPER-ATION		SHUTDOWN					
											PURGE					SAFETY TIME 1														
INPUTS	X4-01.2	Fuel Select Oil	Note 1				M																							
	X3-04.1	Safety Loop (Limits)																												
	X5-03.1	ON / OFF Switch	Note 2																											
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X			M																				
	X4-01.3	Blower Aux. Contact (FCC)				F	X			M																				
		FGR Press. SW (instead of FCC)	Note 15			F	X			M																				
	X9-03.2	POC SW Gas (CPI)																												
		POC SW Oil (CPI)																		F	X	X	X	M						
		POC SW Gas + Oil (CPI)																		F	X	X	X	M						
	X9-03.4	Low Gas Press SW	Note 5					M																						
	X7-03.2	POC SW Gas (CPI)																												
		POC SW Oil (CPI)																		F	X	X	X	M						
		POC SW Gas + Oil (CPI)																		F	X	X	X	M						
	X6-01.1	Start Rel. Oil (Atom. Media PS)						M																						
	X5-02.2	High Oil Press SW						M																						
	X5-01.2	Low Oil Press SW (activated)													M															
		Low Oil Press SW (act from ts)														M														
	X6-01.3	External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X6-01.1	Ext. Flame SG Red. Contact	Note 9													F	X	X	X	X	X	X	X	M						
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12																										
	X4-02.3	Ignition		X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-02.3	Oil Pump Motor Starter	Note 6	X	X	X	X	X	X	See Note 6														X	X	X	X	X	X
	X4-03.3	Start Signal		X	X	X	X	X																						
		3 Way Valve (APS checking)	Note 10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																					X
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-03.3	Oil Valve SV (or Atom. Media)		X	X	X	X	X																	X	X	X	X	X
	X9-01.1	Gas Valve SV (Usually Outdoor)		X	X	X	X	X													X	X	X	X	X	X	X	X	X
	X9-01.2	Gas Valve PV (Pilot Valve)	Note 4	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X
	X8-01.2	Main Fuel Indicator (Oil)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X
	X8-02.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X
	X8-03.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X
	X7-01.3	Oil Valve V2 (Staged, load depen.)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
	X7-02.3	Oil Valve V3 (Staged, load depen.)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Legend :

- Energized
- Energized or De-energized
- X — De-energized
- M — Must be Energized by end of Phase
- F — Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Oil Train : HO w Gasp

	Terminal	Description	Notes	Lockout Phase	Safety Phase	Home Run Position	Burner Standby	Safety Relay = ON	Release of Startup, SV = ON	Combustion Fan = ON	Drive to Prepurge Pos.	Prepurge	Prepurge (Aux 3 Drive to Prepurge Pos.)	Prepurge 2 (Aux 3 FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ignition (Spark) = OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Normal Operation)	Operation 2 (Driving to Low Fire)	Afterburn Time	Driving to Postpurge Position	Mandatory Postpurge 1	Optional Postpurge 3	Direct Start
	Parameter *ProgramStop*										PS		PS		PS				PS		PS					PS		PS		
	Phase		00	01	10	12	20	21	22	24	30	32	34	36	38	40	42	44	50	52	54	60	62	70	72	74	76	78	79
							START-UP															OPER-ATION		SHUTDOWN					
											PURGE					SAFETY TIME 1														
INPUTS	X4-01.2	Fuel Select Oil	Note 1				M																							
	X3-04.1	Safety Loop (Limits)																												
	N/A	Internal Temperature Limit																												
	X5-03.1	ON / OFF Switch	Note 2																											
	N/A	Flame Signal	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X3-02.1	Blower Air SW (APS)	Note 8			F	X			M																				
	X4-01.3	Blower Aux. Contact (FCC)				F	X			M																				
		FGR Press. SW (instead of FCC)	Note 15			F	X			M																				
	X9-03.2	POC SW Gas (CPI)																												
		POC SW Oil (CPI)																		F	X	X	X	M						
		POC SW Gas + Oil (CPI)																		F	X	X	X	M						
	X9-03.4	Low Gas Press SW	Note 5					M																						
	X7-03.2	POC SW Gas (CPI)																												
		POC SW Oil (CPI)																		F	X	X	X	M						
		POC SW Gas + Oil (CPI)																		F	X	X	X	M						
	X6-01.1	Start Rel. Oil (Atom. Media PS)						M																						
		Ext. Flame SG Red. Contact	Note 9													F	X	X	X	X	X	X	X	M						
	X6-01.3	Heavy Oil Direct Start	Note 16						See Note 16																					
		External Flame Safeguard	Note 9			X	X	X	X	X	X	X	X	X	X	X	M								F	X	X	X	X	X
	X5-02.2	High Oil Press SW							M																					
	X5-01.2	Low Oil Press SW (activated)														M														
		Low Oil Press SW (act from ts)															M													
OUTPUTS	X3-01.1	Fan	Note 12	See Note 12																										
	X4-02.3	Ignition		X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-02.3	Oil Pump Motor Starter	Note 6	X	X	X	X	X	X	See Note 6															X	X	X	X	X	X
	X4-03.3	Start Signal		X	X	X	X	X																						
		3 Way Valve (APS checking)	Note 10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		3 Way Valve (APS checking) INV.	Note 10			X	X	X	X																					X
	X3-01.2	Alarm	Note 3		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X6-03.3	Oil Valve SV (or Atom. Media)		X	X	X	X	X																		X	X	X	X	X
	X9-01.1	Gas Valve SV (Usually Outdoor)		X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X	X	X	X
	X9-01.2	Gas Valve PV (Pilot Valve)	Note 4	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X	X	X	X
	X8-01.2	Main Fuel Indicator (Oil)		X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X
	X8-02.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X
	X8-03.1	Oil Valve V1 (Main)		X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X
	X7-01.3	Oil Valve V2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X
	X7-02.3	Oil Valve V3 (Staged, load depen.)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X

Legend :

- Energized
- Energized or De-energized
- X — De-energized
- M — Must be Energized by end of Phase
- F — Must be De-energized by end of Phase

See the first pages of Section 3-3 for notes.

Actuators

Parameter *ProgramStop*									PS		PS		PS				PS		PS				PS		PS					
		Lockout Phase	Safety Phase	Home Run Pos.	Burner Standby	Safety Relay = ON	Release of startup, Safety Valve = ON	Comb. Fan = ON	Drive to Purge Pos.	Prepurge		Prepurge 2 (FGR)	Drive to Ignition Pos.	Preignition (Spark) = ON	Pilot Valve = ON	Ign. (Spark)= OFF	Interval 1 (Pilot Stabilization)	Safety Time 2	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.	Operation 1 (Norm. Operation)	Operation 2 (Driving to L. Fire)	Afterburn Time	Driving to Postpurge Pos.	Mandatory Postpurge 1		Optional Postpurge 3	Direct Start	Evacuate	Atmospheric Test	Fill	Pressure Test
	Phase	00	01	10	12	20	21	22	24	30	32	34	36	38	40	42	44	50	52	54	60	62	70	72	74	76	78	79	80	81	82	83
						START-UP															OPER-ATION		SHUTDOWN						GAS VALVE PROVING			
Actuator	Description	Notes								PRE-PURGE					SAFETY TIME 1										POST-PURGE							
Air, Aux 1, Aux 2, VSD	Expected Position	Note 7	U		H				T	PrP			T	I						T	M	T	S	T	PsP			See Note 7			
	Position Required to Proceed	Note 13																														
	Dynamic Position Checking	Note 13																														
	Run-Time Position Checking	Note 13																														
Gas / Oil or Oil	Expected Position	Note 7	U		H								T	I						T	M	T	S	T	PsP			See Note 7			
	Position Required to Proceed	Note 13																														
	Dynamic Position Checking	Note 13																														
	Run-Time Position Checking	Note 13																														
Aux 3	Expected Position	Note 7	U		H						T	PrP	T	I						T	M	T	S	H		T	PsP	See Note 7			
	Position Required to Proceed	Note 13																														
	Dynamic Position Checking	Note 13																														
	Run-Time Position Checking	Note 13																														

Legend :

- Position checked by stated method
- Position not checked
- **U** Undefined position
- **H** Home position
- **T** Actuators transitioning
- **PrP** Prepurge position
- **I** Ignition position
- **M** Actuators modulating
- **S** Actuators stopped
- **PsP** Postpurge position

See the first pages of Section 3-3 for notes.

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Section 2	Wiring
Section 3	Parameters
Section 4	**Commissioning**
Section 5	VSD
Section 6	O_2 Trim
Section 7	Troubleshooting
Section 8	Modbus
Section 9	ACS450
Section 10	Revision History
Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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Section 4: Commissioning

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Before the LMV5 can be commissioned, certain pre-requisites must be met for the LMV5 control, the burner, the boiler, and the boiler room. Experience has shown that if the points below are addressed properly, commissioning will be safe, timely, and trouble-free.

Pre-Requisites for Basic LMV51 Systems

1. Burner / boiler must be in "good" condition. Burner firing head must be correct for the boiler and the firing head must not be cracked, melted, or otherwise damaged. Other items to check include:

    a. Flame scanner tube must sight pilot and main flame correctly.

    b. Refractory should not interfere with the flame scanner sighting or the flame path of the burner.

    c. For fire tube boilers, the flame should not impinge on the Morrison tube.

2. All LMV5 components (base unit, actuators, flame scanners, etc.) are mounted properly. Please see Section 1 (Overview) and Appendix B (LMV5 Accessories Guide) for mounting details. Particular attention should be paid to the following:

    a. Actuator shaft couplings must accomplish the following:

        i. Compensate for both angular and parallel shaft misalignment generated by the mounting bracket.

        ii. Have little or no backlash.

        iii. Be robust enough to absorb the stall torque of the actuator without damage.

    Solid (rigid) shaft couplings are not acceptable in most applications. Clamp-type couplings that have a D-shape or keyway are preferred since these will not damage the actuator shaft and do provide positive engagement. In linkage-less applications, actuator couplings should be considered to be safety-related components.

    NOTE: Do not couple actuator to valve / damper shaft until actuator is addressed, the direction of rotation for the actuator is set, and the LMV5 alarm is reset. This is outlined later in the commissioning section.

    b. Actuator brackets must be rigid enough so that they do not amplify burner vibration (diving board effect) or distort significantly when the actuator is applying maximum torque to the valve / damper shaft.

c. When actuator is installed and coupled, ensure that all mounting hardware is tightened adequately, and some method of thread locking is employed on the mounting hardware (except for the coupling hardware).

d. Ensure environmental conditions (temperature, vibration, moisture, etc.) are not exceeded.

3. Ensure that all wiring is per the applicable wiring diagram and also meets applicable local and national codes. Particular attention should be paid to the following:

e. If a step-down control transformer is the source of 120 VAC power for the LMV5, the ground and neutral should be bonded (connected) on the transformer.

f. Voltage supply to a 120 VAC LMV5 must be between 102 and 132 VAC, 47-63 Hz. Waveform must be a full sine wave.

g. The small transformer(s) used for the LMV5 (AGG5.210, typically blue or black) must be wired and grounded. See Section 2 (Wiring) for more details. Pay attention to pins 3 and 4 on terminal SEK2 and proper grounding. If more than two SQM48 and one SQM45 actuators are modulated at the same time, a second transformer (AGG5.210) will be required.

h. CANbus wire (AGG5.643) must be used to wire between actuators. Plain, shielded cable is not adequate and is not permitted.

i. Ensure that the last device and only the last device on the CANbus has the termination jumper in the “Bus Termination” position. See Section 2 (Wiring) for more details. The AZL has built-in termination.

4. Fuel (gas) supply must be adequate to support high fire operation and fuel (gas) train must be sized correctly.

j. Fuel (gas) pressure before the firing rate control valve must be correct, stable and repeatable at all firing rates and must not vary when other fuel (gas) burning appliances (other boilers in the building) are being operated.

k. The fuel (gas) pressure regulator on the burner being commissioned should not be fully open at high fire and should not be bouncing off the seat at low fire. Fuel regulator must be sized properly, and have adequate turndown capability.

5. A temporary stack gas analyzer that has been calibrated and at a minimum reads O_2 (%) and CO (ppm) must be used for setting combustion.

6. Knowledge of what fuel flow represents high fire of the burner / boiler combination and also the turndown of the burner / boiler combination. This can typically be found on the burner / boiler nameplate.

7. A method of determining firing rate (fuel flow within +/- 5%) should be used. This, in combination with knowledge of high fire and turndown, is used to set the load numbers on each curve point. An Excel spreadsheet is available for this purpose.

8. For steam boilers, the feedwater supply must be adequate to support high fire operation. Feedwater controls must be working properly.

9. The load on the boiler must be adequate so that a burner / boiler combination can be run at high fire for a minimum of 5 minutes.

Pre-Requisites for LMV52 Systems with a VFD

1. All pre-requisites of the Basic LMV51 system apply.

2. Blower motor speed sensor and speed wheel must be installed correctly. See Appendix B (LMV5 Accessories Guide) for more details.

3. Vector-type VFDs are highly recommended due to their inherently more precise motor speed control. Volt / Hz VFDs are not recommended due to less precise speed control.

4. Proper grounding between the LMV5, the VFD, and the motor must be installed. See Section 2 (Wiring) for more details.

5. VFD parameters must be set correctly to be compatible with both the LMV52 and the blower motor. See Section 5 (VSD) for more details. Particular attention should be paid to the following:

    a. Analog signal configuration. Both the LMV52 and VFD must be configured for a 4-20mA signal.

    b. Ramp rates between the LMV52 and the VFD must be compatible. In general, ramp rates of the VFD should be 10 seconds less than the LMV52.

    c. VFD must be set up as a slave unit for a 4-20mA signal. Damping, dead band, and PID functions must be disabled.

    d. The frequency (Hz) output of the drive must be directly proportional to the analog input signal.

    e. Acceleration / deceleration curves must be linear instead of "S-shaped".

    f. Ramp settings must be ramp up / ramp down instead of ramp up / coast down.

    g. Any type of damping or stall prevention in the VFD should be deactivated.

6. LMV52 / VFD combination must be “Standardized” before operation. See Section 5 (VSD) for more details.

    a. Verify that the air damper opens to pre-purge position before the blower is energized for standardization.

Pre-Requisites for LMV52 Systems with O2 Trim

1. All prerequisites of the Basic LMV51 system apply.

2. The O_2 sensor must be mounted correctly. See Appendix B (LMV5 Accessories Guide) for more details. Particular attention should be paid to the following:

    a. If the O_2 sensor cannot be installed per Appendix B (LMV5 Accessories Guide), contact SCC for assistance.

    b. The QGO20 O_2 sensor is not suited for most types of biogas or fuels that produce ash, such as #6 oil. Contact SCC for advice on the compatibility of uncommon fuels.

3. The O_2 sensor must be wired to the PLL52 correctly. See Section 2 (Wiring) for more details. Particular attention should be paid to the following:

    a. The PLL52 module must be within 30 feet of the O_2 sensor.

    b. Two conduits must be run between the QGO20 O_2 sensor and the PLL52 module. One conduit must contain the low voltage signals while the other conduit must contain the high voltage for the sensor heater.

4. The furnace pressure of the boiler being commissioned must be repeatable at a given firing rate. Repeatability of +/- 0.2 in WC at each firing rate is adequate.

5. A fuel flow meter or some means of determining the load (firing rate) to +/- 3% is required. A more accurate load number (+/- 3%) for each curve point is necessary for reliable O_2 trim functionality.

6. The LMV52 must be powered and configured for the QGO20 O_2 sensor for two hours prior to commissioning. This is done to let the QGO20 sensor heat up thoroughly.

7. The boiler must be up to normal operating temperature / pressure for at least one hour before commissioning the O_2 trim.

Configuring (Parameterization of) an LMV5 with a Default Parameter Set

The procedure below assumes an LMV5 with a default parameter set. If the LMV5 is mounted to a burner / boiler, the OEM(s) may have already changed the parameters from the default setting and parameterized the LMV5 for the application.

Section 3 (Parameters) gives a detailed explanation of all of the parameters in the LMV5, as well as highlights which parameters must be set (marked with a double asterisk **) and which parameters are frequently used (shaded).

This procedure gives a general guideline of what parameters need to be set to get an LMV5 running on a typical burner/ boiler. Every burner is different, so it is likely that every burner will need a somewhat unique parameter set to run correctly.

When an LMV5 with a default parameter set is powered up and wired correctly, it will go into alarm and state that "no fuel train is defined". During the parameterization, the alarm does not need to be reset. Moreover, the alarm will come back immediately until at least a few key parameters are set. The recommendation is to silence the alarm horn, and leave the LMV5 in a state of alarm until the key parameters are set.

1. Log in at the OEM password level. From the factory, the OEM password for the LMV5 is "START".

2. Set the Burner ID. This can be found in the main menu under *Updating.* The OEM password will be required when the *Updating* menu is entered. The Burner ID is a unique number which matches the burner to the parameter set in the LMV5. Typically, the serial number of the burner is used as the Burner ID.

3. Configure the load controller sensor (except LMV51.0…) using the following menu path:

   Params & Display > LoadController > Configuration

   The default configuration is for a hot water boiler (temperature control) with a PT100 RTD temperature sensor. For a steam boiler (pressure control), set the following parameters to the following settings:

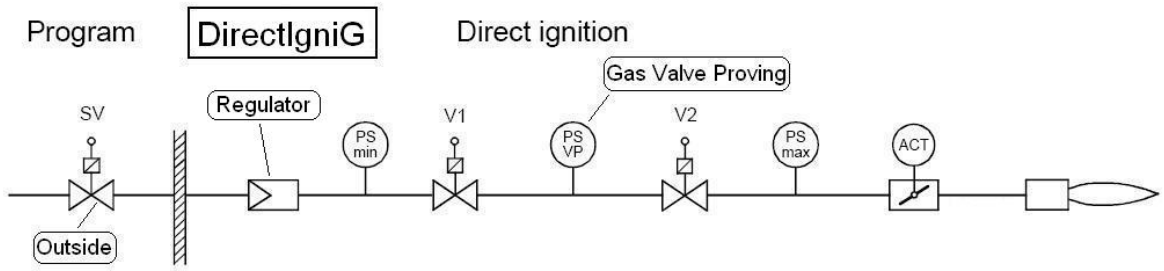
   Sensor Select = PressSensor
   Ext Inp X61 U/I = 0..10V or 4..20mA (sensor dependent)
   MRangePressSens = High range of pressure sensor

4. Set the fuel train(s). If only gas is to be fired, only a gas fuel train must be selected. If only oil is to be fired, only an oil fuel train must be selected. For dual fuel burners, both a gas and oil fuel train must be selected. Fuel trains can be set using the following menu path:

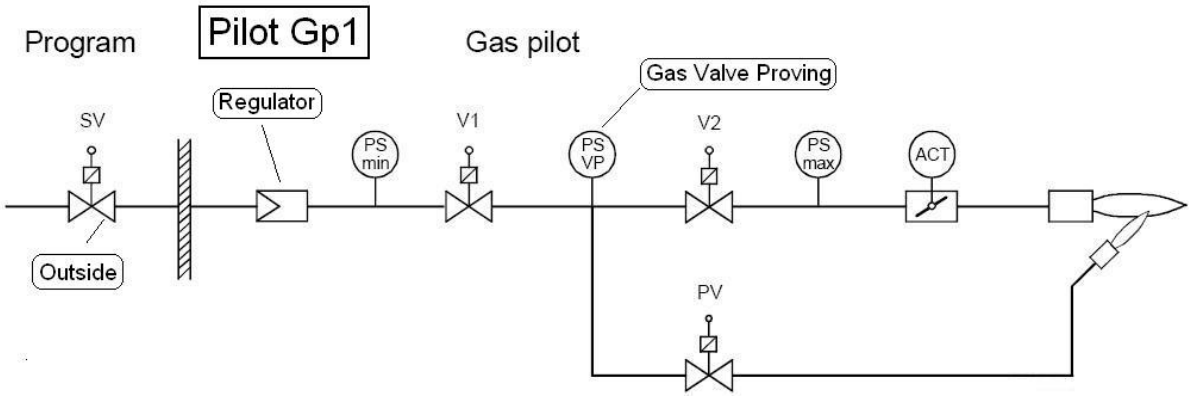
   Params & Display > BurnerControl > Configuration > ConfigGeneral

   See the following pages for fuel train information. “Pilot Gp2” is typical for gas piloted gas burners and “LO w Gasp” is typical for gas piloted oil burners.

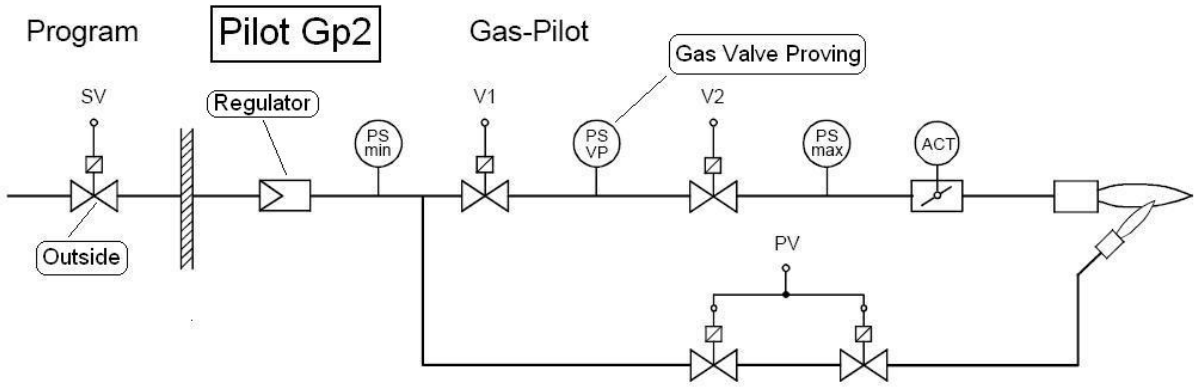
Direct Spark Ignition



Pilot Ignition (Pilot From Between Main Gas Valves V1 and V2)



Pilot Ignition (Pilot Before Main Gas Valves V1 and V2)



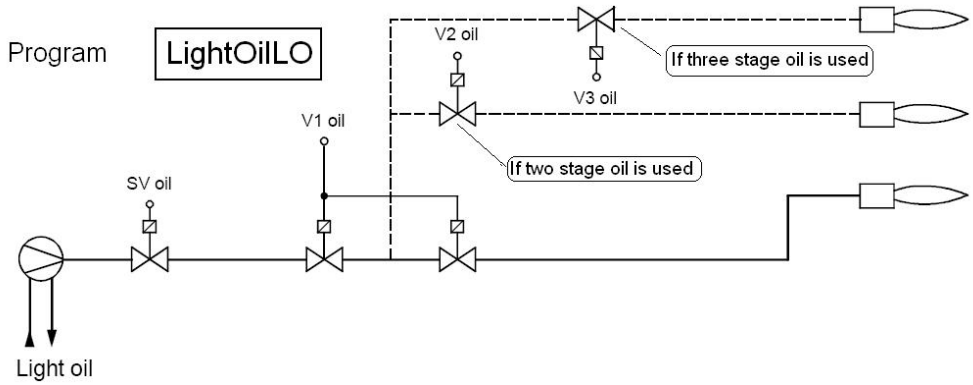
Legend:

ACT =	Actuator	SV =	Shutoff (safety) valve
V1 =	Upstream gas valve (main)	PS =	Pressure switch
V2 =	Downstream gas valve (main)	VP =	Valve proving
PV =	Pilot valve		

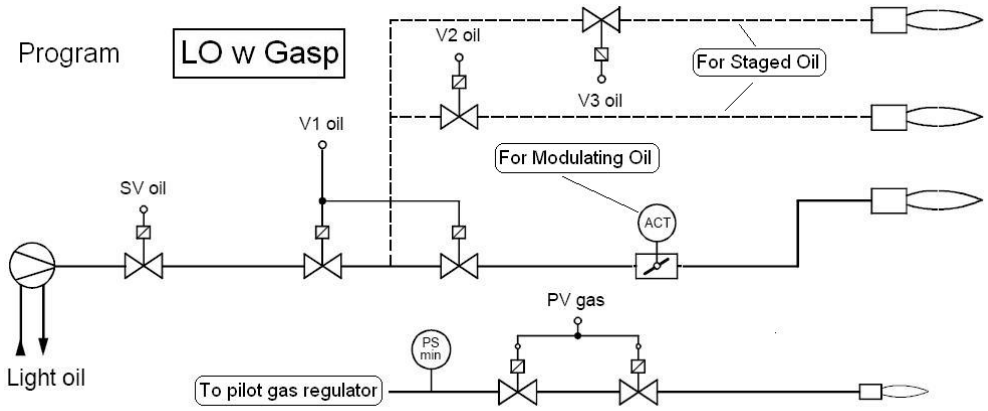
	Terminal	Description	Drive to Ignition Pos.	Preignition (SPARK) = ON	Pilot Valve = ON	IGN (SPARK) = OFF	Interval 1 (Pilot Stabilization)	**Safety Time 2**	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.
			36	**38**	**40**	**42**	**44**	**50**	**52**	**54**
					SAFETY TIME 1					
DirectIgniG	**X4-02.3**	Ignition		■	■					
	X9-01.4	Gas valve V1 (main valve, upstream)			■	■	■	■	■	■
	X9-01.3	Gas valve V2 (main valve, downstream)			■	■	■	■	■	■
Pilot Gp1	**X4-02.3**	Ignition		■	■					
	X9-01.1	Gas valve SV (safety valve, usually outdoors)	■	■	■	■	■	■	■	■
	X9-01.2	Gas valve PV (pilot valve)			■	■	■	■		
	X9-01.4	Gas valve V1 (main valve, upstream)			■	■	■	■	■	■
	X9-01.3	Gas valve V2 (main valve, downstream)						■	■	■
Pilot Gp2	**X4-02.3**	Ignition		■	■					
	X9-01.1	Gas valve SV (safety valve, usually outdoors)	■	■	■	■	■	■	■	■
	X9-01.2	Gas valve PV (pilot valve)			■	■	■	■		
	X9-01.4	Gas valve V1 (main valve, upstream)						■	■	■
	X9-01.3	Gas valve V2 (main valve, downstream)						■	■	■

Figure 4-1: Fuel Train Sequences for Gas (shaded indicates energized)

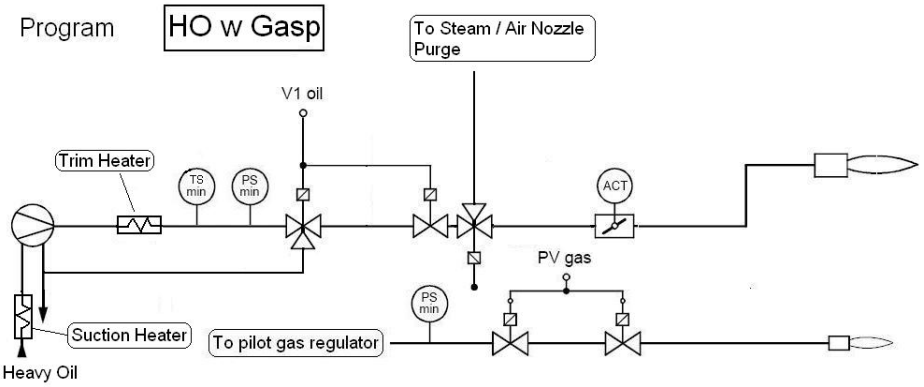
Direct Spark Ignition for Light Oil, Single-stage or Multi-stage (other trains possible)



Gas Pilot Ignition for Light Oil, Staged or Modulating (other trains possible)



Gas Pilot Ignition for Heavy Oil, Modulating (other trains possible)



Legend:

ACT =	Actuator	SV =	Shutoff (safety) valve
V1 =	Oil valves (main)	PS =	Pressure switch
V2 =	Stage 2 oil valve	PV =	Pilot valve
V3 =	Stage 3 oil valve	TS =	Temperature switch

			Drive to Ignition Pos.	Preignition (SPARK) = ON	Pilot Valve = ON	IGN (SPARK) = OFF	Interval 1	**Safety Time 2**	Interval 2 (Main Stabilization)	Drive to Low Fire Pos.
			36	**38**	**40**	**42**	**44**	**50**	**52**	**54**
	Terminal	**Description**			**SAFETY TIME 1**					
LightOilLO	**X4-02.3**	Ignition								
	X8-02.1	Oil valve V1 (main valve)								
	X8-03.1	Oil valve V1 (main valve)								
LO w Gasp	**X4-02.3**	Ignition								
	X9-01.1	Gas valve SV (safety valve, usually outdoors)								
	X9-01.2	Gas valve PV (pilot valve)								
	X8-02.1	Oil valve V1 (main valve)								
	X8-03.1	Oil valve V1 (main valve)								
							Safety Time 2 HO ONLY			
HO w Gasp	**X4-02.3**	Ignition								
	X9-01.1	Gas valve SV (safety valve, usually outdoors)								
	X9-01.2	Gas valve PV (pilot valve)								
	X8-02.1	Oil valve V1 (main valve)								
	X8-03.1	Oil valve V1 (main valve)								

Figure 4-2: Fuel Train Sequences for Oil (shaded indicates energized)

NOTE: Depending on the direction of rotation, home position set in the LMV5, and whether the actuator is activated or deactivated, the actuator may rotate as soon as it is addressed. For this reason it is highly recommended that the actuator shaft be uncoupled from the valve / damper until the parameters pertaining to the above are set, and the initial LMV5 alarm is reset.

5. Address the actuators. This is accomplished by the following steps:

    a. Remove the outer black cover of all actuators to be addressed. This is done by loosening the three Philips (Pozidriv) head screws on the cover and setting the cover aside.

    b. On the AZL, the menu path will be:

        Params & Display > Actuators > Addressing

        Note that when the "Params & Display" menu is entered, it may be necessary to enter the OEM or service level password.

    c. Select the actuator to be addressed. When prompted, press the "Enter" key to begin the addressing assignment.

    d. Press the red button on the appropriate actuator. If done correctly, the AZL should state that the address assignment was successful.

    e. Repeat the procedure above for the other actuators.

    f. The jumper must be set to "Bus termination" on the last device on the CANbus daisy chain. The last device could be an actuator or a PLL module.

    g. After all actuators are successfully addressed, the outer black covers can be reinstalled.

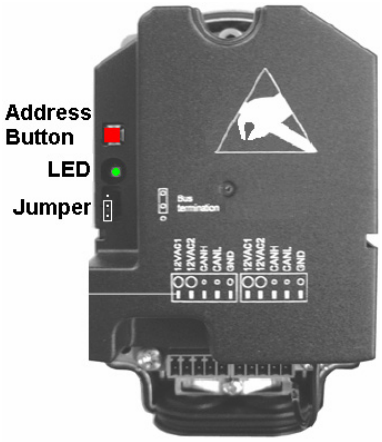


Figure 4-3: Actuator with Cover Removed

Additional information:

- When the actuator is wired correctly, powered up, and not addressed, the green LED should be a solid green, which indicates power and CANbus communication.
- When addressing is successful, the LED should blink a set number of times, pause and repeat. The number of blinks indicates how the actuator is addressed:
  1 = Air 2 = Gas / Oil 3 = Oil 4 = Aux 1
  5 = Aux 2 6 = Aux 3
- The actuator can be un-addressed by holding the red button for 8-10 seconds. A solid green LED will confirm this.
- If using an LMV52 and advanced FGR functions are needed, the FGR actuator must be addressed as the Aux 3 actuator.

6. Activate or deactivate the appropriate actuators / VSD. If the actuator / VSD is not present on the burner, it should be deactivated. If O_2 trim is to be used, set actuators that will influence airflow (typically air actuator and VSD if equipped) to "air influenced" instead of "activated". For dual fuel burners, this will need to be done for both fuels. The menu path to activate and deactivate actuators / VSD is:

   Params & Display > RatioControl > Configuration > GasSettings or *OilSettings*

7. For each actuator that has been addressed and activated, set the direction of rotation using the following menu path:

   Params & Display > Actuators > DirectionRot

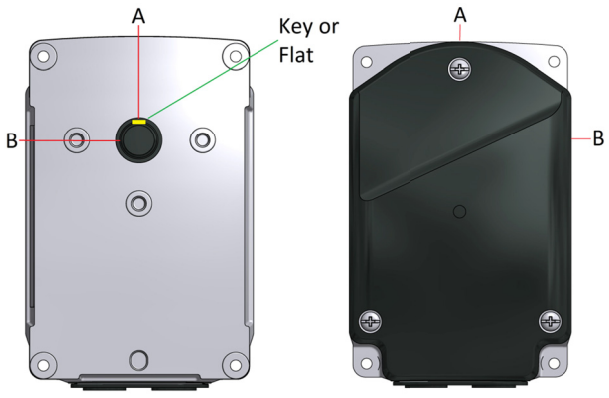


Figure 4-4: Standard and Reversed Rotation

a. **Standard Rotation** - Key or flat is at **A** when indicated actuator position is at 0 degrees. Key or flat will be at **B** when indicated actuator position is 90 degrees. This is how the actuator's shafts come from the factory.

b. **Reversed Rotation** - Key or flat is at **B** when indicated actuator position is at 0 degrees. Key or flat will be at **A** when indicated actuator position is 90 degrees.

NOTE: Make sure that the direction of rotation is set correctly for all actuators at this time, including the oil actuator. If the direction of rotation must be changed later, the fuel-air ratio control curves must be deleted.

8. At this point, the LMV5 alarm can be reset, provided that there is not a call for heat present (burner switch is off / X5-03.1 is not energized). Older LMV5 units also require the safety loop to be closed before the alarm can be reset. The reset can be accomplished via a remote reset button (if wired) or via the menu path:

   OperationalStat > Status/Reset > Press "ESC" then "ENTER" to reset

9. Set actuator home (standby) positions if necessary. Defaults are 0 degrees and 0% VSD. For dual fuel burners this will need to be done for both fuels. The menu path is:

   Params & Display > RatioControl > GasSettings or *OilSettings > SpecialPositions > HomePos*

10. Couple actuators to the valves / dampers. Actuators must not torque against mechanical stops on the valve / damper when at home position. Adjust home positions if necessary.

    NOTE: Actuator shaft couplings must compensate for both angular and parallel shaft misalignment due to the mounting bracket. Solid (rigid) shaft couplings are not acceptable in most applications, especially when formed or welded mounting brackets are used. Couplings should have little to no backlash, and are a safety relevant part of a linkage-less system.

    NOTE: Make absolutely certain that when the actuators are at or near 0 degrees (as indicated on the AZL display) that the valve / damper the actuator is coupled to is in the CLOSED (minimum flow) position. An exception to this is some back-flow type oil burners, where a wide open oil valve will result in minimal flow thru the oil nozzle.

11. With the burner off, stroke each valve / damper through its intended range of motion using the SQM… actuator that is now coupled to the valve / damper. The menu path to do this is:

    Params & Display > RatioControl > GasSettings or *OilSettings > CurveParams*
    (For oil, also go into *Curve Settings*)

    In the Curve Parameters screen, all of the activated actuators for the selected fuel can be stroked through their intended range of motion. An arrow (>) indicates the actuator is driving to the set position and a colon (:) indicates that the actuator is at the set position. Verify that no binding will occur through the intended range of motion. Also note valves / dampers where wide open is less than 90 degrees.

12. Set special positions for all activated actuators. This will define where the actuators / VSD go for ignition, pre-purge, and post-purge. For dual fuel burners this will need to be done for both fuels. Special positions can be set using the following menu path:

    Params & Display > RatioControl > GasSettings or *OilSettings > SpecialPositions*

13. At this point, all other LMV5 parameters under the "BurnerControl" and "RatioControl" headings should be reviewed and set accordingly for the individual burner requirements.

    Params & Display > BurnerControl
    Params & Display > RatioControl

    Section 3 of this literature explains every parameter in detail, and the most commonly used parameters are shaded for easy reference.

14. If the burner has a Variable Speed Drive (VSD) on the blower, it must be standardized. In most cases, the VSD is a Variable Frequency Drive (VFD). See Section 5 in this literature if the VFD parameters are not already set, and for a more detailed standardization procedure. If the VFD parameters are set, standardize the VFD using the following menu path:

    Params & Display > VSD Module > Configuration > Speed

    Once ***Standardization*** is set to "activated", the air damper should open to its pre-purge position, and the blower should ramp up, pause, and then ramp back down. If this does not occur, make sure that the VSD is set to "air influenced" and the safety loop is closed.

Transferring Parameter Sets Using the AZL Display

This procedure will detail how to transfer a parameter set from one burner to another burner. In this example, the parameter set will originate from Burner #1 (B1) and will be copied to Burner #2 (B2). Naturally, using a similar procedure, the parameter set from Burner #1 can be copied to Burners #3, #4, #5, etc. The ACS450 PC software can also be used for this purpose (see Section 9).

Note: Passwords are transferred with the parameter sets. Manual operation settings are not transferred with parameter sets.

1. Obtain the OEM or service level passwords for B1 and B2.

2. On B1, upload all of the current parameters from the LMV5 to the AZL flash memory using the following menu path:

    Updating > ParamBackup > LMV5x -> AZL

    The OEM or service level password for B1 will be necessary to access this. This will upload all of the current LMV5 parameters to the AZL flash memory. This process is complete when the AZL states "Parameters have been stored". If the LMV5 on B2 is known to have a blank burner ID, then power off B1 LMV5, remove the AZL, and skip to step 5. Otherwise, go to the next step.

3. Write down B1 burner ID. This can be found at the following menu path:

    Operation > Burner ID

    After this step, B1 LMV5 can be powered off. After B1 is powered off, remove the AZL.

4. On B2, write down the burner ID if it is not blank. If the burner ID on B2 is not the same as B1, change the burner ID on B2 to match B1. Changing the burner ID can be done using the following menu path:

   Updating > BurnerID

   The OEM level password will be required to change the burner ID.

5. Power off B2 LMV5. After B2 LMV5 is powered off, remove the AZL from B2 and replace with the AZL from B1. Power B2 LMV5 back on.

6. Now that the burner IDs match or the B2 burner ID is blank, the B1 parameter set can be downloaded into B2 using the following menu path:

   Updating > ParamBackup > AZL -> LMV5x

   The OEM or service level password for B2 will be necessary to access this. This will download all of the parameters from B1 AZL into the LMV5 on B2. This process may take up to 5 minutes. This process is complete when the AZL states "Backup Restore finished Parameter BC : Complete" or “Backup Restore finished Parameter BC : Partial". Do not interrupt this process once it is started. Also, the alarm output will be energized when the new parameter set is downloaded to B2 LMV5.

7. After this is complete, B2 can be powered down. The AZL from B1 can be returned to B1 and the AZL from B2 can be reconnected to B2. Power B2 LMV5 back on.

8. If the burner ID on B2 was changed to allow the backup, then return the burner ID to what it was previously. If the burner ID was blank before the download, change the burner ID on B2 to a unique value different than B1. Typically, the burner serial number is used.

   NOTE: An exact copy of all parameters is transferred when the above procedure is executed, including light-off positions, Fuel Air Ratio Control Curves and O_2 Curves. Typically, even "identical" burners and boilers need unique light-off positions, Fuel Air Ratio Control Curves and O_2 curves. Since this is typically the case, curves and ignition positions are typically deleted after the parameter set is downloaded into a new burner.

<u>Suggested Initial Light-off for LMV5 Systems</u>

1. The following procedure assumes the following:

   a. Fuel train "Pilot GP2" was selected for a gas pilot burner.
   b. Pre-requisites for Basic LMV51 systems or LMV52 systems (from above) are met.
   c. Procedure for Configuring (Parameterization of) an LMV5 has been done (from above).
   d. This is a first-time commissioning of the LMV5 and the combustion control curve is blank (no points are entered).

2. Close manual main fuel (gas) valve that is downstream of the pilot take-off.

3. Ensure burner switch is off. If the LMV5 is not yet powered, turn on the power to the LMV5.

4. At this point, all safety interlocks that can be checked should be checked in a safe manner. This includes but is not limited to: low water cut offs, high temperature switches, high gas pressure switch, low gas pressure switch, proof of closure (POC), etc.

5. Later in the procedure when the burner is running, the rest of the safety interlocks must be checked in a safe manner. This includes but is not limited to: Air pressure switches, high steam pressure limits, draft switches, etc.

6. Set parameter ***ProgramStop*** to Interval 1, Phase 44. This will stop the burner from progressing past lighting the pilot. This parameter can be found under the following menu path:

   Params & Display > RatioControl > ProgramStop

7. Turn on the burner switch. The burner should drive to pre-purge (Phase 24), drive to ignition (Phase 38), light the pilot, and stop in pilot stabilization (Phase 44). If the pilot does not light on a new installation, there could be air in the gas line. Bleed the air in a safe manner if necessary and attempt to re-light the pilot.

8. Once the pilot is lit, tune the pilot by adjusting the ignition position of the air actuator and / or adjusting the pilot gas pressure regulator, if necessary. Pilot flame should be stable and return a flame signal of 85% or greater. Ignition positions can be adjusted at this time using the following menu path:

   Params & Display > RatioControl > GasSettings > SpecialPositions > IgnitionPos

9. Once a satisfactory pilot flame is established, set ***ProgramStop*** to Interval 2, Phase 52. The burner should open the main fuel (gas) valves and attempt to light the main flame. The LMV5 should show a flame failure since the manual main fuel (gas) valve is closed.

10. If a flame failure does occur, proceed to reset the LMV5 and open the manual main fuel (gas) valve. The burner should once again proceed through the startup sequence, light the pilot and then attempt to light the main flame.

11. If the main flame lights, adjust the ignition position of the gas valve to achieve a safe main flame. At this time, a calibrated stack gas analyzer should be inserted into the stack and used to evaluate combustion. If the main flame fails to light, the ignition position of the firing rate control valve and / or the gas pressure regulator may need to be adjusted to achieve a combustible mixture at the ignition position. After the combustion has been verified to be safe with an analyzer, ***ProgramStop*** can be left at Interval 2, Phase 52 for boil out or boiler warming if required.

Suggested Ratio Control Curve Commissioning

1. The procedure below assumes the following:

    a. Pre-requisites for Basic LMV51 systems or LMV52 systems (from above) are met.
    b. Procedure for Configuring (Parameterization of) an LMV5 has been done (from above).
    c. This is a first-time commissioning of the LMV5 and the combustion control curve is blank (no points entered).
    d. The burner has been lit off, and is at ignition position.
    e. A calibrated stack gas analyzer is sampling the stack gas and can read %O_2 and ppm CO.
    f. The boiler has been warmed up to operating temperature / pressure.

2. If activated, set parameter ***ProgramStop*** to deactivated. This will permit the ratio control curve to be commissioned. The ratio control curve can be found under the menu:

    Params & Display > RatioControl > GasSettings > CurveParams

3. Go to Point 1. Point 1 is automatically set to ignition position values. When Point 1 is entered, the AZL will prompt to "change" or "delete" the point. "Change" should be selected. Next, the AZL will prompt for "Followed" or "Not followed". "Followed" should be selected. All actuators and / or VSD that have been activated should show up on this screen. If more than one Aux actuator or VSD are activated, the screen may need to be scrolled down to show the other actuators. If an O_2 sensor is being used and is activated, the O_2 reading will also be displayed.

    NOTE: Using the "Not followed" option is possible but not recommended for most situations since the results of changing the actuator positions in "Not followed" mode cannot be seen real time on a combustion analyzer. When "Followed" is selected, a carat (>) is shown when the actuators / VSD are moving to the displayed position. A colon (:) is shown when the indicated positions are reached. A pound (#) is shown when the Aux 3 FGR actuator is being held at position due to a time or temperature-based FGR hold.

4. If the low fire point is not known (maximum burner turndown), adjust the Point 1 actuator positions until maximum safe burner turndown is achieved. Record the fuel flow. If the fuel flow is not available, burner head pressure can be used as a last resort.

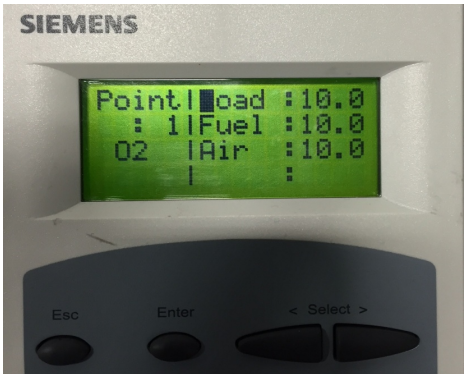


Figure 4-5: Point 1 on the Ratio Control Curve

NOTE: While commissioning the Ratio Control Curves, it is the responsibility of the technician to ensure that safe fuel / air ratios are being maintained. If an AZL5 arrow key is held down when adjusting an actuator position, the position will be changed at a progressively faster rate.

5. Set the load number to 100%. Increase the effective firing rate of the burner by increasing the actuator and / or VSD positions in a way that maintains a safe fuel / air ratio. This is typically accomplished by increasing air, fuel and VSD (if equipped) in a stepwise rotation. Keep increasing the firing rate in this manner until high fire positions of the actuators / VSD are reached.

   NOTE: Typically, the gas pressure regulator immediately upstream of the firing rate control valve will need to be adjusted on a new installation. Adjust the regulator such that the firing rate control valve is between 60-80 degrees open at high fire.

6. Once high fire actuator / VSD positions and gas pressure regulator(s) are set, record actuator / VSD positions, burner head pressure, high fire fuel flow, and gas pressure upstream of the firing rate control valve. After this is recorded, the burner can be shut down.

7. With the burner off, go back to Point 1. When Point 1 is entered, the AZL will prompt to "change" or "delete" the point. "Delete" should be selected, and Point 1 should be deleted.

8. Now that low fire and high fire fuel flows have been established and the gas pressure regulator has been set, the Ratio Control Curves can be laid out using fuel flow. If fuel flow is not available, burner head pressure can be used as a last resort. The curves can be laid out using paper and a calculator, or a free excel spreadsheet is available for this purpose. This spreadsheet, called the "LMVx Curves Spreadsheet", can be found at www.scccombustion.com.

   The next page shows how the "LMVx Curves Spreadsheet" used to set up a 600 BHP steam boiler with FGR (Aux 3 actuator) and a VSD. This is an example to illustrate what a typical setup might look like, and is not intended to be copied verbatim to an LMV5 in the field.

   NOTE: Up to 15 curve points can be entered; however, 10 points are recommended for most applications.

	Indicates infromation to be filled out before commissioning burner
	Indicates infromation to be filled out during burner commissioning

	600 BHP Boiler with FGR and VFD	Units	Input Data
Application Info	Burner Output at High Fire	MM BTU / HR	25
	Burner Head (manifold) pressure at High Fire	IN WC	8
	Burner Turndown	xx to 1	6
	Heating Value of Gas	BTU / SCFH	1000
	Boiler Efficiency	%	82
	LMV Load Numbers : Base on Manual Entry or Auto Calc Gas flow? (M = Manual Entry, A = Automatic Calc)	A or M	A

Actuator / VSD Ratio Control Curves

		Manual Input	These cells are calculated from the "Application Info" cells above							Manually Input during Ratio Control Curve Commissioning					
	LMV Curve Point	Gas flow to Burner (Manual Entry / Paste)	Gas flow to Burner (Auto Calc)	LMV Load at Curve Point	Burner Output		Burner Head Pressure (Approx)	Boiler Output @ Efficiency	Steam Flow 230° F feed 100 PSIG	Air Act Pos	Fuel Act. Pos	VSD Speed	Aux 1 Act Pos	Aux 2 Act Pos	Aux 3 Act Pos
CURVE POINTS (Ratio Control)	#	SCFH	SCFH	%	MM BTU /HR	MW	IN WC	BHP	lb/hr	Deg	Deg	%	Deg	Deg	Deg
	1		4167	16.7	4.2	1.2	0.2	102.1	3448.7	5.0	3.0	55.0			5.0
	2		6481	25.9	6.5	1.9	0.5	158.8	5364.7	12.0	6.0	60.0			10.0
	3		8796	35.2	8.8	2.6	1.0	215.5	7280.7	22.0	12.0	65.0			15.0
	4		11111	44.4	11.1	3.3	1.6	272.2	9196.6	30.0	18.0	70.0			20.0
	5		13426	53.7	13.4	3.9	2.3	328.9	11112.6	42.0	28.0	75.0			25.0
	6		15741	63.0	15.7	4.6	3.2	385.6	13028.6	55.0	39.0	80.0			30.0
	7		18056	72.2	18.1	5.3	4.2	442.3	14944.5	63.0	48.0	85.0			33.0
	8		20370	81.5	20.4	6.0	5.3	499.0	16860.5	68.0	56.0	90.0			30.0
	9		22685	90.7	22.7	6.6	6.6	555.7	18776.5	75.0	64.0	95.0			30.0
	10		25000	100.0	25.0	7.3	8.0	612.4	20692.4	82.0	71.0	100.0			26.0

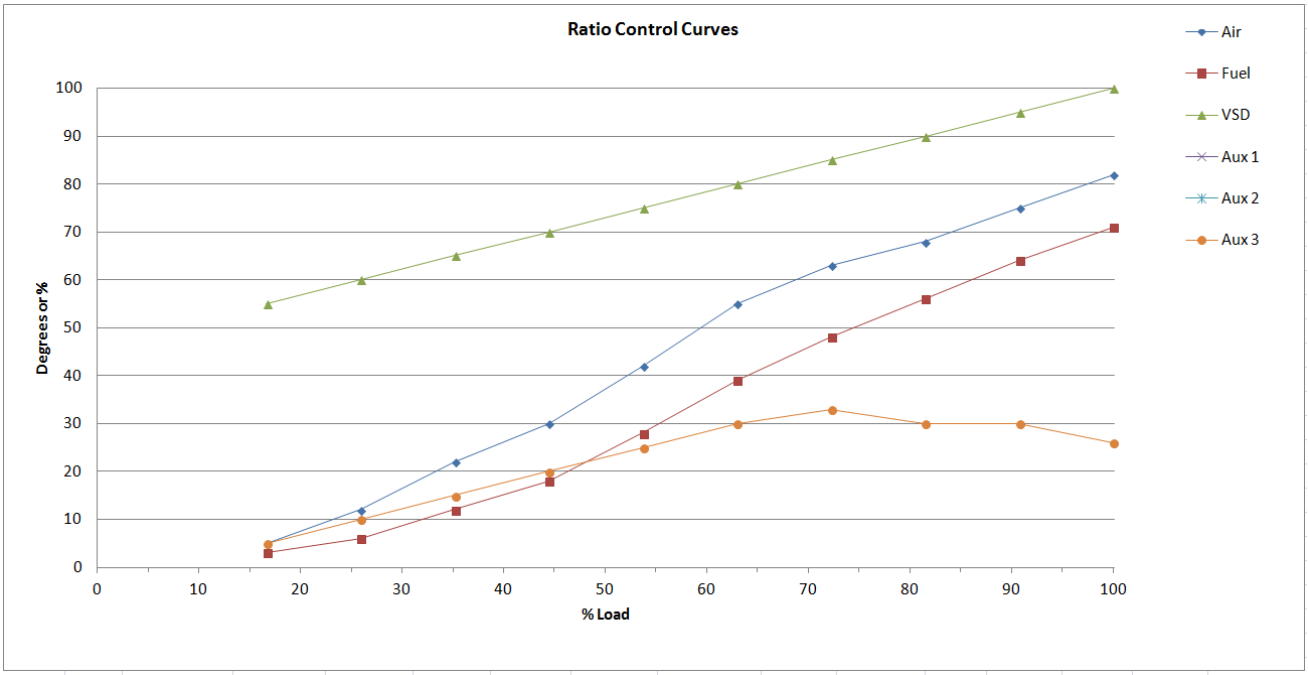


Figure 4-6: LMV5x Curves Spreadsheet Used on a 600 BHP Boiler with FGR and a VSD

NOTE: When in a curve point on the right-hand side of the AZL screen, pressing "Esc" will bring the cursor back to the left, off of the numbers. Pressing "Esc" again while off of the numbers will bring up a prompt to ask if the point is to be stored (press "Enter") or the changes canceled (press "Esc"). If store is selected, a bar will rotate on the left-hand side of the AZL5 display while the point is being stored.

NOTE: When putting in a new point that is not yet defined (XXXX shown for the positions and load), pressing "Enter" will put in values for the positions and load from the previous point based on load number. These values serve as a place to start for the new point.

9. With the Ratio Control Curves laid out on paper or with the spreadsheet, begin setting the curve points from low fire (Point 1) to high fire (Point 10). The general procedure for each point is to match the load number to the fuel flow while maintaining safe combustion. After this is complete, adjust the air and / or FGR as necessary to achieve safe, efficient combustion and emissions compliance on each point.

10. The following is a summary of what should be achieved for each point on the Ratio Control Curve:

    For standard burners (LMV51, or LMV52 without O_2 trim):

    a. Safe, efficient combustion as verified by a calibrated stack gas analyzer
    b. The % load matching the fuel flow within +/- 5%
    c. Emissions compliance
    d. Smooth Ratio Control Curves (no sharp peaks and valleys)

    For standard nozzle mixing burners (no or low % FGR) and O_2 trim (LMV52):

    e. All points **a** thru **d** above
    f. VSD speed should increase with load in a linear fashion (if equipped)
    g. The % load matching the fuel flow within +/- 3%
    h. Find and record the $\%O_2$ wet corresponding to the fuel rich limit (***O2 Alarm*** value) for each point by probing*
    i. Find and record the $\%O_2$ wet corresponding to the fuel lean limit (***O2 MaxValue***) for Point 1 and Point 10 by probing*
    j. Last but not least, leave the curve points so that the $\%O_2$ wet is 2% higher than the fuel rich limit (***O2 Alarm*** value). Record this as the saved value for each curve point.

    For pre-mix mesh burners and nozzle mixing burners (high % FGR) and O_2 trim (LMV52):

    k. All points **a** thru **d** above
    l. VSD speed should increase with load in a linear fashion (if equipped)
    m. The % load matching the fuel flow within +/- 3%
    n. Determine the $\%O_2$ wet corresponding to the fuel rich limit (***O2 Alarm*** Value) for each point. Probing may or may not be possible depending on the burner design. Also, follow burner OEM recommendations. Most mesh burner elements can be damaged if run too fuel rich.*

o. Find and record the $\%O_2$ wet corresponding to the fuel lean limit (***O2 MaxValue***) for Point 1 and Point 10 by probing or according to burner OEM recommendations.*
p. Find the target $\%O_2$. For these burners, the target $\%O_2$ for each point will be the $\%O_2$ wet corresponding to emissions compliance (typically CO, NOx). After the target $\%O_2$ is found, increase the $\%O_2$ and leave the point at least 0.5% O_2 leaner than the target $\%O_2$. Record this as the saved value for each curve point.

*** NOTE: This information will be needed to commission the O_2 trim, and it is convenient to obtain this information when commissioning the Ratio Control Curve. When probing the fuel rich limit, it is not recommended to exceed 200 ppm CO (dry basis) or less than 1.0% O_2 (wet or dry basis) for any point. When probing the fuel lean limit, it is not recommended to exceed 200 ppm CO or adversely affect flame stability for any point. The LMV52 with the QGO20 O_2 sensor reads $\%O_2$ on a wet basis, while most external exhaust gas analyzers read $\%O_2$ on a dry basis.**

11. After Point 10 values have been saved, press “Esc” to exit *CurveParams.*

Suggested Load Control Setup

After the Ratio Control Curve has been commissioned, the load controller should be set up. The load controller can be run in internal load control modes (uses PID inside LMV5) or external load control modes (uses a remote PID control separate from the LMV5). The table below outlines the different load control modes available. Most LMV5s operate with the internal load controller.

Label	Description	LMV5 Setpoint	Upon X62.1 - X62.2 Closure
ExtLC X5-03	External load control, firing rate from 3-position input	N/A (firing rate via 3-position input or staged input)	Change to "IntLC", setpoint W1
	External load control, staged oil		
IntLC	Internal load control, setpoint set locally on LMV5	W1 / W2	Remain in "IntLC", change to setpoint W2
IntLC Bus	Internal load control, setpoint from Modbus command	W3 (Modbus)	Change to "IntLC", setpoint W1
IntLC X62	Internal load control, setpoint from analog signal on terminal X62	Remote setpoint	
ExtLC X62	External load control, firing rate from analog signal on terminal X62	N/A (firing rate via X62)	
ExtLC Bus	External load control, firing rate from Modbus command	N/A (firing rate via Modbus)	

Note: Bump-less transfer (LMV5 will not cycle off) will occur from "IntLC" to any external load control mode. Bump-less transfer will also occur from any external load control mode to "IntLC" provided that the pressure or temperature is not above the cycle-off limit (***SD_ModOff***).

Figure 4-7: LMV51.1 and LMV52 Load Controller Modes

Most boilers use load controller mode "IntLC" which utilizes the local temperature / pressure sensor and a local setpoint entered through the AZL display. The following procedure outlines how to set up this mode:

1. If possible, shut off the burner switch. Let the burner get back to Phase 12 (standby).

2. Verify that the load controller is in the correct mode through the following menu path:

   Params & Display > LoadController > Configuration

   Set parameter ***LC_OptgMode*** to "IntLC". Next, verify that the connected pressure or temperature sensor is configured correctly. In the same menu, set ***Sensor Select*** to "PressSensor" for a steam boiler or to the appropriate temperature sensor for a hot water boiler.

3. If a pressure sensor was selected, two additional parameters must be set in the same menu. Set parameter ***Ext Inp X61 U/I*** to match the pressure sensor wired into the X61 terminal. Typically this will be 0-10VDC or 4-20mA and will be printed on the side of the sensor. Next, set parameter ***MRange PressSens*** to the high range of the pressure sensor. This is typically printed on the side of the pressure sensor.

4. Configure setpoint W1 (the local setpoint) through the following menu path:

   Operation > BoilerSetpoint

5. Set the turn-on point (***SD_ModOn***) and the turn-off point (***SD_ModOff***) for the boiler. These are percentages based on the current setpoint (W1). The menu path for these parameters is:

   Params & Display > LoadController > ControllerParam

   Typically, the burner is shut off 10% over setpoint and turned back on 1% above setpoint.

   NOTE: Other pressure / temperature controls or limits on the boiler must be set above the *SD_ModOff* pressure / temperature.

   NOTE: *SD_ModOff* and *SD_ModOn* are only valid for internal load controller modes. If the LMV5 is in an external load controller mode, *SD_ModOff* and *SD_ModOn* are ignored.

6. If it is safe to do so, turn on the burner switch. If thermal shock is a concern, allow the boiler to warm. The burner can be put in manual and held at low fire if necessary through the *Manual Operation* menu.

7. Once the boiler is up to pressure / temperature, is modulating, and is carrying normal load, adjust the PID values through the following menu path:

   Params & Display > LoadController > ControllerParam > ContrlParamList

Properly adjusted PID values will result in the pressure / temperature staying within +/- 3% of setpoint without constantly changing the load and modulating the actuators.

P-Part (Proportional Band) - Increases firing rate based on how far below setpoint the temperature / pressure is. Smaller values cause a more aggressive P response to a drop in pressure / temperature relative to setpoint. Values that are too small will cause hunting. Typical setting: 10% to 30%.

I-Part (Integral) - Serves to eliminate steady state "droop" caused by the proportional band setting. Thus, this works hand in hand with ***P-Part*** to bring the pressure / temperature up to setpoint. Smaller values cause a more aggressive I response (a setting of 1 is most aggressive). Values that are too small will cause overshoot. Typical setting: 80 sec to 300 sec. A setting of 0 deactivates the feature, but this is not recommended.

D-Part (Derivative) - Serves to eliminate overshoot, and allows a more aggressive integral setting. Larger values cause a more aggressive D response. ***D-Part*** is not needed on many steam boilers. If needed, small values of less than 20 typically work well. A setting of 0 deactivates the feature. Large values will typically cause hunting.

8. After the PID loop has been adjusted, it is possible that the load will still move up and down by a small amount (1-2% load). If this is the case, adjusting parameter ***MinActuatorStep*** may help eliminate this "micro-hunting". This parameter can be found in the following menu:

   Params & Display > LoadController > ControllerParam

   MinActuatorStep is basically a dead band for the output of the PID loop. Typical setting: 1% to 4%. Values above 5% could cause hunting issues in some applications.

Suggested Cold Start (Thermal Shock Protection) Setup

The LMV51.1 and LMV52 have an internal load control and therefore have the ability to perform thermal shock protection. Thermal shock protection only functions when the LMV5 is in an internal load controller mode, namely IntLC, IntLC X62, or IntLC Bus (see chart on previous pages).

The cold start feature requires that the temperature or pressure of the boiler is measured by a sensor connected to the LMV5.

For a hot water boiler (temperature-based modulation), the same temperature sensor that is used for modulation must be used for the cold start feature. For a steam boiler (pressure-based modulation), a temperature sensor is also highly recommended for cold start. Temperature sensors are highly recommended since pressure does not always represent temperature in a non-firing steam boiler, especially when multiple steam boilers are piped to the same steam header. The paragraphs below will only mention temperature-based cold start, but the same ideas also apply to pressure-based cold start.

1. If possible, shut off the burner switch. Let the burner get back to Phase 12 (standby).

2. Access the cold start parameters through the following menu path:

   Params & Display > LoadController > ColdStart

   Set parameter ***ThresholdOn*** to the minimum permissible temperature where the burner can be released to modulate. Below this temperature, cold start will engage on initial startup (not during normal operation). Set ***ThresholdOff*** to a temperature higher than ***ThresholdOn***. If already engaged, cold start will disengage at the ***ThresholdOff*** temperature. Setting ***ThresholdOn*** and ***ThresholdOff*** is required for cold start.

   NOTE: Parameters *ThresholdOn* and *ThresholdOff* are percentages based on the current setpoint (W1). If an additional temperature sensor is used on a steam boiler, *ThresholdOn* and *ThresholdOff* will be based on parameter *Setp AddSensor.*

3. For a steam boiler that is on a common header with other steam boilers, an additional temperature sensor is required for cold start. This will typically be a Pt1000 or Ni1000 RTD wired to terminal X60. Pt100 is possible but not recommended. Choose the appropriate sensor via parameter ***AdditionalSens***.

4. There are four basic ways that the cold start can be set. These are:

   a. Basic Low Fire Hold
   The LMV5 will be held at low fire until the ***ThresholdOff*** temperature is reached, and then the LMV5 will be released to modulate. This "hold" will re-engage when the temperature falls below the ***ThresholdOn*** value. Parameter ***StageLoad*** must be set to 0.

   b. Temperature-based Stepping Start
   The LMV5 will be held at low fire until a certain temperature change is detected, and then a step up in burner output (load) will be taken. This continues until the ***ThresholdOff*** temperature is reached. This will achieve the ***ThresholdOff*** temperature faster than a basic low fire hold. Parameter ***StageLoad*** must be set to a value greater than 0, since the step-up in load is determined by this parameter. Parameter ***StageSetp_Mod*** must also be set to determine the amount of temperature change that will trigger a step-up in load. Parameter ***MaxTmeMod*** should be set to a high number (30 min) so that it has no effect.

   c. Time-based Stepping Start
   The LMV5 will be held at low fire until a certain time elapses, and then a step-up in load will be taken. This continues until the ***ThresholdOff*** value is reached. ***StageLoad*** must be set to a value greater than 0, since the step-up in load is determined by this parameter. Parameter ***StageSetp_Mod*** should be set to a high number (80%) so that it has no effect. Parameter ***MaxTmeMod*** is set to determine how much time should elapse before the next load step is triggered.

d. Temperature / Time-based Stepping Start Combination

This method combines methods **b** and **c** and if set correctly, is the fastest way to safely warm the boiler. The settings are similar to method **b**, but now parameter ***MaxTmeMod*** is set to have an effect (10 minutes for example). When this is done, the maximum time that a step-up in load will take is 10 minutes, regardless of the temperature change. If the temperature change defined by ***StageSetp_Mod*** happens before the 10 minutes elapses, then the temperature change will trigger the step-up in load.

When this mode is used, time usually triggers the load steps at the start of boiler warming and temperature change usually triggers the load steps closer to the ***ThresholdOff*** temperature. This is due to the more rapid rise in boiler temperature at higher firing rates.

5. After parameters are set for one of the methods above, set parameter ***ColdStartOn*** to activated. The next time the burner is started and the water temperature is below the ***ThresholdOn*** temperature, cold start should engage.

Below are typical settings for each of the four ways cold start can be set up.

Example: Steam Boiler with an Additional Temperature Sensor				
Parameter	**Low Fire Hold**	**Temp-based**	**Time-based**	**Temp/time-based**
ColdStartOn	Activated			
ThresholdOn	50% (= 150°F)			
StageLoad	0%	5%	5%	5%
StageSetp_Mod	N/A	5%	100%	10%
StageSetp_Stage	Staged Operation Only			
MaxTmeMod	N/A	63 min	5 min	10 min
MaxTmeStage	Staged Operation Only			
ThresholdOff	80% (= 240°F)			
AdditionalSens	Pt1000			
Temp. ColdStart	Read Only			
Setp AddSensor	300°F			
Release Stages	Staged Operation Only			

Figure 4-8: Typical Cold Start Parameter Settings

The following page shows an example of a time-based stepping start.

Parameter	%	Value	Notes
BoilerSetpoint or ***Setp AddSensor***	N/A	300°F	Current setpoint
ThresholdOn (% of current setpoint)	50	150°F	Measured temperature must go below ***ThresholdOn*** to engage cold start
ThresholdOff (% of current setpoint)	80	240°F	Cold start will not disengage until ***ThresholdOff*** is met
StageSetp_Mod (% of current setpoint)	80	240°F	Defines the necessary temperature change required to trigger a load step
StageLoad	5	N/A	Determines the size of the load step
MaxTmeMod	N/A	10 min	Determines the max. time between load steps

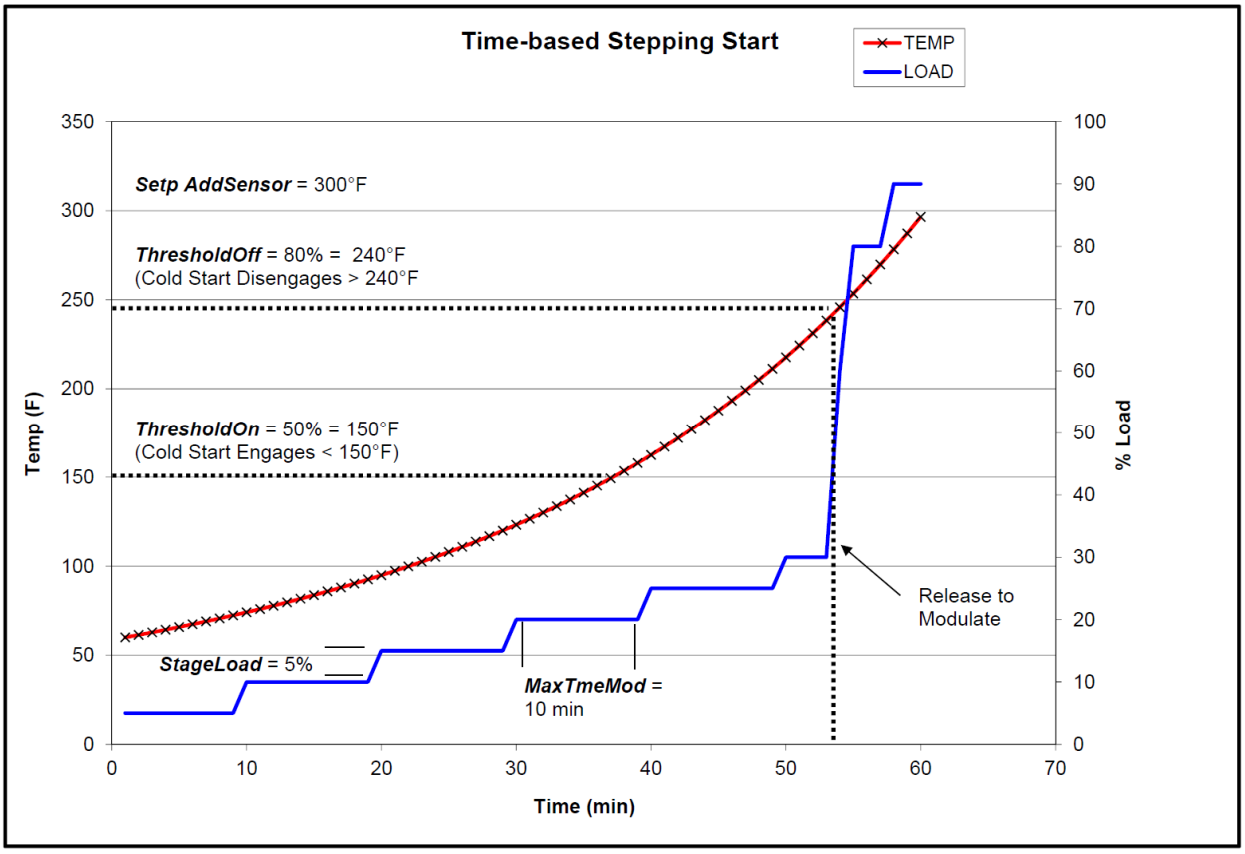


Figure 4-9: Example of a Time-based Stepping Start

Additional Tips for Commissioning

- If an LMV52 is being commissioned, activate the O_2 sensor as soon as possible. Once the O_2 sensor is heated, this will show a fast responding O_2 value on the AZL screen during Ratio Control Curve commissioning. This sensor reads $\%O_2$ wet so the value will be somewhat lower than an external flue gas analyzer.

- Using a fuel flow meter (temporary or permanent) for commissioning is always a good idea even for LMV51's without O_2 trim. If the fuel input (heat output) increases linearly with firing rate, the PID loop in any load control will work much better. A temporary, insertion type of flow meter is available from SCC Inc. for this purpose.

- If burner head pressure must be used as a last resort to estimate firing rate, bear in mind that head pressure does not increase with gas flow in a linear manner. There is a square root relationship between the differential pressure across the burner head and the gas flow. This relationship is very similar to how the pressure varies across a fixed orifice with an increase or decrease in flow. Also, furnace pressure must be accounted for by hooking up both sides of the manometer, one side to the burner head pressure and one side to the furnace pressure.

- Carbon Monoxide (CO) is produced when combustion is incomplete, typically due to the flame being too rich or too lean. CO is potentially explosive when mixed with air in the right proportions. For CO to be explosive in air, it must reach a concentration of at least 12.5% (125,000 ppm) with an ignition source present.

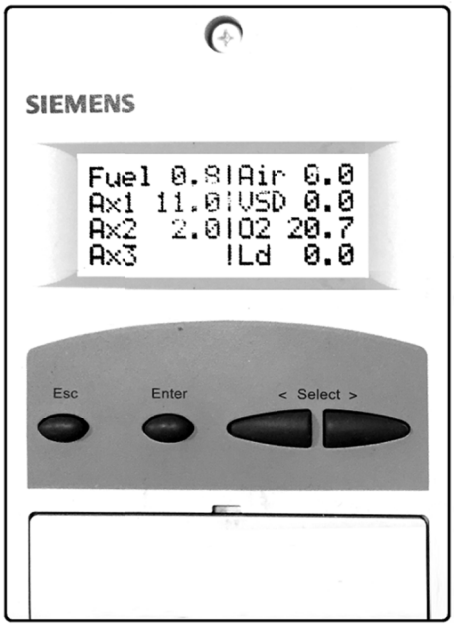
- If a burner is commissioned properly, actuator curves should increase smoothly with increasing load (firing rate). One exception to this would be the FGR actuator (Aux1 or Aux3) which commonly decreases (closes) as firing rate increases. Curves should always be smooth, with no sharp corners.

- The best and fastest method to commission a burner with an LMV5 is to set up a small table where the technician can have his laptop, AZL, fuel flow meter and external flue gas analyzer all within arm's reach. This allows the curve points to be input rapidly and accurately. If the information is entered in the laptop point by point, a very nice start-up report will also be generated.

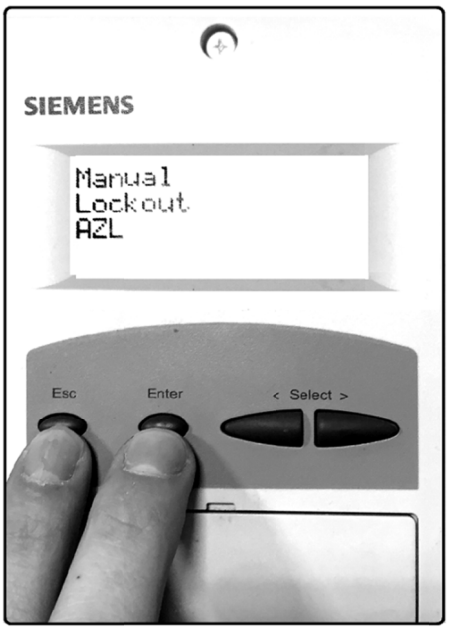
- The ACS450 software is not as fast as using the AZL to commission the LMV5. Since this is the case, the ACS450 is typically not used to commission the LMV5. However, the ACS450 is very valuable when used to download an .mdb file (all parameter settings, fault and lockout history, in English) and also when used to download .par files (the machine-language parameter set from the LMV5). It is recommended to download both of these files after commissioning, so that there is a backup record of all parameter and curve settings.

- To go back out of the menu and check burner operation, press the < and > buttons at the same time. This will take the cursor to Normal Operation, so the normal operation screen can be viewed by pressing Enter. This can be done anywhere in the menu as long as a single parameter is not currently displayed. Pressing Esc will take the cursor back in to where it was in the menu.

- When in the *Normal Operation* screen, “Enter” can be pressed once to go to a "hidden" screen that shows all actuator / VSD positions in real time. Real time load and $\%O_2$ are also displayed.



- Pressing the “Esc” and “Enter” buttons on the AZL at the same time will cause the LMV5 to immediately close the fuel valves and lockout.



- When in the *Normal Operation* screen, the AZL contrast can be adjusted by pressing the “Enter” key with either the left (less) or right (more) arrow key.

Special Features and Settings

The LMV5 has special features and settings that are very useful in some situations. Some of these features are detailed below.

Alarm act/deact An internal alarm silence. Alarm silence will reset when the LMV5 alarm is reset.

MinTmeStartRel Permits the LMV5 to hold in phase 21 for a specified period of time with the start signal terminal energized. This can be used as a delay to let stack and/or fresh air dampers open.

PressReacTme Allows the LMV5 to disregard the high and low gas / oil pressure switches for a settable time period after the main gas / oil valves open. This is used with automatic reset pressure switches so that pressure spikes due to the main valves opening will be ignored. This also allows for a reduced delta between switch setpoints and normal operating pressures. This time can also be reduced to 0.2 seconds, deactivating the feature. Not used with manual reset switches.

NormDirectStart Permits the LMV5 to go from post-purge directly into pre-purge without turning the blower off. The blower air pressure switch must be checked by using a 3-way solenoid valve. The solenoid valve is configured under parameter ***StartSignal***.

ForcedIntermit Shuts the burner down once every 24 hours to cycle and check flame scanner, air pressure switch, POC, and other safety devices.

DriveLowFire Starts driving to low fire (***StartPointOp***) immediately after main fuel valves open. Enables less air to be put on the pilot for ignition, and enables a fuel rich light off without creating excessive CO. Also called "Golden Start" functionality.

StartReleaseGas Configures terminal X7-03.2 as a start release for gas, CPI gas, CPI oil, or CPI gas + oil. Gas and oil POCs can be wired here, freeing up terminal X9-03.2 for gas valve proving. CPI stands for Closed Position Indication, which is essentially the same as Proof of Closure (POC).

Config_PS-VP/CPI Configures terminal X9-03.2 for PS-VP (Pressure Switch - Valve Proving), CPI gas, CPI oil, or CPI gas + oil. CPI stands for Closed Position Indication, which is essentially the same as Proof of Closure (POC).

Config X5-03 Terminal X5-03.3 can be configured to hold the LMV5 in phase 36 (ignition position). Terminal X5-03.2 can be configured to disable O_2 trim.

HeavyOilDirStart Terminal X6-01.3 can be used as an input for an external flame relay.

ReacTmeLossFlame Adjustable flame failure response time (FFRT).

SensOperPhGas Enables two flame detectors to be used on one burner (LMV52 only).

ValveProvingType Enables gas valve proving on start-up or shutdown or both. This type of testing ensures that the gas valves are closed, and that the valve seats are in good condition.

StartPointOp Can adjust which curve point the LMV5 will drive to after light off. This setting does not affect turndown.

NumFuelActuators Permits the LMV5 to run dual fuel with a single actuator - two fuel valves on one actuator.

ProgramStop Stops the LMV5 at a particular phase in the start-up or shutdown sequence. This is particularly useful when set to Phase 44 for tuning the pilot.

FGR-Mode On an LMV52, this setting enables only the Aux 3 actuator to be held from modulating until a certain temperature or time after light off is met. This is usually used to delay the use of FGR until a certain time or until a stack temperature is met.

ReleasecontctVSD If a VSD is being used, this enables the blower to coast down after post-purge is complete.

O2SensServTim This sets a service interval for the O_2 sensor.

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Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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Section 5 - Variable Speed Drive Control

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Introduction

The LMV52 features an integrated, closed-loop Variable Speed Drive (VSD) control that is typically used to ramp the speed of the combustion air blower with firing rate. This is accomplished by transmitting a 4-20 mA signal from the LMV52 to the VSD, and then reading the speed of the motor via a motor-mounted, safety-rated encoder wheel (speed wheel) and speed sensor. By using the speed wheel and sensor, the LMV52 can positively verify both the speed and direction of the blower, thus ensuring proper VSD operation.

Blower speed and direction of rotation have a large impact on the airflow delivered to the burner, and thus the fuel-air ratio. The most common type of VSD, a Variable Frequency Drive (VFD), is typically not safety-rated and will typically not fail in a safe manner (a VFD failure will typically cause the combustion air blower to slow down or stop, causing the burner to go rich). The combustion air pressure switch offers only a small amount of protection in a VFD application, since the switch must be set to allow low fire operation when the blower is spinning slowly and the blower output pressure is low. The motor or blower shaft-mounted, safety-rated speed wheel and sensor ensure that a VFD failure will be quickly detected and the burner will shut down in a safe way.

VFD and AC Induction Motor Fundamentals

VFDs are typically connected to a three-phase alternating current (AC) induction motor that is used to power the combustion air blower. Modern VFDs operate by taking single- or three-phase AC and rectifying this power to high voltage direct current (DC) for the DC bus. The AC power is typically rectified to DC with banks of diodes. The DC bus feeds a bank of Insulated Gate Bipolar Transistors (IGBTs), and a microprocessor is used to fire the IGBTs in a way that the voltage and frequency of the modified sine waves can be controlled. This is done for each of the three phases on the VFD output. The microprocessor varies the voltage and frequency of the modified sine waves in response to a signal; in this case, the 4-20mA input.

By design, a three-phase AC induction motor will attempt to approximately synchronize its speed with the frequency of three-phase power that it is being fed. Thus, if the frequency can be adjusted, so can the speed of the motor. As their name suggests, three-phase induction motors generate magnetic fields in the rotor of the motor by using induction rather than by using slip rings or brushes. The advantage of this type of construction is very low maintenance, and a small disadvantage is a phenomenon called slip. Slip is defined as the difference between the theoretical speed at a given AC frequency and the actual speed at a given AC frequency. Slip increases as the load on the motor (torque output) increases.

Three-phase AC motors that do not have slip are referred to as synchronous motors, since these motors exactly synchronize their speed to the frequency of the incoming AC power. This type of motor is not typically used on blowers, but is mentioned as a comparison to the AC induction motor. A truly synchronous 2-pole motor will spin at exactly 3600 RPM if it is fed exactly 60 Hz. A truly synchronous 4-pole motor will spin at exactly 1800 RPM if it is fed exactly 60 Hz. In contrast, a 2-pole, three-phase AC induction motor fed 60 Hz will spin less than 3600 RPM, and how much less is determined by how heavily the motor is loaded and how much slip that loading causes.

As mentioned above, VFDs switch multiple IGBTs on and off very rapidly to generate a "modified" sine wave on all three phases going to the motor. Doing this has some tradeoffs, one of which is electrical noise, or harmonics. This noise is typically "wire borne" instead of airborne, and can cause issues with electronics in some situations. Thankfully, electrical noise associated with VFDs can be mitigated using proper wiring techniques (connecting shields and grounds correctly) and by the proper application of line reactors and / or load reactors for some applications. For difficult applications, EMC filters for the VFD are also available.

Line Reactors

Line reactors, or "chokes", are typically used when the impedance on the input side of the drive is low. Impedance on the input side of the drive is typically low when a relatively small VFD is being fed by a relatively large transformer. In this situation, the supply side of the drive is "stiff", meaning that an instantaneous current draw by the drive will be met very quickly by the large transformer (think square wave form), causing voltage and current distortions in the power distribution system feeding the drive. In this situation, adding a line reactor will add reactance which opposes instantaneous current draw and "softens" the input side of the drive.

Conversely, if the transformer feeding the drive is not large relative to the drive, the impedance on the input side of the drive is higher and the system is "softer". In this situation, an instantaneous current draw by the drive will not be met as quickly, and the resulting voltage and current distortions in the power distribution system feeding the drive will be smaller. An additional line reactor is this situation is not needed.

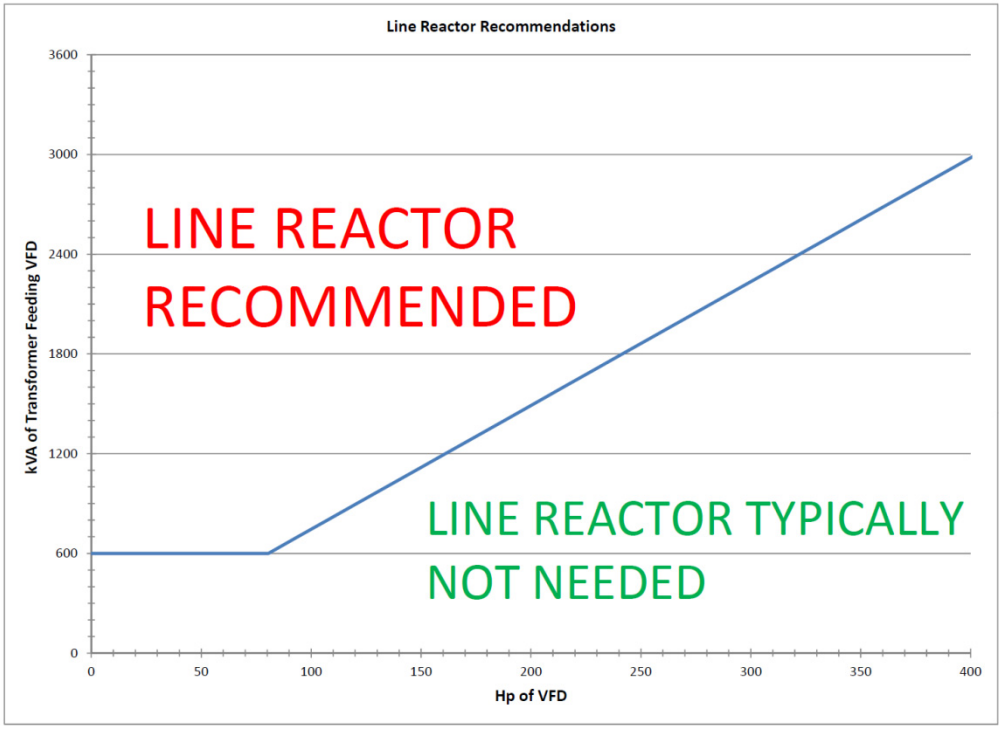


Figure 5-1: Line Reactor Recommendation - VFD (HP) vs Transformer (kVA)

In general, a line reactor is recommended if the supply capacity (kVA) of the transformer feeding the drive is greater than or equal to 10 times the capacity (kVA) of the drive for transformers 600 kVA and larger.

Figure 5-1 notes:

1. Drive power is shown in HP rather than kVA. This conversion can be done assuming a power factor of unity (1) and negligible losses due to efficiency.
2. Transformers less than 600 kVA have high enough impedance ("soft" enough) so that line reactors are typically not necessary.

Example 1: A 25 HP drive is being fed by an 800 kVA transformer. Is a line reactor required?

Assumptions:
The power factor is unity (power factor =1)
Losses due to efficiency and wiring are negligible

1. Convert horsepower to kilowatts: 25 HP x 0.745 HP/kW = 18.63 kW
2. Convert kilowatts to kVA: kW = kVA * Pf (Pf is power factor, which is assumed to be 1 in this example)
   Thus, a 25 HP drive is 18.63 kVA.

3. Calculate the kVA ratio: 800 kVA / 18.63 kVA = 42.94
   Since a ratio of 42.94 is greater than 10, and the transformer is larger than 600 kVA, a line reactor will be necessary for this application. The same conclusion can also be arrived at by using Figure 5-1.

Example 2: A 10 HP drive is fed by a 400 kVA transformer. Is a line reactor required?

Using the same assumptions and calculation as example 1, the kVA ratio is 53.7, but the transformer is smaller than 600 kVA, so a line reactor is not necessary. The same conclusion can also be arrived at by using Figure 5-1.

Output Wiring / Load Reactors

When the VFD / motor are running, high levels of electrical noise are produced on the wiring between the VFD and the motor. This is due to the fact that modified sine waves produced by the drive IGBTs are basically high frequency / high voltage DC pulses. These output wires must be enclosed in some type of shielding (metallic conduit or metal-shielded cable) to mitigate radiated electrical noise.

Wire length between the VFD and the motor should be kept to less than 150 feet if possible due to the reflected wave / standing wave phenomenon and voltage overshoot phenomenon. Both of these phenomena are rather complex, and are a function of the wire length from the VFD to the motor. The reflected wave / standing wave phenomenon and voltage overshoot phenomenon can damage non-inverter duty motor windings over time due to the high peak voltages that these phenomena can produce.

NOTE: The DC bus runs at voltages substantially higher than the incoming voltage to the drive (about 35% higher) and typically employs large capacitors. These capacitors remain charged for a period of time after the incoming power to the drive is de-energized, and are a shock hazard until they discharge. See the VFD manufacturer's recommendations for minimum waiting time to work on the drive after the drive is de-energized.

If wire length cannot be kept to less than 150 feet on the drive output, correction options are available. These are listed in Figure 5-2:

Wire Length - up to (ft)	Correction Option
150	None Required
300	Load Reactor at VFD Output
650	Load Reactor at Motor Input
2000	dV/dT Filter on VFD Output
Consult Motor OEM	Inverter Duty Motor

Figure 5-2: Correction Options for Long Wire Length between VFD and Motor

Shaft Current

As was mentioned earlier, the fast switching or "firing" of the IGBTs enable the VFD to produce modified sine waves of different frequencies and different voltages in order to speed up or slow down a motor. The fast switching of the IGBTs does have electrical side effects, some of which are detailed on the previous pages.

This fast switching of the IGBTs can also cause "shaft current" on the motor. When this happens, a voltage charge builds up on the motor's shaft. When this voltage gets high enough, it will arc to ground through the path of least resistance. The path of least resistance is typically the ball bearings that support the rotor of the motor. When this arcing occurs in the bearings, damage occurs to the bearings. Over time, the bearings will be destroyed, and the motor will fail.

Shaft current can be mitigated by using a grounding ring, which is typically bolted to the motor housing and has some type of conductive filament that contacts the shaft, thus grounding the shaft. Some motor OEMs have grounding rings built into the motor, so an external ring is not necessary.

Braking Resistors

Three-phase AC induction motors can also function as three-phase AC generators if they become driven by what they typically drive. In the case of a blower, the motor drives the blower wheel when the speed of the wheel is increased (accelerated). Conversely, the blower wheel can drive the motor when the speed of the blower wheel is decreased (decelerated) with a closed air damper. When the motor is driven by the blower wheel, it will act as a generator and "push" electrical energy back to the VFD. This energy will be seen as a voltage increase on the VFD’s DC bus.

The DC bus can absorb a small amount of energy in the DC bus capacitors. However, if the motor generates more than what these capacitors can absorb, the DC bus voltage will rise to critical levels and one of two actions will be taken by the VFD. Depending on the parameter setting of the VFD, the VFD will either stop decelerating (stall prevention) or the VFD will alarm and shut down. Either one of the actions is not a desirable result on a combustion air application.

To avoid DC bus overvoltage issues, a braking resistor can be added to the VFD so that the excess electrical energy generated by decelerating the blower wheel can be turned to heat. This process happens seamlessly so that the VFD can decelerate the blower smoothly.

Due to a number of variables, it is difficult to determine if a braking resistor will be needed on a particular application unless that application has been tested. The only disadvantage of having a braking resistor and not needing it is cost and possibly the space for the resistor. Burners having the following characteristics will typically need a braking resistor:

1. A heavy blower wheel - Kinetic energy is stored in a spinning wheel. The heavier the blower wheel, the greater the stored energy. When this wheel is slowed down, the kinetic energy must go somewhere, and it is usually "pushed" back to the VFD as electrical energy.

2. Fast ramp times - The faster the ramp times, the faster the blower wheel must be accelerated and decelerated. Just like a car, more energy is required to accelerate quickly (bigger engine) and more energy is required to be dissipated when decelerating quickly (bigger brakes). Decelerating a given blower wheel more quickly will push more electrical energy back to the VFD.

3. Mostly closed air damper - A motor spinning at 3600 RPM draws fewer amps with a closed or nearly closed air damper as compared to a wide open air damper. Thus, the horsepower used by the motor and the drag (braking) on the blower wheel will be much less with a closed or nearly closed air damper. Decelerating a given blower wheel with reduced drag will also push more electrical energy back to the VFD.

As one might expect, the above points compound one another. Decelerating a heavy blower wheel with a fast ramp time and a mostly closed air damper will push a large amount of electrical energy back at the VFD and will likely cause DC bus overvoltage issues if a braking resistor is not installed.

In contrast, a light blower wheel (sheet metal instead of cast iron), a slower ramp time (90 seconds instead of 30 seconds), and slowing the blower down on a more open air damper are characteristics that will greatly reduce the amount of electrical energy pushed back to the VFD and should allow the braking resistor to be omitted in most cases.

On some models of VFDs, braking resistors can be added after the VFD is installed if necessary. This is a point to consider when installing VFDs for combustion air applications.

Types of VFDs: Vector and Volt/Hz

Although there are over a hundred different manufacturers of VFDs, two main types of VFDs are produced by these manufacturers for use on blower motors. These two types are Vector and Volt/Hz. Vector VFDs can usually be run in either Vector mode or Volt/Hz mode. Vector VFDs are also typically slightly more expensive than Volt/Hz VFDs for a given size.

The advantage of Vector VFDs is that they provide more accurate torque control of the motor. This accurate torque control enables much more accurate speed control of the motor, especially at lower motor speeds. More accurate speed control of the motor enables more accurate, repeatable control of the airflow.

As mentioned earlier, the LMV52 employs a safety-related speed feedback on the blower shaft, thus continuously checking and adjusting (if necessary) the signal to the VFD to achieve the desired blower speed within a certain band. The LMV52 can lockout and shut down the burner if blower speed deviations are large and persist for too long. Due to their increased accuracy, Vector VFDs provide trouble-free operation on almost all LMV52 VFD blower applications. Volt/Hz VFDs can work satisfactorily in some applications, but are not preferred due to their decreased accuracy.

Vector VFDs are typically run in Open Loop Vector (OLV) mode. In this mode, the VFD uses a mathematical model of the motor combined with extremely accurate, fast scanning of the current and other data taken from the rotating motor. In reality, Open Loop Vector mode does have feedback, but the Vector VFD itself does not require a separate encoder to achieve this.

Since Vector VFDs use a mathematic model of the motor, and the design of motors differs somewhat between motor OEMs, a static or dynamic auto-tune is sometimes required so that the Vector VFD "learns" key aspects of the motor it is connected to. A static auto-tune (motor is not spun) does not require that the load (blower wheel) be de-coupled from the motor. A dynamic auto-tune (motor is spun) typically requires that the load (blower wheel) be de-coupled from the motor, which is not possible or practical in many situations. A dynamic auto-tune typically generates the best "learning" of the motor properties. A static auto-tune is typically all that is necessary if speed control issues are encountered on a Vector VFD.

Centrifugal Blower Fundamentals

Since a centrifugal blower is the piece of machinery being controlled by the LMV52 and the VFD, a brief mention of its basic characteristics is warranted. Specifically, there are three fundamental "fan laws" that a person working on such equipment should be aware of. These are:

1. Air flow varies linearly with the speed of the blower. In other words, the CFM of the blower is directly proportional to the RPM of the blower.

$$\text{CFM (new)} = \frac{\text{RPM (new)}}{\text{RPM (old)}} \text{ x CFM (old)}$$

2. The static output pressure of the blower (SP) varies by the square of the change in RPM:

$$SP\ (new) = \left(\frac{RPM\ (new)}{RPM\ (old)} \right)^2 \times SP\ (old)$$

3. The required brake horsepower of the blower (BHP) varies by the cube of the change in RPM:

$$BHP\ (new) = \left(\frac{RPM\ (new)}{RPM\ (old)} \right)^3 \times BHP\ (old)$$

Example: A blower spinning at 1750 RPM produces 10 in WC of static pressure, 4500 CFM of flow, and requires 20 BHP. What happens if the RPM is increased to 2750 RPM?

Assumptions: Air damper is wide open, and system effects (such as the restriction due to the boiler's heat exchanger, the burner's diffuser, etc...) are not taken into account.

Flow: CFM (new) = (2750 / 1750) * 4500 = 7071 CFM

Pressure: SP (new) = $(2750 / 1750)^2$ * 10 = 24.7 in WC

Power: BHP (new) = $(2750 / 1750)^3$ * 20 = 78 BHP

Configuring VFDs for use with the LMV52

Modern VFDs typically have hundreds of parameters that can be set to tailor the VFD to a specific application. As mentioned earlier, there are also at least a hundred different manufacturers of VFDs, each of which have their own unique parameter list. Due to these two factors, SCC Inc. offers pre-programmed VFDs that can be purchased with the VFD parameters set up for use with an LMV52.

If a VFD for use with an LMV52 is purchased and programmed independently, the following points will serve as a general guideline for programming the VFD for the LMV52 application. Note that this guideline is necessarily general due to the variety of VFDs offered in the marketplace.

1. If a Vector VFD is used (recommended), set the "Control Method" to Open Loop Vector mode or equivalent.

2. The stopping method (after the run / stop contact is opened) should be set to "Coast to Stop" to let the motor coast to a stop after post-purge.

3. Reverse operation (the ability to reverse the motor with an input) should be disabled.

4. Configure the VFD to accept an external run / stop signal via the dry contact on the LMV52.

5. The VFD should be able to do a "flying start" so that the VFD will not try to stop a free-wheeling blower wheel before starting the wheel spinning again. Blower wheels frequently free-wheel due to draft and other factors.

6. Ramp times - the VFD should be set to slightly faster ramp times compared to the LMV52 ramp times (LMV52 parameters ***TimeNoFlame*** and ***OperatRampMod***). If the shorter LMV52 ramp time is set to 60 seconds, the ramp up and ramp down times in the VFD should be set no longer than 55 seconds. In general, a 5 second differential will work well in most situations.

   Note: If short ramp times are necessary with large blowers (heavy blower wheels), a braking resistor may be necessary. See the braking resistor explanation on the previous pages.

7. Ramps must be linear with the 4-20mA signal. S-shaped ramps and PID / filtering on the 4-20mA signal will cause speed faults on the LMV52.

8. The analog signal should be configured for a 4-20mA signal and it should be spanned so that 4mA = 0Hz and 20mA = 62Hz (for blowers designed for 60 Hz power). The additional 2Hz is to make sure that full blower speed is achievable even with a 19.5 mA standardization (see standardization section below).

9. The motor nameplate data must be entered for the motor that the VFD is connected to.

10. Some VFDs have a feature that will stop ramping the drive if a critical limit in the drive is approached. On some VFDs, this feature is referred to as "stall prevention". Two common limits are the maximum amperage drawn and the DC bus voltage. Stall prevention, while protecting the drive, can cause speed faults with the LMV52 due to the drive ceasing to ramp in concert with the LMV52. If a braking resistor is used, stall prevention can typically be deactivated.

11. For Vector VFDs, perform at least a static auto-tune so that the VFD "learns" the characteristics of the motor it is connected to. A static auto-tune does not require that the load (blower wheel) be disconnected since the load is not spun. Some dynamic auto-tunes require that the load is disconnected.

12. If a braking resistor is being used, the braking resistor will typically have a high temperature switch. The drive should be programmed and wired so that a braking resistor over temperature will cause the drive to shut down.

Standardizing the LMV52

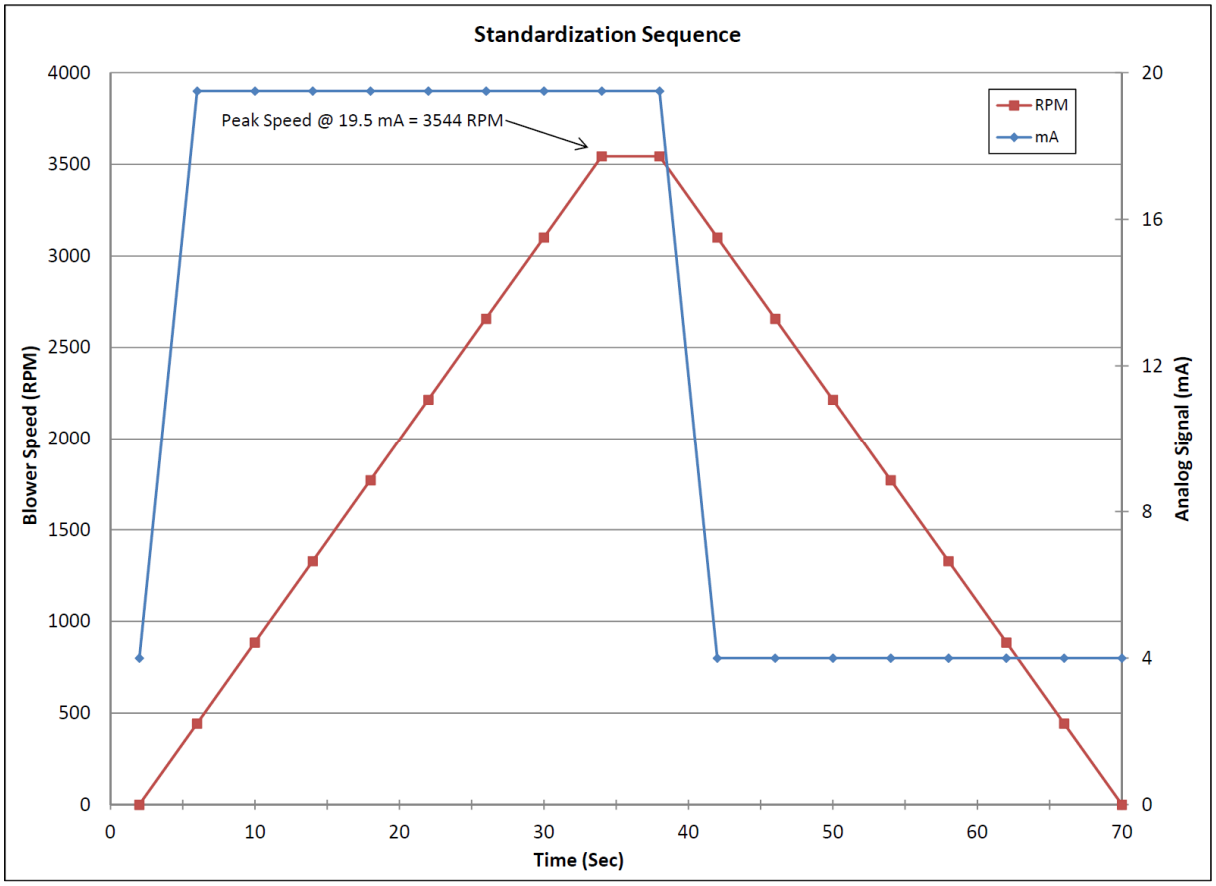
After the LMV52, VFD, blower, and speed sensor are installed and wired correctly (see Section 2), and the VFD parameters are set correctly, the LMV52 must be standardized.

This only needs to be done once, as long as there are not changes to the VFD and / or blower. If any changes are made (including VFD programming), it is recommended to re-standardize so that the LMV52 can "learn" the change that was made.

The purpose of the standardization (calibration) procedure is to establish the relationship between the LMV52 analog output signal (4-20mA) and the blower speed, as read by the speed sensor connected to the LMV52. This is done by recording a blower speed with 19.5 mA applied to the VFD. Once started, basic steps in the standardization are as follows:

1. The air damper is opened to pre-purge position.
2. The run / stop dry contact in the LMV52 is closed.
3. An analog signal of 19.5 mA is applied to the VFD.
4. The VFD / blower ramp up to speed. After the speed has stabilized, the actual peak RPM is recorded by the LMV52.
5. The analog signal is returned to minimum (typically 4 mA).
6. The run / stop dry contact in the LMV52 is opened.
7. The air damper is returned to home position.

A typical standardization process for a 2-pole (~3600 RPM) blower is shown graphically in Figure 5-3. If a standardization was performed on a 4-pole (~1800 RPM) blower, the procedure would be similar but the blower speed achieved at 19.5 mA would be approximately 1750 RPM.



Time (sec)	LMV52 output to VSD (mA)	Blower Shaft Speed (RPM)	VFD output Freq. (Hz)
2	4	0	0
6	19.5	443	7.5
10	19.5	886	15.0
14	19.5	1329	22.5
18	19.5	1772	30.0
22	19.5	2215	37.5
26	19.5	2658	45.0
30	19.5	3101	52.5
34	19.5	3544	60.0
38	19.5	3544	60.0
42	4	3101	52.5
46	4	2658	45.0
50	4	2215	37.5
54	4	1772	30.0
58	4	1329	22.5
62	4	886	15.0
66	4	443	7.5
70	4	0	0.0

Figure 5-3: Standardization Process for a 2-Pole Blower Motor (values are approximate)

NOTE: The total time of the standardization shown in Figure 5-3 is 70 seconds with a VFD ramp time of 30 seconds. Longer VFD / LMV52 ramp times will increase the total time taken for the standardization.

NOTE: The VFD is spanned so 20mA = 62Hz. Thus, 19.5mA is approximately 60Hz.

Based off of the RPM that was read at 19.5 mA (in this case 3544 RPM) and an assumption of 0 RPM at minimum signal (typically 4mA), a two point linear interpolation is automatically done by the LMV52, which establishes the linear relationship between the analog signal and the blower RPM . This relationship is shown in Figure 5-4.

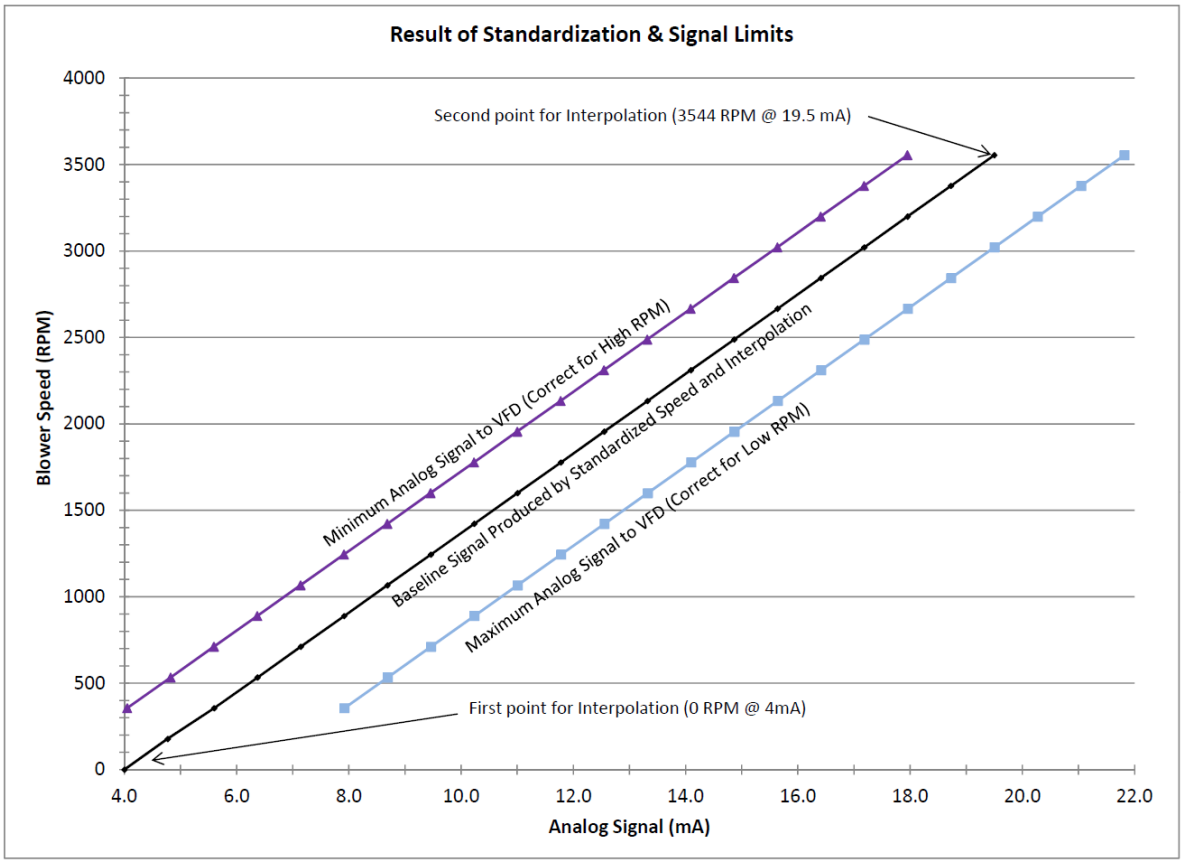


Figure 5-4: Result of Standardization (2-pole blower motor) and Analog Signal Correction Limits

When the burner is in operation, the LMV52 has active, closed-loop control of the blower motor speed and can compensate for motor slip and other factors within limits. The analog signal can be increased to compensate for low blower RPM and decreased to compensate for high blower RPM. These analog signal limits are also shown in Figure 5-4.

If the analog signal is increased to the maximum allowable signal and the blower RPM is still low, a message will be displayed on the AZL that states “Fan speed not reached”.

If the analog signal is decreased to the minimum allowable signal and the blower RPM is still high, a message will be displayed on the AZL that states “Control range limitation VSD Module”.

The reason that the standardization is done at 19.5mA instead of at 20mA is to give the LMV52 some additional "room" to increase the analog signal for a low RPM condition at high fire. Because the standardization is done at 19.5mA, the analog input on the VFD is spanned so that 20mA = 62 Hz. This is done so that the blower will still achieve full 60 Hz blower speed at high fire on jobs where the blower is just large enough.

NOTE: Most VFDs can be scaled to output 400 Hz or more. Consult the blower and / or motor manufacturer before over-speeding the motor and blower, since blower wheels and motor rotors can catastrophically fail if RPM limits are exceeded.

In addition to limits on how much the 4-20mA signal can be compensated, the LMV52 also has limits on how far the blower speed can deviate from the standardized speed line. The next section explains how the blower speed is monitored when the burner is in operation.

Blower Speed Monitoring

Blower speed has a large impact on the airflow delivered to the burner and thus the fuel-air ratio. Fuel-air ratios must be kept in a safe range while a flame is present in the boiler. If the fuel-air ratio cannot be kept in a safe range, the burner must be shut down.

To help ensure that the burner is either operated at a safe fuel-air ratio or is shut down, the blower speed is constantly monitored while a flame is present in the boiler. The speed is monitored so that nuisance shutdowns are eliminated, but fast shutdowns will occur if the speed deviation is large. To do this, the LMV52 evaluates the magnitude of the speed deviation in combination with how long the speed deviation exists. To accomplish this, three distinct bands and one limit centered about the standardized speed line are used. These bands are:

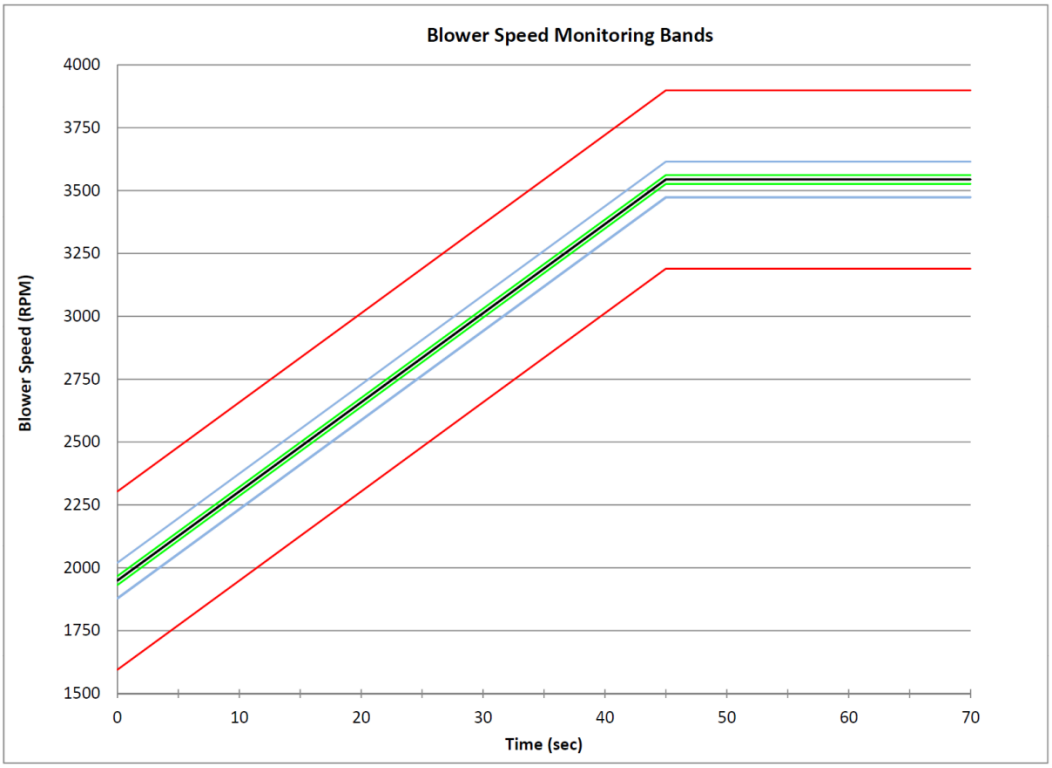
1. **Neutral Band** - if the speed is within this band, it is considered to be OK and no action is taken. The width of this band is +/- 0.5% of the standardized speed.

2. **Low Risk Band** - if the speed is within this band, the analog signal to the VFD is adjusted to bring the speed back into the Neutral Band. If the Neutral Band speed cannot be achieved in 8 seconds, a lockout will occur. The width of this band is +/- 2.0 % of the standardized speed.

3. **Outside Low Risk Band** - if the speed is outside the Low Risk Band but does not exceed the High Risk Limit, the analog signal to the VFD is adjusted to bring the speed back into the Low Risk Band and then ultimately into the Neutral Band. The width of this band varies with the setting of the High Risk Limit (parameter ***TolQuickShutdown***). If the Low Risk Band speed cannot be achieved in 3 seconds, a lockout will occur.

4. **High Risk Limit (parameter *TolQuickShutdown*)** - if the speed exceeds the High Risk Limit threshold for more than 1 second, a lockout will occur. This limit is determined by parameter ***TolQuickShutdown***, which can be set by the burner OEM. The default setting is +/- 10% of the standardized speed.

Figure 5-5 illustrates the same blower that was standardized in Figure 5-3, this time ramping from low fire to high fire when the burner is operating. The black line is the standardized speed line (the same line as shown in Figure 5-4). The lines surrounding the black line are the different speed monitoring bands. The width of each band in % and the time permitted in each band is shown in Figure 5-5.



Name and Timing of Speed Band				Neutral Band No Time Limit		Low Risk Band 8 seconds		Outside Low Risk Band - 3 seconds		High Risk Limit 1 second	
High Limit of Speed Band				+0.5%		+0.5% to +2.0%		+2.0% to +10%		10% or greater	
Low Limit of Speed Band				-0.5%		-0.5% to -2.0%		-2.0% to -10%		-10% or less	
RPM Tolerance for Std. Speed of 3544				+/- 18		+/- 71		+/- 213		+/- 354	
	Time (sec)	VSD (%)	Standarized speed line RPM	Max RPM	Min RPM	Max RPM	Min RPM	Max RPM	Min RPM	Max RPM	Min RPM
RAMP UP	0	55	1949	1967	1931	2020	1878	2303	1877	2304	1595
	5	60	2126	2144	2109	2197	2056	2480	2055	2481	1772
	10	65	2304	2321	2286	2374	2233	2657	2232	2658	1949
	15	70	2481	2499	2463	2552	2410	2834	2409	2835	2126
	20	75	2658	2676	2640	2729	2587	3011	2586	3012	2304
	25	80	2835	2853	2817	2906	2764	3189	2763	3190	2481
	30	85	3012	3030	2995	3083	2942	3366	2941	3367	2658
	35	90	3190	3207	3172	3260	3119	3543	3118	3544	2835
	40	95	3367	3385	3349	3438	3296	3720	3295	3721	3012
	45	**100**	**3544**	3562	3526	3615	3473	3897	3472	3898	3190
HIGH FIRE	50	100	3544	3562	3526	3615	3473	3897	3472	3898	3190
	55	100	3544	3562	3526	3615	3473	3897	3472	3898	3190
	60	100	3544	3562	3526	3615	3473	3897	3472	3898	3190
	65	100	3544	3562	3526	3615	3473	3897	3472	3898	3190
	70	100	3544	3562	3526	3615	3473	3897	3472	3898	3190

Figure 5-5: Blower Speed Monitoring Bands

Suggested Setup Procedure for the VFD Control

After verifying that all VFD related components are installed and wired correctly, the VFD control can be set up. Naturally, if the burner has a VFD, this must be done before the Ratio Control Curves are commissioned.

Particular attention should be paid to the following points:

1. The arrow on the speed wheel points in the same direction as the correct blower rotation.
2. The gap between the inductive sensor and the speed wheel finger is correct (approx. 1/16").
3. The VFD, motor, and LMV52 share a common ground.
4. The analog signal from the LMV52 to the VFD must be in shielded cable with one end of the shield grounded.

After these points are double-checked, the LMV52 parameters can be set.

1. Activate the VFD. The VFD control can be activated / deactivated for either fuel in a dual fuel burner. Typically, if a burner has a VFD, it will be activated on each fuel. The VFD can be activated using the following menu path:

   Params & Display > RatioControl > Gas/Oil Setting > VSD

2. Set the air actuator to be “air influenced”. This is done so that the air damper will open to pre-purge position when the LMV52 is standardized. This can be done using the following menu path:

   Params & Display > RatioControl > Gas/Oil Settings > AirActuator = **air influen**

3. Set or check the LMV52 ramp times. Both of these must be at least 5 seconds longer than the ramp times set in the VFD. The ramp times can be checked using the following menu path:

   Params & Display > RatioControl > Times > OperatRampMod
   Params & Display > RatioControl > Times > TimeNoFlame

4. If using a 6-finger speed wheel (rarely necessary - only if the VFD will be operated under 300 RPM), change the number of pulses per revolution from 3 to 6 using the following menu path:

   Params & Display > VSD Module > Configuration > Speed > Num Puls per R

5. Configure the analog output of the LMV52 to match the analog input of the VFD. Typically, a 4-20mA signal is used. The analog output signal can be set using the following menu path:

   Params & Display > VSD Module > Configuration > Speed > Setpoint Output

6. If the VFD was not purchased pre-programmed for an LMV52, set the relevant VFD parameters. See section on previous pages titled "Configuring VFDs for use with the LMV52".

7. If working on an un-configured LMV52, parameters unrelated to the VFD must be set before the VFD can be standardized. These are thoroughly outlined in Section 4 under "Configuring (Parameterization of) an LMV5 with a Default Parameter Set". To summarize, the following must be set: burner ID, fuel train, actuator addresses, actuator directions of rotation, and actuator special positions.

8. The LMV52 safety loop must be closed (high limit, low water, burner flange, etc...) or the standardization will not occur even if the LMV52 is not in alarm.

9. The burner switch must be off (LMV52 input X5-03.1 must be de-energized).

10. The VFD must be in remote mode so that it will respect the run-stop contact and the analog signal from the LMV52.

11. The LMV52 / VFD / blower are now ready to be standardized. The standardization process can be initiated using the following menu path:

    Params & Display > VSD Module > Configuration > Speed > Standardization

    Set parameter ***Standardization*** to “activated”. The air damper should then drive to the pre-purge position and the VFD / blower should ramp up to approximately 60 Hz (100% VFD). After a few seconds at 60 Hz, the VFD / blower should ramp back down to 0 Hz. The air damper should also drive back to home position.

12. Check the standardized speed, which is the product of the standardization, using the following menu path:

    Params & Display > VSD Module > Configuration > Speed > StandardizedSp

    For 2-pole blowers, the standardized speed should be 3500 RPM, +/- 100 RPM. If the speed is out of this range, the drive was most likely not spanned so that 20mA = 62Hz, or the motor is heavily loaded (a lot of slip). The same logic applies to 4-pole motors, except the speed should be 1700 +/- 100 RPM.

13. If the LMV52 does not have O_2 trim, the air damper actuator can be set back to “activated” instead of “air influen” using the following menu path:

    Params & Display > RatioControl > Gas/Oil Settings > AirActuator = **activated**

Additional Tips for Burners with VFD Control

- Most of the time, speed faults that are seen on the LMV52 are caused by the VFD not being able to decelerate the blower when the blower is being ramped down. If fast ramp times are not critical for the application, ramp times can be increased and this should correct the issue. If fast ramp times are necessary, a braking resistor may also be required to achieve the fast ramp down times.

- The LMV52 / VFD / blower response can be watched to check for proper operation. This can be done in standby Phase 12 (burner off) by using the following menu path:

  Params & Display > RatioControl > Gas/Oil Settings > CurveParams or *Curve Settings*

  When the blower is at a speed other than what is displayed, an arrow (>) is displayed on the AZL next to the VFD position. When the blower is at the displayed speed, a colon (:) is displayed on the AZL next to the VFD position. By ramping the VFD up and down, the response of the VFD can be observed. Transitioning back and forth between a colon (:) and a (>) after ramping the VFD up or down indicates a speed control issue.

- The LMV52's closed loop speed control is based on PI (proportional-integral) logic. The response of this loop can be tuned using the following menu path:

  Params & Display > VSD Module > Configuration > Speed > Setteling Time

  In most cases, this does not need to be tuned. See Section 3 (Parameters) for a full explanation.

- The absolute speed as read in real time by the speed wheel can be watched at any point in time. When the LMV52 is not modulating or when it is at a fixed VFD speed (pre-purge, post-purge, ignition, etc.), the speed should be steady, not deviating by more than +/- 10 RPM. This can be viewed at:

  Params & Display > VSD Module > Configuration > Speed > Absolute Speed

- The combustion air pressure switch should be set by taking the VFD to 10% below the lowest anticipated low fire speed (if low fire is 50%, take the VFD to 40%) and setting the switch to open at that point. This should maximize the safety potential of the combustion air pressure switch and minimize nuisance trips. This can be done in standby by setting the home position of the VFD to 40% and setting the switch.

- In most applications with an air damper, there is little reason to decrease blower speed below about 50% VFD (30 Hz). Power consumption decreases by the cube of the RPM even without the additional restriction of an air damper. Referencing information from the "Centrifugal Blower Fundamentals" section on the previous pages, decreasing the speed of a 25 HP (18.62 kW) motor from 3600 RPM (60 Hz) to 1800 RPM (30 Hz) will cause the power consumption to be reduced from 18.62 kW down to 2.32 kW, an electrical savings of over 800%.

- A VFD alone without an air damper or sliding head offers limited accuracy and repeatability for the airflow at higher burner turndowns. For most boiler burners, modulating the VFD alone without an air damper is okay for turndowns of 4-to-1 or less. Using only a VFD for airflow regulation at higher turndowns may lead to airflow repeatability issues.

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Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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Section 6: Oxygen Trim

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Introduction

The LMV52.240 and the LMV52.440 both have O_2 (oxygen) trim and O_2 alarm (previously called "monitor") capability. In addition, the LMV52.440 offers advanced features such as temperature compensated light-off and more dynamic O_2 trim capabilities. In general, the LMV52.440 is recommended for more difficult applications such as low and ultra-low NOx burners where the burner stability band is much smaller than a traditional nozzle mixing burner. Some features in the LMV52.440 were specifically designed for ultra-low NOx mesh burners.

The O_2 trim functions by using an in-situ O_2 sensor installed in the boiler stack, and then adjusting actuators and / or VSD to maintain a % O_2 setpoint. Only air-related (air influenced) actuators are adjusted, thus the O_2 trim does not adjust the firing rate (fuel-related load). Only the air rate (air-related load) is adjusted.

Each Ratio Control Curve Point that is entered (see Section 4) will have a corresponding O_2 trim setpoint, rich limit (O_2 alarm) and lean limit (O_2 max value). The exception to this rule is that O_2 trim cannot be performed on Point 1. If 10 points are entered on the Ratio Control Curve, there will be 9 trim points and 10 rich limit (O_2 alarm) points. Having 10 points on the Ratio Control Curve is recommended.

As is the case with advanced systems such as O_2 trim, the fundamental systems that lie underneath the advanced system must be in place and working correctly to enable the advanced system to work correctly. For example, if the gas pressure supply is not repeatable upstream of the firing rate control valve (fundamental system), then the O_2 trim (advanced system) is likely to deactivate. The fundamental systems on the burner / boiler that must be working correctly are outlined in detail in the Pre-Requisites listed in Section 4. The Pre-Requisites for LMV52 systems with O_2 trim must be met before O_2 trim commissioning is attempted.

If the Pre-Requisites are satisfied, then reliable operation of the O_2 trim depends on correct parameter settings for the application and correct commissioning of the O_2 trim. This section will outline the basics behind how the O_2 trim system operates, and will outline the typical commissioning procedure for a traditional nozzle mixing burner (standard emissions) and a pre-mix mesh burner (low or ultra-low NOx). Nozzle mixing burners that use a high percentage of FGR to achieve low NOx typically behave in a way that is similar to a pre-mix mesh burner, so the commissioning procedure for these types of burners is similar to a pre-mix mesh burner.

O_2 Trim (O_2 Control) Fundamentals

By definition, an O_2 trim (O_2 control) system monitors the level of O_2 in the exhaust gases of the boiler and adjusts the fuel or air flow to maintain an O_2 setpoint. The LMV52 accomplishes this task by reading the %O_2 (wet basis) with an in-situ O_2 sensor and by adjusting the angular position of air flow influencing actuators. If the burner is equipped with a VSD (variable speed drive) for the blower, the O_2 trim can also adjust the blower speed to influence the burner airflow.

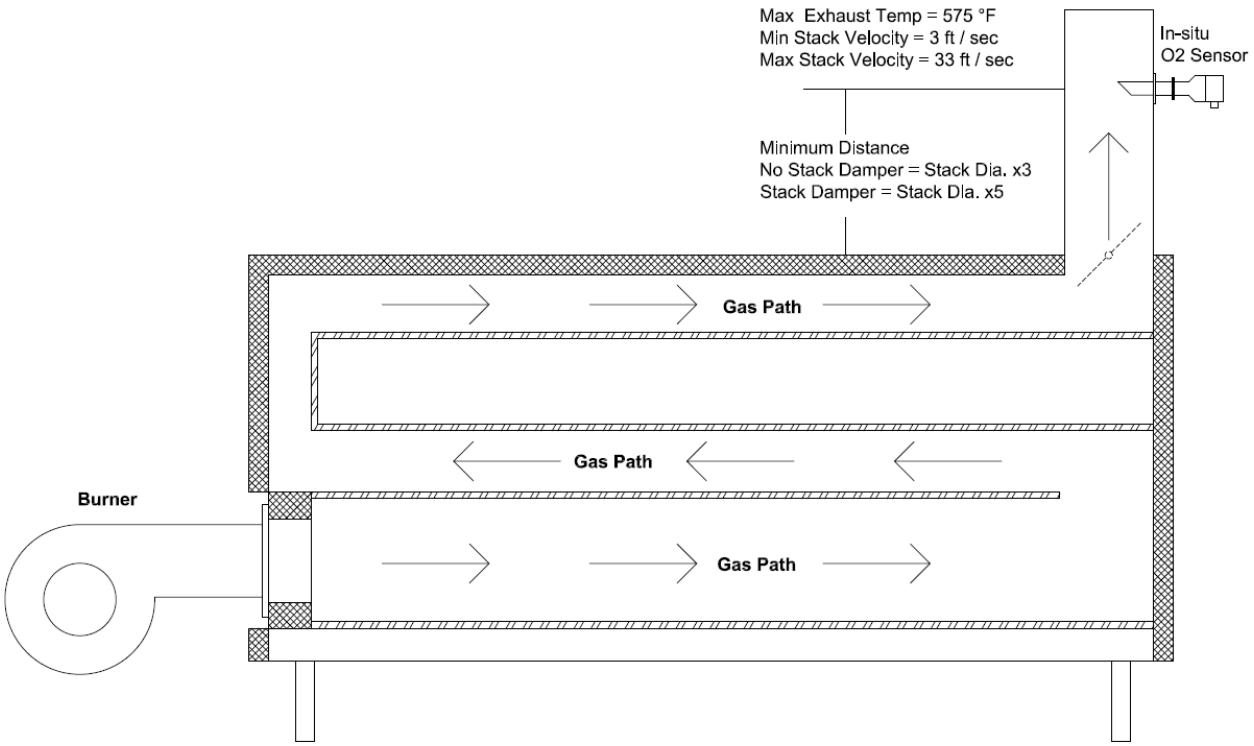


Figure 6-1: Physical Arrangement of Burner, O_2 Sensor, and Gas Path

Since the O_2 sensor is located in the boiler's exhaust (stack), there always exists a delay time (Tau time) between when air flow is adjusted at the burner and when the change is detected by the O_2 sensor. This physical reality forces the O_2 trim to use "old" O_2 readings, which will be discussed later. The delay time depends on the length of the gas path through the boiler and the velocity of the gas. The length of the gas path is fixed for a given boiler, but the gas velocity depends upon the firing rate. Higher firing rates equate to higher gas velocities and smaller delay times (Tau times).

If the fuel flow increases linearly with the firing rate (the load number accurately reflects the fuel flow), the Tau time will decrease in a predictable manner as the firing rate increases. Likewise, given an accurate load number, the Tau time will increase in a predictable manner as the firing rate decreases. This enables the Tau time to be automatically calculated at every point from Point 2 to high fire. Once the Tau time is calculated for every point from Point 2 to high fire, the PI (proportional + integral) response for the O_2 trim can be automatically calculated for every point between Point 2 and high fire.

Another place where the Tau time must be accounted for is at startup. Immediately before main flame ignition, the gas path of the boiler is full of air. To get a representative O_2 reading that can be used for trimming, the gas path of the boiler must be full of products of combustion (exhaust gases). Thus, the main flame of the burner must be ignited and the burner must be running for a period of time to flush out all of the air. The time it takes to flush out this air is estimated by taking the Tau time (at Point 2) times a multiplier. For example, if the Tau time at Point 2 is measured to be 6 seconds, then the time it takes to get a representative O_2 reading after light off might be 6 x 6 = 36 seconds. In this example, closed loop O_2 trim cannot occur until 36 seconds after light off. This is precisely where the temperature compensation functionality is used for some burners (LMV52.440 only).

For many nozzle mixing burners (traditional boiler burners), the O_2 setpoint will be a higher value at low fire and a lower value at high fire. This is true since most nozzle mixing burners need more excess air (higher O_2) at low fire to achieve complete combustion. For this type of burner an O_2 setpoint of 5% O_2 (wet) at low fire and an O_2 setpoint of 2% O_2 (wet) at high fire is not uncommon.

Pre-control

As mentioned above, all O_2 trim systems with an O_2 sensor in the boiler's exhaust must use "old" O_2 readings due to physical realities of the boiler. This fact, combined with an O_2 setpoint that typically varies from low fire to high fire means that the O_2 trim system cannot actively trim when the burner makes a large change in firing rate. This begs the question of what happens to the O_2 trim when the burner transitions from 20% firing rate to, say, 80% firing rate. The answer is the O_2 trim changes modes from active trim to what is referred to as "pre-control".

Pre-control is possible because the LMV52 learns the characteristic of the burner at each point on the curve during the O_2 trim commissioning. The specific characteristic that the LMV52 learns is how much of a change in airflow (air rate) is necessary to achieve a certain change in the $\%O_2$. This specific characteristic is known as the Lambda Factor, and is essentially the burner's signature from an O_2 trim standpoint. Just like the delay time (Tau time) that was mentioned earlier, it is necessary for the fuel flow to match the load number so that the Lambda Factor is correct and accurate for each point.

Pre-control uses the Lambda Factor so that the burner can be modulated while keeping the $\%O_2$ close to the O_2 setpoint, even though the setpoint changes with the firing rate and the O_2 trim is using "old" O_2 readings. Once the burner stops modulating or only modulates a small amount (+/- 5%), the O_2 trim will change modes back to "active" and perform active O_2 trim once again.

A properly commissioned O_2 trim system will typically maintain the $\%O_2$ setpoint with a deviation of +/- 0.1% O_2 when the burner is not modulating a significant amount (+/- 5% load change). With this small load change, the O_2 trim will stay in the "active" mode. When significant modulation is encountered (+/- 15% load change), the pre-control will engage and the deviation from setpoint will increase. Deviations of +/- 0.3% or less are typical during modulation when the pre-control is engaged.

O_2 Trim Terminology

1. **$\%O_2$ Wet** – In-situ O_2 sensors, like the QGO20 sensor that is used with the LMV52, read the $\%O_2$ on a wet basis. This is in contrast to the vast majority of portable combustion analyzers that read $\%O_2$ on a dry basis. $\%O_2$ wet should always be a lower value than $\%O_2$ dry. Figure 6-11 (located later in this section) gives the approximate relationship between $\%O_2$ wet and $\%O_2$ dry.

2. **Tau Time** - This is the delay time between when an adjustment is made at the burner (moving the air damper, etc.) and when that adjustment is read at the O_2 sensor. For a given burner / boiler, this time will be shorter at high fire and longer at low fire.

3. **O_2 Ratio Control** - This is the measured $\%O_2$ wet when the actuators / VSD are on the Fuel-Air Ratio Control Curve and are not being trimmed. This is recorded for each point on the curve except Point 1. This is also commonly referred to as the “lean curve”.

4. **O_2 Control** - This is the setpoint of the O_2 trim system for each point on the curve except Point 1. This is also commonly referred to as the “trim curve”.

5. **O_2 Alarm** - This is the rich O_2 limit for each point. Every Fuel-Air Ratio Curve point including Point 1 must have a corresponding O_2 alarm point. This is also commonly referred to as the “rich curve” or “rich alarm”.

6. **O_2 Max Value** - This is the lean O_2 limit, and is a single value for all points. This is also referred to as the “lean alarm”.

7. **Lambda Factor** - A value that is learned by the LMV52 for each point on the curve except Point 1. This value is learned when the O_2 control curve is being set, and is based on how the measured $\%O_2$ responds when the burner is being transitioned from an O_2 Ratio Control point to the O_2 Control point during O_2 Control commissioning. This value represents how much the air flow needs to be changed to get a change in the measured $\%O_2$, and is essentially the "signature" of the burner from an O_2 trim perspective.

8. **Fuel Rate –** This is the percentage of high fire fuel flow and is also referred to as the firing rate. This is also the same as the "Load" number seen during Ratio Control Curve commissioning. For a 10-to-1 turndown burner, high fire would be 100% and low fire would be 10%. For a 4-to-1 turndown burner, high fire would be 100% and low fire would be 25%. For O_2 trim systems, it is very important that the fuel rate (load number) matches the actual fuel flow to the burner within +/- 3%.

9. **Air Rate** - When no O_2 trim is taking place (running on Ratio Control Curve), the air rate is the same as the fuel rate. This is also known as the air flow. For example, a 10-to-1 turndown burner running at Point 5 on the Ratio Control Curve will have a fuel rate of 50% and an air rate of 50%. If the O_2 trim is engaged and the O_2 sensor reads values higher than setpoint, the air rate will be reduced relative to the fuel rate until the setpoint is achieved.

10. **Standardized Value** - This is a percentage reduction of the air rate and is used when the O_2 Control Curve is being set. For example, if the air rate is 50%, and a Standardized Value of 10% is entered, the air rate will be reduced to 45%. The math would be: (50% * 10% = 5%), then (50% -5%) = 45%.

11. **Pre-Control** - When large load changes occur during modulation, this will engage and temporarily disable the closed-loop O_2 trim. This temporary "open-loop" trim is based on using a correct Lambda Factor to predict how the burner will react when modulating. Pre-control is necessary for burners where the O_2 setpoint is not constant from low fire to high fire.

O_2 Control and O_2 Alarm Curves

When the O_2 system is commissioned, curves and parameters must be set to define how the system will operate. When set correctly, the curves seen in Figure 6-2 will achieve the following:

1. Establish a safe operating envelope for the burner.
2. Ensure repeatable $\%O_2$ levels in the boiler exhaust with changing ambient conditions:
   a. To consistently operate at peak efficiency (lowest $\%O_2$ and excess air)
   b. For reliable operation while meeting emissions requirements (low and ultra-low NOx)

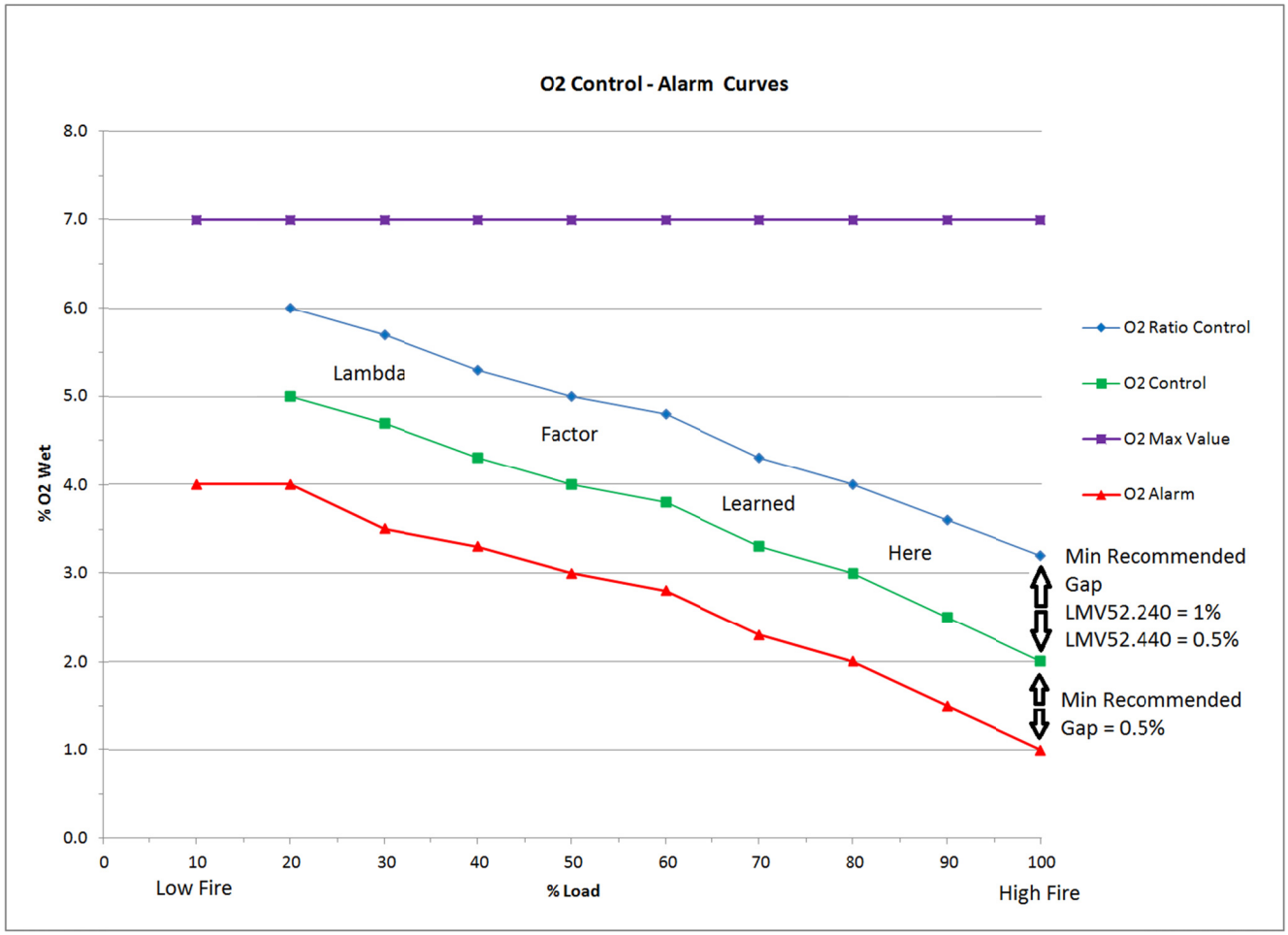


Figure 6-2: O_2 Control and O_2 Alarm Curves

As seen in Figure 6-2 above, parameter ***O_2 MaxValue*** sets the fuel lean boundary for the burner and the O_2 Alarm Curve sets the fuel rich boundary for the burner. These must be set in such a way so that unsafe / unstable operation of the burner is not permitted. However, being too conservative with these boundaries will handicap the system and cause nuisance deactivations of the O_2 trim. General guidelines for these settings will be discussed later in this section. These two curves together set the safety envelope for the burner from a $\%O_2$ standpoint.

The O_2 Ratio Control Curve reflects the $\%O_2$ that resulted from setting the Fuel-Air Ratio Control Curve. The O_2 Control Curve is the target for the O_2 trim system when it is activated. When the burner is transitioned from the O_2 Ratio Control Curve to the O_2 Control Curve by increasing the Standardized Value, the Lambda Factor will be learned and recorded at that specific point. A larger gap between the O_2 Ratio Control Curve and the O_2 Control Curve will give the LMV52 the best opportunity to learn the Lambda Factor of the burner, and thus yield the best pre-control when the burner is modulating. A gap of 1% O_2 or more is ideal, and it is typically achievable on nozzle mixing burners with no or low percentages of FGR. A 1% gap is typically not achievable on premix mesh burners or on nozzle mixing burners that use a high percentage of FGR. This gap also sets the available quantity of "lean" trim for an LMV52.240, and that is why the minimum recommended gap for an LMV52.240 is 1%. The LMV52.440 uses a different O_2 trim algorithm for premix, mesh and high percentage FGR burners and can deal with a minimum gap of 0.5%.

O_2 Trim Configuration (Parameterization) Before Commissioning

The procedure below assumes an LMV52 with default parameters for the *O2 Contr/Alarm* menu and the *O2 Module* menu. If the LMV52 is mounted to a burner / boiler, the burner / boiler OEM may have already changed the parameters from the default setting and parameterized the LMV52 for the application. This procedure also assumes that all O_2 trim components are installed and wired correctly, and that the O_2 trim will be commissioned on natural gas.

Section 3 gives a detailed explanation of all of the parameters in the LMV52 as well as highlights which parameters must be set (marked with a double asterisk **) and which parameters are frequently used (shaded).

This procedure gives a general guideline of what parameters need to be set on both a traditional nozzle mixing burner with little to no FGR, and also for low and ultra-low NOx burners that are pre-mix mesh type or high percentage FGR. Every burner is different, so it is likely that every burner will need a somewhat unique parameter set to run correctly.

1. Log in at the OEM password level. From the factory, the OEM password for the LMV5 is "START".

2. If not done so already, activate the O_2 sensor using the following menu path:

   Params & Display > O2 Module > Configuration > O2 Sensor = **QGO20**

3. If being used, configure the appropriate temperature sensors for blower inlet air temperature and stack temperature. This is done through the following menu path:

   Params & Display > O2 Module > Configuration > SupAirTempSens
   Params & Display > O2 Module > Configuration > FlueGasTempSens

   Parameter ***SupAirTempSens*** activates and configures the blower inlet air temperature sensor. Parameter ***FlueGasTempSens*** activates and configures the stack temperature sensor. Options are Ni1000 or Pt1000 2-wire sensors for both inputs.

NOTE: Both sensors are required to do a boiler efficiency calculation. The boiler efficiency calculation is not required for O_2 trim operation. If sensors are activated but not reading correctly or not wired correctly, the O_2 trim will not activate. Burner inlet temperature must be read to perform a temperature-compensated startup on the LMV52.440.

4. Set the appropriate actuators to “air influen” (air influenced). These are typically only the actuators / VSD that will directly influence the burner air rate. The menu path for these parameters is:

   Params & Display > RatioControl > Gas Settings

   Typically, only the air actuator and the VSD (if used) are set to air influenced. If used, the FGR actuator is usually not set to air influenced.

5. Set the operating mode of the O_2 system to “man deact” (manually deactivated). This is necessary for the O_2 system curves to be commissioned. The menu path for this parameter is:

   Params & Display > O2Contr/Alarm > Gas Settings > OptgMode = **man deact**

6. Set the curve point at which the low fire delay time will be measured. This is typically set to Point 2, unless oversized exhaust stacks with high turndown burners are encountered, which may make gas velocity in the stack too low at low fire. For these applications, setting this parameter to a higher point than Point 2 will increase the gas velocity past the O_2 sensor and yield a more responsive O_2 reading. This can be set through the following menu path:

   Params & Display > O2Contr/Alarm> Gas Settings > Control Param > LowfireAdaptPtNo

7. Set the load value at which the O_2 trim will disengage. Typically, this is set to the load value for Point 2 on the Fuel-Air Ratio Control Curve. The exception to this is if parameter ***LowfireAdaptPtNo*** is set to a point other than Point 2. If this is the case, set this for the load value that corresponds to the point set by ***LowfireAdaptPtNo***. This can be set through the following menu path:

   Params & Display > O2Contr/Alarm > Gas Settings > Control Param > O2 CtrlThreshold

8. Set the desired type of pre-control. For most natural gas burners where the gap between O_2 curves is large enough that the Lambda Factor can be learned (see O_2 Control and O_2 Alarm Curves in Figure 6-2), this should be set to "like P air". The "like theory" setting is typically used for oil burners, and "LambdaFact1" should only be used as a last resort. The menu path for setting the type of pre-control is:

   Params & Display > O2Contr/Alarm > Gas Settings > Control Param > Type Air Change

Suggested O_2 Trim Commissioning - Traditional Nozzle Mixing Burner with No or Low Percentage FGR (Typically LMV52.240)

1. The commissioning procedure assumes the following:
   a. All Pre-Requisites for an LMV52 system with O_2 trim (and VSD if equipped) have been met according to Section 4 of this literature.
   b. The Ratio Control Curves have been commissioned according to Section 4 of this literature.
   c. Section 6 of this literature has been read and understood up to this point.

2. As was the case for the Ratio Control Curves in Section 4, the same free spreadsheet can also be used to assist in the commissioning of the O_2 trim. This spreadsheet graphically illustrates the O_2 curves as well as provides an orderly way to record the details of how the burner was set up.

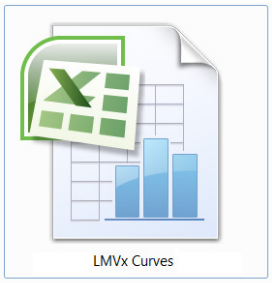


Figure 6-3: LMVx Curves Spreadsheet

3. The key to commissioning the O_2 curves quickly and easily is contained in the Ratio Control Curves. Specifically, the following must be achieved for each point on the Ratio Control Curves (as paraphrased from Section 4 of this literature):

   a. Safe, efficient combustion as verified by a calibrated stack gas analyzer
   b. The % load matching the fuel flow within +/- 3%
   c. Emissions compliance
   d. Smooth Ratio Control Curves (no sharp peaks or valleys)
   e. VSD speed should increase with load in a linear fashion (if equipped)
   f. Find and record the $\%O_2$ wet corresponding to the fuel rich limit (***O2 Alarm*** value) for each point by probing.*
   g. Find and record the $\%O_2$ wet corresponding to the fuel lean limit (***O2 MaxValue***) for Point 1 and Point 10 by probing.*
   h. Last but not least, leave the curve points so that the $\%O_2$ wet is 2% higher than the fuel rich limit (***O2 Alarm*** value). Record this as the "saved" value for each curve point.

   *** NOTE: When probing the fuel rich limit, it is not recommended to exceed 200 PPM CO (dry basis) or less than 1.0% O_2 (wet or dry basis) for any point. When probing the fuel lean limit, it is not recommended to exceed 200 PPM CO or adversely affect flame stability for any point.**

NOTE: The $\%O_2$ values read and displayed by the LMV52 system are always on a wet basis ($\%O_2$ wet). Most if not all external exhaust gas analyzers read and display $\%O_2$ and other gases on a dry basis ($\%O_2$ dry). All O_2 curves must be commissioned using $\%O_2$ wet values as read by the LMV52. The external exhaust gas analyzer is used to read CO, NOx, and also serves as a way to double check the $\%O_2$ wet values. Figure 6-11 gives the approximate relationship between $\%O_2$ wet and $\%O_2$ dry.

4. Make sure that the QGO20 O_2 sensor has been activated for at least 2 hours and is up to temperature. This gives the Zirconium cell time to heat-soak and also to burn off any contaminants. The temperature of the cell can be checked if desired through the following menu path:

   Params & Display > O2 Module > Process Data > QGO SensorTemp

5. With the burner off (Phase 12), set the fuel rich limit (***O2 Alarm*** value) for each point. This can be done with the burner off since these values have already been found and recorded during Ratio Control Curve commissioning (see above). Once into the ***O2 Alarm*** curve, simply enter in the recorded value for each point and save each point. To access the ***O2 Alarm*** curve, use the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Alarm > O2 Alarm

6. With the burner off (Phase 12), set the fuel lean limit (***O2 MaxValue***) based on the values that have already been found and recorded for Point 1 and Point 10 during Ratio Control Curve commissioning (see above). To set the fuel lean limit, use the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Alarm > O2 MaxValue

7. If the LMVx Curves spreadsheet is not being used, take the recorded O_2 Alarm values and add 0.5% for each point. Take the "saved" $\%O_2$ from the Ratio Control Curve and subtract 1.0% for each point. This will provide a target band for setting the O_2 Control Curve points. Example: The O_2 Alarm value is 2%. The Ratio Control Curve point "saved" is 4%. Add 0.5% to the O_2 Alarm = 2.5%. Subtract 1% from the Ratio Control = 3%. For this point, the target for the O_2 Control is between 2.5% and 3%.

8. When it is safe to do so and when there is adequate load available, start the burner / boiler and let it warm up to operating temperature.

9. Access the O_2 Ratio Control Curve and the O_2 Control Curve using the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Control

10. Once the O_2 Control Curve is entered, Point 2 should be displayed. Pressing Enter again should drive the burner to Point 2 if it is not already there. When the burner is driving to Point 2, a carat (>) will be displayed. Once the burner is at Point 2, a colon (:) will be displayed. If the aux 3 actuator is used for FGR and ***FGR-Mode*** is not set for “Aux3onCurve”, a pound (#) indicates the aux 3 actuator has not released to the curve.

11. The AZL52 will then prompt "when value stable, continue with ENTER". After the burner is at Point 2, wait at least an additional 30 seconds to make sure that the O_2 value being read is representative of Point 2, then press Enter. Pressing Enter stores the O_2 Ratio Control Curve point. The value that is stored should be close (+/- 0.2%) to the "saved" value that was recorded for Point 2 during Ratio Control Curve commissioning.

    NOTE: It is important to wait long enough to get a steady-state O_2 value before Enter is pressed. If in doubt, wait longer for the value to stabilize. Waiting longer than necessary has no ill effects for the O_2 trim commissioning.

    NOTE: If the O_2 value displayed on the AZL52 is not steady (oscillating more than +/- 0.1% O_2), it is likely that the O_2 sensor is not mounted correctly, or there are other issues with the burner / boiler that are affecting the fuel / air ratio. These issues must be corrected before proceeding.

12. Next, slowly increase the StandardVal number, which reduces the air flow into the burner. The reading beside O2 Control should start to drop as StandardVal is increased. Note that the Tau time of the boiler comes into play here, so it may take 10-15 seconds or more for a change in the StandardVal number to be seen in the O_2 reading.

13. Once the StandardVal number has been increased enough to get the %O_2 into the target band (at least 0.5% O_2 above the O_2 Alarm and 1% below the O_2 Ratio Control Curve point), the point can be stored. This is done by pressing Enter, Escape, and then Enter again.

14. After the point is stored, the delay time at Point 2 (***Tau Low-Fire***) will be measured. This should occur and the AZL52 should state "Measurement Successful, Control Parameters Stored".

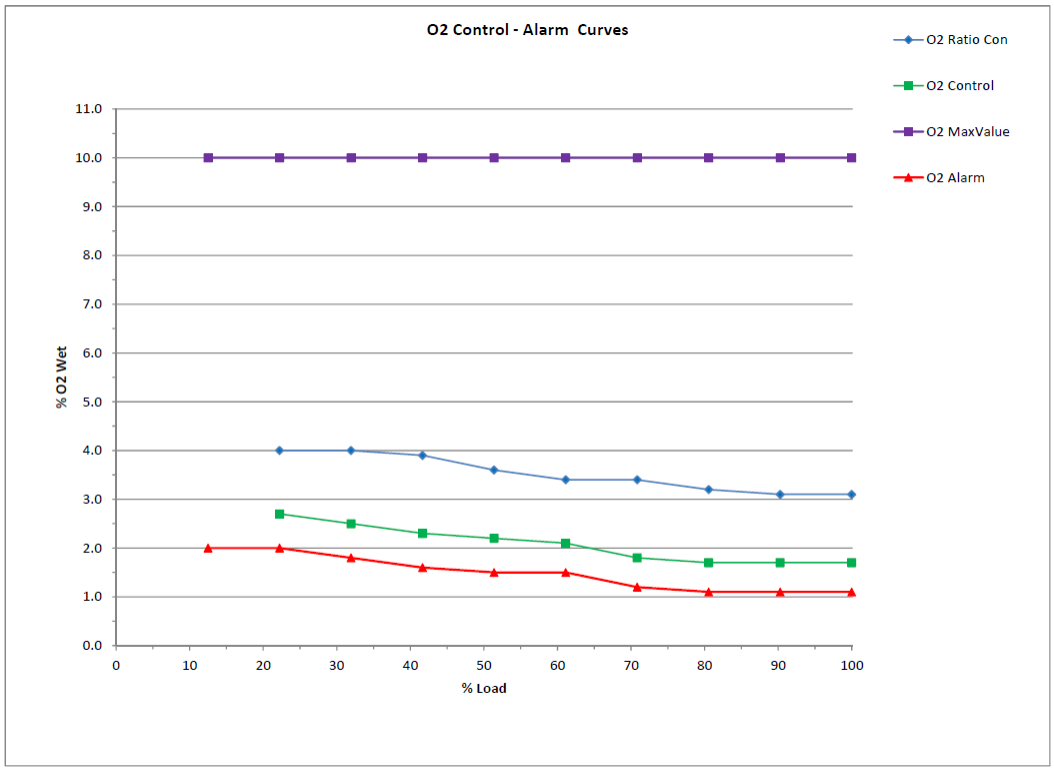
15. The rest of the Points (3 thru 10) can now be done in a similar manner. The delay time (***Tau High-Fire***) will also be measured at the high fire point, in this case Point 10.

16. After the delay time is successfully measured at Point 10, escape out of the O_2 Control Curve. See Figures 6-4 and 6-5 below for an example of what typical O_2 trim curves and Lambda Factor curves might look like for this application.

17. The O_2 trim can now be activated in one of two modes. Mode "conAutoDeac" allows the O_2 trim to work as long as the measured %O_2 does not exceed the rich limit (***O_2 Alarm***) or the lean limit (***O_2 MaxValue).*** If either of these limits is exceeded, the O_2 trim will deactivate and the burner will run on the normal Ratio Control Curves. Mode "O2 Control" also allows the O_2 trim to work, except that if the limits are exceeded a lockout will occur. Mode "conAutoDeac" is typically used. To set the O_2 control operating mode, use the following menu path:

    Params & Display > O2Contr/Alarm > Gas Settings > OptgMode

18. The O_2 trim is now commissioned and activated. Some additional tuning may be required depending on the application. See "Post Commissioning Tuning" later in this section for more information.

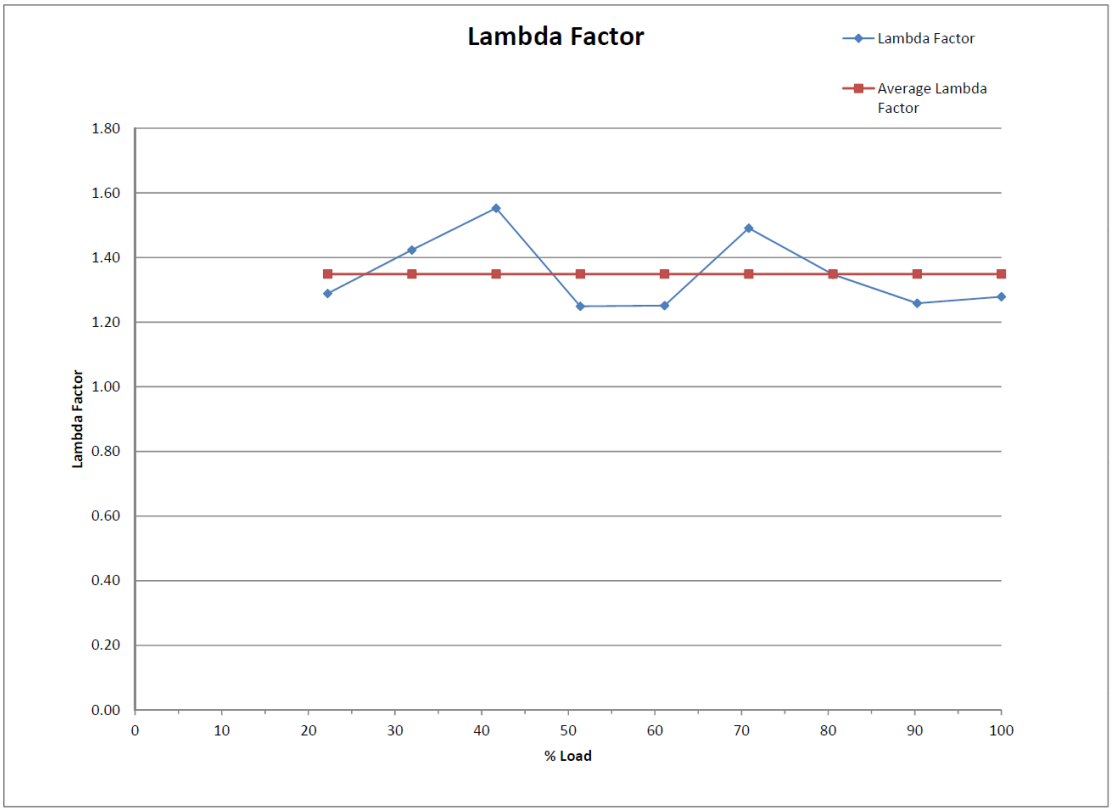


%O2 Control - Alarm Curves																	
From Above			Based on O2 Alarm Rich and O2 Ratio		Based on burner capabilities		As saved in the LMV52			Emissions Data from Exhaust Gas Analyzer @ O2 Ratio Control			Emissions Data from Exhaust Gas Analyzer @ O2 Control		
CURVE POINTS (O2 Control-Alarm)	LMV Curve Point	LMV Load at Curve Point	Target for O2 Control		O2 Alarm (Rich Limit)*	O2 MaxValue (Lean Limit)	O2 Ratio Control	O2 Control	Standard Val	O2 (Dry)	CO	Nox	O2 (Dry)	CO	Nox
	#	%	% O2 Wet		% O2 Wet		% O2 Wet		%	%	PPM	PPM	%	PPM	PPM
	1	12.5	MAX	MIN	2.0	10.0	Cannot trim on Point 1			Cannot trim on Point 1			Cannot trim on Point 1		
	2	22.2	3.0	2.5	2.0	10.0	4.0	2.7	6.0	5.0	1.0	34.0	3.7	1.0	38.0
	3	31.9	2.8	2.3	1.8	10.0	4.0	2.5	6.2	5.0	1.0	33.0	3.5	1.0	37.0
	4	41.7	2.6	2.1	1.6	10.0	3.9	2.3	6.0	4.9	0.0	32.0	3.3	0.0	36.0
	5	51.4	2.5	2.0	1.5	10.0	3.6	2.2	6.5	4.6	0.0	34.0	3.2	0.0	38.0
	6	61.1	2.5	2.0	1.5	10.0	3.4	2.1	6.0	4.4	0.0	35.0	3.1	0.0	39.0
	7	70.8	2.2	1.7	1.2	10.0	3.4	1.8	6.1	4.4	2.0	35.0	2.8	2.0	39.0
	8	80.6	2.1	1.6	1.1	10.0	3.2	1.7	6.3	4.2	2.0	37.0	2.7	2.0	41.0
	9	90.3	2.1	1.6	1.1	10.0	3.1	1.7	6.3	4.1	1.0	38.0	2.7	1.0	42.0
	10	100.0	2.1	1.6	1.1	10.0	3.1	1.7	6.2	4.1	1.0	39.0	2.7	1.0	43.0

Figure 6-4: Example of Typical O_2 Control Curves - Nozzle Mixing Burner (No or Low % FGR)

The curves above illustrate traits that are common to most nozzle mixing burners. These are:

- Wide stability band - 8% O_2 or more between the rich and lean limits
- Curves decrease in %O_2 from low fire to high fire
- 1% O_2 or more between the O_2 Ratio Control Curve and the O_2 Control Curve (accurate Lambda Factor)
- O_2 Control Curve close to rich limit (minimize %O_2 to maximize burner efficiency)
- Curves are set up for efficiency (NOx emissions are not a priority)
- LMV52.240 O_2 trim system adequate for this type of setup



LMV52 Load	Lambda Ratio control Curve	Lambda O2 control curve	Lambda Factor	Average Lambdafactor	Standard Dev
22.2	1.26	1.16	1.29	1.35	0.11373
31.9	1.26	1.15	1.42	1.35	
41.7	1.25	1.14	1.55	1.35	
51.4	1.23	1.13	1.25	1.35	
61.1	1.21	1.12	1.25	1.35	
70.8	1.21	1.10	1.49	1.35	
80.6	1.20	1.10	1.35	1.35	
90.3	1.19	1.10	1.26	1.35	
100.0	1.19	1.10	1.28	1.35	

Figure 6-5: Example of Typical Lambda Factors for O_2 Control Curves in Figure 6-4 (above)

The Lambda Factor curves serve as a tool to evaluate how accurate and repeatable the fundamental mechanical systems of the burner are and how well all the curves were commissioned. In general, the Lambda Factor curve should be as constant or "flat" as possible. The actual numerical value is not important, but the consistency between points is. An approximate guide for evaluation of the Lambda Factor:

- Difference in Lambda Factor between adjacent points -> lower numbers are better. Max = 0.35 (Higher numbers may lead to O_2 trim deactivations on some burners during modulation).
- Standard Deviation of all points on the curve -> lower numbers are better. Max = 0.30 (Higher numbers may lead to O_2 trim deactivations on some burners during modulation).

Suggested O_2 Trim Commissioning - Premix Mesh Burner or Nozzle Mixing Burner with High Percentage of FGR (Typically LMV52.440)

1. The commissioning procedure assumes the following:
   a. All Pre-Requisites for an LMV52 system with O_2 trim (and VSD if equipped) have been met according to Section 4 of this literature.
   b. The Ratio Control Curves have been commissioned according to Section 4 of this literature.
   c. Section 6 of this literature has been read and understood up to this point.
   d. If a start mode with combustion air temperature compensation will be used, the air temperature sensor must be installed and activated.

2. As was the case for the Ratio Control Curves in Section 4, the same free spreadsheet can also be used to assist in the commissioning of the O_2 trim. This spreadsheet graphically illustrates the O_2 curves as well as provides an orderly way to record the details of how the burner was set up.

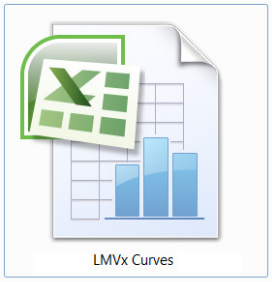


Figure 6-3: LMVx Curves Spreadsheet

3. The key to commissioning the O_2 curves quickly and easily is contained in the Ratio Control Curves. Specifically, the following must be achieved for each point on the Ratio Control Curves (as paraphrased from Section 4 of this literature):

   a. Safe combustion as verified by a calibrated stack gas analyzer
   b. The % load matching the fuel flow within +/- 3%
   c. Emissions compliance
   d. Smooth Ratio Control Curves (no sharp peaks or valleys)
   e. VSD speed should increase with load in a linear fashion (if equipped)
   f. Determine the $\%O_2$ wet corresponding to the fuel rich limit (O_2 Alarm value) for each point. Probing may or may not be possible depending on the burner design. Also, follow burner OEM recommendations. Most mesh burner elements can be damaged if run too fuel rich.*
   g. Find and record the $\%O_2$ wet corresponding to the fuel lean limit (***O2 MaxValue***) for Point 1 and Point 10 by probing or according to burner OEM recommendations.*
   h. Find the target $\%O_2$. For these burners the target $\%O_2$ for each point will be the $\%O_2$ wet corresponding to emissions compliance (typically CO, NOx). After the target $\%O_2$ is found, increase the $\%O_2$ and leave the point at least 0.5% O_2 leaner than the target $\%O_2$. Record this as the "saved" value for each curve point.

*** NOTE: When probing the fuel rich limit, it is not recommended to exceed 200 PPM CO (dry basis) or less than 1.0% O_2 (wet or dry basis) for any point. When probing the fuel lean limit, it is not recommended to exceed 200 PPM CO or adversely affect flame stability for any point.**

NOTE: The $\%O_2$ values read and displayed by the LMV52 system are always on a wet basis ($\%O_2$ wet). Most if not all external exhaust gas analyzers read and display $\%O_2$ and other gases on a dry basis ($\%O_2$ dry). All O_2 curves must be commissioned using $\%O_2$ wet values as read by the LMV52. The external exhaust gas analyzer is used to read CO, NOx, and also serves as a way to double check the $\%O_2$ wet values. Figure 6-11 gives the approximate relationship between $\%O_2$ wet and $\%O_2$ dry.

4. Make sure that the QGO20 O_2 sensor has been activated for at least 2 hours and is up to temperature. This gives the Zirconium cell time to heat-soak and also to burn off any contaminants. The temperature of the cell can be checked if desired through the following menu path:

   Params & Display > O2 Module > Process Data > QGO SensorTemp

5. With the burner off (Phase 12), set the fuel rich limit (***O2 Alarm*** value) for each point. This can be done with the burner off since these values have already been found and recorded during Ratio Control Curve commissioning (see above). Once into the ***O2 Alarm*** curve, simply enter in the recorded value for each point and save each point. To access the ***O2 Alarm*** curve, use the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Alarm > O2 Alarm

6. With the burner off (Phase 12), set the fuel lean limit (***O2 MaxValue***) based on the values that have already been found and recorded for Point 1 and Point 10 during Ratio Control Curve commissioning (see above). To set the fuel lean limit, use the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Alarm > O2 MaxValue

7. The target $\%O_2$ (recorded above) will be used for the O_2 Control Curve. The O_2 Control Curve points should be set to the target $\%O_2$ within a band of (+0.2 / -0.0).

8. When it is safe to do so and when there is adequate load available, start the burner / boiler and let it warm up to operating temperature.

9. Access the O_2 Ratio Control Curve and the O_2 Control Curve using the following menu path:

   Params & Display > O2 Contr/Alarm > Gas Settings > O2 Control

10. Once the O_2 Control Curve is entered, Point 2 should be displayed. Pressing Enter again should drive the burner to Point 2 if it is not already there. When the burner is driving to Point 2, a carat (>) will be displayed. Once the burner is at Point 2, a colon (:) will be displayed. If the aux 3 actuator is used for FGR and ***FGR-Mode*** is not set for "Aux3onCurve", a pound (#) indicates the aux 3 actuator has not released to the curve.

11. The AZL52 will then prompt "when value stable, continue with ENTER". After the burner is at Point 2, wait at least an additional 30 seconds to make sure that the O_2 value being read is representative of Point 2, then press Enter. Pressing Enter stores the O_2 Ratio Control Curve point. The value that is stored should be close (+/- 0.2%) to the "saved" value that was recorded for Point 2 during Ratio Control Curve commissioning.

    NOTE: It is important to wait long enough to get a steady-state O_2 value before Enter is pressed. If in doubt, wait longer for the value to stabilize. Waiting longer than necessary has no ill effects for the O_2 trim commissioning.

    NOTE: If the O_2 value displayed on the AZL52 is not steady (oscillating more than +/- 0.1% O_2), it is likely that the O_2 sensor is not mounted correctly, or there are other issues with the burner / boiler that are affecting the fuel / air ratio. These issues must be corrected before proceeding.

12. Next, slowly increase the StandardVal number, which reduces the air flow into the burner. The reading beside O2 Control should start to drop as StandardVal is increased. Note that the Tau time of the boiler comes into play here, so it may take 10-15 seconds or more for a change in the StandardVal number to be seen in the O_2 reading.

13. Once the StandardVal number has been increased enough to get the $\%O_2$ at least 0.5% below the O_2 Ratio Control Curve, the point can be stored. This is done by pressing Enter, Escape, and then Enter again.

    NOTE: If the Ratio Control Curve point was saved 0.5% O_2 above the target $\%O_2$ (see step 3 above), then lowering the $\%O_2$ by 0.5% using the StandardVal should put the O_2 Control Curve point on or very close to the target $\%O_2$.

14. After the point is stored, the delay time at Point 2 (***Tau Low-Fire***) will be measured. This should occur and the AZL52 should state "Measurement Successful, Control Parameters Stored".

15. The rest of the Points (3 thru 10) can now be done in a similar manner. The delay time (***Tau High-Fire***) will also be measured at the high fire point, in this case Point 10.

16. After the delay time is successfully measured at Point 10, escape out of the O_2 control curve. See Figures 6-6 and 6-7 below for an example of what typical O_2 trim curves and Lambda Factor curves might look like for this application.

17. If the burner must always be run with either temperature compensation or O_2 trim (most ultra-low NOx mesh burners):

    a. Limit the low fire to the load number at Point 2. This can be done by setting parameter ***MinLoadGas*** to the load number of Point 2 using the following menu path:

    Params & Display > RatioControl > Gas Settings > LoadLimits > MinLoadGas

b. Make the burner drive to Point 2 immediately after light off. This can be done by setting parameter ***StartPointOp*** to 2 using the following menu path:

Params & Display > RatioControl > Gas Settings > StartPointOp = **2**

18. If the burner needs air temperature compensation after light off (most ultra-low NOx mesh burners), activate air temperature compensation. Multiple modes of temperature compensation are available; the most often used mode is "IgnPtWithTC". This mode will enable temperature compensation after light off and at Point 2 before the O_2 trim engages. Temperature compensated light off can be activated using the following menu path:

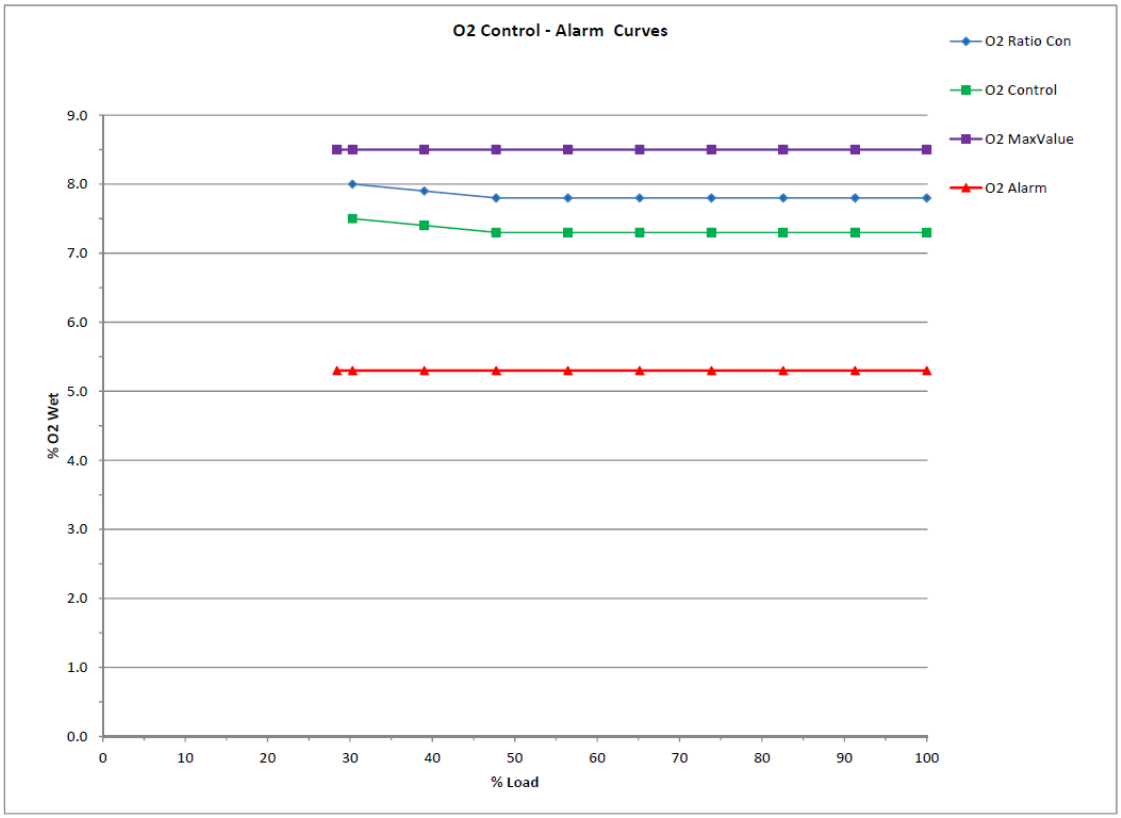
Params & Display > O2Contr/Alarm > Gas Settings > Startmode > Startmode

NOTE: Air temperature compensation requires an air temperature sensor wired to the LMV52.440. See "O_2 Trim Configuration (Parameterization) Before Commissioning" above for more information.

19. The O_2 trim can now be activated in one of two modes. Mode "conAutoDeac" allows the O_2 trim to work as long as the measured %O_2 does not exceed the rich limit (***O_2 Alarm***) or the lean limit (***O_2 MaxValue).*** If either of these limits is exceeded, the O_2 trim will deactivate and the burner will run on the normal Ratio Control Curves. Mode "O2 Control" also allows the O_2 trim to work, except that if the limits are exceeded a lockout will occur. Mode "conAutoDeac" is typically used. To set the O_2 control operating mode, use the following menu path:

Params & Display > O2Contr/Alarm > Gas Settings > OptgMode

20. The O_2 trim is now commissioned and activated. Some additional tuning may be required depending on the application. See "Post Commissioning Tuning" later in this section for more information.

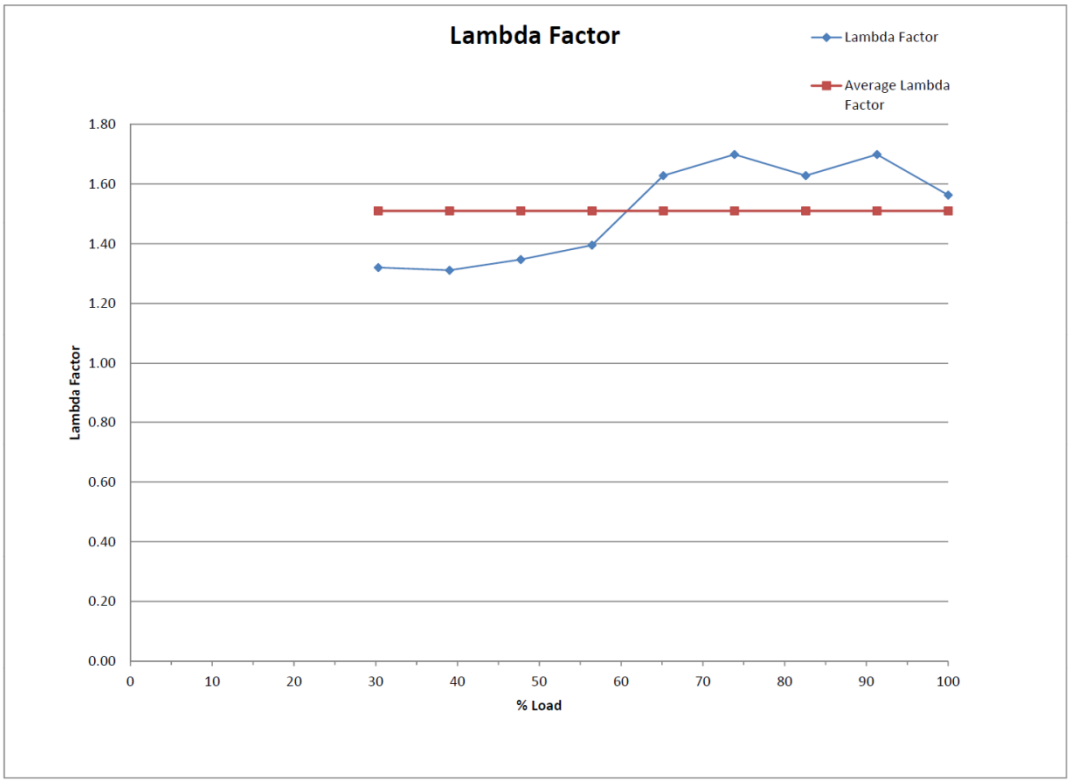


%O2 Control - Alarm Curves																
	From Above		Based on burner capabilities			As saved in the LMV52			Emissions Data from Exhaust Gas Analyzer @ O2 Ratio Control			Emissions Data from Exhaust Gas Analyzer @ O2 Control		
CURVE POINTS (%O2 Control - Alarm)	LMV Curve Point	LMV Load at Curve Point	Target for O2 Control	O2 Alarm (Rich Limit)	O2 MaxValue (Lean Limit)	O2 Ratio Control	O2 Control	Standard Val	O2 (Dry)	CO	Nox	O2 (Dry)	CO	Nox
	#	%	% O2 Wet			% O2 Wet		%	%	PPM	PPM	%	PPM	PPM
	1	28.4	X	5.3	8.5	Cannot trim on Point 1			Cannot trim on Point 1			Cannot trim on Point 1		
	2	30.3	7.5	5.3	8.5	8.0	7.5	3.0	9.0	2.0	4.0	8.5	1.0	5.0
	3	39.0	7.4	5.3	8.5	7.9	7.4	3.0	8.9	1.0	5.0	8.4	0.0	6.0
	4	47.7	7.3	5.3	8.5	7.8	7.3	2.9	8.8	0.0	4.0	8.3	0.0	5.0
	5	56.4	7.3	5.3	8.5	7.8	7.3	2.8	8.8	3.0	3.0	8.3	0.0	5.0
	6	65.2	7.3	5.3	8.5	7.8	7.3	2.4	8.8	0.0	4.0	8.3	1.0	5.0
	7	73.9	7.3	5.3	8.5	7.8	7.3	2.3	8.8	0.0	4.0	8.3	2.0	5.0
	8	82.6	7.3	5.3	8.5	7.8	7.3	2.4	8.8	0.0	4.0	8.3	3.0	5.0
	9	91.3	7.3	5.3	8.5	7.8	7.3	2.3	8.8	1.0	5.0	8.3	5.0	6.0
	10	100.0	7.3	5.3	8.5	7.8	7.3	2.5	8.8	1.0	4.0	8.3	10.0	6.0

Figure 6-6: Example of Typical O_2 Control Curves - Mesh Burner or Nozzle Mix with High % FGR

The curves above illustrate traits that are common to most mesh burners. These are:

- Narrow stability band - typically 3.5% or less
- Curves are flat or nearly flat from low fire to high fire
- 0.5% O_2 between the O_2 Ratio Control Curve and the O_2 Control Curve - minimum to learn Lambda Factor
- O_2 Control Curve close to lean limit - high $\%O_2$ to cool combustion
- Curves are set up for low NOx - efficiency is lower due to high $\%O_2$
- LMV52.440 O_2 trim systems are typically required for this type of setup



LMV52 Load	Lambda Ratio control	Lambda O2 control curve	Lambda Factor	Average Lambda Factor	Standard Dev
30.3	1.68	1.62	1.32	1.51	0.1646359
39.0	1.67	1.61	1.31	1.51	
47.7	1.66	1.59	1.35	1.51	
56.4	1.66	1.59	1.40	1.51	
65.2	1.66	1.59	1.63	1.51	
73.9	1.66	1.59	1.70	1.51	
82.6	1.66	1.59	1.63	1.51	
91.3	1.66	1.59	1.70	1.51	
100.0	1.66	1.59	1.56	1.51	

Figure 6-7: Example of Typical Lambda Factor for O_2 Control Curves in Figure 6-6 (above)

The Lambda Factor curves serve as a tool to evaluate how accurate and repeatable the fundamental mechanical systems of the burner are and how well all the curves were commissioned. In general, the Lambda Factor curve should be as constant or "flat" as possible. The actual numerical value is not important, but the consistency between points is. An approximate guide for evaluation of the Lambda Factor:

- Difference in Lambda Factor between adjacent points -> lower numbers are better. Max = 0.45 (Higher numbers may lead to O_2 trim deactivations on some burners during modulation).
- Standard Deviation of all points on the curve -> lower numbers are better. Max = 0.40 (Higher numbers may lead to O_2 trim deactivations on some burners during modulation).

Post Commissioning Tuning

After the O_2 curves have been set up according to the procedures above, some additional burner / boiler specific tuning may be necessary to keep the O_2 trim operating properly. When and how to use these tuning parameters is discussed below.

LoadCtrlSuspend **-** This sets the load change that is necessary to make the O_2 trim transition from active O_2 trim to pre-control. Many factors influence the setting of this parameter.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Control Param*

Higher settings (more active trim, less pre-control) can help the O_2 trim stay close to setpoint in the following situations:

1. The O_2 Control Curve is relatively flat from low fire to high fire (varies less than 0.5% O_2)
2. The modulation ramp time is slow (***OperatRampMod*** is set to 60 seconds or more)
3. The delay time (Tau time) of the boiler is relatively fast (***Tau Low-Fire*** is set to 7 seconds or less)

Lower settings (less active trim, more pre-control) can help the O_2 trim stay close to setpoint in the following situations:

1. The O_2 Control Curve slopes from low fire to high fire (varies more than 0.5% O_2)
2. The modulation ramp time is fast (***OperatRampMod*** is set to 30 seconds)
3. The delay time (Tau time) of the boiler is slow (***Tau Low-Fire*** is set for more than 7 seconds)

O2TrimBehavior **-** If parameter ***Startmode*** is set to "standard", this setting controls how the O_2 trim responds if the measured O_2 value starts to move away from the O_2 setpoint significantly.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Control Param*

1. A setting of "ForcedAirAdd" will help if deactivations are due to the rich limit (O_2 alarm) since air will be added more aggressively.
2. A setting of "ForcedAirRed" will help if deactivations are due to the lean limit (***O2 MaxValue***) since air will be subtracted more aggressively.
3. A setting of "symmetric" is used when the rich limit (O_2 alarm) and the lean limit (***O2 MaxValue***) are relatively close together, and an aggressive correction in one direction might cause a deactivation due to the other limit.

NOTE: On an LMV52.440 with the *StartMode* set to something other than "standard", the setting of *O2TrimBehavior* has no effect.

O2ModOffset **-** During a load change when the pre-control becomes active (see ***LoadCtrlSuspend***), this will temporarily add more air beyond what is prescribed by the Lambda Factor. Increasing this setting can help with rich limit (O_2 alarm) deactivations during modulation, but this parameter should not be used as a substitute for proper O_2 trim commissioning procedures.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Control Param*

O2MaxManVariable* and *O2MinManVariable – These parameters set how much the O_2 system can trim in an attempt to achieve the O_2 setpoint - essentially the trim limits for the O_2 system. ***O2MaxManVariable*** sets how much the system can increase the air rate. Likewise, ***O2MinManVariable*** sets how much the system can decrease the air rate.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Control Param*

These trim limits must be set so that the O_2 system can achieve the O_2 setpoint. However, the limits should not be set in a way that allows the burner to run at an unsafe fuel-air ratio.

Ideally, the O_2 trim system must compensate for two main environmental conditions. These conditions are ambient air temperature and barometric pressure. Figure 6-8 illustrates how much the manipulated variable needs to change to compensate for these environmental conditions. The chart in Figure 6-8 and the example in Figure 6-9 serve as a guideline for setting the ***O2MaxManVariable*** and ***O2MinManVariable*** parameters.

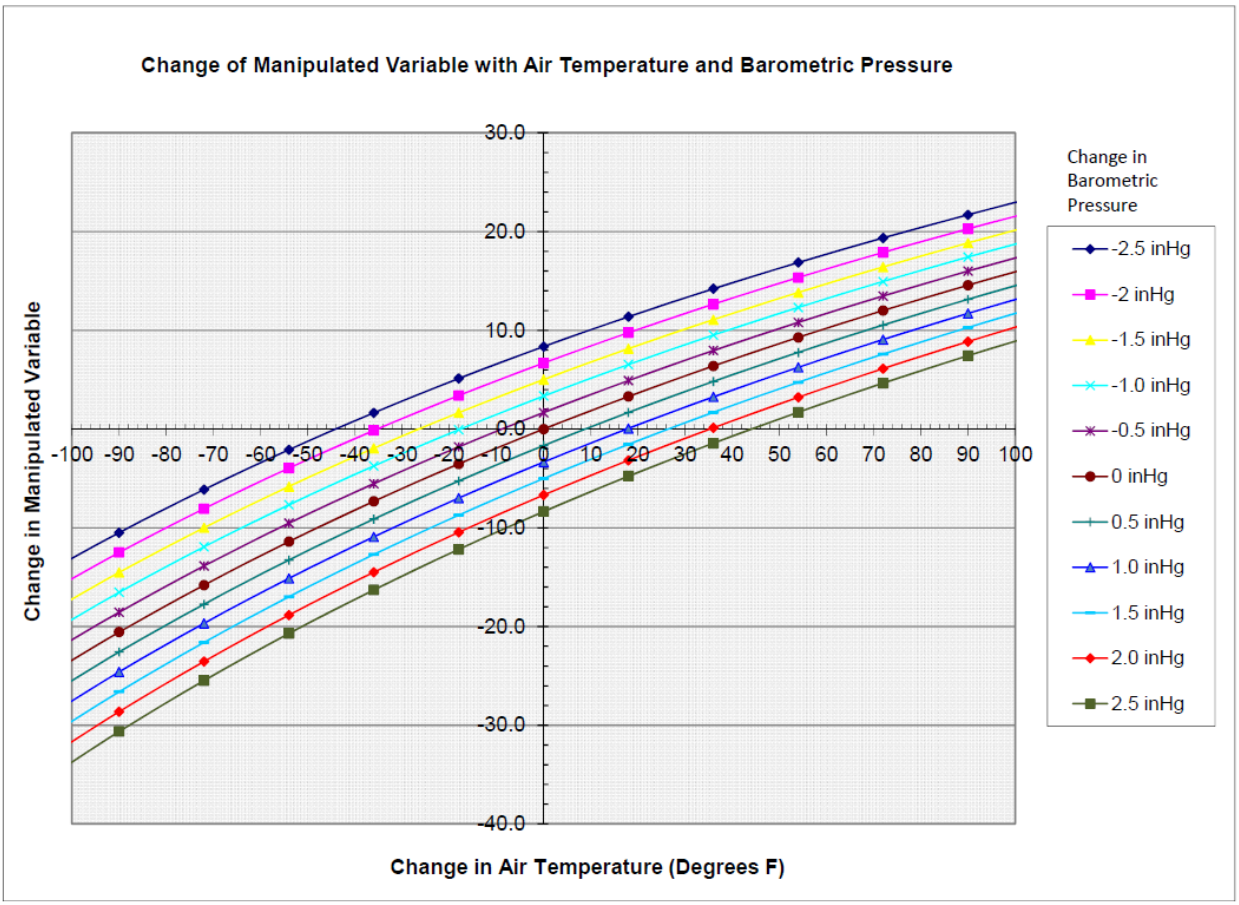


Figure 6-8: Theoretical Change of the Manipulated Variable with Changes in Ambient Temperature and Pressure

When the O_2 Control Curve is commissioned, all burners will be at (0, 0) on the chart, where the X-axis and Y-axis cross. As air temperature and barometric pressure change from the air temperature and

barometric pressure that existed during O_2 Control Curve commissioning, the manipulated variable must change to keep the same $\%O_2$ in the stack. An example is done below and illustrated in Figure 6-9:

Air temperature during O_2 Control Curve commissioning = 80°F
Barometric pressure during O_2 Control Curve commissioning = 30.0 inHg

Maximum expected air temperature = 120°F (+40°F compared to commissioning)
Minimum expected air temperature = 30°F (-50°F compared to commissioning)
Maximum expected barometric pressure = 31.5 inHg (+1.5 inHg compared to commissioning)
Minimum expected barometric pressure = 28.0 inHg (-2.0 inHg compared to commissioning)

Using Figure 6-8 and the information above, the following values can be found:

O2MaxManVariable = 13
O2MinManVariable = -16

Since other small factors exist that can change (heating value of the fuel, change in draft, etc.), it is suggested that an additional 5% are added to the max and subtracted from the min, giving the following settings:

O2MaxManVariable = 18
O2MinManVariable = -21

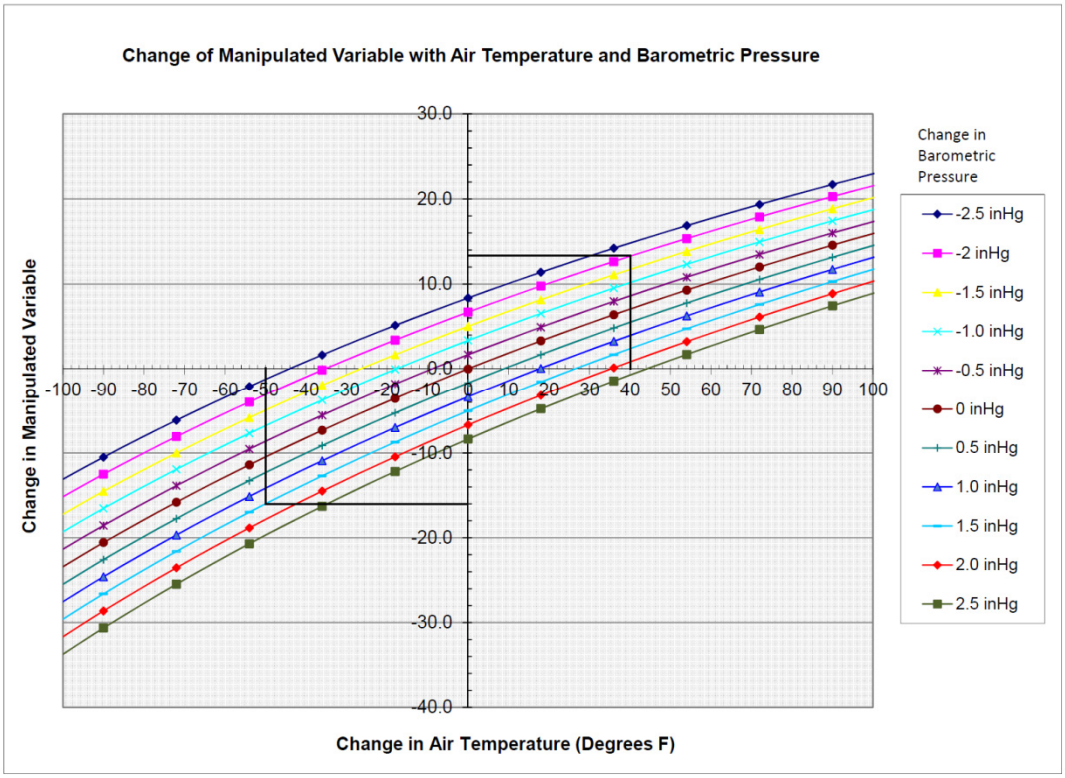


Figure 6-9: Finding the Theoretical Max and Min Manipulated Variable for Given Conditions

NumberTauSuspend* -** The length of time after main flame light-off that is required until an accurate, representative O_2 value is read by the O_2 sensor. Basically, the time it takes to replace all of the air in the boiler with products of combustion. This parameter is a multiplier that is taken times the delay time at low fire (Tau Low-Fire***) to determine the length of waiting time before a representative O_2 value is measured and the O_2 trim can engage.

If ***Tau Low-Fire*** was read to be 5 seconds during O_2 Control Curve commissioning, and ***NumberTauSuspend*** is set to 10, then the O_2 trim would engage 50 seconds after main flame light-off.

A setting of 10 will work for almost all applications, and will be conservative for most. Higher numbers (more waiting time) are more conservative and lower numbers are less conservative.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Startmode*

***Startmode* -** This determines how the burner transitions from light-off to engaging the O_2 trim. Two of the modes, "Ign Load TC" and "IgnPtWithTC", require a combustion air temperature sensor.

Immediately after main flame light-off, the O_2 sensor does not have a valid reading since the gas path of the boiler is full of air. Some burner designs, most notably ultra-low NOx mesh burners, require some type of compensation at light-off to ensure flame stability before the O_2 sensor has a valid reading. Four options are available:

1. **Standard** - Burner will modulate right after light-off, not waiting for the O_2 trim to engage. O_2 trim will engage after the time defined by ***NumberTauSuspend*** expires at the burner's current load.
2. **Ign Load TC** - This **will** vary the ignition positions (special positions) of the actuators based on the combustion air temperature and also based on a defined load number (parameter ***Load of Ignition***). This also will drive the "temperature compensated" actuators to Point 2 (or whichever point is defined by parameter ***StartPointOp***). The burner will be held in Phase 60 at Point 2 (or whichever point is defined by parameter ***StartPointOp***) until the time defined by ***NumberTauSuspend*** expires. The burner will then be released to modulate with the O_2 trim active.
3. **IgnPtWithTC** - This **will not** vary the ignition positions (special positions) of the actuators based on the combustion air temperature. It will drive the actuators from the temperature-compensated set ignition positions to Point 2 (or whichever point is defined by parameter ***StartPointOp***). The burner will be held in Phase 60 at Point 2 (or whichever point is defined by parameter ***StartPointOp***) until the time defined by ***NumberTauSuspend*** expires. The burner will then be released to modulate with the O_2 trim active.
4. **IgnPtWoutTC** - Similar to "IgnPtWithTC", but less accuracy due to the lack of a combustion air sensor.

On burners with a wide flame stability band, such as traditional nozzle mixing burners with little or no FGR, a ***StartMode*** setting of "standard" typically works well. On burners with a more narrow flame stability band (low and ultra-low NOx mesh burners), "IgnPtWithTC" typically works well.
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Startmode*

O2InitOffset* -** For the other three start modes other than "standard", this is a rich or lean bias that is applied to the temperature compensation. Negative values (-2 to -0.1) will bias the temperature compensation more rich, and positive values (0.1 to 2) will bias the temperature compensation more lean. Note that the units on this are $\%O_2$, so a setting of -2 will offset the O_2 approximately 2% more rich. This offset is dissolved after the O_2 trim becomes active (NumberTauSuspend*** expires).
Menu path: *Params & Display > O2Contr/Alarm > Gas Settings > Startmode*

Observing the Behavior of the O_2 Trim

After the O_2 curves are commissioned and post commissioning tuning is done, the behavior of the O_2 trim can be observed and evaluated to determine if further tuning is necessary.

Current O2 Value and ***O2 Setpoint***
Menu path: *Operation > O2 Module*

Parameters can be toggled between to see how well the O_2 setpoint is being followed at different firing rates and when transitioning between firing rates.

Expected behavior: the difference between the O_2 setpoint and actual value should be slightly more when the burner is transitioning between firing rates and less when not transitioning. As a guideline, the difference should be less than +/- 0.2% O_2 when not transitioning and less than +/-0.4% O_2 when transitioning.

ManVar O2 Ctrl
Menu path: *Params & Display > O2 Contr/Alarm > Process Data*

This parameter shows the amount of trim. The value shown is defined below:
1. A value of 50% indicates no trimming.
2. Values greater than 50% - more air is needed to achieve O_2 setpoint compared to when the O_2 Control Curve was commissioned.
3. Values less than 50% - less air is needed to achieve O_2 setpoint compared to when O_2 Control Curve was commissioned.

Expected behavior: should stay relatively consistent from low fire to high fire. Should change with external changes such as combustion air temperature, barometric pressure, draft, heating value of fuel, air filters becoming dirty, etc.

State O2 Ctrl
Menu path: *Params & Display > O2 Contr/Alarm > Gas/Oil Settings > Process Data*

This parameters identifies the state of the O_2 control. Possible values are:
1. Deactivated – the O_2 control was either manually or automatically deactivated
2. Locked – the manipulated variable (amount of trim) is being held at the last value
3. LockTStart – O_2 control is waiting to engage after light-off (waiting for ***NumberTauSuspend*** to expire)

4. InitContr – O_2 control is preparing to engage but is still locked
5. LockTLoad – O_2 control is engaged but locked (in pre-control) due to a load change
6. Active – O_2 control is actively trimming based on setpoint and measured O_2 value
7. LockTCAct - O_2 control is engaged but locked due to an excursion from setpoint

If the state of the O_2 control is shown as "locked", parameter ***Diag Reg State*** will show the reason why.

Diag Reg State
Menu path: *Params & Display > O2 Contr/Alarm > Gas/Oil Settings > Process Data*

This parameter shows the reason that the O_2 control is locked. Possible values are:
0 – The load is below the load limit set by parameter ***O2 CtrlThreshold***
1 – The load controller is in auto tune
2 – The O_2 sensor is being tested for response (self-check of O_2 sensor)
3 – The fuel-air ratio or O_2 trim curves are being programmed
4 – The measured % O_2 is above the lean limit or below the rich limit
5 – There is an error in the PLL52 module
6 – There is an error in the pre-control

Using the O_2 Alarm Functionality without O_2 Trim

As was previously mentioned, the O_2 system can be run in different modes. The modes are set using parameter ***OptgMode***, which can be found using the following menu path:

Params & Display > O2 Contr/Alarm > Gas/Oil Settings

The available operating modes are:
1. **Man deact** - deactivates all O_2 trim and O_2 alarm functionality. $\%O_2$ value can still be viewed.
2. **O2 Limiter** - Only the O_2 alarm is active. This means that a lockout will occur if the lean limit (***O2 MaxValue***) is exceeded for a time longer than what is set for parameter ***Time O2 Alarm***. Likewise, a lockout will occur if the rich limit (O_2 alarm curve) is exceeded for a time longer than what is set for parameter ***Time O2 Alarm***. No trim functionality is active.
3. **O2 Control** - The same as O2 Limiter, except O_2 trim is now enabled. Exceeding rich or lean limits will cause a lockout in the same way as the O2 Limiter mode.
4. **ConAutoDeac** – In this mode, exceeding the rich or lean limits will not cause an immediate lockout. Exceeding the rich or lean limits will cause the O_2 trim to be temporarily deactivated. After a waiting time of 3 times Tau, the measured $\%O_2$ will be re-evaluated. If the $\%O_2$ is higher than the rich alarm, the O_2 trim will be deactivated. If the $\%O_2$ is lower than the rich alarm, a lockout will occur. The O_2 trim can be automatically deactivated and reactivated the number of times allowed by parameter ***NumMinUntilDeact***. The maximum setting is 5. If more than 5 deactivations and reactivations occur, then the O_2 trim mode will be changed to “auto deact” until the O_2 trim control is manually re-activated.
5. **Auto deact** - indicates that the O_2 trim has been automatically deactivated for some reason. See error codes in Section 7. Do not select this mode.

If only the O_2 alarm function is to be used and the O_2 trim has not been commissioned, a few key parameters must be set. These are:

1. ***O2 MaxValue*** - set to the maximum safe $\%O_2$ (wet) for all points.
2. ***O2 Alarm*** curve - enter the minimum safe $\%O_2$ (wet) for each point.
3. ***Tau Low-FireOEM*** - the delay time of the burner / boiler at low fire
4. ***Tau High-FireOEM*** - the delay time of the burner / boiler at high fire
5. ***OptgMode*** - set to O2 Limiter

If the O_2 trim has not been commissioned, it will be necessary to manually enter ***Tau Low-FireOEM*** and ***Tau High-FireOEM***. These Tau times do not have to be as accurate as if the O_2 trim was being used. These can be manually timed by using the O_2 reading on the AZL (recommended), or typical values can be used. Higher turndown burners will produce longer low fire Tau times. Typically, for a 5-to-1 turndown burner, ***Tau Low-FireOEM*** is between 10-20 seconds. ***Tau High-FireOEM*** is typically 4 seconds or less.

How the O_2 is Measured with the QGO20 Sensor and PLL52 Module

The QGO20 is a Zirconium type sensor that is heated to approximately 1292°F. The high temperatures allow oxygen to diffuse through the Zirconium cell and produce a milli-volt signal. This milli-volt signal is referred to as the Nernst Voltage. The Nernst Voltage that is produced for a given $\%O_2$ is dependent on the concentration of oxygen and the temperature of the Zirconium cell. The PLL52 module reads both the Nernst Voltage and the temperature of the Zirconium cell. With this information, the $\%O_2$ can be accurately determined and sent back to the LMV52 over CANbus.

As well as taking the milli-volt signals and converting these to CANbus data, the PLL52 also serves as the controller for the Zirconium cell's heating element. The PLL52 is also a place to connect the combustion air temperature sensor and the stack gas temperature sensor.

Three milli-volt signals originate in the QGO20:

1. Nernst Voltage from the Zirconium oxide O_2 cell	terminals B1 and M
2. O_2 cell thermocouple signal	terminals B2 and M
3. Cold junction thermocouple compensation	terminals G2 and U3

These three milli-volt signals between the QGO20 and the PLL52 must be run in a separate conduit and / or a shielded cable.

See Section 2 for complete details on wiring the QGO20 to the PLL52.

High voltage wires are also connected from the PLL52 to the QGO20 for the heater. It is very important that these wires are run in a separate conduit away from the milli-volt signals.

NOTE: Never connect the QGO20 heater directly to line voltage! Permanent damage will result to the heating element and the sensor. High voltage wires for the heater to the QGO20 must come from the PLL52 module. See Section 2 for more information.

Also, due to possible interference on the milli-volt signals, the PLL52 must be installed within 30 feet of the QGO20.

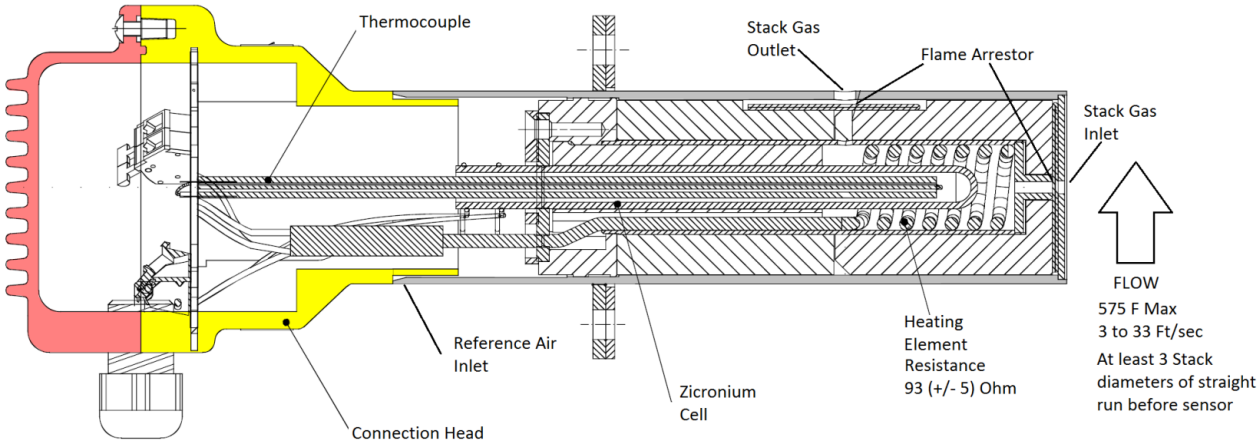


Figure 6-10: Cut-Away View of the QGO20 Sensor (shown without collector)

As previously mentioned, the QGO20 is only capable of measuring $\%O_2$ wet. This is true since it is an in-situ oxygen sensor, not needing any type of water trap, desiccant, or filter. In-situ sensors typically have a much shorter delay time (Tau time) and require much less maintenance than other types of O_2 sensors.

Most hand-held combustion analyzers measure $\%O_2$ dry, and therefore will be considerably different from the $\%O_2$ wet measured by the QGO20 sensor.

Figure 6-11 shows these approximate differences along with the raw milli-volt signal from the Zirconium oxide O_2 cell. As one would expect, the raw milli-volt signal varies with sensor temperature, but this variance is compensated by the PLL52 module so the LMV52 is fed an accurate, compensated O_2 value.

$\%O_2$ Wet	$\%O_2$ Dry (Natural Gas)	Output Voltage (mV) @ 1292 F	Output Voltage (mV) @ 1320 F
0.1	0.1	111.79	113.59
1	1.3	63.61	64.63
1.5	1.9	55.12	56.01
2	2.5	49.10	49.90
2.5	3.1	44.43	45.15
3	3.8	40.62	41.27
3.5	4.4	37.39	38.00
4	5.0	34.60	35.16
4.5	5.6	32.13	32.65
5	6.3	29.93	30.41
5.5	6.9	27.93	28.39
6	7.5	26.11	26.54
6.5	8.1	24.44	24.83
7	8.7	22.89	23.26
7.5	9.3	21.44	21.79
8	9.9	20.09	20.42
8.5	10.6	18.83	19.13
9	11.2	17.63	17.91
10		15.43	15.67
11		13.43	13.65
12		11.61	11.80
13		9.94	10.10
14		8.38	8.52
15		6.94	7.05
16		5.59	5.68
17		4.32	4.39
18		3.13	3.18
19		1.99	2.03
20		0.92	0.94
20.9		0.00	0.00

Figure 6-11: O_2 Wet, O_2 Dry, and Nernst Voltage Conversion (approximate)

Considerations when Using O_2 Trim with FGR

Some burners use a high percentage of FGR (FGR flow compared to air flow) to lower NOx emissions. Since flue gases change in $\%O_2$ and are being drawn back into the blower in significant quantities, these types of burners are inherently more difficult to trim the $\%O_2$ in the stack.

The reason behind this increased difficulty is the oxygen content of the air / FGR mixture is dependent on the $\%O_2$ in the stack, which adds another dynamic variable into the system. On a burner without FGR, the oxygen content of the air at the blower intake is always a constant 20.9% O_2. Naturally, a larger percentage of FGR (20%) has the potential to vary the oxygen content of the air / FGR mixture at the blower intake more than a small percentage of FGR (5%) would.

Moreover, a large percentage of FGR can change the oxygen content of the air / FGR mixture at the blower intake in a way that can set up a "cycle of intensification". An example of this cycle is below:

1. The $\%O_2$ in the stack increases for some reason.
2. The $\%O_2$ in the FGR also increases.
3. The oxygen content of the air / FGR mixture at the blower intake increases, which increases the $\%O_2$ in the stack even more.

Naturally, the example above would also hold if the $\%O_2$ in the stack decreased, except the cycle of intensification would serve to push the burner rich instead of lean.

In addition to the cycle of intensification that is inherent to many FGR burners, the mechanical design of the burner / boiler influences the repeatability of the FGR flow. The repeatability of the FGR flow has a large influence on how well the O_2 trim system can work. Obviously, non-repeatability in the FGR flow will cause non-repeatability in the $\%O_2$ read in the stack and therefore the operation of the O_2 trim.

Two different methods of inducing FGR into a burner are illustrated and explained below, and their behaviors from an FGR flow repeatability standpoint are discussed.

<u>Method shown in Figure 6-12:</u>

Pressure P1 relative to pressure P2 (differential pressure across the FGR damper) changes drastically with firing rate. Very little differential pressure will be generated across the FGR damper at low fire, requiring the FGR damper to be mostly open to achieve even minimal FGR flow at low fire. As firing rate increases, P1 will decrease and P2 will increase, yielding much more differential pressure across the FGR damper. As a result, the FGR damper will need to be ramped closed as the burner is ramped up to high fire. Due to the much higher differential pressure at high fire the FGR damper might be oversized for effective control at high fire. Other points to consider:

1. If using O_2 trim, trimming with the air actuator (set to "air influenced") closed should serve to decrease P1 and decrease the FGR flow slightly (depending on the position of the stack damper).

2. At low fire when the FGR valve is mostly open, even small changes in the differential pressure across the FGR damper will cause large changes in FGR flow.

3. If the fixed air inlet damper and / or the fixed stack damper are adjusted to provide adequate differential pressure across the FGR valve at low fire, pressure drops across these fixed dampers at high fire will be high, requiring a larger blower.

Small pressure changes (pressure inside a boiler room vs the pressure in the stack) are common. These are typically due to doors being opened and closed in the boiler room and convective effects in the stack. Depending on the installation, these changes might be non-existent or they might be as large as 2” WC. With the arrangement shown in Figure 6-12, even small pressure changes can cause the FGR flow to be non-repeatable. A few examples are given below:

Example: At low fire, the differential pressure across the FGR control valve is 0.2" WC. Some external change increases P1 by 0.2” WC. This represents a very small absolute change in pressure, but a 100% change in the differential pressure across the FGR control valve which will lead to a large percentage change in FGR flow.

Example: At high fire, the differential pressure across the FGR control valve is 6.0" WC. Some external influence increases P1 by 0.2” WC. This represents a very small absolute change in pressure and a 3.3% change in differential pressure across the FGR control valve. This will lead to a negligible percentage change in FGR flow.

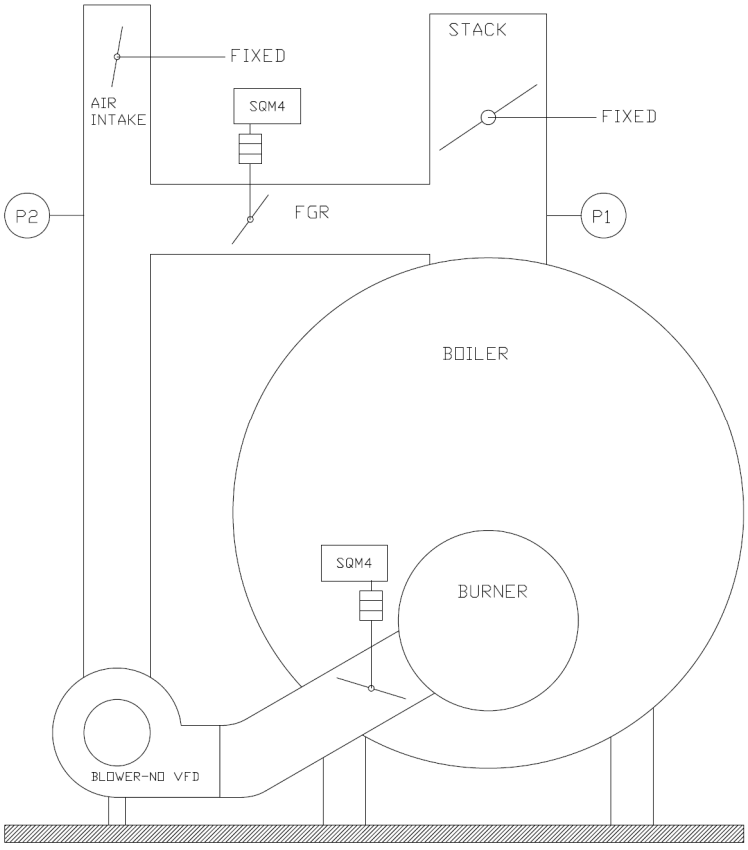


Figure 6-12: FGR Burner with no VFD and an Air Damper on the Blower Outlet

Method shown in Figure 6-13:

Pressure P1 relative to pressure P2 (differential pressure across the FGR damper) is more constant with firing rate. Differential pressure will be generated across the FGR damper at low fire by using the suction of the blower against the air damper. The differential pressure across the FGR damper can also be adjusted with the speed of the VFD. As firing rate increases, P2 will increase (less vacuum) and P1 will increase due to increased pressure behind the stack damper, yielding a more consistent differential pressure. As a result, the FGR damper can be sized more appropriately and should offer better control. Other points to consider:

1. If using O_2 trim, the effect that the trim has on FGR flow can be adjusted. Three possibilities:

    a. If only the air damper is trimmed (set to "air influenced"), trimming closed and reducing air flow will increase the vacuum at P2 and increase FGR flow relative to air flow.

    b. If only the VFD is trimmed (set to "air influenced"), trimming slower and reducing air rate will reduce the vacuum at P2 and reduce the FGR flow relative to the air flow.

    c. If both the air damper and VFD are trimmed (set to "air influenced"), trimming closed should keep the vacuum at P2 relatively constant and keep the FGR flow constant relative to the air flow.

2. Differential pressure across the FGR damper is significant even at low fire due to the vacuum provided by the blower. Small changes in the differential pressure across the FGR damper will cause small changes in FGR flow. FGR flow will be more repeatable as compared to the method in Figure 6-12, especially at low to mid fire.

3. No fixed air dampers exist for the blower intake, and the fixed damper in the stack may be able to be opened further, reducing the blower pressure requirements.

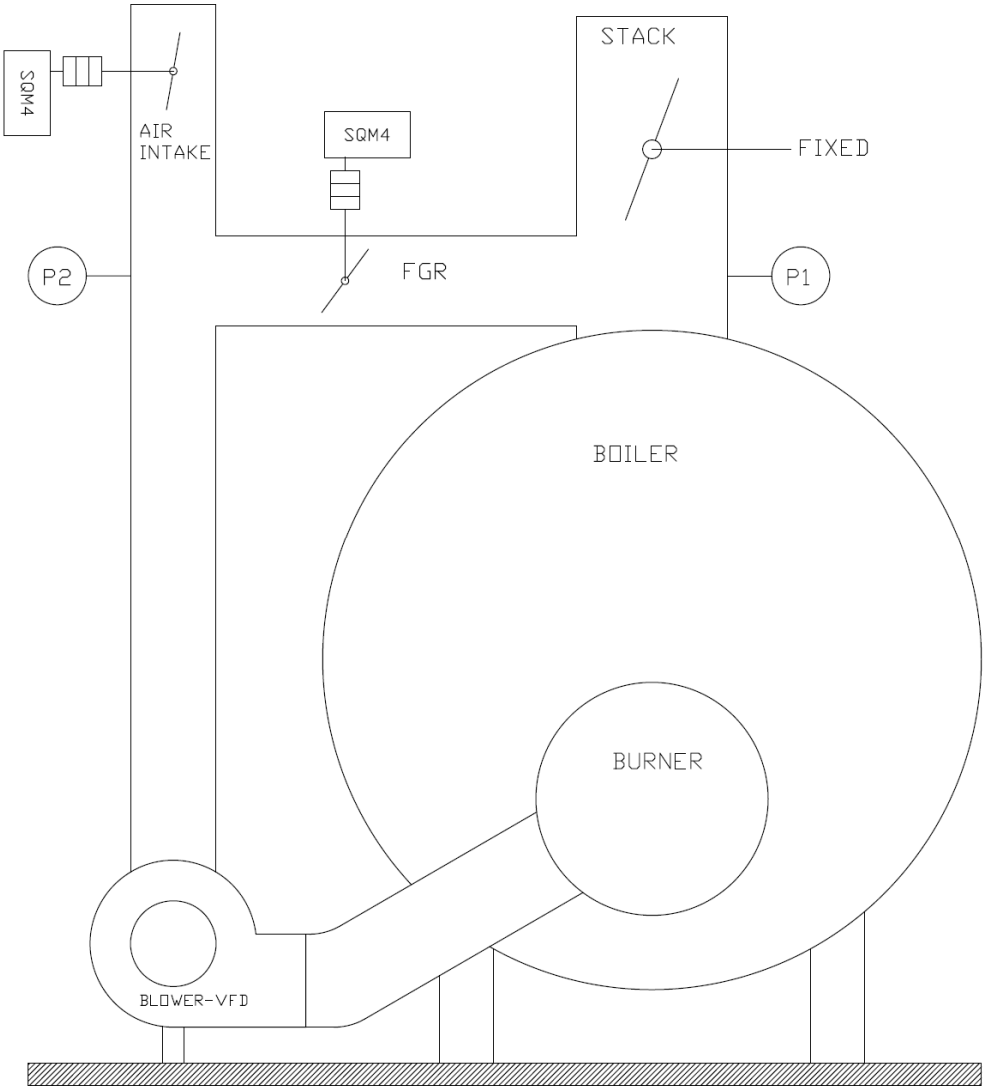


Figure 6-13: FGR Burner with VFD and Air Damper on Blower Inlet

In summary, the arrangement shown in Figure 6-13 is preferable for the following reasons:

1. Better repeatability of FGR flow with slight pressure changes from P1 to P2.
2. Greater adjustability of the FGR to air ratio when trimming.
3. The ability to draw more FGR at lower firing rates.

Additional Tips for O_2 Trim Commissioning and Tuning

- If the AZL52 displays that the O_2 trim has been automatically deactivated, it can be re-activated under the following menu path:

  Operation > O2Ctrl activate

  Repeated deactivations can be caused by many different problems, including inaccurate load numbers.

- All of the points on the O_2 Control Curve should be completed in one session, and the session should be less than an hour. This is preferable, since ambient conditions (air temperature and barometric pressure) typically do not change a significant amount in one hour.

- Every point on the O_2 Ratio Control Curve must have a corresponding point on the rich limit (O_2 alarm) curve. For Point 2 and above, every point on the O_2 Ratio Control Curve must also have a corresponding point on the O_2 Control Curve. If this is not done, an immediate O_2 trim deactivation will occur.

- If a point on the O_2 Ratio Control Curve is changed (actuator positions), the corresponding point on the O_2 Control Curve will be deleted. The O_2 trim will automatically deactivate and cannot be re-activated if points are missing on any of the curves (O_2 Ratio Control, O_2 Control, O_2 Alarm).

- Considering the items above, if one point is changed on the O_2 Ratio Control Curve, then the O_2 Ratio Control Curve and the O_2 Control Curve should be redone so that the Lambda Factor at each point is known to be based on the same ambient conditions. Setting the O_2 Ratio Control Curve and the O_2 Control Curve in a piecemeal fashion typically does not yield reliable O_2 trim operation.

- The LMV52.240 can only decrease the air influencing actuator positions below their settings on the O_2 Ratio Control Curve. This is typically not an issue if the gap between the O_2 Ratio Control Curve and the O_2 Control Curve is large enough (1%). The LMV52.440 can increase or decrease the air influencing actuator positions, so the gap between the O_2 Ratio Control Curve and the O_2 Control Curve can be smaller (0.5%). This also gives the LMV52.440 the ability to deal with more challenging applications such as FGR and low NOx mesh burners.

- Most burners will flame fail in a safe way if operated too lean. However, overly lean operation may be hazardous for some burner designs. If one of these burners is encountered, the O_2 Ratio Control Curve can be set to function as the lean limit using the following menu path:

  Params & Display > O2Contr/Alarm > Gas/Oil Settings > O2 Alarm > Type O2 MaxValue

  Set this to “O2MaxCurve”. For this type of burner it is also recommended to set the operating mode of the O_2 trim to “O2 Control”, so a lockout will occur if the lean limit is reached.

  Params & Display > O2Contr/Alarm > Gas/Oil Settings > OptgMode = **O2 Control**

- If a combustion air temperature sensor is installed and activated, the air temperature will be recorded when the last point is entered into the O_2 Control Curve. This temperature is stored under the following menu path:

  Params & Display > O2Contr/Alarm > Gas/Oil Settings > Startmode > Adjust. Temp O2

  This is the temperature that will be compared against the current air temperature to perform temperature compensated light-off if parameter ***StartMode*** is set to "IgnLoadTC" or "IgnPtWithTC" (LMV52.440 only).

- When terminal X5-03.2 is properly configured (see Section 3 - Parameters), it can be energized to cause a deactivation of the O_2 trim. When this is done, the LMV52 will operate on the O_2 Ratio Control Curve. The O_2 rich and lean limits will be active as long as there is a valid O_2 signal. This deactivation via X5-03.2 occurs without a notification being displayed on the AZL52.

- Pre-purge must be set so that 20.9% (+/- 2.0% O_2) is read by the QGO20 sensor. If this is not met, a lockout or deactivation will occur depending on the setting of parameter ***OptgMode***.

- When using the LMV52.440 on low or ultra-low NOx mesh burners, a ***StartMode*** of "IgnPtWithTC" is typically used combined with adjusting ***O2InitOffset*** in the negative direction (more rich). If done properly, this should make the transition from light-off position to low fire richer than normal operation so that the transition is stable and reliable under varying environmental conditions. While the burner is being held at Point 2 awaiting ***NumberTauSuspend*** to expire, the ***O2InitOffset*** will gradually dissolve and the %O_2 will be trimmed to setpoint before the burner is released to modulate.

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Section 3	Parameters
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Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

Section 1	Overview
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7-1: Troubleshooting Introduction

The LMV5 has an extensive list of fault codes to help clarify the nature of any fault. Section 7-3 describes what every fault code is and gives some guidance on how to correct it.

The most common issues seen on the LMV5 are described in greater detail in Section 7-2 to offer additional troubleshooting help. The issues covered in Section 7-2 are:

General

CANbus Faults Including "*AZL not on Bus*" and "*System Test*" 2
Fault Positioning Actuator – Error Code 15 6
Internal Fault Actuator – Error Code 19 7
Flame Failure – Error Code 25 or 26 8
Open Circuit / Short Circuit Sensor Faults – Error Code A6 (Diagnostics 50…5A) 9
Open Safety Loop – Error Code 21 10
LMV5 Will Not Start (Stays in Phase 12) 11
LMV5 Will Not Modulate Properly 12

O2 Trim

O_2 Sensor is Not Reading 13
O_2 Sensor Reading Grossly High or Low 14
O_2 Sensor Reads But Responds Very Slowly 14
Ambient or Stack Temperature Sensor Reading Incorrectly 15
AZL says "*O2 Module not active or not Available*" 15
AZL Says "*O2 Setpoint must lie 0.1% below O2 Ratio Control" or "O2 Setpoint must lie 0.1% above O2 Min*" 16
AZL Says "*Measurement not Successful*" When Measuring the Delay Time for O_2 Trim 17
AZL Says "*O2 Trim Control Automatically Deactivated*" 18

Variable Speed Drive (VSD)

VSD Will Not Operate 19
Unsuccessful VSD Standardization 20
AZL Says "*Fan Speed Not Reached*" or "*Control Range Limitation VSD Module*" 22

7-2: Common Problems

CANbus Faults Including "*AZL not on Bus*" and "*System Test*"

The majority of all LMV5 wiring errors are related to the wiring of the CANbus network. The CANbus network includes the following components:

- LMV5 controller
- AGG5.210 transformer(s)
- One main fuse (FU1) and two 12VAC fuses (FU2, FU3)
- AZL display
- AGG5.643 special CANbus cable
- SQM45/48/91 actuators
- PLL52 O_2 module (if equipped)

An illustration of the CANbus network with a single transformer is shown below in Figure 7-2.1.

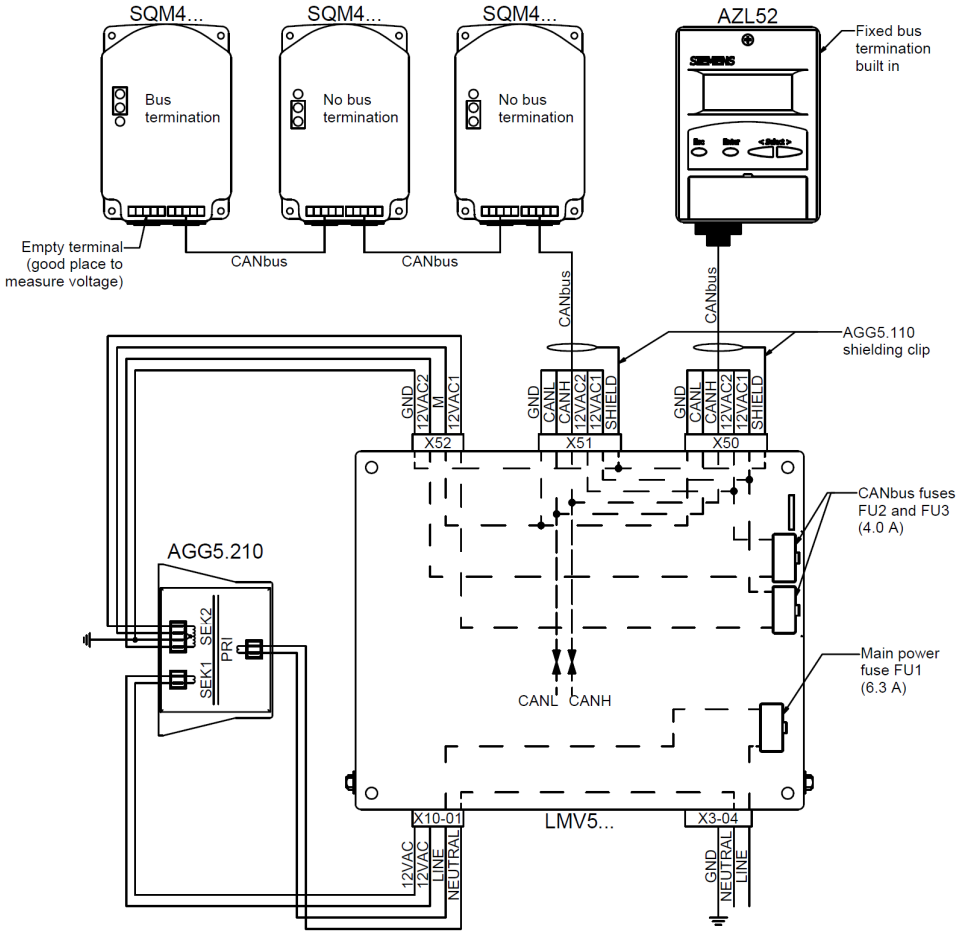


Figure 7-2.1: Illustration of the LMV5 CANbus Network

CANbus Faults Including "*AZL not on Bus*" and "*System Test*" (continued)

The most common CANbus errors are:

- "AZL not on Bus"
- Stuck in "System Test"
- Error code 99
- Error code A7, diagnostic 17

However, there are many additional error codes that can also be caused by an issue with the CANbus network. The following procedure can be used to diagnose any CANbus related error:

1. Take the cover off of the last actuator (or PLL52 O_2 module) on the CANbus network wired to terminal X51 on the LMV5. This should have only one 5-pin green connector plugged into it. The other CANbus terminals should be empty, and is a perfect place to measure voltage. Ensure that the following voltages are present on the pins of the empty CANbus terminal:

   - 12 VAC between pins 12VAC1 and GND
   - 12 VAC between pins 12VAC2 and GND
   - 24 VAC between pins 12VAC1 and 12VAC2

   When measuring to ground (GND), it is ok to have anywhere from 10.2-13.2 VAC as long as both measurements are the same. For example, it is okay to have 11 VAC between pins 12VAC1 and GND as long as there is also 11 VAC between pins 12VAC2 and GND. In addition, the voltage between pins 12VAC1 and 12VAC2 must be exactly double the other two measurements. If these three voltage measurements are correct, skip to step 3.

2. If one or more of the voltage measurements is incorrect, check the following:

   - CANbus fuses FU2 and FU3 are located on the right hand side of the LMV5. Check that these fuses are not blown. If either one is blown, check the LMV5 wiring for incorrect terminations. Once any wiring errors have been fixed, replace the blown fuse.
   - The most common wiring error has to do with pins 3 and 4 on transformer terminal SEK2. Pin 3 on terminal SEK2 should be wired to terminal X52, pin 4 on the LMV5. Pin 4 on terminal SEK2 should be wired to terminal X52, pin 3 on the LMV5.
   - Make sure pin 3 on terminal SEK2 of the transformer is grounded properly.
   - Make sure the rest of the CANbus network is wired properly. See Section 2 for additional wiring assistance.

CANbus Faults Including "*AZL not on Bus*" and "*System Test*" (continued)

3. Check the LMV5 fault history. If the faults always occur in phase 38, the CANbus errors are being caused by noise from the ignition transformer. Make sure the ignition transformer is grounded properly and has a good neutral. Also, make sure any CANbus wires that run close to the ignition transformer are in proper conduit. It may be necessary to either relocate the ignition transformer or add a shield between the ignition transformer and any nearby CANbus wires.

4. Unplug the 6-pin green connector plugged into terminal X51 on the top of the LMV5. This leaves the AZL, the LMV5, and the cable between them as the only CANbus components still plugged in. Reset the fault on the LMV5. At this point, two things can happen:

    - If the AZL faults with "Fault Feedback Air Actuator", then the AZL, the LMV5, and the cable between them are all working properly. This means that there is likely an issue with the wiring of the actuators or O_2 module. Go to step 5.

    - If the same CANbus fault recurs, then there is a problem with the AZL, the LMV5, or the cable between them. Check the wiring and terminations on the cable. Though unlikely, the AZL or the LMV5 might be damaged and need to be replaced. If a spare AZL is available, try it. If no spare AZL is present, check for any noticeable damage to either the AZL or the LMV5 to determine which component to replace.

5. To find the wiring issue with the actuators or O_2 module, plug components back in one at a time to terminal X51 on the LMV5 to determine which component is causing the CANbus errors. First, plug in <u>just the cable (unplugged from the actuator)</u> that connects the first actuator to terminal X51 on the LMV5. Reset the fault on the LMV5. If "Fault Feedback Air Actuator" shows up again, the cable itself is okay. Next, plug in <u>just the first actuator (unplugged from the cable running to the second actuator)</u>. Reset the fault on the LMV5. As long as actuator feedback faults continue to show up after each component is plugged in and the LMV5 is reset, continue to plug in another component. At some point, plugging in a component should cause the CANbus fault to recur.

6. Once the component causing the CANbus errors has been found, check the following to correct the problem:

    - Make sure all terminations to the actuator are done properly and no wire strands from adjacent pins are touching one another and causing a short.

CANbus Faults Including "*AZL not on Bus*" and "*System Test*" (continued)

- Make sure the shielding of the CANbus cable is grounded properly. The shielding of the CANbus cable is immediately under the plastic sheathing and encircles all five conductors. The shielding on all segments of the CANbus cable must have continuity with terminal X51.1. This can be checked with a multi-meter by connecting one probe on the AGG5.110 shielding clip attached to terminal X51.1, and the other probe on the last actuator (or O_2 module) on the CANbus network.

- If everything else checks out, and every time one of the actuators is plugged in it immediately causes a CANbus fault, replace the appropriate actuator.

Fault Positioning Actuator – Error Code 15

An error code 15 essentially means that an actuator has not reached the position it is being told to drive to by the LMV5. The diagnostic code will detail which actuator is having the problem. If an error code 15 is encountered, check for the following causes:

1. **Binding.** At full torque output, the actuator cannot move the valve or damper it is trying to move. This is typically due to the actuator pushing against mechanical stops on the valve or damper. Check that the actuator was properly coupled. This may also be caused by a valve or damper that requires more torque than the actuator is capable of.

2. **Temperature.** All SQM… actuators are rated for a maximum operating temperature of 140°F. However, when operating temperatures exceed 120°F, the torque output of the actuator is decreased by 15%. If this is the case, reduce the heat to the actuator.

3. **Duty Cycle.** All SQM… actuators are rated for a 50% duty cycle, meaning that the actuator can only be moving half of the time. Duty cycles over 50% can cause the actuator to overheat which reduces the torque output severely. If the actuator is constantly moving, improve the PID settings and / or adjust parameter ***MinActuatorStep***.

4. **Flutter.** This typically occurs on air or FGR dampers. Highly turbulent flow across a damper blade can cause an alternating torque to be applied to the damper shaft. This in turn puts an alternating torque on the actuator shaft. For example, let's say that the LMV5 is commanding the air actuator to drive to 50.0° which is a highly turbulent spot on the air damper. The following action may be seen:

    - LMV5 sees actuator at 50.3° and repositions it counterclockwise
    - LMV5 sees actuator at 49.7° and repositions it clockwise
    - LMV5 sees actuator at 50.3° and repositions it counterclockwise
    - LMV5 sees actuator at 49.7° and repositions it clockwise

    In this scenario, eventually the LMV5 determines that the actuator cannot reach the 50.0° position and faults with an error code 15. If a flutter is present on the air damper, a constant torque can be applied to the air damper assembly to eliminate the effects of the flutter.

5. **Power.** All of the actuators for the LMV5 run off of 24 VAC power. Measure between terminals 12VAC1 and 12VAC2 on the actuator to ensure there are approximately 24 VAC provided to the actuator throughout the firing range. If there are not, see Section 2 for help on CANbus wiring. Depending on the load requirements of the system, a second transformer may be necessary.

Fault Positioning Actuator – Error Code 15 (continued)

6. If everything else checks out okay, replace the actuator.

Internal Fault Actuator – Error Code 19

SQM45 and SQM48 actuators have dual potentiometers that provide feedback to the LMV5 to verify actuator position. When these two potentiometers disagree, the LMV5 faults with an error code 19. The diagnostic code will detail which actuator is having the problem. If an error code 19 is encountered, check the following:

1. Ensure that parameter ***allowed Pot.diff*** is set to 15. This allows a maximum disagreement of 1.5° between the two potentiometers.

2. If ***allowed Pot.diff*** is set to 15 and the LMV5 continues to receive error code 19, the actuator must be replaced. The likely cause of the damaged actuator is excessive side load on the actuator shaft or excessive vibration. Over time, excessive side load on the actuator shaft can wear down the shaft bearings of the actuator. Since the potentiometers are mounted directly onto the back of the shaft, they will disagree more and more as the shaft bearings wear. Excessive vibration can also cause potentiometer wear and lead to an error code 19.

3. It is imperative that proper couplings are used when mounting actuators. It is highly recommended to use an SCC flexible coupling on all actuators. SCC couplings eliminate excessive side load due to their design. Furthermore, SCC couplings allow up to 1/16” of parallel misalignment and 3° of angular misalignment between the actuator and valve shafts. See Document No. CPBK-1000 for more information on available flexible couplings.

4. It is also important to use a rigid mounting bracket when mounting any actuator. Excessive vibration over time can wear the potentiometer tracks. If the wear is too severe, error code 19 can result. Rigid mounting brackets help to minimize the effects of vibration. SCC offers a wide variety of brackets and fully assembled valve actuator assemblies to ensure proper mounting of actuators. See Section 1 for more details.

Flame Failure – Error Code 25 or 26

If either an error code 25 or error code 26 is encountered, a flame failure has occurred. An error code 25 means that a flame failure occurred during pilot, while an error code 26 means that a flame failure occurred during operation. To remedy either fault, check the following:

1. Increase the flame failure response time through the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigFlameDet > ReacTmeLossFlame

   The LMV5 has a base flame failure response time of 0.8 seconds. The setting of parameter ***ReacTmeLossFlame*** adds an additional 0.2 – 3.2 seconds for a maximum of a 4 second flame failure response time (FFRT).

2. Use a flame source to check if the flame scanner is defective. The flame signal can be viewed using the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigFlameDet > FlameSignal

   Parameter ***FlameSig QRI_B*** can be used to view the flame signal when using an infrared scanner (QRI2…) or an ultraviolet scanner (QRA7…). Parameter ***FlameSig ION*** can be used to view the flame signal when using a flame rod. A flame failure occurs below a 20% flame signal. If the flame signal reads 0% when using a flame source, check the wiring of the scanner. See Section 2 for wiring assistance. If the wiring is correct, replace the defective scanner.

3. If an error code 25 occurred, check the wiring of the ignition transformer and pilot valve. Also, check to make sure any manual shutoff valves are open on the pilot line.

4. If an error code 25 occurred, check the position of the air damper during ignition. This can be viewed using the following menu path:

   Params & Display > RatioControl > Gas Settings > SpecialPositions > IgnitionPos > IgnitionPosAir

   Decrease this position if the pilot flame is being blown out.

5. If an error code 26 occurred, there could be flame signal decay due to glowing refractory inside the boiler. If this is the case, replace the QRI2… infrared scanner with a QRA7… ultraviolet scanner.

Open Circuit / Short Circuit Sensor Faults – Error Code A6 (Diagnostics 50…5A)

An error code A6 (diagnostic code 50…5A) means that the LMV5 is configured for a certain type of sensor, but it is not detecting that the sensor is connected. This means that a parameter in the LMV5 is set incorrectly, the wiring of the sensor is incorrect, or the sensor has failed.

Note: Some of the fault code messages refer to Input 2 or Input 3. Input 2 is terminal X61 which is used for pressure sensors. Input 3 is terminal X62 which is used for remote setpoint and modulation signals.

Check the following:

1. Ensure that the parameters used to program the analog inputs are set correctly:

   - ***LC_OptgMode***
   - ***Sensor Select***
   - ***Ext Inp X61 U/I***
   - ***Ext Inp X62 U/I***

   See Section 3 for information on how these parameters should be set.

2. If all of the above parameters are set correctly, check the wiring of the attached sensors. See Section 2 for information on how to wire sensors to the LMV5.

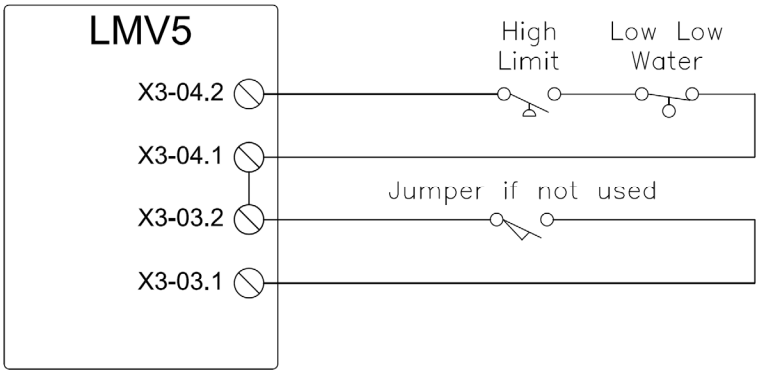
3. On a steam boiler, a temperature sensor can be used in addition to the pressure sensor for the cold start function. If this is the case, check the setting of parameter ***AdditionalSens***. See Section 3 for more information on how to set this parameter.

4. An additional FGR temperature sensor can be installed to perform an FGR hold function. If parameter ***FGR-Mode*** is set to "temperature", "temp.contr.", or "TCautoDeact", an FGR sensor is expected to be wired into terminal X60 or X86, depending on the setting of ***FGR-sensor***. If this parameter is set to X60, check that the sensor is wired correctly.

5. If O_2 trim is being used, an ambient air temperature sensor can be wired into terminal X60. Check the setting of parameter ***AirTempX60PT1000***. If this is set to activated, a Pt1000 temperature sensor is expected to be wired into terminal X60.

Open Safety Loop – Error Code 21

The safety loop is meant only for safety limits such as an auxiliary low water cutout or a high limit. The safety loop must be complete, and cannot be reconfigured. The wiring of the safety loop is shown below:



If an error code 21 is encountered, check the following:

1. **The burner flange switch wired between terminals X3-03.1 and X3-03.2.** There should be 120 VAC on terminal X3-03.1 at all times. If a burner flange switch is not present, a jumper must be placed between terminals X3-03.1 and X3-03.2.

2. **Operating switches in the safety loop**. Operating (cycling) switches should not be wired into the safety loop. If a cycling switch is placed in this loop and it cycles off, the LMV5 will lockout. The cycling switch should be relocated in series with the burner on / off switch wired to X5-03.1:

    - If the LMV5 is in any external load controller mode (*ExtLC*…), this is used to cycle the burner on and off.
    - If the LMV5 is in any internal load controller mode (*IntLC*…), then a cycling switch may not be necessary, since this is done automatically in the LMV5 using parameters ***SD_ModOn*** and ***SD_ModOff***.

3. **The safety loop between terminals X3-04.1 and X3-04.2.** There should be 120 VAC on terminal X3-04.1 at all times. If there is not, then one or more of the devices wired into the safety loop are open. Check each device wired into the safety loop to find which one is open.

LMV5 Will Not Start (Stays in Phase 12)

1. Ensure that the LMV5 is in automatic mode through the following menu path:

   ManualOperation > Autom/Manual/Off = **Automatic**

2. The burner will not start if the safety loop is open. Verify that there is 120 VAC on both terminals X3-03.1 and X3-04.1.

3. Verify that there is 120 VAC at burner switch input terminal X5-03.1.

4. Verify that the LMV5 is not in alarm. If so, correct the issue causing the alarm and reset the fault.

5. Verify that ignition positions are defined for all activated actuators, including the VSD. This can be done through the following menu path:

   Params & Display > RatioControl > Gas/Oil Settings > SpecialPositions > IgnitionPos

6. Verify that the actual value of the boiler is less than the switch on threshold of the burner (setpoint + ***SD_ModOn***).

LMV5 Will Not Modulate Properly

1. Ensure that the LMV5 is in automatic mode through the following menu path:

   ManualOperation > Autom/Manual/Off = **Automatic**

2. Check the PID settings and make sure that they are set for the application.

   P-Part – This is the **proportional band.** The proportional band increases firing rate based on how far below setpoint the temperature / pressure is. Smaller values cause a more aggressive response to a drop in pressure / temperature relative to setpoint. Values that are too small will cause hunting. Typical setting: 10% to 30%.

   I-Part – This is the **integral part**, which serves to eliminate steady state "droop" caused by the proportional band setting. Thus, this works hand in hand with ***P-Part*** to bring the pressure / temperature up to setpoint. Smaller values cause a more aggressive response (a setting of 1 is most aggressive). Values that are too small will cause overshoot. Typical setting: 80 sec to 300 sec. A setting of 0 deactivates the feature, but this is not recommended.

   D-Part – This is the **derivative part**, which serves to eliminate overshoot, and allows a more aggressive integral setting. Larger values cause a more aggressive response. ***D-Part*** is not needed on many steam boilers. If needed, small values of less than 20 typically work well. A setting of 0 deactivates the feature. Large values will typically cause hunting.

3. Check the load limit parameters (***UserMaxLoad***, ***MinLoad***, ***MaxLoad***) to verify that they are not limiting modulation.

4. Check the load mask parameters under each fuel and verify that they are not preventing modulation. These can be checked using the following menu path:

   Params & Display > RatioControl > Gas/Oil Settings > LoadLimits

   Default values are: ***LoadMaskLowLimit*** = 0%, ***LoadMaskHighLimit*** = 0%.

5. If the LMV5 goes to high fire in phase 52, check parameter ***StartPointOp*** under each fuel. This should typically be set to 1 (low fire).

Note: If PID values are set properly, the load should change no more than once every 8 seconds on most installations. If PID values are set improperly, the duty cycle of the SQM… actuator can be exceeded.

O2 Sensor is Not Reading

If the O_2 value on the main screen is displayed as "XXXX", check the following:

1. Ensure that the QGO20 O_2 sensor is activated through the following menu path:

   Params & Display > O2 Module > Configuration > O2 Sensor = **QGO20**

2. The PLL52 O_2 module controls the QGO20 O_2 sensor's heater to achieve a sensor temperature of approximately 1292 ^{o}F. The sensor cannot read %O_2 if the sensor is below 1202 ^{o}F. Check the temperature of the QGO20 sensor through the following menu path:

   Params & Display > O2 Module > Process Data > QGO SensorTemp

   If the temperature is below 1202 °F, check the heating load to the O_2 sensor:

   Params & Display > O2 Module > Process Data > QGO HeatingLoad

   The maximum QGO heating load is 60%. If the heating load is at or near 60%, the QGO20 sensor temperature should be increasing. If it is, the O_2 sensor will begin reading once the temperature is over 1202 °F. If the temperature is not increasing, check the following:

   - The stack velocity may be too high, thus cooling the sensor. The maximum stack velocity is 33 ft / second.
   - The wiring between the O_2 sensor and the PLL52 O_2 module may be incorrect. Refer to Section 2 to check the wiring between the two devices.
   - The heating element in the QGO20 O_2 sensor may be damaged. Measure the resistance between terminals Q4 and Q5 on the QGO20 O_2 sensor. There should be between 5 and 150 Ohms between these terminals. If there is an open circuit between these two terminals, the heating element has been damaged and the QGO20 O_2 sensor needs to be replaced.

Note: The QGO20 sensor can take up to two hours to achieve operating temperature on the initial startup.

O2 Sensor Reading Grossly High or Low

If the O_2 readings from the O_2 sensor are grossly high or low, check the following:

1. The milli-volt signals from the QGO20 to the PLL52 could have interference. Ensure that the high and low voltage wires that run from the QGO20 to the PLL52 are in a separate conduit.

2. The QGO20 sensor reads $\%O_2$ wet. Most combustion analyzers read $\%O_2$ dry, so the O_2 number shown on the AZL52 is typically at least 1% O_2 lower than the combustion analyzer.

3. The QGO20 sensor may be mounted incorrectly, and the sensor is not picking up a representative reading of the $\%O_2$ in the stack.

O2 Sensor Reads But Responds Very Slowly

If the $\%O_2$ being displayed is responding slowly to combustion changes, check the following:

1. Ensure that the QGO20 sensor is clean. This can be done by shutting off the power to the LMV52, and removing the QGO20 from the stack. Be careful as the sensor is likely to be very hot. After the QGO20 is removed from the stack, let it cool for at least an hour.

   After the sensor has cooled, it can be blown out using low pressure compressed air (less than 15 PSIG) through the top of the sensor and out the front. If this is done when the QGO20 sensor is hot, the ceramics inside the sensor will most likely be cracked and the sensor will need to be replaced.

2. Check the orientation of the QGO20 sensor and the AGO20 collector. The one notch on the AGO20 collector's flange should be between the two notches on the QGO20 sensor's flange. Also, ensure that the bevel of the collector is pointed into the flow of the stack gas.

3. Check the internal resistance of the QGO20 sensor using the following menu path:

   Params & Display > O2 Module > Process Data > QGO Resistance

   This value increases as the sensor ages. As the internal resistance increases, the response time of the sensor also increases. A new sensor has 0 Ohms, while the maximum resistance is 150 Ohms, indicating replacement of the sensor is necessary.

Ambient or Stack Temperature Sensor Reading Incorrectly

If the ambient or stack temperature sensor wired into the PLL52 are not reading (displayed as "XXXX" on the AZL screen), or the sensors are reading incorrectly, check the following:

1. Ensure that the sensors are wired into the PLL52 module correctly. See Section 2 to verify proper wiring.

2. Both sensors must be a 2-wire, 1000 Ohm, platinum or nickel RTD. Check to see that the sensors are activated and properly configured under the following menu paths:

   Params & Display > O2 Module > Configuration > SupAirTempSens
   Params & Display > O2 Module > Configuration > FlueGasTempSens

Note: The ambient and stack temperature sensors are not necessary for O_2 trim. However, if one or both inputs are configured for a sensor and either sensor is not reading, the O_2 trim will not activate.

AZL Says "*O2 Module not active or not Available*"

If the AZL displays the message "O2 Module not active or not Available" when trying to access one of the following menus, the LMV52 has lost communication with the PLL52 O_2 module.

Params & Display > O2Contr/Alarm -or-
Params & Display > O2 Module

Check the CANbus wiring between the LMV52 and the PLL52. See Section 2 for wiring assistance. Once communications have been re-established, access to the O_2 menus will be allowed.

To deactivate the O_2 module entirely, use the following menu path:

Params & Display > SystemConfig > O2Ctrl/LimitrGas(Oil) = **man deact**

During O2 Commissioning, AZL Says "*O2 Setpoint must lie 0.1% below O2 Ratio Control" or "O2 Setpoint must lie 0.1% above O2 Min"*

When setting the O_2 control curve, one of the following messages appears:

- *"O2 Setpoint must lie 0.1% below O2 Ratio Control*"
- "*O2 Setpoint must lie 0.1% above O2 Min*".

If this is the case, check the following:

1. Ensure that there is an absolute minimum of 0.2 %O_2 between the O_2 alarm curve and the O_2 ratio control curve at every point on these curves.

2. Also ensure that the %O_2 that is to be set on the O_2 control curve is at least 0.1% O_2 above the O_2 alarm curve and 0.1% O_2 below the O_2 ratio control curve.

Note 1: In most cases, the %O_2 gap between the curves should be larger than the absolute minimum. Depending on the burner characteristic, doing this may also lead to more trouble-free operation. See Section 6 for more information on these curves.

- It is preferable to have a 1 to 1.5% gap between the O_2 alarm curve and the O_2 control curve.
- It is preferable to have a 1.5% gap between the O_2 ratio control curve and the O_2 control curve.

Note 2: When setting up the three O_2 curves, these curves are set using the %O_2 values displayed on the AZL5. These values are given on a wet basis.

A separate combustion analyzer (which typically measures dry %O_2) is required for reference and to monitor CO and NOx production.

AZL Says "*Measurement not Successful*" When Measuring the Delay Time for O2 Trim

When setting the low fire point or the high fire point on the O_2 control curve, the AZL measures what is called the "delay time" (Tau time). The delay time is defined as the length of time it takes a change in the air damper position to be detected by the O_2 sensor. This time is longer at low fire and shorter at high fire due to gas velocity. If an error occurs while trying to measure this delay time, the AZL says "*Measurement not Successful*".

To troubleshoot this, check the following:

1) Verify that ***OptgMode*** is set to "man deact" using the following menu path:

   Params & Display > O2Contr/Alarm > Gas/Oil Settings > OptgMode

2) Verify that ***LowfireAdaptPtNo*** is set to 2 (combustion curve point 2) or higher if desired. By default, this parameter is set to "X" (undefined). The menu path for this parameter is:

   Params & Display > O2Contr/Alarm > Gas/Oil Settings > Control Param > LowfireAdaptPtNo

3) If both of the above parameters are set correctly, then it is possible that the O_2 readings on the ratio control curve were set incorrectly. When setting each point on the O_2 control curve, the LMV5 will prompt with the message "When value stable continue w ENTER". Pressing ENTER then sets the $\%O_2$ for the ratio control curve. If ENTER is pressed too early before the O_2 value has stabilized, a non-representative O_2 value will be entered for the ratio control curve. If this is the case, go back into the O_2 control curve and at each point wait to get a stable reading before pressing ENTER to ensure that the O_2 reading is representative of the current air damper position. 30-60 seconds is not too long to wait once the arrow (>) turns into a colon (:) indicating that the actuators have stopped moving.

AZL Says "*O2 Trim Control Automatically Deactivated*"

Many different problems can cause the O_2 trim control to automatically deactivate. When this happens, check the fault history. The most recent fault will likely be error code BF, diagnostic 00. This is the error code for an automatic deactivation of the O_2 trim. Check the previous error code in the fault history to see what actually caused the automatic deactivation. The most common are:

1. **Error code B5, diagnostic code 01.** This means that the current O_2 value went below the O_2 alarm curve for more than 3 seconds, which caused the O_2 trim to deactivate.

    a. Make sure the load numbers on the Ratio Control Curve match the actual fuel flow. Use a fuel flow meter if possible.

    b. Increase the $\%O_2$ gap between the O_2 Control Curve and the O_2 Alarm Curve at and around the point where the fault occurred (can be determined by the load listed in the fault history).

    Also, parameter ***O2ModOffset*** can be increased in 0.5% increments. Parameter ***LoadCtrlSuspend*** can be decreased in 1% increments. See Section 3 for more information on these parameters.

2. **Error code AB, diagnostic code 15 or 16.** Check the configuration of the ambient and stack temperature sensors. If these sensors are activated and are not wired in or are not functioning correctly, the O_2 trim will automatically deactivate immediately after it is reactivated.

3. **Error code AB, diagnostic code 20.** Check the temperature of the QGO20 sensor using the following menu path:

    Params & Display > O2 Module > Process Data > QGO SensorTemp

    The temperature should be at least 1202 ^{o}F. If the temperature falls below this value during prepurge or anytime during operation, the $\%O_2$ cannot be read and the O_2 trim will automatically deactivate. If this is the case, the QGO20 sensor may be mounted improperly or the gas velocity may be too high.

VSD Will Not Operate

If the VSD will not operate the blower (blower will not spin) when the LMV52 standardization is activated, check the following:

1. Ensure that the VSD is activated through the following menu path in the LMV52:

   Params & Display > RatioControl > Gas/Oil Settings > VSD = **activated**

2. The VSD cannot standardize if the safety loop is open. Check that the safety loop is closed by making sure there is 120 VAC on terminal X3-03.1. If there is not, check the limits in the safety loop and the burner flange to see which limit is open.

3. Ensure that the LMV52 is not in alarm. If so, reset the fault and attempt to standardize again.

4. Verify that the 0/4-20 mA signal and the run/stop contact wired between the VSD and the LMV52 are wired correctly. See Section 2 for more information on wiring.

5. Verify that the three-phase motor wiring between the VSD and the motor is correct.

6. Verify that the VSD is set up properly for the motor it is driving. Specifically, check the following:

   - The VSD should be spanned so that 0/4mA equals 0Hz and 20mA = 62Hz (on a 60 Hz grid frequency). See Section 5 for more information.
   - The VSD is in remote mode so that it looks for a 0/4-20mA signal and a run/stop contact. Closing the run/stop contact should cause the VSD to operate the motor.

7. Disconnect the analog signal and run/stop contact wires between the VSD and the LMV52. Use a handheld 0/4-20mA source and a toggle switch to verify that the VSD responds to a contact closure and a varying 0/4-20mA signal.

   If the VSD does not respond, correct the configuration of the VSD.

   If the VSD responds to the contact closure and the varying 0/4-20mA signal, then go to the next step.

8. With the wires between the LMV52 and VSD still disconnected, use a multi-meter to verify that the LMV52 outputs about 19.5mA during the standardization (see note below). Also verify that the run/stop contact in the LMV52 closes and remains closed during the standardization.

Unsuccessful VSD Standardization

For information on what VSD standardizing is or how to perform standardization, see Section 5.

The standardized speed can be viewed using the following menu path:

Params & Display > VSD Module > Configuration > Speed > StandardizedSp

For a 3600 RPM motor, the standardized speed is typically 3500 +/- 100 RPM. If this is the case, the standardization was successful. If the VSD does not standardize successfully, check the following:

1. The VSD cannot standardize if the safety loop is open. Check that the safety loop is closed by making sure there is 120 VAC on terminal X3-03.1. If there is not, check the limits in the safety loop and the burner flange to see which limit is open.

2. Ensure that the LMV52 is not in alarm. If so, reset the fault and attempt to standardize again.

3. Verify the speed wheel is installed on the blower motor correctly and the gap between the speed sensor and the speed wheel is correct (about 1/16”). Also, use Section 2 to verify that the wiring from the speed sensor to the LMV52 is correct. The yellow LED on the back of the speed sensor should blink every time a speed wheel “finger” passes by the nose of the sensor. If it does not blink, the sensor is wired incorrectly, the sensor is mounted too far from the speed wheel, or the sensor is defective.

4. Check to ensure that the air damper opens when the standardization is activated.
   If this does not happen, set the air actuator to “air influenced” using the following menu path:

   Params & Display > RatioControl > Gas/Oil Settings > AirActuator

5. Check the ramp times on the LMV52 and the VSD.
   The ramp times on the VSD must be faster (shorter) than the ramp times on the LMV52.
   The LMV52 ramp times can be found using the following menu paths:

   Params & Display > RatioControl > Times > OperatRampMod
   Params & Display > RatioControl > Times > TimeNoFlame

   In general, the VSD ramp times should be set about 5 seconds faster (shorter) than the LMV52 ramp times.

Unsuccessful VSD Standardization (continued)

6. Monitor the speed of the blower motor during the standardization process. After standardization is activated, the real time speed can be read using the following menu path:

   Params & Display > VSD Module > Speed > Absolute Speed

   During standardization, the absolute speed should rise up to a peak value and hold steady at that value for a few seconds. Then, the value should drop back down to zero (or near zero).

   The peak value that is seen should be recorded as the standardized speed. If this doesn't happen, it's likely that there's a problem with the VSD or the speed sensor.

AZL Says "*Fan Speed Not Reached*" or "*Control Range Limitation VSD Module*"

During burner operation, the LMV52 sends a 0/4-20 mA signal to the VSD to control the speed of the blower. The speed sensor sends feedback to the LMV52 to let it know the actual speed of the blower. If the speed is too high or too low, the LMV52 will increase or decrease the signal to the VSD accordingly. However, there are limits on how much the LMV52 can increase or decrease the signal. If these limits are met, the LMV52 will lockout with one of the following messages:

- "Fan Speed Not Reached" – Error code 15, diagnostic 10 or 40
- "Control Range Limitation VSD Module" – Error code A9, diagnostic 0D

"*Fan Speed Not Reached*" indicates that the blower speed is still too low even though the LMV52 has increased the 0/4-20mA signal as far as possible.

"*Control Range Limitation VSD Module*" indicates that the blower speed is too high even though the LMV52 has decreased the 0/4-20mA signal as far as possible.

If either of these messages appears, do the following:

1. Increase the ramp times of both the VSD and LMV52. Shorter ramp times on the VSD and LMV52 create a more demanding application for the VSD. Simply put, a shorter ramp time will cause the VSD to draw or absorb much more amperage for a given change in blower speed since the change in speed occurs more quickly. To adjust the ramp times of the LMV52, use the following menu paths:

   Params & Display > RatioControl > Times > OperatRampMod
   Params & Display > RatioControl > Times > TimeNoFlame

2. Large blower motors connected to large, heavy blower wheels have high rotating inertia. As the inertia of the blower wheel increases, the power needed to accelerate and decelerate the blower increases. If increasing the ramp times does not help, a braking resistor may need to be installed on the VSD to help decrease the speed of the blower motor more quickly.

7-3: Complete Error Code List

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
01	01	LMV5	Internal Fault Basic Unit	ROM error	If fault occurs sporadically, reduce electrical noise. If fault occurs continously, replace LMV5.
02	Any #			RAM error	
	01			RAM error in register bank 0 (LMV51...)	
	02			RAM error in IDATA area (LMV51...)	
	03			RAM error in XDATA area (LMV51...)	
	04			RAM error of variables used	
	05			RAM error variable consistency	
	06			RAM error reading back test pattern	
	07			Error RAM test code run	
03	Any #			Error in connection with data comparison (internal communication) between µC1 and µC2	
	01			Timeout during program run synchronization prior to data transmission	
	02			Timeout during data transmission	
	03			CRC error during data transmission	
	05			Timeout during program run synchronization with initialization	
	10			Error counter "Flame intensity outside tolerance" has elapsed	Check flame detector signal. If ok, and fault re-occurs, replace LMV5
	11			Error counter "Target phase unequal" has elapsed	If fault occurs continously, replace LMV5.
	12			Error counter "Reset-lockout input unequal" has elapsed	
	40			Fuel train unequal	
	41			Relay control word unequal	
	42			ROM-CRC signature unequal	
	43			Phase unequal	
	44			(Key + main loop counter) unequal	
04	-			Unsuccessful synchronization of the 2 µCs	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Flame scanner (QRI) or Base Unit (LMV5)					
05	Any #	LMV5 / Flame Dect.	Fault Flame Detector Test	Fault during test of the flame signal amplifier	If fault occurs sporadically: Improve shielding / isolation of flame detector wires. High LMV5 temperatures can also cause this fault. If fault occurs constantly: Lower LMV5 temperature, replace flame detector, or replace LMV5.
	01			Fault during test of the flame signal amplifier	
	02			Crosstalk fault between test pin and flame signal amplifier channel (with LMV52 FSV channel QRI... / QRB...)	
	03			Crosstalk fault between test pin and FSV channel ION (LMV52 only)	
	10			Monitoring of redundancy contact on external high-temperature or flame safegaurd	Check the wiring and the parameters of the external safety limit thermostat / external flame safeguard including the redundancy contact.
Fault with Base Unit (LMV5)					
06	Any #	LMV5	Internal Fault Basic Unit	Fault internal hardware tests	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01			Fault during test of the ignition relay	
	02			Fault during test of the safety relay	
	03			Fault during voltage supervision test	
	04			Relay voltage not switched off after reset	
Fault with devices or wiring connected to the Base Unit (LMV5)					
10	Any #	Devices conn. to LMV5	Internal Fault Basic Unit	Basic unit has detected an improper circuit at one of the outputs, a faulty diode, or a short-circuit in the power supply of the contact feedback network. The diagnostic code indicates the input affected.	1) Check connections of the neutrals to all of the connected switches, valves, etc... 2) Check for inductive loads that cause voltage to be present on the terminal after the LMV de-energizes the terminal. If voltage exists on an output terminal, such as a fuel valve, after the LMV de-energizes the terminal, this will cause a fault. Voltage must drop to zero on the terminal within about 10 ms after the terminal is de-energized.
	01			Load controller on / off	
	02			Fan contact	
	03			Selection of oil-firing	
	04			Selection of gas-firing	
	05			Reset	
	06			Pressure switch oil maximum	
	07			Pressure switch oil minimum	
	08			Pressure switch valve proving	
	09			Safety valve oil feedback	
	0A			Fuel valve 1 oil feedback	
	0B			Fuel valve 2 oil feedback	
	0C			Fuel valve 3 oil feedback	
	0D			Safety valve gas feedback	
	0E			Fuel valve 1 gas feedback	
	0F			Fuel valve 2 gas feedback	
	10			Fuel valve 3 gas feedback	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with devices or wiring connected to the Base Unit (LMV5)					
10	11	Devices conn. to LMV5	Internal Fault Basic Unit	Safety chain burner flange	1) Check connections of the neutrals to all of the connected switches, valves, etc... 2) Check for inductive loads that cause voltage to be present on the terminal after the LMV de-energizes the terminal. If voltage exists on an output terminal, such as a fuel valve, after the LMV de-energizes the terminal, this will cause a fault. Voltage must drop to zero on the terminal within about 10 ms after the terminal is de-energized.
	12			Safety relay feedback	
	13			Pressure switch gas minimum	
	14			Pressure switch gas maximum	
	15			Ignition transformer feedback	
	16			Fan pressure switch	
	17			Start release oil	
	18			Heavy oil direct start	
	19			Load controller open	
	1A			Load controller closed	
	1B			Start release gas	
11	01			Basic unit has detected a short-circuit in the contact feedback network	
Fault with Connected actuators or VSD					
15	Any #	Actuator / VSD Control	Fault Positioning Actuator or Fan Speed Not Reached	LMV5 has detected a positioning error on one or several actuators, or the VSD module if equipped.	**If error occurs on one actuator only :** 1) Ensure torque requirements of dampers / valves are less than actuator output. Actuators running over rated 50% duty cycle may have significantly reduced torque output. 2) Verify that no damper / valve is bound. 3) If 1 and 2 do not solve the problem: replace actuator. **If error occurs on multiple actuators (01-3F) :** 1) Verify that the CANBus wiring is correct. 2) Verify that shields (screens) on CANBus cables are connected properly. **If error occurs on VSD :** 1) Check speed sensor on motor for correct installation, especially gap between sensor and wheel. 2) Check for filters, damping, and / or delays on the input signal to the VSD. The VSD should respond to the input signal in a linear fashion. Extend VSD and LMV5 ramp times.
	01-3F		Fault Positioning Actuator	The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	
	01	Air Actuator		Positioning fault air actuator	
	02	Active Fuel		Positioning fault fuel actuator	
	04	Aux1 Actuator		Positioning fault auxiliary actuator 1	
	08	Aux2 Actuator		Positioning fault auxiliary actuator 2	
	10	VSD module	Fan Speed Not Reached	The fan in combination with the VSD has not reached the required speed	
	20	Aux3 Actuator	Fault Positioning Actuator	Positioning fault auxiliary actuator 3	
	40	VSD Module	Fan Speed Not Reached	The difference of actual value and speed setpoint is greater than permitted by parameter ***TolQuickShutdown***	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) Ratio Control, O2 Trim, VSD					
16	Any #	LMV5	Internal Fault Basic Unit	Basic unit has detected a plausibility fault in the ratio control system.	The diagnostic code describes the cause of the fault (see below).
	00			Ratio curve of the air actuator is not fully defined	Ensure that actuators that are addressed and activated have their positions defined. Check curve points to see if correct values have been entered for the actuator or VSD. Readjust the ratio curve, if required.
	01			Ratio curve of the fuel actuator is not fully defined	
	02			Ratio curve of auxiliary actuator 1 is not fully defined	
	03			Ratio curve of auxiliary actuator 2 is not fully defined	
	04			Ratio curve of auxiliary actuator 3 is not fully defined	
	05			VSD curve is not fully defined	
	0A			Calculated P-part outside the permissible range	Check parameters (P Low-Fire, I Low-Fire, Tau Low Fire, P High-Fire, I High-Fire, Tau High-Fire). These values normally self-set when the delay time is measured. Check the values of these parameters against the maximum and minimum ranges. Readjust O2 control curve if necessary.
	0B			Calculated I-part outside the permissible range	
	0C			Calculated system delay time outside the permissible range	
	0D			Calculated O2 setpoint outside the permissible range	The O2 control curve must be 0.1% O2 lower than the %O2 measured at the ratio control curve, and 0.1% above the O2 alarm curve. Readjust curves.
	0E			Calculated O2 min. value outside the permissible range	
	0F			Calculated O2 ratio value outside the permissible range	
	14			Calculated standardized value lies outside the permissible range	Check if the correct values have been entered for the standardized values. Readjust O2 trim control, if required, or repeat the settings.
	20			With hysteresis compensation: Permissible target positioning range exceeded	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	21			The load / point number predefined by the AZL… lies outside the permissible range	
	22			Unplausible program branch	
	23			Unplausible fuel-air ratio phase	
	40			Unplausible target positions	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
17	Any #	LMV5	Internal Fault Basic Unit	(Internal) communication error of ELV	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	3F			Detection of different data when making the data comparison	
	01			Timeout with program synchronization prior to data transmission	
	02			Timeout with data transmission	
	03			CRC fault during data transmission	
18	Any #		Invalid Curve Data	Corruption in the combustion curve data	Values on curve should be within 0.0% - 100.0% for load and VSD, 0.0° - 90.0° for actuators. If possible, adjust curve values back into the valid range. If this fault occurs on a unit that was functioning correctly after commissioning, replace LMV5.
Fault with Actuator					
19	Any #	Actuator	Internal Fault Actuator	Basic unit (ratio control system) has detected a fault when comparing potentiometer channels A and B. Diagnostic code shows on which actuator the fault occurred. See diagnostic code.	1) If fault occurs constantly: Replace actuator according to diagnostic code. If a solid coupling was being used on the defective actuator, replace with a flexible coupling. After actuator(s) are replaced, make sure that the actuators do not "hunt" during operation. This can be done by adjusting parameter ***MinActuatorStep*** and the PID loop.
	01..2F			The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	
	01	Air Actuator		Fault occurred on the individual actuator (see diagnostic code) when comparing potentiometer channels A and B	
	02	Active Fuel Actuator			
	04	Aux 1 Actuator			
	08	Aux 2 Actuator			
	20	Aux 3 Actuator			

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Actuator (VSD) Positioning or Actuator (VSD) Run Time					
1A	01	LMV5	Slope too steep	A section of actuator curve is too steep.	Check maximum slope sections of actuator curves. Maximum allowable slopes are as follows: - 3.6° per 0.1% load (30 sec ramp) - 1.8° per 0.1% load (60 sec ramp) - 0.9° per 0.1% load (120 sec ramp) If these maximums are exceeded, adjust curve section below these maximum slopes.
1B	Any #		Operation in Parameter Setting Mode quit	Curve parameters (actuator curves) programming mode is still active in phase 62 (drive to low fire and shutdown) and the target positions (normal operation) have not been reached.	When setting the curve parameters, the plant should be operated in manual mode. This prevents the internal load controller from triggering the change to shutdown. Response of the internal temperature limiter can trigger this same fault. However, the curve point currently being set can still be stored in standby or lockout.
1C	Any #		Ignition Pos not defined	Ignition positions for activated actuators (or VSD) have not been set. See diagnostic code to indicate the faulted actuator.	Set the ignition position of the actuator(s). The ignition positions for each fuel are independent, and the positions are also independent of the low fire position.
	01..3F			The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format).	
	01			Ignition position for air actuator not set.	
	02			Ignition position for active fuel actuator not set.	
	04			Ignition position for aux1 actuator not set.	
	08			Ignition position for aux2 actuator not set.	
	10			Ignition position for VSD not set.	
	20			Ignition position for aux3 actuator not set.	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
FAULT WITH POSITIONING AN ACTUATOR OR VSD SPEED					
1D	Any #	Actuator / VSD / LMV5	Fault Running Time	Running time fault of actuators or VSD.	1) Check parameters ***TimeNoFlame*** and ***OperatRampMod***. These should be set to values greater than the ramping time of the attached actuators or VSD. 2) Check connected actuators to determine if their torque rating is being exceeded (stuck damper or valve, etc...). 3) Check the two 12V fuses located under black covers on the right side of the LMV5. 4) Check the CANBus power supply (blue or black transformer) terminal SEK2. Pin 1 and pin 4 should have 12VAC to reference ground which is pin 2. Voltage between pin 1 and pin 4 should be 24VAC.
	01..3F			The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	
	01	Actuator / LMV5	Fault Running Time Air Actuator	Running time fault of air actuator	
	04		Fault Running Time Aux Actuator	Running time fault of auxiliary actuator 1	
	08		Fault Running Time Aux Actuator	Running time fault of auxiliary actuator 2	
	10	VSD / LMV5	Fault Running Time VSD	Running time fault of VSD	
	20	Actuator / LMV5	Fault Running Time Aux Actuator	Running time fault of auxiliary actuator 3	
1E	Any #	Actuator / VSD	Special Pos not reached	Basic unit has detected that one or several actuators (incl. VSD module) has / have not reached the special position pertaining to the phase	1) Check connected actuators to determine if their torque rating is being exceeded (stuck damper or valve, etc...). 2) Check the two 12V fuses located under black covers on the right side of the LMV5 3) Check the CANBus power supply (blue or black transformer) terminal SEK2. Pin 1 and pin 4 should have 12VAC to reference ground which is pin 2. Voltage between pin 1 and pin 4 should be 24VAC. 4) If a VSD is being used, check for filters, damping, and / or delays on the input signal to the VSD. The VSD should respond to the input signal in a linear fashion. See Error Code 15 for more information.
	01..3F	Actuator / VSD		The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	
	01	Actuator		Positioning fault of air actuator	
	02			Positioning fault of active fuel actuator	
	04			Positioning fault of auxiliary actuator 1	
	08			Positioning fault of auxiliary actuator 2	
	10	VSD Module		VSD has not reached the speed	
	20	Actuator		Positioning fault of auxiliary actuator 3	
	40	VSD Module		VSD quick shutdown, as the difference between the speed setpoint and the actual speed exceeds the value permitted in the ***TolQuick Shutdown*** parameter.	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
				Fault with VSD	
1F	Any #	VSD Module	Code for VSD Module Fault	Basic unit has detected a fault in connection with the VSD module	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01		Speed Acquisition faulty	Internal VSD module test was not successful	
	02		Wrong Direction of Rotation	Fan rotates in the wrong direction	1) Check to see if the motor's direction of rotation is correct. Reverse if necessary 2) Check to see if the arrow on the speed wheel points in the correct direction of rotation. Reverse if necessary.
	03		Speed Acquisition faulty	Pulse sequence and length at the speed input were different from those anticipated	1) Check and or adjust the gap between the speed wheel and the sensor. The gap should be about 1/16" (2mm) or about two turns away from the speed wheel. 2) Check the wiring of the speed sensor. Ensure reference ground is connected.
	04		Standardization canceled because of VSD	Fan was not able to keep the standardized speed at a constant level	
	05		Standardization canceled because of Air Actuator	Air actuator (or other air influenced actuator) has not reached the prepurge position. For this reason, speed standardization is not possible	1) Check to see if all air-influencing actuators travel to the prepurge position and remain in that position for the VSD standardization. 2) Ensure torque requirements of air influencing dampers / valves is less than actuator output. 3) Verify that no air influencing damper / valve is bound. 4) Check the two 12V fuses located under black covers on the right side of the LMV5 5) Check the CANBus power supply (blue or black transformer) terminal SEK2. Pin 1 and pin 4 should have 12VAC to reference ground which is pin 2. Voltage between pin 1 and pin 4 should be 24VAC.
	06		Speed Test was not successfully completed	Internal VSD module speed test was not successful	Set parameter ***Settling Time*** to 16. If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	07		Safety loop open	Standardization not possible when safety loop is open	Check all switches wired into the safety loop circuit. This also includes the burner flange circuit.
				Fault with devices or wiring connected to the Base Unit (LMV5)	
21	Any #	Devices conn. to LMV5	Safety Loop open	Limit switches wired into the safety loop have opened (such as low low water or high Limit)	Check all switches wired into the safety loop circuit. This also includes the burner flange circuit.
22	Any #		Internal Temp Limiter has responded	Internal temperature limiter has switched off because the value of parameter ***TL_Thresh_Off*** has been exceeded.	Check the burner / boiler temperature sensor located on terminal X60.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with devices or wiring connected to the Base Unit (LMV5)					
23	Any #	LMV5 / Flame Detect.	Extraneous Light on Startup	Basic unit has detected extraneous light during startup	1) Ensure that the source of extraneous light is not a flame. If it is a flame, take corrective action immediately. 2) If the QRI scanner is used, ambient light can cause an extraneous light error. Ensure sensor is viewing a dark area such as the inside of a boiler. 3) If the QRI scanner is used, check for glowing refractory. If glowing refractor is the cause, the afterburn time may need to be lengthened or a UV scanner may have to be used.
	00				
	01… 03			Basic unit has detected extraneous light during startup 01 = QRI / QRB, 02 = ION / UV, 03 = any (LMV52 only)	
24	Any #		Extraneous Light on Shutdown	Basic unit has detected extraneous light during shutdown	
	00				
	01… 03			Basic unit has detected extraneous light during shutdown 01 = QRI / QRB, 02 = ION / UV, 03 = any (LMV52 only)	
25	Any #	LMV5 / Flame Detect.	No Flame at End of Safety Time	No flame detected at the end of safety time TSA1 or TSA2.	1) With a piloted gas train, this means that the pliot did not light. Check wiring of ignition transformer and pilot valve. 2) Check manual shutoff valves for the pilot gas. 3) Check position of air damper. Close further if necessary. Pilot may be blowing out. 4) Check flame detector for signal in the presence of flame using a flame source. Replace if detector does not generate the anticipated signal.
	00				
	01… 03			No flame detected at the end of safety time TSA1 or TSA2 01 = QRI / QRB, 02 = ION / UV, 03 = any (LMV52 only)	
26	Any #		Loss of Flame	Loss of flame during normal operation (phase 60-62)	1) Check flame detector for signal in the presence of flame using a flame source. Replace if detector does not generate the anticipated signal. 2) Check for flame signal "decay" as burner refractory heats up. If this happens, a UV scanner may be needed. 3) Increase setting of ***ReacTmeLossFlame***.
	00				
	01… 03			(LMV52 only) Loss of flame during normal operation 01 = QRI / QRB, 02 = ION / UV, 03 = any (LMV52 only)	
27	Any #	Devices conn. to LMV5	Air Pressure on	Air pressure = on, but should have been off	1) Make sure blower starts in phase 22 and shuts off in phase 78 or 83 (see sequence diagrams). 2) Check the setpoint on the air pressure switch. Raise setpoint if necessary. Switch should open after postpurge.
28	Any #		Air Pressure off	Air pressure = off, but should have been on	
	00				
	01				The error message may be traced back to an open safety loop / burner flange.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with devices or wiring connected to the Base Unit (LMV5)					
29	Any #	Devices conn. to LMV5	Fan Contactor Contact is on	FCC signal = on, but should have been off	1) If not using FCC, make sure parameter ***FGR-PS/FCC*** is not set to "FCC". 2) If an FCC fault occurs in phase 70, call a Siemens representative. A spark killer may be necessary.
2A	Any #		Fan Contactor Contact is off	FCC signal = off, but should have been on	
	00				
	01				The error message may be traced back to an open safety loop / burner flange.
2B	Any #		Flue Gas Recirculation Pressure Switch on	FGR-PS = on, but should have been off	1) Check setpoint on FGR pressure switch. Adjust if necessary. 2) If a FGR-PS fault occurs in Phase 70, call a siemens representitve. A spark killer may be necessary.
2C	Any #		Flue Gas Recirculation Pressure Switch off	FGR-PS = off, but should have been on	
	00				
	01				The error message may be traced back to an open safety loop / burner flange.
2D	Any #		Valve not open	Closed Position Indicator (CPI) = on, but should have been off	1) Check wiring to the fuel valves. With manual shutoff valves closed, ensure that the fuel valves are opening in the proper phase (see sequence diagrams). 2) Ensure CPI (POC) switches are opening when the valve opens. If this does not happen, check wiring, adjust switch, or replace fuel valve actuator.
	00				
	01			CPI via terminal StartRelease_Gas Closed Position Indicator (CPI) = on, but should have been off	
2E	Any #		Valve or Closed Position Indicator (CPI) open	Closed Position Indicator (CPI) = off, but should have been on	1) Check wiring to the fuel valves. Ensure fuel valves are wired to the correct terminal (see wiring diagram). With manual shutoff valves closed, ensure that the fuel valves are opening in the proper phase (see sequence diagrams). 2) Check wiring of the CPI (POC) switches. See wiring diagram.
	00				
	01			CPI via terminal StartRelease_Gas Closed Position Indicator (CPI) = off, but should have been on	
2F	Any #		Gas Pressure has dropped below minimum Limit	Low gas pressure switch is open	1) Check gas supply and / or manual shutoff valves. 2) Check setpoint and / or wiring of low gas pressure switch.
30	Any #		Gas Pressure has exceeded maximum Limit	High gas pressure switch is open	1) Check pressure regulators for ruptured diaphragms. 2) Check setpoint and / or wiring of high gas pressure switch.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with devices or wiring connected to the Base Unit (LMV5)					
31	Any #	Devices conn. to LMV5	Gas Pressure at Valve proving: Valve on Gas Side leaking	PS(M)-VP (Pressure Switch Valve Proving) has detected pressure between the gas valves during the atmospheric test. Switch opened when should have been closed.	1) Bubble test gas valve to ensure that the upstream valve is not leaking. If leaking, replace valve. 2) Ensure that the setpoint of the PS(M)-VP is 50% of the pressure upstream of V1 (upstream valve).
32			No Gas Pressure Valve Proving: Valve on Burner Side leaking	PS(M)-VP (Pressure Switch Valve Proving) has detected the absence of pressure between the gas valves during the pressure test. Switch closed when should have been open.	1) Bubble test gas valve to ensure that the downstream valve is not leaking. If leaking, replace valve. 2) Ensure that the setpoint of the PS(M)-VP is 50% of the pressure upstream of V1 (upstream valve).
33			Oil Pressure on although Oil Pump off	Low oil pressure switch is closed when oil pump is not running.	1) Configure oil train so that low oil pressure switch is off when the oil pump is not running. 2) Check to ensure switch is wired Normally Open.
34			Oil Pressure below Minimum	Low oil pressure switch is open when oil pump is running.	1) Ensure oil pressure exists at the switch when the oil pump is running. Adjust pressure reg. if needed. 2) Check to ensure switch is wired Normally Open. Check setpoint of switch.
35			Oil Pressure above Maximum	High oil pressure switch is open.	1) Ensure excess oil pressure is not present at the switch. Adjust pressure reg. if needed. 2) Check to ensure switch is wired Normally Closed. Check setpoint of switch.
36			No Start Release for Oil	Switches wired to the start release oil terminal (typically the atomizing media PS) are not closed when anticipated.	1) Check setpoint of switches. 2) Ensure switches are closing and opening at the correct times (see sequence diagram).
37			No direct Heavy Oil direct start	Switches wired to the direct start heavy oil terminal are not closed when anticipated.	
38			Lack of Gas Program	Shortage-of-gas program in progress.	1) If repetition counter is enabled (outside North America), the LMV is waiting for gas pressure to return.
Fault with Base Unit (LMV5)					
39	Any #	LMV5	Internal Fault Basic Unit	Parameter of max. safety time faulty	If fault occurs continuously, replace LMV5.
	01			Fault with timer1	
	02			Fault with timer2	
	03			Fault with timer3	
3A	Any #		No Burner ID defined	No burner identification defined	Enter a unique burner Identification. Typically the burner SN.
3B	Any #		No Service Password defined	No service password defined	Enter a valid service password.
3F	Any #		Error-free	The LMV5 is error-free.	None

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
40	Any #	LMV5	Internal Fault Basic Unit	Wrong contact position of safety relay	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
41	Any #			Wrong contact position of ignition	Check wiring on igniton transformer.
42	Any #			Wrong contact position of a fuel valve relay	1) Check to see if any source is feeding back voltage onto the output. If so, eliminate the voltage source. 2) Check for switches in the safety loop that are opening and closing again very quickly. This could be a pressure switch or a low water cut-out that is on the edge of opening and is "chattering". All outputs are powered through the safety loop, so the microprocessor that monitors the outputs can detect this, resulting in a fault.
	01.. FF			The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	
	01			Contact position fault safety valve (SV) oil	
	02			Contact position fault V1 oil	
	04			Contact position fault V2 oil	
	08			Contact position fault V3 oil	
	10			Contact position fault safety valve (SV) gas	
	20			Contact position fault V1 gas	
	40			Contact position fault V2 gas	
	80			Contact position fault pilot valve (PV) gas	
43	Any #	LMV5	Internal Fault Basic Unit	Fault in connection with plausibility check. For cause of fault, refer to diagnostic code.	If fault occurs sporadically: reduce electrical noise.
	01			No fuel selection	Select a fuel externally (by energizing or de-energizing terminals) or select a fuel through the AZL.
	02		No Fuel Train defined	No defined fuel train parameterized or undefined type of fuel	Select the proper fuel trains for gas and / or oil. See section on settings.
	03		Internal Fault Basic Unit	Variable "Train" not defined	Select a fuel externally (by energizing or de-energizing terminals) or select a fuel through the AZL.
	04			Variable "Fuel" not defined	
	05			Operating mode with load controller not defined	
	06			Prepurge time gas too short	The time defined by ***PrepurgeTmeGas(Oil)*** is less than the time defined by parameter ***MinT_PrepurgeGas(Oil)***. Change so that ***PrepurgeTmeGas(Oil)*** is longer than ***MinT_PrepurgeGas(Oil)***. See section on settings.
	07			Prepurge time oil too short	
	08			Safety time 1 gas too long	The time defined by ***Max SafetyTGas(Oil)*** is less than the time defined by parameter ***SafetyTmeGas(Oil)***. Parameter ***Max SafetyTGas(Oil)*** can only be changed by Siemens. Lengthen ***SafetyTmeGas(Oil)***.
	09			Safety time 1 oil too long	
	0A			Ignition off time > TSA1 gas	If fault occurs sporadically, reduce electrical noise.
	0B			Ignition off time > TSA1 oil	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with devices or wiring connected to the Base Unit (LMV5) / or Base Unit (LMV5)					
43	0C	LMV5	Internal Fault Basic Unit	Safety time 2 gas too long	The time defined by ***Max SafetyTGas(Oil)*** is less than the time defined by parameter ***SafetyTmeGas(Oil)***. Parameter ***Max SafetyTGas(Oil)*** can only be changed by Siemens. Lengthen ***SafetyTmeGas(Oil)***.
	0D			Safety time 2 gas too long	
44	Any #		-	Fault at deactivated inputs	Check inputs according to the diagnostic code. Disconnect wires or activate inputs for the specific application. Information concerning the configuration of the terminals can be found in the settings section.
	01		Controller input connected but deactivated	Controller input (burner on / off switch) connected but deactivated, terminal X5-03.1	
	02		Air Press Switch connected but deactivated	APS connected but deactivated, terminal X3-02.1	
	03		FCC / FGR – APS connected but deactivated	FCC / FGR – PS connected but deactivated, terminal X4-01.3	
	04		Gas Pressure-MIN connected but deactivated	Low gas pressure switch connected but deactivated, terminal X9-03.4	
	05		Gas Pressure-MAX connected but deactivated	High gas pressure switch connected but deactivated, terminal X9-03.3	
	06		Oil Pressure min connected but deactivated	Low oil pressure switch connected but deactivated, terminal X5-01.2	
	07		Oil Pressure max connected but deactivated	High oil pressure switch connected but deactivated, terminal X5-02.2	
	08		Start Signal Oil connected but deactivated	Start release oil connected but deactivated, terminal X6-01.1	
	09		HO Start connected but deactivated	HO start connected but deactivated, terminal X6-01.3	
	0A		Start Signal Gas connected but deactivated	Start signal gas connected but deactivated, terminal X7-03.2	
	0B		HO Start connected but deactivated	High-temperature flame safeguard connected but deactivated, terminal X6-01.3	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
45	Any #	LMV5	Locked by SLT	Shutdown via safety limit thermostat (SLT) test	SLT was activated and safety shutdown was triggered (usually by the safety loop opening)
46	Any #		Programstop active	Program stop was activated. System has stopped at the parameterized position	Deactivate the program stop if no longer required.
	01			Program stop in phase 24 (driving to prepurge position) active.	
	02			Program stop in phase 32 (prepurge) active	
	03			Program stop in phase 36 (ignition position) active	
	04			Program stop in phase 44 (interval 1) active	
	05			Program stop in phase 52 (interval 2) active	
	06			Program stop in phase 72 (driving to postpurge position) active	
	07			Program stopin phase 76 (postpurge) active	
47	Any #		No Start Release for Gas	Start release gas = off	Check the configuration of terminal X7-03.2. Deactivate terminal if not used. See settings section as a guide for configuration of the terminal.
48	Any #		2 Flame Signals with 1 Detector Operation	System parameterized for 1-detector operation but 2 flame signals present	Check flame detector wiring. If two detector operation is desired, configure the LMV52 for this type of operation. See settings section.
	00			Parallel operation with 2 flame detectors	
49	Any #		2 flame signals	2 flame signals present on external flame safeguard	See corrective action based on diagnostic code.
	01			Parallel operation of external flame safeguard via contact and internal flame detector evaluation	When using an external flame safegaurd via terminal X6-01.3 (***HeavyOilDirStart*** = ext.FlameGd), there must not be a flame detector connected to the LMV5.
	02			Parallel operation of external high-temperature safeguard via contact and internal flame detector evaluation	When using a high-temperature safegaurd via terminal X6-01.3 (***HeavyOilDirStart*** = HTempGuard), only one flame detector may be connected to the LMV5 for low-temperature operation.
50	Any #		Internal Fault Basic Unit	Fault during key value check	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	00..07			Number of time block in which the fault was detected	
51	Any #			Time block overflow	
	00..07			Number of time block in which the fault was detected	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
52	Any #	LMV5	Internal Fault Basic Unit	Stack error	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01			Stack overflow	
	02			Value dropped below preset minimum limit	
	03			Test values in stack range exceeded	
53	01			Faulty reset state has occurred	
57	Any #		Invalid parameterization	Invalid parameter setting.	See corrective action based on diagnostic code.
	00			AND NOT ("& /") settings are not permitted in the gas extraneous light phases	Correct the setting for the ***SensExtralGas*** parameter.
	01			AND NOT ("& /") settings are not permitted in the oil extraneous light phases	Correct the setting for the ***SensExtralOil*** parameter.
	02			AND NOT ("& /") settings are not permitted in the gas pilot phases	Correct the setting for the ***SensPilotPhGas*** parameter.
	03			AND NOT ("& /") settings are not permitted in the oil pilot phases	Correct the setting for the ***SensPilotPhOil*** parameter.
	04			AND NOT ("& /") settings are not permitted in the gas operating phases	Correct the setting for the ***SensOperPhGas*** parameter.
	05			AND NOT ("& /") settings are not permitted in the oil operating phases	Correct the setting for the ***SensOperPhOil*** parameter.
	06			The temperature-compensated flue gas recirculation function is not permitted	This function is only enabled for the LMV52.4. Setting ***FGR-Mode*** to Temp.comp, TCautoDeact, deactMinpos, or auto deact. is not permitted.
	07			The high-temperature flame safeguard function is not permitted	This function is only enabled for the LMV50. Setting ***HeavyOilDirStart*** to "HTempGuard" is not permitted.
	08			The external flame safeguard function is not permitted	This function is only enabled for the LMV50 and LMV52. Setting ***HeavyOilDirStart*** to "ext.FlameGd" is not permitted.
	09			The flue gas recirculation function is not permitted	This function is only enabled for the LMV50, LMV51.3, and LMV52. Changing ***FGR-Mode*** from "deactivated" is not permitted.
	0A			The VSD / auxiliary actuator 3 function is not permitted	This function is only enabled for the LMV50, LMV51.3, and LMV52. Setting ***AuxActuator*** to VSD and / or AUX3 is not permitted.
	0B			The cooling in standby function is not permitted	This function is only enabled for the LMV50. Setting ***Config X5-03*** to "CoolfctStby" is not permitted.
	0C			X5-03 double assignment: External load controller via contact (operating mode 1) / deactivation O2 and startup stop phase 36	Adjust ***LC_OptgMode*** or ***Config X5-03*** to prevent the double assignment.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
57	0D	LMV5	Invalid parameterization	The redundancy contact monitoring function is not permitted	This function is only enabled for the LMV50 and LMV52. Setting ***StartReleaseOil*** to "HT/FG-RedCo" is not permitted.
	0E			The COx function is not permitted.	This function is only enabled for the LMV50 and LMV52. Changing ***OptgMode COx Gas(Oil)*** from "deactivated" is not permitted.
58	Any #		Parameter Set damaged	Internal communication (µC1 <> µC2)	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) Check for inductive loads on the outputs. 4) If fault cannot be rectified by the reset: Restore parameters form the AZL to the LMV5
59	Any #			After initialization, EEPROM page is on ABORT (last parameterization was possibly interrupted due to a power failure)	
				Page number	
5A	Any #			CRC error of a parameter page	
				Page number	
5B	Any #			Page is on ABORT	
				Page number	
5C	Any #		Parameter Backup Restore	Page is on WR_RESTO. A backup restore was made	Reset the LMV5
				Page number	
5D	Any #		Internal Fault Basic Unit	Page open too long	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters form the AZL to the LMV5 4) If fault occurs continuously, replace LMV5.
				Page number	
5E	Any #			Page has an undefined status	
				Page number	
5F	Any #		Parameter Set damaged	Last backup restore invalid (was interrupted)	Repeat parameter set download (from AZL to LMV5)
60	Any #		Internal Fault Basic Unit	Fault when copying a parameter page	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters form the AZL to the LMV5 4) If fault occurs continuously, replace LMV5.
61	Any #			Number of parameter page	
	01			Fault in connection with EEPROM initialization	
	02			Fault during initialization of EEPROM	
	10			Number of write attempts exceeded	
	11			EEPROM was busy when accessed	
	12			Comparison of EEPROM and RAM area revealed dissimilarity	
	13			Page area of EEPROM exceeded during write process	
				Access conflict µC1 <> µC2 (arbitration)	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5)					
61	20	LMV5	Internal Fault Basic Unit	Fault when calling the "ParAccess()" function	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters form the AZL to the LMV5 4) Replace the LMV5
	21			Written EEPROM block unequal RAM block	
	22			CRC of page is faulty	
	23			Matching fault µC1, µC2 when saving the error page	
63	Any #		No display of error (can only be read out via eBus)	Unit is error-free	None
70	Any #		Internal Fault Basic Unit	Fault during restoring of lockout information	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01			When reading from EEPROM (initialization)	
	02			When test writing in the initialization	
	03			No write access to error page in init.	
	04			Repetition counter "Internal fault" has elapsed	
71	Any #		Manual Lockout	Lockout was made manually via contact	This lockout occurs when escape and enter on the AZL are pressed simultaneously. This lockout also occurs when the remote reset X4-01.4 is energized when an alarm condition does not exist.
72	Any #		Internal Fault Basic Unit	Plausibility fault in connection with fault entry	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01			Fault in "seterr()"	
	02			Fault in "seterr()"	
	03			Fault in "error_manager()"	
	04			Fault in "storeerr()"	
Fault with Connected Actuators					
80	Any #	Aux 3 Actuator	Fault Feedback Aux Actuator 3	Basic unit has detected wrong state of the auxiliary 3 actuator	1) This fault occurs when an un-addressed actuator is connected to the CANBus. Addressing the actuator should eliminate the fault. 2) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 3) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 4) If fault occurs sporadically: Reduce electrical noise. 5) If fault occurs constantly: Replace actuator according to diagnostic code.
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
81	Any #	Air Actuator	Fault Feedback Air Actuator	Basic unit has detected wrong state of the air actuator	
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
82	Any #	Gas (Oil) Actuator	Fault Feedback Gas (Oil) Actuator	Basic unit has detected wrong state of the gas actuator	
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Connected Actuators					
83	Any #	Oil Actuator	Fault Feedback Oil Actuator	Basic unit has detected wrong state of the oil actuator	1) This fault occurs when an un-addressed actuator is connected to the CANBus. Addressing the actuator should eliminate the fault. 2) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 3) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 4) If fault occurs sporadically: Reduce electrical noise. 5) If fault occurs constantly: Replace actuator according to diagnostic code.
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
84	Any #	Aux 1 Actuator	Fault Feedback Aux Actuator 1	Basic unit has detected wrong state of the auxiliary 1 actuator	
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
85	Any #	Aux 2 Actuator	Fault Feedback Aux Actuator 2	Basic unit has detected wrong state of the auxiliary 2 actuator	
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
Fault with Base Unit (LMV5) or AZL5					
86	Any #	LMV5	Fault Feedback Load Controller	Basic unit has detected wrong state of the internal load controller	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
87	Any #	AZL5	Fault Feedback AZL5	Basic unit has detected wrong state of the AZL…	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace AZL5...
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
88	Any #	All		Plausibility fault NMT	If fault occurs sporadically, reduce electrical noise. If fault occurs constantly, replace the defective unit (see diagnostic code) or the LMV5. Note: The internal load controller and VSD module are part of the LMV5.
	01	Actuator	Fault Feedback Actuator	Undefined fault class of actuator	
	02	LMV5	Fault Feedback Load Controller	Undefined fault class of load controller	
	03	AZL5	Fault Feedback AZL	Undefined fault class of AZL5	
	04	VSD module	Fault Feedback VSD Module	Undefined fault class of VSD module	
	05	O2 Mod.	Fault Feedback O2 Module	Undefined fault class of O2 module	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Connected actuators					
90	Any #	Aux 3 Actuator	Fault Feedback Aux Actuator 3	Basic unit has detected a ROM-CRC error on the auxiliary 3 actuator when checking its feedback signal	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace actuator according to diagnostic code.
91		Air Actuator	Fault Feedback Air Actuator	Basic unit has detected a ROM-CRC error on the air actuator when checking its feedback signal	
92		Gas (Oil) Actuator	Fault Feedback Gas (Oil) Actuator	Basic unit has detected a ROM-CRC error on the gas actuator when checking its feedback signal	
93		Oil Actuator	Fault Feedback Oil Actuator	Basic unit has detected a ROM-CRC error on the oil actuator when checking its feedback signal	
94		Aux 1 Actuator	Fault Feedback Aux Actuator 1	Basic unit has detected a ROM-CRC error on the auxiliary 1 actuator when checking its feedback signal	
95		Aux 2 Actuator	Fault Feedback Aux Actuator 2	Basic unit has detected a ROM-CRC error on the auxiliary 2 actuator when checking its feedback signal	
Fault with Base Unit (LMV5), or AZL5					
96	Any #	LMV5	Fault Feedback Load Controller	Basic unit has detected a ROM-CRC error on the load controller when checking its feedback signal	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace actuator according to diagnostic code.
97		AZL5	Fault Feedback AZL	Basic unit has detected a ROM-CRC error on the AZL… when checking its feedback signal	
98		All	Fault two equal Addresses	There are several components with the same address on the CAN bus (CAN overflow)	Check to see if two actuators are addressed identically. If so, erase the address on the incorrect actuator (hold red button down about 10 seconds) and re-address.
99			Internal Fault Basic Unit	CANBus OFF. A CANBus user (actuators, O2 module) switches the CANBus to OFF mode.	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace AZL.., LMV5
9A				CAN warning level. Fault probably occurred when connecting or disconnecting a CANBus user	
9B	Any #			Overflow of CAN queue	
	01			Overflow of RX queue	
	02			Overflow of TX queue	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Connected Actuators					
A0	See diagnostic codes for A1 error codes. These diagnostic codes are identical, except they apply to the Auxiliary 3 Actuator.				
A1	Any #	Air Actuator	Internal Fault Air Actuator	Air actuator has detected own fault and reported it to the basic unit. Type of fault: See diagnostic code	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace air actuator
	01			CRC fault during ROM test	
	02			CRC fault during RAM test	
	04			Fault during key value check	
	05			Error code for time block overflow	
	07			Sync fault or CRC fault	
	08			Error code for main loop counter	
	09			Fault during stack test	
	0C		Overtemperature Air Actuator	Temperature warning and shutdown	Check the temperature of the air actuator. The max. temperature 140 °F.
	0D		Internal Fault Air Actuator	Actuator turns in the wrong direction	Verify that the air damper is not stuck. A stuck air damper will cause the actuator to trip on overcurrent. During this short trip the actuator can be momentarily pushed backwards by torsional effects.
	0E		Ramp time too short Air Actuator	Actuator operates with too short a ramp time, or with an angular rotation that is too long for the ramp time	1) Match ramp time to the slowest connected actuator (SQM48.4 - 30 sec, SQM48.6 - 60sec, SQM9 - 30 sec) 2) Check the CANBus power supply. Verify fuses FU2 and FU3 are ok. Verify CANBus is not overloaded (see wiring section).
	10		Internal Fault Air Actuator	Timeout during A/D conversion	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs constantly, replace air actuator.
	11			Fault during ADC test	
	12			Fault during A/D conversion	
	13		Position Fault Air Actuator	Actuator is outside the valid angular rotation (0-90°) or linearization data are faulty	Check to see if actuator is within the valid positioning range (0-90°). When the actuator is not powered, it could be moved out of the valid positioning range. Take power off the actuator and position shaft back within the valid positioning range.
	15		Internal Fault Air Actuator	CAN fault	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug)
	16			CRC fault of a parameter page	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Connected Actuators					
A1	17	Air Actuator	Internal Fault Air Actuator	Page too long open	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters form the AZL to the LMV5 4) If fault occurs continuously, replace LMV5.
	18			Page disrupted	
	19			Invalid parameter access	
	1B			Fault during copying of parameter page	
	1E			External plausibility fault. This type of fault covers possible faults occurring due to invalid presettings in the drive commands. In response, the presettings will be ignored	1) Check the paramters related to special positions. The special positions of each activated actuator should be programmed between 0 and 90 degrees.
	1F			Internal plausibility fault. This type of fault covers possible faults that can occur due to strong electrical noise	1) If fault occurs sporadically: Reduce electrical noise.
A2	See diagnostic codes for A1 error codes. These diagnostic codes are identical, except they apply to the Gas (Oil) Actuator.				
A3	See diagnostic codes for A1 error codes. These diagnostic codes are identical, except they apply to the Oil Actuator.				
A4	See diagnostic codes for A1 error codes. These diagnostic codes are identical, except they apply to the Auxiliary 1 Actuator.				
A5	See diagnostic codes for A1 error codes. These diagnostic codes are identical, except they apply to the Auxiliary 2 Actuator.				
Fault with Base Unit (LMV5) Internal Load Controller					
A6	Any #	LMV5 Load Controller Module	-	Internal load controller has detected a fault. Type of fault: See diagnostic code	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	10		No actual Value Slope at End of Identification	-	
	12		Adaption invalid	Invalid XP identified	
	13			Invalid TN identified	
	14			TU longer than identification time	
	15			Invalid TV identified	
	16		Timeout with Adaption	Timeout during observation time	PV (Process Varible) is not changing in response to firing rate during the adaption time. Adaption times out due to lack of change in the measured PV. Check sensor and thermal system.
	17		Cold Start thermal Shock Protection active	A warning indicating that the Cold Start Thermal Shock Protection (CSTP) is activated	This can be deactivated, if desired. See parameters concerning the load controller in the settings section.
	18		Timeout with Adaption	Timeout during delivery of adaption rate and while process is being watched	PV (Process Varible) is not changing in response to firing rate during the adaption time. Adaption times out due to lack of change in the measured PV. Check sensor and thermal system.
	22		Setpoint Temp Controller above maximum Limit	The current setpoint (W1, W2, W3) is above the value of the internal temperature limiter.	Raise the value of the internal temperaure limiter or decrease the current setpoint.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) Internal Load Controller					
A6	30	LMV5 Load Controller Module	Internal Fault Load Controller	EEPROM does not respond within the expected period of time	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	31			Max. number of EEPROM attempts exceeded	
	32			Fault during opening of page	
	33		Parameter Set damaged	Invalid CRC when reading a page	Reset the unit. Restore parameters from AZL to LMV5 if necessary.
	34		Internal Fault Load Controller	Page cannot be set to FINISH	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	35			No access to PID after identification	
	36			No access to PID Standard after identification	
	37			No reading of EEPROM at identification fault	
	38			No EEPROM write access for PID possible	
	39			No EEPROM write access for PID Standard possible	
	3A			No access if reception via COM	
	3B			Invalid page access	
	40			Page too long open	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters from the AZL to the LMV5 4) If fault occurs continuously, replace LMV5.
	41			Invalid phase during parameterization of the safety-related page P_TW	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	42			Invalid phase during parameterization of the safety-related page P_STATUS	
	43			Invalid phase during parameterization of the safety-related page P_SYSTEM	
	44		Parameter Set damaged	Page has been set to ABORT	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Download parameters from the AZL to the LMV5 4) Replace the LMV5
	45		Parameter Backup Restore	Page has been set to RESTO	
	46		Internal Fault Load Controller	Page has an invalid status	
	4A			CAN error	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	4B			CAN error	
	4C			CAN error	
	4D			CAN error	
	4E			CAN error	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Sensors Connected to Internal Load Controller, in Base Unit (LMV5)					
A6	50	LMV5 Load Controller Module	Short-circuit Pt100 Sensor	Short-circuit sensor PT100, terminals X60.1, X60.4	Check temperature sensors connected to X60 terminals. Check wiring and sensor. Check parameter ***Sensor Select.*** Re-wire or replace sensors if necessary.
	51		Open-circuit Pt100 Sensor	Open-circuit sensor PT100, terminals X60.1, X60.4	
	52		Open-circuit Pt 100 Sensor (Line Compens)	Open-circuit compensation line of sensor PT100, terminals X60.2, X60.4	
	53		Short-circuit Pt1000 Sensor	Short-circuit sensor PT1000, terminals X60.3, X60.4	
	54		Open-circuit Pt1000 Sensor	Open-circuit sensor PT1000, terminals X60.3, X60.4	
	55		Short-circuit Ni1000 Sensor	Short-circuit sensor Ni1000, terminals X60.3, X60.4	
	56		Open-circuit Ni1000 Sensor	Open-circuit sensor Ni1000, terminals X60.3, X60.4	
	57		Overvoltage at Input 2	Overvoltage at input 2, terminal X61	1) Check pressure sensors wired to X61. Check wiring and sensor. Check parameters ***Sensor Select*** and ***Ext Inp X61 U/I***. Re-wire or replace sensors if necessary. 2) If using a 4-20 mA pressure sensor, this fault occurs when the boiler pulls a vacuum. Replace with a 0-10 Vdc sensor, or a higher range 4-20mA sensor.
	58		Open-circuit / Short-circuit at Input 2	Open-circuit / short-circuit input 2, terminal X61	
	59		Overvoltage at Input 3	Overvoltage at input 3, terminal X62	1) Check signals wired to X62. Check wiring. Check parameter ***Ext Inp X62 U/I***. Re-wire if necessary.
	5A		Open-circuit / Short-circuit at Input 3	Open-circuit / short-circuit input 3, terminal X62	
	5B		Output Value for Analog Output not available	Selected output value for analog output is not available in the current configuration	Ensure parameter ***OutValueSelection*** is a valid selection based on the devices connected to the basic unit.
	5C		Sensor already in use (LC, FGR, or temp. of the combustion air)	The selected sensor for flue gas recirculation is not available in the current configuration	Ensure parameter ***FGR-sensor*** is a valid selection based on the devices connected to the basic unit.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) Internal Load Controller					
A6	60	LMV5 Load Controller Module	Internal Fault Load Controller	Timeout during calibrate_ADC	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	61			Timeout during read_conversion	
	62			Timeout during calibrate_ADC	
	63			Fault during RedInv reading from A/D converter	
	64			Fault internal A/D converter	
	65			Gain register has been changed	
	66			Offset register has been changed	
	67			Too great / small gain for self-calibration of A/D converter	
	68			Too great / small offset for self-calibration of A/D converter	
	69			Fault internal A/D converter	
	6A			Fault during PWM test	
	6B			Faulty reference voltage	
	6C			Fault transmitter power supply	
	6D			Fault analog output, voltage deviation too great	
	6E			Fault during resistance test PT100 input (X60)	
	6F			Fault during diode test PT100 input	
Fault with Sensors Connected to Internal Load Controller, in Base Unit (LMV5)					
A6	70	LMV5 Load Controller Module	Internal Fault Load Controller	Measured value varies too much: PT100 sensor (terminal X60)	1) Check wiring and sensor. Re-wire or replace sensors if necessary. 2) Use shielded cable on sensor wiring. 3) Make sure that sensor wiring is not run next to high voltage AC wiring. 4) If the diagnostic code indicates excessive voltage, check input with meter. Trace voltage source.
	71			Measured value varies too much: PT100 line (terminal X60)	
	72			Measured value varies too much: PT1000 (terminal X60)	
	73			Measured value varies too much: PWM	
	74			Measured value varies too much: Voltage measurement input 2 (terminal X61)	
	75			Measured value varies too much: Current measurement input 2 (terminal X61)	
	76			Measured value varies too much: Voltage measurement input 3 (terminal X62)	
	77			Measured value varies too much: Current measurement input 3 (terminal X62)	
	78			Excessive voltage value or wrong polarity PT100 sensor (terminal X60)	
	79			Excessive voltage value or wrong polarity PT100 line (terminal X60)	
	7A			Excessive voltage value or wrong polarity PT1000 (terminal X60)	
	7B			Excessive voltage value or wrong polarity PWM	
	7C			Excessive voltage value or wrong polarity voltage measurement input 2 (terminal X61)	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Sensors Connected to Internal Load Controller, in Base Unit (LMV5)					
A6	7D	LMV5 Load Controller Module	Internal Fault Load Controller	Excessive voltage value or wrong polarity current measurement input 2 (terminal X61)	1) Check wiring and sensor. Re-wire or replace sensors if necessary. 2) Use shielded cable on sensor wiring. 3) Make sure that sensor wiring is not run next to high voltage AC wiring. 4) If the diagnostic code indicates excessive voltage, check input with meter. Trace voltage source.
	7E			Excessive voltage value or wrong polarity voltage measurement input 3 (terminal X62)	
	7F			Excessive voltage value or wrong polarity current measurement input 3 (terminal X62)	
A6	80	LMV5 Load Controller Module	Internal Fault Load Controller	Fault during internal muliplexer test PT100 sensor	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	81			Fault during internal multiplexer test PT100 line	
	82			Fault during internal multiplexer test PT100	
	90			Max. number of synchronization failures exceeded	
	91			Wrong CRC with synchronizations object	
	92			Wrong CRC with synchronizations object	
	93			Main loop counter does not agree with basic unit	
	96			Fault during multiplexer test	
	97			Paraccess with FINISH unsuccessful	
Fault with Base Unit (LMV5) Internal Load Controller					
A6	9B	LMV5 Load Controller Module	Internal Fault Load Controller	Fault PageAccess, invalid access status	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	9C			Fault voltage monitor test	
	9E			Fault during readout of PDO message	
	A0			XP smaller than min. value	
	A1			XP larger than max. value	
	A2			TN smaller than min. value	
	A3			TN larger than max. value	
	A4			TV smaller than min. value	
	A5			TV larger than max. value	
	A6			Parameter outside the permissible range	
	A7		Inadmissible Selection aux Sensor Cold Start	Inadmissible selection of the auxiliary sensor	When using the auxiliary temperature sensor for cold start, a pressure sensor or temperature transmitter must be selected at input 2 (terminal X61) via parameter ***Sensor Select*** (PressSensor, TempSensor)
	B0		Internal Fault Load Controller	Red/Inv fault with float variables	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	B1			Red/Inv fault of a Red/Inv variable	
	B2			Fault during key value check	
	B4			Fault in fault routine	
	B5			Unplausible software interrupt	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) Internal Load Controller					
A6	B6	LMV5 Load Controller Module	Internal Fault Load Controller	Time block too long: Time block 0	If fault occurs sporadically, reduce electrical noise. If fault occurs continuously, replace LMV5.
	B7			Time block too long: Time block 1	
	B8			Time block too long: Time block 2	
	B9			Time block too long: Time block 3	
	BA			Time block too long: Time block 4	
	BB			Time block too long: Time block 5	
	BC			Time block too long: Time block 6	
	BD			Time block too long: Time block 7	
	C0			CRC fault in page	
	E0			Identpower	
	E1			Controller parameter KP	
	E2			Scanning time	
	EA			Invalid branch in EEPROM module()	
	EB			Invalid branch in EEPROM module()	
	EC			Invalid branch in EEPROM module()	
	ED			Invalid branch in EEPROM module()	
	EE			Invalid branch in EEPROM module()	
	EF			Invalid branch in EEPROM module()	
	F0			Fault during ROM test	
	F1			Fault during RAM test	
	F2			Fault during RAM test, register bank 0	
	F3			Fault during RAM test, IDATA range	
	F4			Fault during RAM test, XDATA range	
	F5			Stack pointer does not point at stack	
	F6			Stack overflow	
	FE			Fault messages in fault management	
	FF			Fault messages in fault management	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
				Fault with AZL5...	
A7	Any #	AZL5	Internal Fault AZL	AZL5…has detected own fault and reported it to the basic unit. Type of fault: see diagnostic code.	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) If fault occurs sporadically: Reduce electrical noise. 4) If fault occurs constantly: Replace AZL5...
	01			CRC fault during ROM test	
	02			CRC fault during RAM test	
	03			Fault during stack test	
	04			Fault during key value check	
	05			Time block overflow	
	07			Sync fault or CRC fault	
	08			Fault main loop counter	
	09		Manual Lockout AZL	Fault message for emergency off function via AZL…	This message is dispayed if escape and enter on the AZL are pressed simulaneously, causing a manual lockout. Can be reset normally.
	0A		Internal Fault AZL	Invalid AZL5… page	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	0B		>250,000 startups, service required	250,000 cycles have been exceeded. Internal parts in the LMV5.. are close to the end of their life.	Replace LMV5
	0C		Internal Fault AZL	Save fault parameter	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	0D		Menu for firing on oil. Current Fuel is Gas	Fuel changeover from oil to gas when an "oil only" menu is being viewed.	Escape out of current menu, or change the fuel that is selected.
	0E		Menu for firing on gas. Current Fuel is Oil	Fuel changeover from gas to oil when a "gas only" menu is being viewed.	
	15		Internal Fault AZL	CAN queue fault	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	16			CAN overflow fault	
	17			CANBus OFF. A CANBus user (actuators, O2 module) switches the CANBus to OFF mode.	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) Check the wiring of the CANBus power supply (12 VAC transformer). Ensure that fuses FU2 and FU3 are not blown. Ensure that the CANBus power supply is not overloaded (too many actuators on CANBus)

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with AZL5...					
A7	18	AZL5	Internal Fault AZL	CAN warning level	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	1A			EEPROM fault	1) If the error occurs in phase 22 together with a VSD, check the wiring of the VSD 2) If fault occurs sporadically: Reduce electrical noise. 3) If fault occurs constantly: Replace AZL5…
	1B		No valid Parameter Backup	Fault during copying of a parameter page	Back up LMV5 parameters to AZL. A prompt for this comes up when exiting the Params & Display menu.
	1C		Internal Fault AZL	Page in EEPROM was disrupted, has been restored	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	20			Display fault	
	22			RTC is locked, permanently busy	
	24			Buffer for page copies too small	
	28			Time stamp could not be sent	
	30		Fault Communication eBUS	Fault in connection with eBUS communication	Check wiring on RJ45 connector, located on the underside of the AZL5..
	38		Internal Fault AZL	Interface mode could not be terminated	Reset the unit.
	40		Communication AZL with PC tool	Parameterization fault PC tool. Disclosed by key value check in AZL	Check cable between AZL and PC. A null modem adapter must be used on the 9 pin connector if the cable does not have this internally. A USB-to-serial adapter is OK to use when connecting the AZL to a laptop.
	88		Internal Fault AZL	RAM fault with redundant inverse variables	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace AZL5…
	89			Program run fault, execution of program code that will probably never be executed	
	8A			Unintentional watchdog reset	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) VSD Module					
A9	Any #	VSD module	Internal Fault VSD Module	VSD module has detected own fault and reported it to the basic unit. Type of fault: see diagnostic code.	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
	01			CRC fault during ROM test	
	02			CRC fault during RAM test	
	04			Fault during key value check	
	05			Error code for time block overflow	
	07			Sync fault or CRC fault	
	08			Error code for main loop counter	
	09			Fault during stack test	
	0A			Max IRQ speed reached	1) Possibly interference on the line to the speed sensor, check cable routing, use shielded cable. 2) If fault occurs sporadically: Reduce electrical noise. 3) If fault occurs constantly: Replace LMV5
	0C		Alarm from VSD	VSD reports a fault to the VSD module	1) This indicates that a fault has been relayed to the LMV5 from the VSD via the VSD alarm input terminal. This indicates a fault in the VSD, not the LMV5. Thus, check the VSD error codes and take action based on those codes. 2) Check VSD settings (ramps, motor settings), increase ramp time on VSD and basic unit, if necessary. 3) Check motor and VSD for proper sizing.
	0D		Control Range Limitation VSD Module	VSD module could not offset speed differential within its control limits	1) This indicates that the LMV5 has decreased its signal to the VSD as much as possible and the motor RPM is still too high. Increase VSD / LMV52 ramp times. Also increase VSD braking if possible. 2) Ensure the VSD and LMV5 are configured for the same analog signal (ex. 4-20 mA) 2) Re-standardize the speed. Ensure that the air damper is at purge position for the standardization (should do this automatically if the air damper is set to air-influencing) 3) Be sure to check combustion after the re-standardization.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) VSD Module					
A9	0E	VSD module	Internal Fault VSD Module	Fault during the speed calculation test	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
	15			CANBus fault, disturbed CANBus transmissions	1) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 2) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug) 3) Check terminating resistors for correct position.
	16			CRC fault of a parameter page	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters from the AZL to the LMV5 4) Replace the LMV5
	17			Page too long open	
	18			Page disrupted	
	19			Invalid access to parameters	
	1B			Fault when copying a parameter page	
	1E			External plausibility fault. This type of fault covers possible faults occurring due to invalid presettings in the drive commands. In response, the presettings will be ignored.	Check the special positions for valid value range (0-100%)
	1F			Internal plausibility fault. This type of fault detects faults that cannot practically occur.	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
Fault with O2 Module (PLL5..)					
AB	Any #	PLL5..	Internal Fault O2 Module	The O2 module has detected own fault and reported it to the basic unit. Type of fault: see diagnostic code	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace PLL5..
	01			CRC fault during ROM test	
	02			CRC fault during RAM test	
	04			Fault during key value check	
	05			Error code for time block overflow	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with O2 Module (PLL5..) or Oxygen Sensor (QGO2..)					
AB	07	PLL5..	Internal Fault O2 Module	Sync fault or CRC fault	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace PLL5..
	08			Error code for main loop counter	
	09			Fault during stack test	
	0A			Feedback values invalid	
	10		Unplaus Value Nernst Voltage O2 Module	Nernst voltage outside the valid range	1) Check the wiring between the O2 Module and the O2 sensor. Ensure high and low voltage are in seperate conduits. 2) Check the power supply to the O2 Module 3) Check fuse in the O2 Module 4) Check the heating control on the O2 Sensor 5) Check the temperature inside the O2 Sensor terminal box. Should be between -13 and 248° F 5) If fault occurs constantly, Replace O2 Sensor and / or Module.
	12		Unplaus Value Thermocouple O2 Module	Thermocouple voltage outside the valid range	
	13		Unplaus Value Compensation Element	Compensation element voltage outside the valid range	
	15		Unplaus Value Flue Gas Temp O2 Module	Temperature of combustion air sensor outside the valid range (-20...+800 °C)	1) Check the wiring between the O2 Module and the O2 sensor. 2) Check the ambient / flue gas temperature. Compare to valid range.
	16		Unplaus Value Flue Gas Temp O2 Module	Temperature of flue gas sensor outside the valid range (-20...+800 °C)	
	17		Internal Fault O2 Module	Fault during combustion air temperature sensor test	1) Check the wiring between the O2 Module and the O2 sensor. 2) If fault occurs constantly, replace O2 Sensor and / or O2 Module
	18			Fault during thermocouple test	
	19			Fault during compensation element test	
	1A			Fault during channel comparison of O2 signal	
	1B			Fault ADC test voltages	
	20		O2 Sensor Temp too low	Temperature of QGO measuring cell too low	1) Check the temperature of heated sensor via parameter ***QGO SensorTemp.*** Minimum operating termperature is 1202 °F, maximum 1382 °F. O2 sensor could take up to 20 minutes to reach temperature. 2) Ensure O2 sensor is installed properly (see mounting section) and that stack gas velocity is correct. Min = 3.2 ft / sec, max = 32 ft / sec. 3) Check the power supply to the O2 Module 4) Check fuse in the O2 Module
	21		O2 Sensor Temp too high	Temperature of QGO measuring cell too high	
	22		Internal Fault O2 Module	Fault during calculation test	If fault occurs constantly, replace O2 Sensor and / or O2 Module

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with O2 Module (PLL5..) or Oxygen Sensor (QGO2..)					
AB	23	PLL5..	Unplaus Value Ri 02 Measuring Cell	Measured internal resistance of the QGO measuring cell is smaller than 5 Ohm or greater than 150 Ohm	1) Check the wiring between the O2 Module and the O2 sensor. 2) O2 Sensor may have reached the end of its service life (check resistance through AZL - ***QGO Resistance***). If greater than 140 - 150 ohms, replace sensor.
	24		Response Time O2 Measuring Cell too long	Measured response time of the QGO measuring cell exceeds 5 seconds (completely electronic)	1) Check mounting position / orientation of O2 sensor. 2) Check to see if O2 sensor is dirty. Do not blow out with compresed air when hot! Cool, then blow out with low pressure compressed air (less than 10 psi) 3) O2 Sensor may have reached the end of its service life (check resistance through AZL - ***QGO Resistance***). If greater than 140 -150 ohms, replace sensor.
	25		O2 Sensor Test aborted by O2 Module	Fault occurred during O2 sensor test	Check (through the AZL - ***Normal Operation***) to see if the measured O2 value is fluctuating.
	30		Internal Fault O2 Module	CAN fault	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs constantly, replace PLL5..
	31			CRC fault of a parameter page	1) Reset the LMV5 2) If fault occurred after changing a parameter, check the parameters that were last changed. 3) If fault cannot be rectified by the reset: Restore parameters from the AZL to the LMV5 4) Replace the LMV5
	32			Page too long open	
	33			Page disrupted	
	34			Invalid access to parameters	
	38			Fault during copying of a parameter page	
	3E			External plausibility fault. This type of fault covers possible faults occurring due to invalid presettings in the drive commands. In response, the presettings will be ignored.	
	3F			Internal plausibility fault. This type of fault covers possible errors that cannot practically occur.	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs constantly, replace PLL5..
Fault with Base Unit (LMV5)					
B0	Any #	LMV5..	Internal Fault Basic Unit	Fault during test of port outputs	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
	01			Fault when resetting the set outputs	
	02			Fault during ZR test	
B1	01			Fault during short-circuit test between inputs and outputs	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Oxygen Sensor (QGO2..)					
B5	Any #	LMV5..	-	O2 monitor	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
	01		Below O2 Min Value	O2 value has dropped below O2 min. value	1) Check the %O2 between the O2 guard curve and the O2 setpoint curve. Increase the %O2 "gap" between these two curves at the load point where the fault is occurring. 2) Check for mechanical lash (slop) between actuators and dampers / valves. Also check dampers for worn bearings. Change to zero lash flexible couplings if necessary. 3) If necessary, adjust parameters ***O2 OffsetGas(oil)*** and / or ***O2CtrlThreshold***
	02		O2 Min Values undefined	Invalid O2 min. value	Set a point for the O2 min value curve (or O2 guard curve) for each point set up on the ratio control curve (12 points on ratio control curve = 12 points on O2 min value curve)
	03		O2 Setpoints undefined	Invalid O2 setpoint	Set a point for the O2 setpoint curve (or O2 Control Curve) for each point set up on the ratio control curve except for point 1 (12 points on ratio control = 11 points on O2 setpoint curve)
	04		O2 Delay Time undefined	Invalid O2 delay time	The delay time has not been measured successfully at Point 2 or the highest curve point. See O2 trim section for possible causes.
	05		Actual O2 Value invalid	No valid actual O2 value in operation for ≥ 3 s	1) Check the wiring between the O2 Module and the O2 sensor. 2) Check the power supply to the O2 Module
	06		O2 Value Prepurging not reached	During prepurging, the parameterized air oxygen content of +/- 2 % was not reached	1) Check the parameter ***O2 Content Air***. This %O2 must be reached within +/- 2% during prepurge. 2) Check prepurge time. The time that is set may not be long enough to completely purge the boiler. 3) Sensor may be dirty. Do not blow out with compressed air when hot! Cool, then blow out with low pressure compressed air (less than 15 psi). 4) O2 Sensor may have reached the end of its service life (check resistance through AZL - ***QGO Resistance***) If greater than 140 -150 ohms, replace sensor.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Oxygen Sensor (QGO2..)					
B5	07	LMV5..	O2 Value in Operation too high	O2 value of 15% in operation was exceeded	1) Check mounting of O2 sensor. Ensure no air is entering the stack upstream of the sensor. 2) Verify that the O2 level in the stack is not 15% during operation.
	08		O2 - Parameter points of curve undefined	The curves for minimum / maximum O2 values are incomplete or no adaption has yet been carried out to determine the Tau values	1) Check O2 min (guard) curve to ensure all points have a value. 2) If parameter ***Type O2 Max Curve*** is set for O2 MaxCurve, ensure all points on ratio control curve have a valid O2 value.
	09		Testing period for minimum O2 values not defined	No value has been specified for the testing period (parameter ***Time O2 Alarm)***	Enter a valid value for parameter ***Time O2 Alarm***
	0A		Internal Fault Basic Unit	-	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace LMV5.
BA	01		O2 Sensor Test aborted	O2 sensor test was not successful. E.g. reset of O2 module during probe test	1) If fault occurs sporadically, reduce electrical noise. 2) If fault occurs continuously, replace PLL5..
BB	00		Service interval reached for O2 sensor test	The O2 trim control is removed and the system moves along the set ratio control curves	Fault occurs because the time set in parameter ***O2SensServTim*** has elapsed. Carry out maintenance or replace O2 sensor.
BE	Any #			Invalid parameterization of O2 operating mode / flue gas recirculation sensor / COx monitoring	Set O2 mode (***OptgMode***) to O2 Alarm or O2 Control, or set flue gas recirculation temp sensor (***FGR-sensor***) to X60
BE	00		O2 mode with FGR is not possible with selected temp. sensor	An error occurred in connection with the O2 trim control / O2 alarm and flue gas recirculation functionality	
BF	Any #		O2 trim control automatically deactivated	Fault occurred in connection with O2 trim control or with the O2 monitor. It led to automatic deactivation of O2 trim control or the O2 monitor	See previous error code in fault history (typically B5 error codes). This will detail the reason for the automatic deactivation.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Connected Components					
C5	Any #	Any	Version Conflict	When comparing the versions of the individual units, the AZL5 has detected old versions	Before replacing any units, start the system and wait about 1 minute (until, after entering the parameter level, the display “Parameters will be updated“ disappears). Then, reset the unit. Replace the unit only if the fault message does not disappear. Replace the relevant units by new versions
	01..2F			The diagnostic value is made up of the following faults or their combinations (the individual diagnostic codes are added up in hexadecimal format)	Replace the unit(s) called out in the diagnostic code. Be sure that the new unit has up-to-date software.
	01	LMV5		Software of the basic unit too old	
	02			Software of the load controller too old	
	04	AZL5		Software of the AZL5 too old	
	08	Actuator		Software of 1 or several actuators too old	
	10	LMV5		Software of VSD module too old	
	20	PLL5		Software of O2 module too old	
D1	Any #	LMV5	Fault Feedback VSD Module	Basic unit has detected a wrong state of the VSD module. Corresponds to the "8x"-faults with the other CAN users	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace LMV5 3) Check CANBus cabling. Ensure that all cable shields (screens) which are located in the cable sheath are terminated correctly at each actuator, O2 module, and at the LMV5x... 4) Check each CANBus connector to ensure proper termination (no conductors exposed on the back of the plug)
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
D3	Any #	PLL5	Fault Feedback O2 Module	Basic unit has detected a wrong stage of the O2 module	
	01			CRC error	
	02			Key error main loop counter	
	03			No feedback for max. number	
E1	Any #	LMV5	Fault Feedback VSD Module	Basic unit has detected a ROM-CRC fault in the VSD module when checking its feedback signal	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace LMV5
E3	Any #	PLL5	Fault Feedback O2 Module	Basic unit has detected a ROM-CRC fault in the O2 module when checking its feedback signal	

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Connected Components					
F0	Any #	LMV5	Internal Fault Basic Unit	Plausibility fault during calculation of interpolation values	1) If fault occurs sporadically: Reduce electrical noise. 2) If fault occurs constantly: Replace LMV5.
F1	Any #		Internal Fault Basic Unit	Internal fault during calculation of precontrol	1) Check to make sure that all curves (Ratio control, O2 guard, and O2 control) are defined at every point in the firing range. If the ratio control curve has 12 points, the O2 guard must have 12 points, and the O2 trim must have 11 points.
	01			-	
	02			-	
	03			-	
	04			-	
	05			-	
	06			Internal fault calculation of precontrol. Undefined value in the curves used for the calculation	
	07			Internal fault calculation of precontrol. Undefined value for a type of fuel parameter	
F2	Any #		Internal Fault Basic Unit	Code for faulty temperature values from O2 module when calculating the air rate change	See diagnostic code.
	07			O2 module has delivered invalid value	If fault occurs constantly: Replace LMV5
	08		Flue Gas Temp too high	Flue gas temperature outside the permissible value range	Increase parameter ***MaxTempFlGasGas(Oil)*** or decrease flue gas temperature.
	0A		QGO in Heating-up Phase	QGO probe not yet sufficiently heated up	Check the temperature of the O2 Sensor via parameter ***QGO SensorTemp***. The sensor needs to be a minumum of 1202 °F to operate properly. Wait up to 20 minutes for sensor to reach operating termpeature.

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Connected Components					
F3	Any #	LMV5	-	O2 trim control fault	See diagnostic code.
	01		Missing or faulty Control Parameters	PID parameter for controller algorithm missing	Check the O2 trim PID control parameters.
	02		Missing or faulty O2 controller manipulated variable limitation	The parameters for limiting the O2 controller manipulated variable have not yet been set	Check the parameters (***O2MinManVariable*** and ***O2MaxManVariable***) for limiting the O2 controller manipulated variable and reset if necessary.
	03		O2 controller manipulated variable limitation	The O2 controller manipulated variable is limited	1) Check the settings of the O2 trim control. 2) Check that the O2 sensor is installed correctly. 3) Check that the ***O2MaxManVariable*** and ***O2MinManVariable*** parameters are set correctly (especially when copying parameters from devices before software version 05.00 and 10.10).
	04		O2 curves incomplete	Missing value in the O2 trim control curves	Check for missing values in the O2 control curve, O2 ratio control curve, or O2 minimum value curve.
	05		Internal Fault Basic Unit	-	If fault occurs constantly: Replace LMV5
	06		Faulty set temperature or supply air temperature	There is no valid supply air temperature for initialization; there was no valid set temperature when the O2 trim control curves were set	For temp-compensated start modes (see parameter ***Startmode***), an ambient air temperature must be read during commissioning. Check parameter ***Adjust. Temp O2*** to see if a valid reading was taken. If not, use a non temp-compensated start mode or attach an ambient air sensor and recommission a point on the O2 control curve.
	07		O2 controller operation locking time for QGO21 too short	The QGO21 requires a longer waiting time than the QGO20 when entering into operation.	Adjust parameter ***NumberTauSuspend*** to 40.
	08		O2 value too high during O2 controller initialization	The O2 controller could not be initialized correctly after entering into operation because the O2 value was too high (greater than approx. 13%)	Check for an O2 sensor malfunction. Check for false air in the stack. Increase startup locking time (***NumberTauSuspend***).

Error Code	Diag. Code	Device	Display	Meaning for the LMV5x System	Corrective Action
Fault with Base Unit (LMV5) or Connected Components					
F4	Any #	PLL5	-	A fault occurred in the O2 module in connection with the flue gas recirculation	See diagnostic code.
	01		Fault with Feedback from O2 Module	The flue gas temperature sensor PLL52… input X86 is selected, but no response is registered on the CAN	Check CANbus and main power wiring to the PLL5.
	15		Implausible supply air temperature value	Temperature of supply air sensor on PLL52 input X87 is outside of the valid range (0 to 1472 °F)	Check wiring of the ambient air sensor connected to terminal X87. Check ambient air temperature.
	16		Implausible flue gas temperature value	Value of flue gas temperature sensor on PLL52 input X87 is outside of the valid range (0 to 1472 °F)	Check wiring of the flue gas temperature sensor connected to terminal X86. Check flue gas temperature.
F5	01	LMV5	Fault with Feedback from Load Controller	The Pt1000/Ni1000 on the load controller input X60 is selected, but no response is registered on the CAN	Check CAN wiring. If fault occurs sporadically, reduce electrical noise. If fault occurs constantly, replace the defective unit.
F6	Any #		-	A fault occurred in connection with the flue gas recirculation function	See diagnostic code.
	01		Flue gas recirculation automatically deactivated	The flue gas recirculation function was automatically deactivated	Check the fault history for the error that happened just before fault F6 for the cause of the automatic deactivation.
	02		Invalid parameterization of flue gas recirculation operating mode / flue gas recirculation sensor	Invalid parameterization of flue gas recirculation operating mode / flue gas recirculation sensor in connection with O2 controller / O2 alarm	Set flue gas recirculation operating mode (***FGR-Mode***) from TCautoDeact to Temp.comp, or set flue gas recirculation temperature (***FGR-sensor***) to X60

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*Can be found at www.scccombustion.com.

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8-1: Modbus

Master-slave principle

Communication between Modbus users takes place according to the master-slave principle. The AZL5 always works as a slave.

Data Transmission

Transmission mode (RTU)

– The transmission mode used is RTU (Remote Terminal Unit)
– Data is transmitted in a binary format (hexadecimal) with 8 bits
– The LSB (least significant bit) is transmitted first
– ASCII operating mode is not supported

Structure of data blocks

All data blocks use the same structure with the following four fields:

Slave Address	Function Code	Data Field	Checksum CRC16
1 byte	1 byte	x byte	2 bytes

Slave Address Device address of a certain slave

Function Code Function selection (reading / writing words)

Data Field Contains the following information:
- Word address
- Number of words
- Word value

Checksum Identification of transmission errors

Checksum (CRC16)

The checksum (CRC16) is used to detect transmission errors. If, during evaluation, an error is detected, the relevant device will not respond.

Calculation scheme

```
CRC = 0xFFFF
    CRC = CRC XOR ByteOfMessage
    For (1 through 8)
        CRC = SHR (CRC)
        if (flag shifted at right = 1)
        then                    | else
        CRC = CRC XOR           |
        0xA001                  |
while (not all ByteOfMessage handled)
```

☞ The low-byte of the checksum is transmitted first.

Example

Data query: Reading 2 words from address 6 (CRC16 = 0x24A0)

0B	03	00	06	00	02	A0	24
						CRC16	

Reply: (CRC16 = 0x0561)

0B	03	04	00	00	42	C8	61	05
			Word 1		Word 2		CRC16	

Mapping Words

B0	B1	B2	B3	B4	B5	B6	B7
Byte High							

B8	B9	B10	B11	B12	B13	B14	B15
Byte Low							

Transmission mode: The LSB (least significant bit) is transmitted first.

Mapping Long Values

Byte High	Byte Low	Byte High	Byte Low
Word Low		Word High	

Communication Process

Start and end of a data block are characterized by transmission pauses. The maximum permissible time between two successive characters is 3.5 times the time required for the transmission of one character. The character transmission time is dependent on the Baud rate and the data format used.

Having a data format of 8 data bits, no parity bit and one stop, the character transmission time is calculated as follows:

Character transmission time [ms] = 1000 * 9 bits / Baud rate

And with other data formats:

Character transmission time [ms] = 1000 * 10 bits / Baud rate

Process

Data query from the master
Transmission time = n characters * 1000 * x bits / Baud rate

Marking for end of data query
3.5 characters * 1000 * x bits / Baud rate

Data query handling by the slave

Reply of slave
Transmission time = n characters * 1000 * x bits / Baud rate

Marking for end of reply
3.5 characters * 1000 * x bits / Baud rate

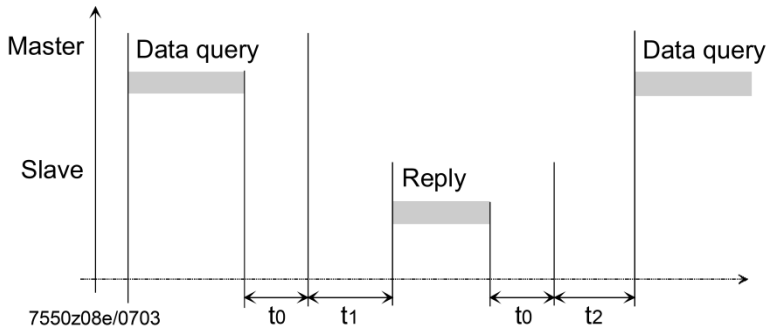
Example Marking for data query or end of reply with data format 10 / 9 bits

Waiting time = 3.5 characters * 1000 * x bits / Baud rate

Baud rate [Baud]	**Data format** [bit]	**Waiting time** [ms]
9600	10	3.125
	9	2.813

Data query process

Time diagram A data query is made according to the following time diagram:



where:

- t0 Marking for end = 3.5 characters (time is dependent on the Baud rate)
- t1 This time is dependent on internal handling; the maximum handling time is dependent on the data type (internal and external data) and on the number of data; for more detailed information, see below!
- t2 $t2 \geq 20$ ms
  This time is required by the device to switch from transmitting back to receiving; this time must be observed by the master before a new data query is made; it must always be observed, even if a new data query to some other device is made

Communication during the slave's internal handling time

During the slave's internal handling time, the master is not allowed to make any data queries. The slave ignores data queries made during this period of time.

Communication during the slave's reply time

During the slave's reply time, the master is not allowed to make any data queries. Data queries made during this period of time cause all data on the bus at this instant to be deleted.

Number of messages

The number of addresses per message is limited:

- 20 addresses of the size of one word when reading
- 6 addresses of the size of one word when writing
- For lockout history, messages must be exactly 16 addresses
- For error history, messages must be exactly 8 or 16 addresses

Reply time of AZL... to a message from the master

1. Reading data from the LMV5... system:

1...3 addresses	25...75 ms
4...9 addresses	75...125 ms
10...15 addresses	125...175 ms
16...20 addresses	175...225 ms

These periods of time are defined from the complete writing of the message from the master to sending the first byte by the AZL...

2. Writing data to the LMV5... system:

1 address	25...75 ms
2...3 addresses	75...125 ms
4...5 addresses	125...175 ms
6 addresses	175...225 ms

Modbus functions

The following Modbus functions are supported:

Function number	**Function**
03 / 04	Reading n words
06	Writing 1 word
16	Writing n words

For more information about the Modbus protocol, refer to www.modbus.org.

Table of addresses

Function	Address	Number of words	Data designation	Access	Data format	Data type / coding	Range	Updating rate
03/04	0	1	Phase	R	U16		0...255	Fast
03/04	1	1	Position of currently active fuel actuator	R	S16	Degrees	-3... 93°	Fast
03/04	2	1	Position of gas actuator	R	S16	Degrees	-3...93°	Fast
03/04	3	1	Position of oil actuator	R	S16	Degrees	-3...93°	Fast
03/04	4	1	Position of air actuator	R	S16	Degrees	-3...93°	Fast
03/04	5	1	Position of auxiliary actuator 1	R	S16	Degrees	-3...93°	Fast
03/04	6	1	Position of auxiliary actuator 2	R	S16	Degrees	-3...93°	Fast
03/04	7	1	Position of auxiliary actuator 3	R	S16	Degrees	-3...93°	Fast
03/04	8	1	Manipulated variable for variable speed drive	R	S16	Percent	0…110 %	Fast
03/04	9	1	Current type of fuel	R	U16	0= Gas 1= Oil	0...1	Fast
03/04	10	1	Current output	R	U16	Fire rate	0…100 %	Fast
03/04	11	1	Current setpoint / temperature / pressure	R	U16	Process units		Medium
03/04	12	1	Actual value / temperature / pressure Unit: See address 18 / 19	R	U16	Process units	0…2000 °C 0…100 bar	Medium
03/04	13	1	Flame signal	R	U16	Percent	0…100 %	Medium
03/04	14	1	Current fuel throughput	R	U16	0..65534		Fast
03/04	15	1	Current O2 value (LMV52...)	R	U16	Percent	0…100 %	Fast
03/04	16	1	Volume unit of gas	R	U16	0= m³ 1= ft³	0…1	Slow
03/04	17	1	Volume unit of oil	R	U16	0= l 1= gal	0…1	Slow
03/04	18	1	Unit of temperature	R	U16	0= °C 1= °F	0…1	Slow
03/04	19	1	Unit of pressure	R	U16	0= bar 1= psi	0…1	Slow
03/04	20	1	Sensor selection	R	U16	0=Pt100 1=Pt1000 2=Ni1000 3=temp. sensor 4=press. sensor 5=Pt100Pt1000 6=Pt100Ni1000 7=no sensor	0…7	Slow
03/04	21, 22	2	Startup counter total	R	S32		0…999999	Slow
03/04	23, 24	2	Hours run counter	R	S32		0…999999	Slow
03/04	25	1	Current error: Error code	R	U16		0...0x FF	Fast
03/04	26	1	Current error: Diagnostic code	R	U16		0…0x FF	Fast
03/04	27	1	Current error: Error class	R	U16		0...5	Fast
03/04	28	1	Current error: Error phase	R	U16		0...255	Fast
03/04	29	1	Temperature limiter OFF threshold, in degrees Celsius / Fahrenheit (in address 129: Temperature limiter switching differential ON)	R	U16		0…2000 °C 32…3632 °F	Slow
03/04	30	1	Supply air temperature, in degrees Celsius / Fahrenheit (LMV52...)	R	U16		-100…+923 °C -148..+1693 °F	Slow
03/04	31	1	Flue gas temperature, in degrees Celsius / Fahrenheit (LMV52...)	R	U16		-100...+923 °C -148...+1693 °F	Slow
03/04	32	1	Combustion efficiency (LMV52...)	R	U16	Percent	0...200 %	Slow

Function	Address	Number of words	Data designation	Access	Data type / coding	Range	Updating rate
03/04	35	1	**Inputs (bits)**	R	U16	-	Medium

Coding: 0 → inactive 1 → active

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

B8	Safety loop	B0	Controller ON/OFF
B9		B1	Fan contactor contact
B10	Pressure switch-min-gas	B2	Fuel selection oil
B11	Pressure switch-max-gas	B3	Fuel selection gas
B12		B4	
B13	Air pressure switch	B5	Pressure switch-max-oil
B14	Start release oil	B6	Pressure switch-min-oil
B15	Heavy oil immediate start	B7	Pressure switch – valve proving

Function	Address	Number of words	Data designation	Access	Data type / coding	Range	Updating rate
03/04	37	1	**Outputs (bits)**	R	U16	-	Medium

Coding: 0 → inactive 1 → active

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

B8	Fuel valve SV oil	B0	Alarm
B9	Fuel valve V1 oil	B1	
B10	Fuel valve V2 oil	B2	
B11	Fuel valve V3 oil	B3	
B12	Fuel valve SV gas	B4	Ignition
B13	Fuel valve V1 gas	B5	Start signal / 3-way solenoid valve
B14	Fuel valve V2 gas	B6	Fan
B15	Fuel valve PV gas	B7	Oil pump / magnetic coupling

Function	Address	Number of words	Data designation	Access	Data format	Data type / coding	Range	Updating rate
R 03/04 W 06/16	38	1	Program stop	R/W* EEPROM	U16	0=deactivated 1=24 PrePurgP 2=32 PrePFGR 3=36 IgnitPos 4=44 Interv 1 5=52 Interv 2 6=72 PostPPos 7=76 PostPFGR	0...7	Slow
R 03/04 W 06/16	39	1	Operating mode with load controller	R/W* EEPROM	U16	0=ExtLC X5-03 1=IntLC 2=IntLC Bus 3=IntLC X62 4=ExtLC X62 5=ExtLC Bus	0…5	Slow
R 03/04	40	1	Selection of manual or automatic operation	R	U16	0=automatic 1=burner on 2=burner off	0…2	Fast
R 03/04 W 06/16	41	1	Modbus mode: Local / Remote	R/W	U16	0 = Local 1 = Remote	0…1	Slow

Function	Address	Number of words	Data designation	Access	Data format	Data type / coding	Range	Updating rate
R 03/04 W 06/16	42	1	Modbus downtime: Max. time with no communication. When this time has elapsed, automatic changeover from Remote to Local takes place	R/W* EEPROM	U16		0…7200 s	Slow
R 03/04 W 06/16	43	1	Operating mode in Remote mode. Auto, Remote ON, Remote OFF	R/W	U16	0 = Auto 1 = ON 2 = OFF	0…2	Fast
R 03/04 W 06/16	44	1	External setpoint W3 Unit: See address 18 / 19	R/W[2]	U16	Process units	See ”Data types” on page 15	Fast
R 03/04 W 06/16	45	1	Predefined output mod. / multistage	R/W	U16	Fire rate	See ”Data types” on page 15	Fast
R 03/04 W 06/16	46	1	Fuel selection AZL...	R/W* EEPROM	U16	0 = Gas 1 = Oil	0…1	Slow
R 03/04 W 06/16	47	1	Setpoint W1	R/W[1, 2] EEPROM	U16	Process units	See ”Data types” on page 15	Slow
R 03/04 W 06/16	48	1	Setpoint W2	R/W[1, 2] EEPROM	U16	Process units	See ”Data types” on page 15	Slow
R 03/04 W 06/16	49	1	Weekday	R/W	U16	0 = Sunday 1 = Monday ...	0…6	Slow
R 03/04 W 16	50-52	3	Date	R/W	U16[3]	Data structure Date		Slow
R 03/04 W 16	53-55	3	Time of day	R/W	U16[3]	Data structure Time of day		Slow
R 03/04 W 16	56, 57	2	Hours run gas (adjustable to zero only)	R/W* EEPROM	S32		0...999999 h	Slow
R 03/04 W 16	58, 59	2	Hours run oil stage 1 or modulating (adjustable to zero only)	R/W* EEPROM	S32		0...999999 h	Slow
R 03/04 W 16	60, 61	2	Hours run oil stage 2 or modulating (adjustable to zero only)	R/W* EEPROM	S32		0...999999 h	Slow
R 03/04 W 16	62, 63	2	Hours run oil stage 3 or modulating (adjustable to zero only)	R/W* EEPROM	S32		0...999999 h	Slow
R 03/04 W 16	64, 65	2	Hours run total (adjustable to zero only)	R/W* EEPROM	S32		0...999999 h	Slow
03/04	66, 67	2	Hours run total (read only)	R	S32		0...999999 h	Slow
03/04	68, 69	2	Hours run device connected to power (read only)	R	S32		0...999999 h	Slow
R 03/04 W 16	70, 71	2	Startup counter gas (adjustable to zero only)	R/W* EEPROM	S32		0...999999	Slow
R 03/04 W 16	72, 73	2	Startup counter oil (adjustable to zero only)	R/W* EEPROM	S32		0...999999	Slow
R 03/04 W 16	74, 75	2	Startup counter total (adjustable to zero only)	R/W* EEPROM	S32		0...999999	Slow
03/04	76, 77	2	Startup counter total (read only)	R	S32		0...999999	Slow
03/04	78, 79	2	Fuel volume gas (read only) (resettable from AZL5... version V4.10) 0…199999999.9 m³ 0…1999999999 ft³	R/W* EEPROM	S32		See ”Data types” on page 15	Slow

1. Can only write to setpoint W1 or W2 if in mode “IntLC Bus”, otherwise it is ignored.
2. When in mode “IntLC Bus”, setpoints W1, W2, and W3 will be affected by parameters ***Ext MinSetpoint*** and ***Ext MaxSetpoint***.

Function	Address	Number of words	Data designation	Access	Data format	Data type / coding	Range	Updating rate
03/04	80, 81	2	Fuel volume oil (read only) (resettable from AZL5... version V4.10) 0…199999999.9 l 0…199999999.9 gal	R/W* EEPROM	S32		See ”Data types” on page 15	Slow
03/04	82	1	Number of lockouts	R	U16		0…65535	Slow
03/04	83	1	Extra temperature sensor (from AZL5... version V4.10 or later)	R	U16	°C: °F:	0..2000 °C 32..3632 °F	Slow
Parameters 84...137 are available on AZL5... version V4.20 or later								
03/04	84-91	8	AZL5... ASN	R	U8[16]	String		Constant
03/04	92	1	AZL5... parameter set code	R	U16			Constant
03/04	93	1	AZL5... parameter set version	R	U16			Constant
03/04	94-96	3	AZL5... identification date	R	U16[3]	Date		Constant
03/04	97	1	AZL5... identification number	R	U16			Constant
03/04	98-105	8	Burner control ASN	R	U8[16]	String		Constant
03/04	106	1	Burner control parameter set code	R	U16			Constant
03/04	107	1	Burner control parameter set version	R	U16			Constant
03/04	108-110	3	Burner control identification date	R	U16[3]	Date		Constant
03/04	111	1	Burner control identification number	R	U16			Constant
03/04	112	1	Software version AZL5...	R	U16	Hexadecimal		Constant
03/04	113	1	Software version burner control	R	U16	Hexadecimal		Constant
03/04	114	1	Software version load controller	R	U16	Hexadecimal		Constant
03/04	115-122	8	Burner identification	R	U8[16]	String		Upon reset
03/04	123	1	Min-output gas	R	U16	Fire rate	0...100 %	Slow
03/04	124	1	Max-output gas	R	U16	Fire rate	0...100 %	Slow
03/04	125	1	Min-output oil	R	U16	Fire rate	0...100 % 1001...1003	Slow
03/04	126	1	Max-output oil	R	U16	Fire rate	0...100 % 1001...1003	Slow
R 03/04 W 16	127	1	Load limitation enduser (modulating)	R/W* EEPROM	U16	Fire rate	0...100 %	Slow
R 03/04 W 16	128	1	Load limitation enduser (multistage)	R/W* EEPROM	U16	0: S1 1: S2 2: S3	0...2	Slow
03/04	129	1	Temperature limiter switching differential ON (in address 29: Temperature limiter OFF threshold, in degrees Celsius / Fahrenheit)	R	S16	Percent	-50...0 %	Slow
03/04	130	1	Measuring range temperature sensor	R	U16	0: 150°C / 302°F 1: 400°C / 752°F 2: 850°C / 1562F	0...2	Slow
03/04	131	1	Adaption active / inactive	R	U16	0: Inactive 1: Active	0...1	Fast
03/04	132	1	Adaption state	R	U16	Adaption list	0...12	Slow
R 03/04 W 16	133	1	Start adaption	R/W	U16	0: Reset value 1: Start 2: Abort	0...2	Slow
R 03/04 W 16	134	1	Adaption output Permissible values: 40%, 50%, 60%, 70%, 80%, 90%, 100%	R/W* EEPROM	U16	Percent	40...100 %	Slow
R 03/04 W 16	135	1	P-value	R/W* EEPROM	U16	Percent	2...500 %	Slow
R 03/04 W 16	136	1	I-value	R/W* EEPROM	U16	Seconds	0...2000 s	Slow

Function	Address	Number of words	Data designation	Access	Data format	Data type / coding	Range	Updating rate
R 03/04 W 16	137	1	D-value	R/W* EEPROM	U16	Seconds	0...1000 s	Slow
03/04	400	16	Lockout history (current lockout)	R	U16/U32 []			Fast
03/04	416	16	Lockout history (current lockout -1)	R	U16/U32 []			Fast
03/04	432	16	Lockout history (current lockout -2)	R	U16/U32 []			Fast
:	:	:	:	:	:			
03/04	528	16	Lockout history (current lockout -8)	R	U16/U32 []			Fast
03/04	544	8	Error history (current error)	R	U16/U32 []			Fast
03/04	552	8	Error history (current error -1)	R	U16/U32 []			Fast
:	:	:	:	:	:			
03/04	704	8	Error history (current error -20)	R	U16/U32 []			Fast

* These parameters do not need to be continually written since they are stored in EEPROM, which only permits a limited number of write accesses over its lifecycle (< 100,000).

Data structures

Date	U16	1: Year 2: Month 3: Day
Time of day	U16	1: Hour 2: Minute 3: Second
Lockout history	U16	1: Error code 2: Error diagnostics 3: Error class 4: Error phase 5: Fuel 6: Output 7: Date - Year 8: Date - Month 9: Date - Day 10: Time of day - Hours 11: Time of day - Minutes 12: Time of day - Seconds
	U32	13, 14: Startup counter total 15, 16: Hours run total
Error history	U16	1: Error code 2: Error diagnostics 3: Error class 4: Error phase 5: Fuel 6: Output
	U32	7, 8: Startup counter total

Legend to address table

Access	R R / W	Value can only be read Value can be read and written
Data format	S16 U16 S32	16 bit integer, subject to sign 16 bit integer, not subject to sign 32 bit integer, subject to sign Note: In the AZL..., this data type is also used to mark an invalid or non-available value by using the value of «-1»
[ ]		Data array

* These parameters do not need to be continually written since they are stored in EEPROM, which only permits a limited number of write accesses over its lifecycle (< 100,000).

Data types

TYPE	Phys.	Int. range	Resolution	Conversion int. / phys.
Percent	0...100 %	0...1000	0.1 %	/ 10
Percent	0...110 %	0...1100	0.1 %	/ 10
Degrees	-3.0...93.0°	-30...930	0.1°	/ 10
Process units	0...2000° 32...3632 °F 0...100 bar 0...1449 psi	0...2000 32...3632 0...1000 0...1449	1 °C 1 °F 0.1 bar 1 psi	1 1 / 10 1
Fire rate	Modulating operation: 0...100 % Multistage operation: 1001 = stage 1 1002 = stage 2 1003 = stage 3	0...1003	Modulating operation: 0.1 % Multistage operation: 1	Modulating operation: / 10 Multistage operation: - 1000
Adaption list	0: Undefined 1: Identification completed, parameter determined 2: Undefined 3: Adaption aborted by user 4: Temperature differential too small, temperature will be lowered with low-fire 5: Monitoring time running 6: Delivery of identification load set 7: Error during identification (path) 8: Error during identification (internally) 9: Monitoring time running 10: Changeover from modulating to multistage during an identification 11: Timeout monitoring time 12: Timeout heating output on path with monitoring			

Modbus Address / LMV5 Parameter Cross-Reference Guide

Modbus Address	Description	LMV5 Parameter
0	Phase	See "Normal Operation" screen
1	Position of active fuel actuator	
2	Position of gas actuator	
3	Position of oil actuator	
4	Position of air actuator	
5	Position of aux 1 actuator	
6	Position of aux 2 actuator	
7	Position of aux 3 actuator	
8	Position of VSD	
9	Current fuel	
10	Current output	
11	Current setpoint	
12	Actual value	
13	Flame signal	***FlameSig QRI_B***
14	Current fuel throughput	***Curr Flow Rate***
15	Current O2 value	***Current O2 Value***
16	Gas volume unit	***PulseValueGas***
17	Oil volume unit	***PulseValueOil***
18	Unit of temperature	***PhysicalUnits***
19	Unit of pressure	***PhysicalUnits***
20	Sensor type	***Sensor Select***
21, 22	Startup counter total	***TotalStartCount***
23, 24	Hours run total	***TotalHours***
25	Current error: code	See "Status/Reset" screen
26	Current error: diagnostic	
27	Current error: class	
28	Current error: phase	
29	Temperature limiter off threshold	***TL_ThreshOff***
30	Supply air temperature	***SupplyAirTemp***
31	Flue gas temperature	***FlueGasTemp***
32	Combustion efficiency	***CombEfficiency***
35	Inputs (bits)	N/A
37	Outputs (bits)	N/A
38	Program stop	***ProgramStop***
39	Load controller operating mode	***LC_OptgMode***
40	Manual / automatic operation	***Autom/Manual/Off***
41	Modbus mode: local / remote	***Local / Remote***
42	Modbus downtime	***Timeout***
43	Modbus: operating mode in remote	***Remote Mode***
44	External setpoint W3	***W3***
45	Predefined output	***SetLoad***
46	AZL fuel selection	***CurrentFuel***
47	Setpoint W1	***SetpointW1***
48	Setpoint W2	***SetpointW2***
49	Weekday	***Weekday***
50-52	Date	***Date***
53-55	Time of day	***TimeOfDay***

Modbus Address	Description	LMV5 Parameter
56, 57	Hours run on gas	***GasFiring***
58, 59	Hours run on oil stage 1	***OilStage1/Mod***
60, 61	Hours run on oil stage 2	***OilStage2***
62, 63	Hours run on oil stage 3	***OilStage3***
64, 65	Total hours run (resettable)	***TotalHoursReset***
66, 67	Total hours run (not resettable)	***TotalHours***
68, 69	Total hours system has been powered	***SystemOnPower***
70, 71	Startup counter gas	***GasStartCount***
72, 73	Startup counter oil	***OilStartCount***
74, 75	Startup counter total (resettable)	***TotalStartCountR***
76, 77	Startup counter total (not resettable)	***TotalStartCount***
78, 79	Total volume of gas	***Volume Gas***
80, 81	Total volume of oil	***Volume Oil***
82	Total number of lockouts	***LockoutCounter***
83	Additional sensor: current temperature	***Temp. ColdStart***
84-91	AZL5 ASN	***ASN***
92	AZL5 parameter set code	***ParamSet Code***
93	AZL5 parameter set version	***ParamSet Vers***
94-96	AZL5 identification date	***ProductionDate***
97	AZL5 identification number	***SerialNumber***
98-105	LMV5 ASN	***ASN***
106	LMV5 parameter set code	***ParamSet Code***
107	LMV5 parameter set version	***ParamSet Vers***
108-110	LMV5 identification date	***ProductionDate***
111	LMV5 identification number	***SerialNumber***
112	AZL5 software version	***SW Version***
113	LMV5 software version	***SW Version***
114	Load c ontroller software version	***SW Version***
115-122	Burner ID	***BurnerID***
123	Minimum allowed load on gas	***MinLoadGas***
124	Maximum allowed load on gas	***MaxLoadGas***
125	Minimum allowed load on oil	***MinLoadOil***
126	Maximum allowed load on oil	***MaxLoadOil***
127	Load limitation end user, modulating	***User MaxLoadMod***
128	Load limitation end user, multi-stage	***User MaxLoadStg***
129	Temperature limiter ON differential	***TL_SD_On***
130	Measuring range for temperature sensors	***MeasureRangePtNi***
131	Adaption active / inactive	***StartAdaption***
132	Adaption state	***StartAdaption***
133	Start adaption	***StartAdaption***
134	Adaption output	***AdaptionLoad***
135	PID proprtional band value	***P-Part***
136	PID integral value	***I-Part***
137	PID derivative value	***D-Part***
400-543	Lockout history	***LockoutHistory***
544-711	Fault history	***FaultHistory***

Starting adaption via Modbus

The routine used for identifying the path in the integrated load controller (termed “adaption” here) of the LMV5... system can be controlled and monitored via Modbus.

In principle, the general conditions are the same as those used when making adaptions with the AZL52... (refer to subsection 6.4.2 *Self-setting of control parameters (adaption*)) in the Basic Documentation of the LMV5... system (P7550).

The terms *Start adaption*, *Adaption active / inactive* and *Adaption state* indicate the respective Modbus addresses (refer to “Table of addresses”).

Start the adaption via *Start adaption* and change the value from ≠ 1 to = 1. Starting the adaption has no impact on adaption processes already under way (*Adaption active / inactive* = 1).

If *Adaption active / inactive* = 1, the process can be monitored via *Adaption state* (refer to data type Adaption list). When *Adaption active / inactive* = 0, the adaption process is completed. On completion of the process, the result can be read out via *Adaption state*.

To complete the adaption process prematurely, the value at *Start adaption* must be changed from ≠ 2 to = 2.

Updating rate of AZL5

Fast	System data that have already been updated automatically by the system process are available on request, at a typical repetition rate of 200 ms.
Medium	These data are cyclically queried in the system by the AZL... The typical updating rate here is 5 seconds, depending on system load.
Slow	These data are cyclically queried in the system by the AZL... The typical updating rate that can be expected here is 25 seconds, depending on system load.
Constant	These data are updated in the system by the AZL5... upon each *Power On* or reset. When making a query, the updated data will be available after 25 seconds. Data that cannot be changed (e.g. the production date, etc.) – neither with the AZL5... nor via the ACS450 – can be identified by the value of *0* in the first Byte of the strings.
Upon reset	Same as constant data, but these data can be changed in the system.

Error handling

Error codes	The AZL… does not send any exception codes. A faulty message or a message with an invalid address or function code will receive no response.

Selection menus in the AZL5

Activation of Modbus operation

Ensure the gateway mode is set to Modbus:
Operation > OptgModeSelect > Type of Gateway

Activation takes place via menu:
Operation > OptgModeSelect > GatewayBASon

Having made the selection, the menu item can be quit via ESC.The setting is retained until *Operation > OptgModeSelect > GatewayBASoff* is selected via the AZL… menu.

When GatewayBASon is activated, plant operation and diagnostics via the AZL... are still possible.

Deactivation takes place via menu:
Operation > OptgModeSelect > GatewayBASoff

Slave address

Selection is made via menu:
Params & Display > AZL > Modbus > Address

According to Modicon specifications, addresses between 1...247 can be selected. The slave address is filed in nonvolatile memory of the AZL...

Transmission parameters

Transmission rate	The setting is made via menu: *Params & Display > AZL > Modbus > Baudrate.* There is a choice of 9600 bit/s or 19200 bit/s.
Parity	Using the AZL... menu: *Params & Display > AZL > Modbus > Parity*, parity can be set to none, even or odd.

Timeout communication failure

When there is no Modbus communication, this timeout defines the period of time on completion of which the AZL… changes automatically from Remote to Local.

The setting is made via menu *Params & Display > AZL > Modbus > Timeout*.

Local «-» Remote mode

This setting defines whether the AZL… shall work in Local or Remote mode.

Remote mode

Display of Remote Auto, Remote On, Remote Off mode. A change can only be made via Modbus.

AZL5 interface

General

The AZL... serves the Modbus via its COM2 port (8-pole Western jack RJ45). The port is assigned to the functional low-voltage range.

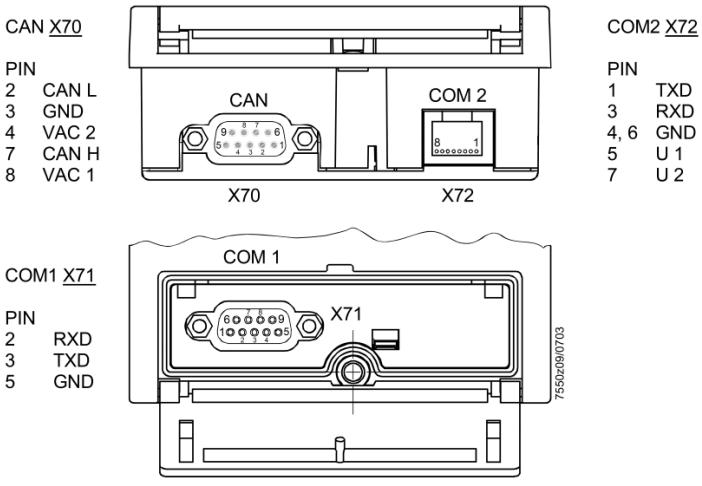
Assignment of RJ45 pins:

PIN		
1	TXD (RS-232 level or V28)	Modbus
2	Not used	
3	RXD (RS-232 level or V28)	
4	GND	
5	U1 (typically +8.2V)	eBUS
6	GND	
7	U2 (typically -8.2V)	
8	Not used	

When preparing and fitting a connecting cable between the AZL... and a converter, it is to be noted that PIN 5 and PIN 7 can deliver a current of 5 mA each. Adequate insulation against other potentials must be ensured.

The maximum permissible data line length between COM2 and a converter is 3 m. In exceptional cases, this data line length can be exceeded, depending on environmental conditions (electrical interference) and the type of cable used – without Siemens assuming responsibility.

To ensure protection against electric shock hazard, it must be made certain that AC 120 V lines are strictly separated from the functional low-voltage area.



Note: COM1 (PC port) and COM2 cannot be active at the same time!

RS-232 – RS-485 Converter

This converter converts a V.24 / RS-232 port into an RS-485 port.

Technical Requirements

- Code transparency, that is, data must remain unchanged
- When using the RS-485 interface as a bus, control of the transmitting section on the RS-485 side must be ensured by the transmitter power of the AZL…
- The interfaces must be galvanically separated to improve EMC

Available Converter (SCC Part Number K3SC-10-AC100-240)

RS-232 to Converter Wiring

AZL COM2 (RJ45 Connection)		RS-232 – RS-485 Converter (K3SC-10-AC100-240)	
Terminal Number	**Description**	**Terminal Number**	**Description**
1	TxD	5	SD
3	RxD	6	RD
4	GND	3	SG

Converter to RS-485 Wiring

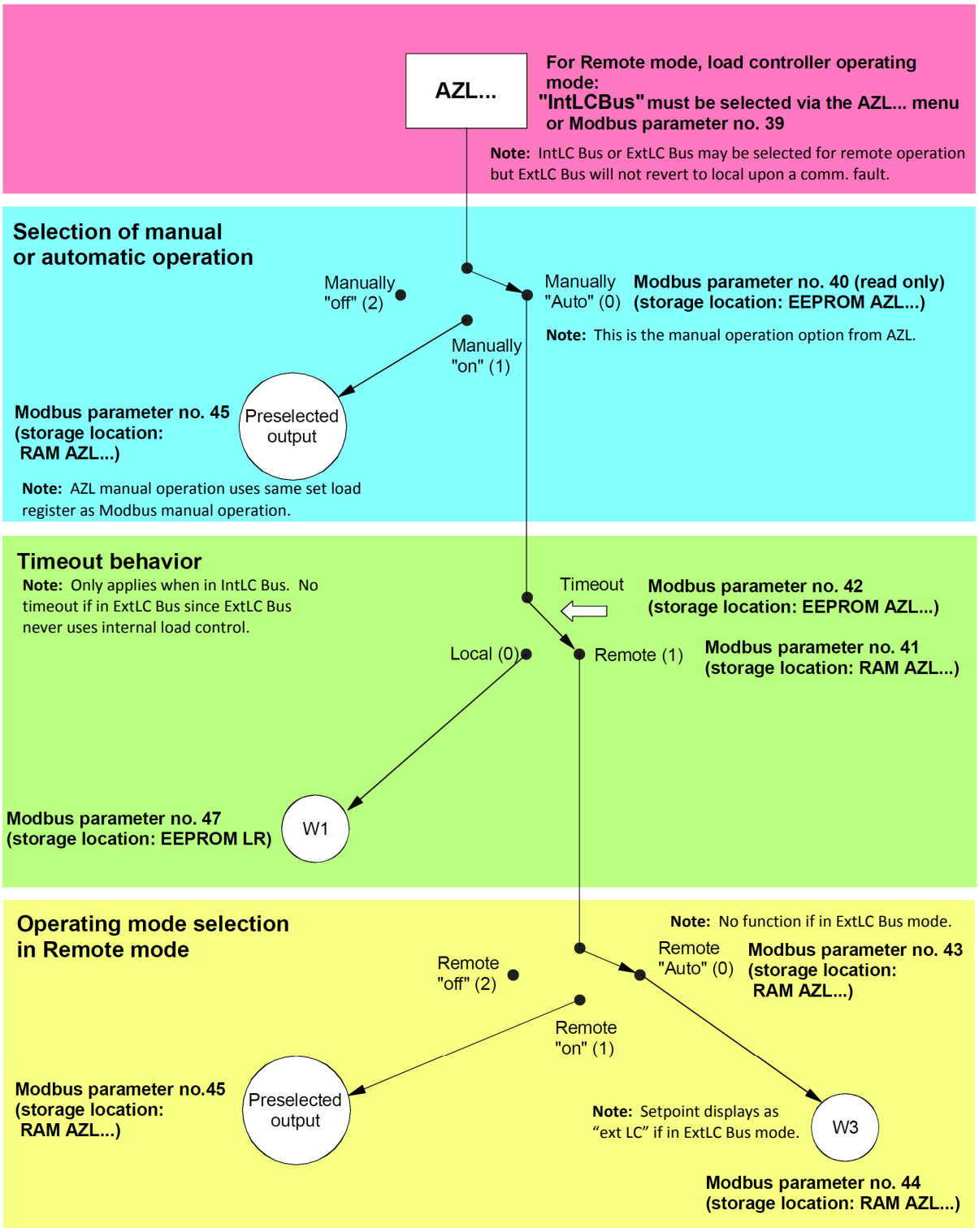
RS-232 – RS-485 Converter (K3SC-10-AC100-240)		RS-485 Field Connection
Terminal Number	**Description**	**Description**
12	SDB(+)	RS-485(+)
9	SDA(-)	RS-485(-)
7	SG	Signal ground

Dip switch settings

The following dip switch settings are necessary to program the RS-232 to RS-485 converter for a 19,200 Baud rate, 8 data bits, 1 stop bit, no parity, and no echoback.

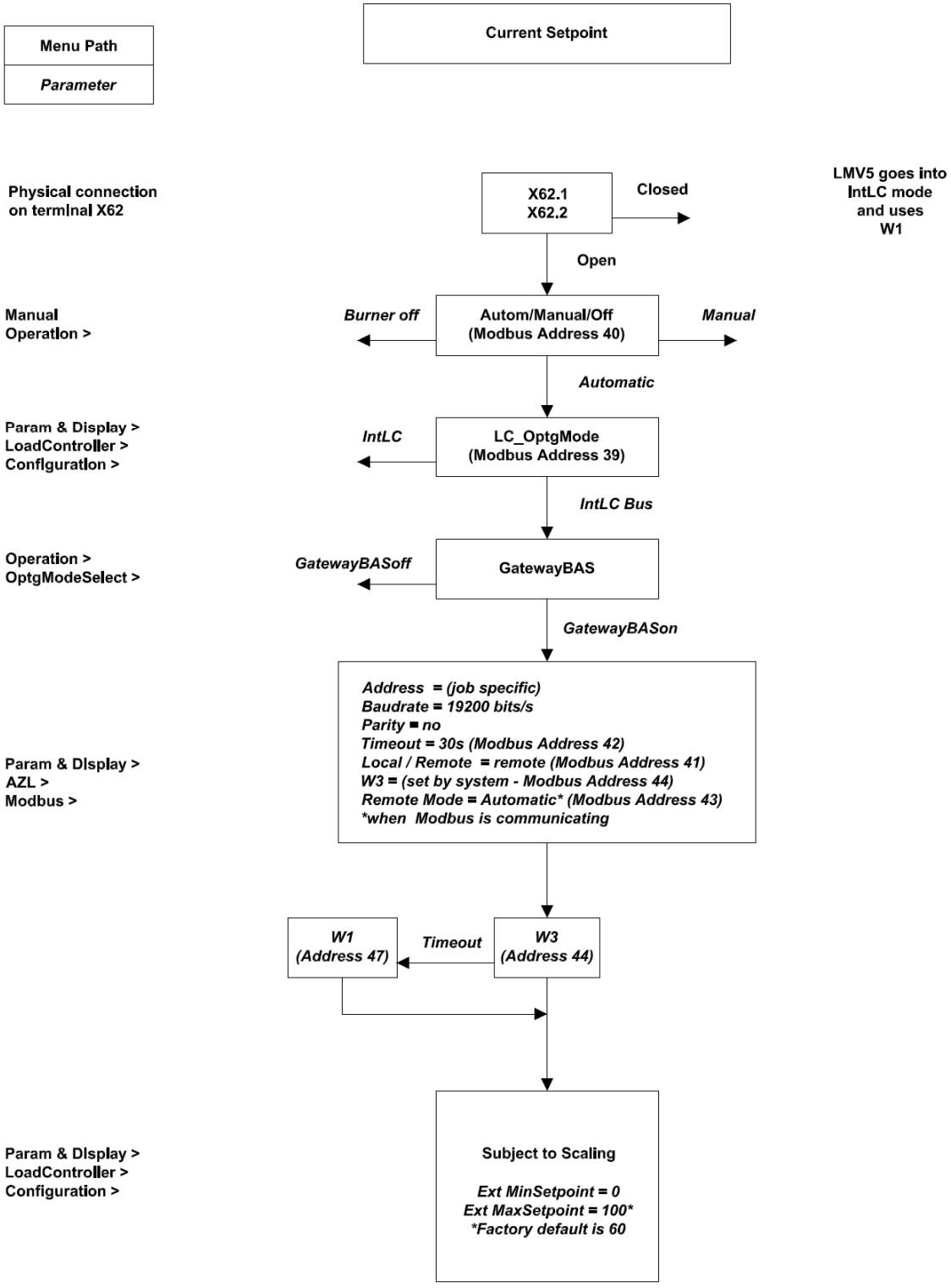
1: ON
2: OFF
3: ON
4: ON
5: ON
6: OFF
7: ON
8: OFF
9: OFF
10: OFF

Overview of «Operating mode changeover of controller»



W3 Setpoint Troubleshooting

If setpoint W3 is not being displayed as the current setpoint, check the following:



Notes on operating modes

Modbus downtime

When there is no more communication between BAS and AZL..., the Modbus downtime is used to switch over from Remote mode to the preselected setpoint in Local mode. The timer will be activated when changing from Local to Remote. With every permissible Modbus communication to this slave (AZL...), the timer will be reloaded. Should the timer lapse, the BAS must again set the Remote mode, if required. The timer value will be retained in EEPROM and will also be retained after power off.

When deactivating the "Gateway BAS" mode (menu item *OptgModeSelect > GatewayBASoff*), automatic changeover to Local takes place, that is, preselected output W1 will apply.

Changeover of operating mode via parameter 43

This changeover was introduced primarily because of the requirements of boiler sequence control.
In that case, the individual boiler can be operated at low output via manually "On". When switching to "Auto" via sequence control, preselected output W3 will be used.

Default parameter settings

Parameter	Address	Storage location	Preselection	Choices for making changes
Setpoint W1	47	EEPROM	See Basic Documentation «Menu and parameter lists»	• On the AZL... (menu) • Preselection via Modbus
Setpoint W2	48	EEPROM	See Basic Documentation «Menu and parameter lists»	• On the AZL... (menu) • Preselection via Modbus
External setpoint W3	44	RAM	«0» will be reinitialized when resetting the AZL...	• On the AZL... (menu) • Preselection via Modbus
Set target load mod / multistage	45	RAM	«0» will be reinitialized when resetting the AZL...	• On the AZL... (menu) • Preselection via Modbus
Local / Remote	41	RAM	«Local»	• Via Modbus • On the AZL... (menu) • Via lapse of timer «Communication failure» from Remote to Local
Selection of manual or automatic operation	40	EEPROM	See Basic Documentation «Menu and parameter lists»	• On the AZL... (menu)
Operating mode: Remote "off" / remote "on" / W3	43	RAM	«Auto» will be reinitialized when resetting the AZL...	• Preselection via Modbus
Operating mode with load controller	39	EEPROM	See Basic Documentation «Menu and parameter lists»	

Note: An AZL5 reset will be triggered when switching power on, or in the event of severe system errors.

Important Modbus Notes

Operating Mode (Address 39)	Remote Mode (Address 43)	X62 Action (Hard-wired)	Remote -> Local (Address 41)	Modbus Control Action
IntLC Bus	0 (automatic)	Bumpless transition to W1	Bumpless transition from W3 to W1	Burner controls to W3 setpoint using internal load controller
	1 (manual)	No transition to W1 but W1 is now displayed as setpoint	Bumpless transition if a valid W3 is already established	Burner modulates at commanded firing rate without load controller intervention
	2 (burner off)		Transition to W1	Burner remains off
ExtLC Bus	0 (automatic)	Bumpless transition to W1	Local/Remote is not considered, remains at firing rate in memory	Burner modulates at commanded firing rate without load controller intervention*
	1 (manual)			
	2 (burner off)		Local/Remote is not considered, remains off	Burner remains off

*A value of 1 must be written to address 43 to turn the burner on if a value of 2 was previously written to address 43 to turn the burner off.

Manual Operation

Manual operation from the AZL takes priority over any Modbus operation, although "SetLoad" is common to the remote firing rate. If a previous firing rate or "SetLoad" is established in memory, it will be used when manual or remote firing rate operation is commanded.

ExtLC Bus Caution

In operating mode ExtLC Bus, a communication loss will cause the burner to stay in the last commanded state. If the burner was firing, it will restart at the firing rate in memory. If the burner was commanded off, operation will not resume unless communication is re-established or the operating mode is changed.

Displayed Setpoint

When in ExtLC Bus, setpoint is displayed as "ext LC" since it is not used. When in IntLC Bus and providing a remote firing rate, the W3 setpoint is displayed (even if it is 0) although it is not used. It is important to send a valid setpoint for display purposes as well as for bumpless transfer to W1 after a communication timeout or switch to Local mode since a transition from firing rate control to W3 setpoint control will occur for at least one scan before assigning control to W1. If W3 is less than the actual setpoint plus the "off" hysteresis, the burner will shut down before transferring to W1. This is not necessary when going from Local to Remote, but would be good practice.

Sequence of Control

Local to Remote: W1 setpoint control -> remote firing rate control
Remote to Local (or communication timeout): remote firing rate control -> W3 setpoint control (very briefly) -> W1 setpoint control

Considerations When Using Remote Firing Rate Control

When the internal load controller is not used to provide the firing rate, functions such as the thermostat function and cold start function will not work. However, these should still be configured for use in Local mode. In Remote mode, it is important to duplicate the functionality when determining the firing rate. An additional temperature sensor connected to X60 for cold start can be read via Modbus address 83 if a Pt1000 or Ni1000 RTD is used.

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Section 2	Wiring
Section 3	Parameters
Section 4	Commissioning
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Section 7	Troubleshooting
Section 8	Modbus
Section 9	**ACS450**
Section 10	Revision History
Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

Section 1	Overview
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Section 9-1: ACS450 Introduction

The LMV5 system can be completely programmed using either the AZL5 or a PC with the ACS450 software. Most people find that using the AZL5 is more convenient than the ACS450 for a "manual" setup of the LMV5 parameters. However, the ACS450 has additional capabilities that are not available with the AZL5 / LMV5 alone. These additional, valuable capabilities are:

1. Saving and printing all LMV5 settings, combustion curves, and information in a report format. This provides a convenient, comprehensive startup report.

2. Saving and uploading entire LMV5 parameter sets to or from a PC.

3. Updating AZL5 software.

4. Viewing and saving trends (particularly useful for tuning PID loops).

5. Viewing a "dashboard" of the LMV5 inputs and outputs as well as the LMV5 operating state.

Sections 9-2 through 9-4 will cover the software installation, communication setup, and AZL5 software updates. Sections 9-5 through 9-8 will explain how to utilize the basic capabilities of the ACS450 software, including startup reports, parameter sets, trending, and the "dashboard".

Since most people prefer to use the AZL5 to set parameters and combustions curves in the LMV5, the procedure to do this with ACS450 will not be covered in this guide. For technical information about how to program the LMV5 through the ACS450 software, email techsupport@scccombustion.com.

The ACS450 software can be used with the following PC operating systems:

- Windows 98
- Windows 2000
- Windows XP
- Windows 7
- Windows 8

ACS450 cannot be used with the following PC operating systems:

- Windows Vista
- Windows ME

9-2: ACS450 Software Installation

The following steps outline the procedure for installing the ACS450 software on a PC:

1. The ACS450 software can be acquired in a couple of ways:
   a. Download it from the SCC website: *www.scccombustion.com/acs450_form.htm*
      - After filling out a short form, you will receive an e-mail containing the Username and Password required to download the software. Once the Username and Password are acquired, use the "click here" link on the same webpage in order to start the download.
   b. Download it from SCC's Combustion CD.
   c. Acquire it via an e-mail attachment.

2. The files shown below must reside in the same folder on the PC or on the CD before proceeding.

- acs450.msi
- InstMsiA.exe
- InstMsiW.exe
- setup.exe
- setup.ini

Double-click on the setup.exe file. This should start the installation. Pick the desired options as the installation prompts.

3. Once installed, the files will be located on the computer's hard drive at the following location: *C:\Program Files (x86)\ACS450*

4. Open this folder and check to make sure that all of the .cod files listed below are there. These are necessary for the AZL5 to communicate properly with the ACS450 software.

- Para_Nr_0400.cod
- Para_Nr_0410.cod
- Para_Nr_0420.cod
- Para_Nr_0450.cod
- Para_Nr_0460.cod
- Para_Nr_0470.cod
- Para_Nr_0480.cod
- Para_Nr_0490.cod
- Para_Nr_0500.cod

Any missing .cod files can be acquired from the SCC Combustion CD or by emailing techsupport@scccombustion.com.

5. At this point, the ACS450 is ready to run. The first time ACS450 is started it will prompt for a license code. When prompted, type the following license code: **041028000703GH.**

9-3: AZL5 Communication Setup

The following steps summarize the procedure for establishing communication between the AZL5 and a PC.

1. The table below outlines the cables necessary for connecting the PC to the AZL5. These cables will vary depending on whether or not the PC has a serial port to connect to.

Table 9-3.1: Necessary Cables to Connect PC to AZL5

Type of PC	Null modem cable	USB-to-serial converter w/ FTDI chipset
PC with serial port	X	
PC without serial port	X	X

For convenience, SCC stocks both the null modem cable and the USB-to-serial cable with the FTDI chipset. See Section 1 for part numbers and technical information for these cables.

2. Once the correct connection cables are acquired, the PC can be connected to the AZL5. Plug one end of the connection cable into the 9-pin RS-232 port on the front of the AZL5 (under the front cover). Plug the other end of the connection cable into the PC.

3. In order to connect, the AZL5 must be put into *InterfacePC* mode. This selection is found using the following menu path in the AZL5:

Operation > OptgModeSelect > InterfacePC

4. Once the AZL5 is in *InterfacePC* mode, attempt to connect with the ACS450 on the user level. This is done by going to the "System LMV5x" dropdown menu and selecting "Connect". When the dialog box appears, select "User" and press OK. If the connection is successful, proceed to step 5.

If the connection is not successful, check the com port settings. To check which com port the connection cord is plugged into, open the computer's Device Manager. Once open, expand the "Ports (COM & LPT)" tab and check which com port is called "USB Serial Port". This port must match the port that the ACS450 software is reading. The com port being read by the ACS450 can be changed by going to the "System LMV5x" dropdown menu and selecting "Options".

Note: The ACS450 software only recognizes com ports 1 through 8. If the port that the connection cord is plugged into is higher than 8, it needs to be changed. This is done by right-clicking on "USB Serial Port" and selecting "Properties". Go to the "Port Settings" tab and click "Advanced". From here, the com port number can be changed to any number that is not currently being used by another device.

5. After the connection at the user level is successful, disconnect from the AZL5 and then reconnect at the service or OEM level, if desired. This is done by going to the “System LMV5x” dropdown menu and selecting “Disconnect”. Remember that a password will be necessary to access the LMV5 on the service or OEM level and that the password is case-sensitive.

Note: If a fault window appears, it is not necessary to close the fault window. It can be moved to the side and temporarily ignored. Most tasks can be performed with the fault window open. If the fault window is closed and the fault is not cleared, the fault window will reappear in a few seconds.

9-4: AZL5 Software Updates

The AZL5 software package is frequently updated with new parameters and features. The software of any AZL5 can be updated using the ACS450 software. If the AZL5 ever states that there is a "Version Conflict" when it is connected to the LMV5, the AZL5 software needs to be updated via the ACS450 software.

The current software version of the AZL5 can be checked via the following menu path on the AZL5:

Params & Display > Access w-out PW > AZL > SW Version

At the time of publication, the latest software version is 5.00, which will display as "0500" on the AZL5.

The following steps outline the procedure for updating the software version of the AZL5.

1. Ensure that ACS450 is installed on the computer being used to update the AZL5 software. See Section 9-2 if necessary.

Note: Prior to attempting an AZL5 software update, deactivate the Modbus port (RJ45) on the bottom of the AZL5 if it is being used. The port can be deactivated under:

Operation > OptgModeSelect > GatewayBASoff

2. Locate the correct .bin file. The ACS450 will prompt for the file later in this procedure. The .bin file that is necessary for the update is shown below. If the .bin file cannot be located, it can be acquired from the SCC Combustion CD or by emailing techsupport@scccombustion.com.

- AZL52.00_V0500.BIN

3. Connect the PC to the AZL5 using the necessary cables. The requirements of this connection are outlined in Section 9-3.

4. On the main menu in the AZL5, scroll down to “Updating”. When “Enter” is pressed, a password prompt will appear. Either the service or OEM level password will be necessary. After access is gained, scroll down to “Load_SW_from_PC” and press “Enter”. This screen will state “Start Process with ENTER”. Do not press “Enter” at this time.

Note: If the AZL5 displays “Version Conflict”, press “Esc” on the AZL5 in order to get to the main menu. When the AZL5 is in a “Version Conflict”, **only** the service password will grant access to the “Load_SW_from_PC” option.

5. Open up the ACS450 on the computer, go to the “System LMV5x” dropdown menu, and select “Update AZL Flash”. The ACS450 will then ask for the .bin file. Locate and open the correct .bin file. Once the .bin file is opened, press “Enter” on the AZL5 to begin the update.

Note: It is important that steps 4 and 5 are completed as specified above. Make sure to press “Enter” on the AZL5 immediately after opening the .bin file on the computer. If these steps are performed too far apart, the update process could take a long time, or not happen altogether.

6. The AZL5 screen should say “SW-Update” on the top. If everything is working properly, the AZL5 should say “clearing flash” and then it should say “programming”. During the process, there should be a horizontal bar on the AZL5 screen and also on the computer screen that slowly fills in from the left to the right. The update procedure takes at least 5 minutes. When everything is finished, the ACS450 should say “Transfer finished, press cancel” and the AZL should say “SW-Update OK, FLASH : V05.00, cancel : left key”.

7. Press “Esc” on the AZL5. It will go into “System Test” and then come up normally. The AZL5 flash update is now complete.

9-5: Creating an LMV5 Startup Report

The following steps outline the procedure for saving, viewing and printing a startup report (.mdb file) to a PC. The LMV5 must have a burner ID to create a backup report.

Saving the .mdb file

1. Ensure that the ACS450 software is open, and the PC is connected to the AZL5 at the user, service, or OEM level. See Sections 9-2 or 9-3 if necessary. A full report will be saved at any password level. The report can be filtered later by password level when it is viewed.

2. Go to the ACS450 "System LMV5x" dropdown menu, and select "Backup for offline mode".

3. The ACS450 will then read the parameters on the LMV5 and compose a report. The status of the backup will be indicated on the backup window. The backup process may take up to 10 minutes. This report will be automatically saved in *C:\Program Files (x86)\ACS450\daten.* The file name is automatically saved as the burner ID of the LMV5.

4. After the backup process is complete, go to the ACS450 "System LMV5x" dropdown menu, and select "Disconnect". A window will appear that asks "Do you want to store parameters for offline mode?" Since this was just done in Step 3, it is not necessary to repeat. Click "No".

5. The ACS450 is now disconnected from the LMV5, and the .mdb file is saved. Once disconnected, the .mdb file can be viewed or printed with the ACS450 software.

Viewing and printing the .mdb file contents

6. Ensure that the ACS450 software is open, and **not connected** to the LMV5. Go to the "File" dropdown menu, and select "Show Parameters". When this is selected, a dialogue window will appear. Select the .mdb file to be opened. The default location for the .mdb files is *C:\Program Files (x86)\ACS450\daten.*

7. Once the file is selected, another window will appear for the access level. Any level can be chosen to view and print the parameter list without needing a password. The level chosen will affect what parameters appear, so selecting the OEM level will show all parameters available. Once the access level is selected, a list of the parameters and their settings should appear.

8. Once the parameter list is visible on the screen, it can be viewed and / or printed. The fault and lockout history can also be viewed and / or printed. To access the fault and lockout history, go to the "Parameters" dropdown menu and slide the cursor to "Operating State". The options of "Fault History" and "Lockout History" should appear. Click on either to view.

Note: Many people prefer to create the startup report in a more universal document format, such as a .pdf file type. This can be done with Adobe ® software that has a writer function. To create the .pdf files, simply print the desired pieces of the .mdb file to the .pdf writer instead of an actual paper and toner printer. Most people prefer to have a .pdf file of the parameter list, fault history, and lockout history. These pieces provide a very inclusive LMV5 startup report.

9-6: Saving and Uploading Parameter Sets

The following steps outline the procedure for saving parameter sets (.par files) to a PC and also uploading parameter sets from a PC to an LMV5.

Saving a .par file to the PC

1. Ensure that the ACS450 software is open, and the PC is connected to the AZL5 at the service or OEM level. See Sections 9-2 or 9-3 if necessary.

2. To save an LMV5 parameter set to a PC, go to the ACS450 “System LMV5x” dropdown menu, and select “Backup LMV > PC”.

3. A window will appear titled “Backup LMV > PC” and will have a message at the bottom stating the “Status”. The “Status” will start as “1” and will proceed to saying “Input file name”. From the time the window appears to when the message states “Input file name” could take up to three minutes, but is usually less.

4. A comment can be typed in if desired. If not, click on “Save in File” and another window will come up. In this window, type the file name (a name containing the burner ID is recommended) and select an appropriate folder to save the file. The default location for .par file storage is *C:\Program files (x86)\ACS450\daten*. Click on “Save”.

5. When being saved, the message on the “Backup LMV > PC” window should state “Reading Parameters”. When saving is completed successfully, the message should say “Success, press Close”. Click “Close”. The .par file is now stored on the PC in the specified location.

Note: The .par file is stored in machine language, so it is not useful as a startup report.

Uploading a .par file to the LMV5

6. Ensure that the ACS450 software is open, and the PC is connected to the AZL5 at the service or OEM level. See Sections 9-2 or 9-3 if necessary.

7. To upload a parameter set from a PC to an LMV5, go to the ACS450 “System LMV5x” dropdown menu, and select “Restore PC > LMV”.

8. A prompt will appear, asking for the desired .par file. Select the desired .par file and click on “Open”. **This .par file will overwrite the parameter set on the LMV5 and will determine the behavior of the LMV5. Be sure that the correct .par file is selected.**

9. A window will appear titled “Restore PC > LMV”. If the message on the bottom of the window states “Burner ID is ok” or “New base unit”, then proceed to Step 11. If the message states “Burner ID is different”, proceed to the next step.

10. If the burner ID contained in the .par file is different than the burner ID on the LMV5, the ACS450 software will **not** permit the .par file to be uploaded to the LMV5. The exception to this is if the burner ID on the LMV5 is blank. If the burner ID is blank, then the upload is permitted. If the burner ID is different, two options are available (perform either option A or B below):

A. Change the burner ID on the LMV5 to match the burner ID contained in the .par file. This can be done via the ACS450 software or through the AZL5 directly. The OEM password is required to do this with either method.

   i. If using ACS450 – Once connected at the OEM level, go to the “Parameters” dropdown menu. The path to change the burner ID is *Operation > Burner ID*. Change the Burner ID in the dropdown menu.

   ii. If using the AZL5 - Disconnect the PC. Once disconnected, the path through the AZL5 is *Updating > Burner ID*. A prompt will appear for the password when “Updating” is selected on the AZL5.

B. Reset and then initialize the LMV5 using the ACS450.

   i. Connect to the LMV5 with the ACS450 at the Service or OEM level. After connecting successfully, go to the “System LMV5x” dropdown menu and select “Reset BU”. A reset window will appear that states the burner ID and fuel train will be deleted.

   ii. Click “Reset”, and the LMV5 will be reset (burner ID and fuel train). An alarm window will immediately appear that states “No Fuel Train Defined”. This alarm window does not need to be closed. The alarm window can be moved out of the way. Click on “Close” to close the reset window.

   iii. The burner ID and fuel train are now erased. Go under the “System LMV5x” dropdown menu and select “Disconnect”. A window will appear that asks “Do you want to store parameters for offline mode?” Click “No” if a backup (.mdb file) file is not necessary. If “Yes” is clicked, the ACS450 will create an .mdb file. The .mdb file creation can take up to 10 minutes. Creating an .mdb file is discussed in Section 9-5.

iv. Next, go to the “System LMV5x” dropdown menu and select “Init BU”. A window will appear and the ACS450 will begin reading the parameters. This will take a few minutes. After this is complete, a window will appear that asks for a .par file. Select the .par file that contains the parameter set to be uploaded. **This parameter set (.par) will overwrite the parameter set on the LMV5 and will determine the behavior of the LMV5. Be sure that the correct .par file is selected.**

11. Click on “Store in LMV”. This will start the upload process.

12. The following messages should appear on the “Restore PC > LMV” window. These messages are (in order): “Function Succeeded”, “Transferring Parameters”, “Status = 1”, “Status = 2”, “Status = 3”, and “Parameter Transfer Succeeded”. The upload process may take up to five minutes to complete. Also, an alarm may occur during the upload. This alarm is normal, and is to alert the technician that the new parameter set has been uploaded to the LMV5.

13. Once the “Parameter Transfer Succeeded” message is shown on the “Restore PC > LMV” window, click on “Close”. The alarm resulting from the upload can also be reset at this time. The upload is now complete.

9-7: Saving and Viewing Trends

The ACS450 software can be used to view and save trends. Trending enables a technician to easily view and quantify system behavior over time. This feature is particularly useful for setting up PID loops since “hunting” can be easily recognized on a trend. The following steps outline the procedure for viewing and saving trends with the ACS450 software:

1. Connect to the AZL5 at any access level. See Section 9-3 if necessary. After the connection is established, go to the “System LMV5x” dropdown menu and select “Record Trending”. A window will appear asking where the trending files are to be saved. Type an appropriate file name in front of the .tbd extension. A valid file name would look like: siemens.tdb. Notice that the * is no longer in the file name.

2. After the file name is typed in, click on “Open”. Click on “Yes” when the window appears asking if you would like to create the file. The trending screen should now appear and will look similar to Figure 9-7.1 below.

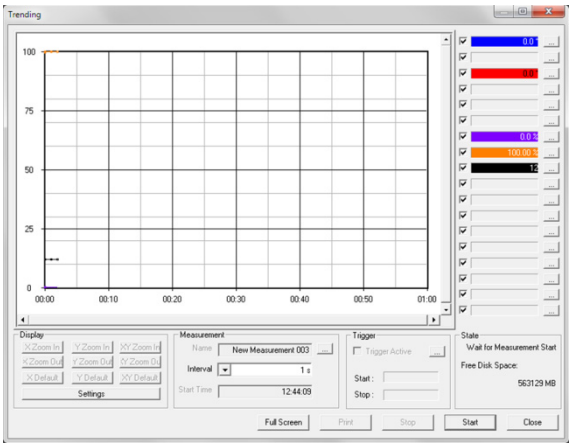

Figure 9-7.1: The ACS450 Trending Screen

3. The trending screen will trend all of the variables that are checked on the right hand side of the screen. These can be turned off and on by clicking on the checkmark. The variables can be identified and pen colors changed by clicking in the box to the right of each variable.

4. The title and measurement interval for the trend can be changed in the measurement box. Triggers can also be set to start the trending automatically.

5. After the trending screen is set up, trends can be recorded. To start recording a trend manually, click on “Start”. The “State” window should indicate that the measurement has started.

6. Trends will be buffered until “Stop” is clicked. When “Stop” is clicked, the trends will be saved under the previously defined .tbd file.

7. Trends can be viewed when the ACS450 is disconnected from the AZL5. To view trends, go to the “File” dropdown menu and select “Show Trending”. A window will appear prompting for the correct .tbd file.

8. Select the trend to be viewed or exported. If “Ok” is clicked, the trend can be seen in ACS450. If “Export” is clicked, a .csv file can be created that can be opened with Microsoft Excel.

9-8: Viewing the LMV5x Dashboard

When connected to the AZL5, the ACS450 can provide an overview screen or “dashboard”. This provides a useful summary of the LMV5 inputs and outputs, as well as the operating state of the LMV5. The following steps outline the procedure for viewing the ACS450 dashboard:

1. Connect to the AZL5 at any password level. This is covered in Section 9-3.

2. Once connected, go to the “Parameters” drop down menu, followed by the “Operating State” menu. Click on “Normal Operation”, and the dashboard should appear detailing the operating state of the LMV5. The dashboard looks like Figure 9-8.1 below.

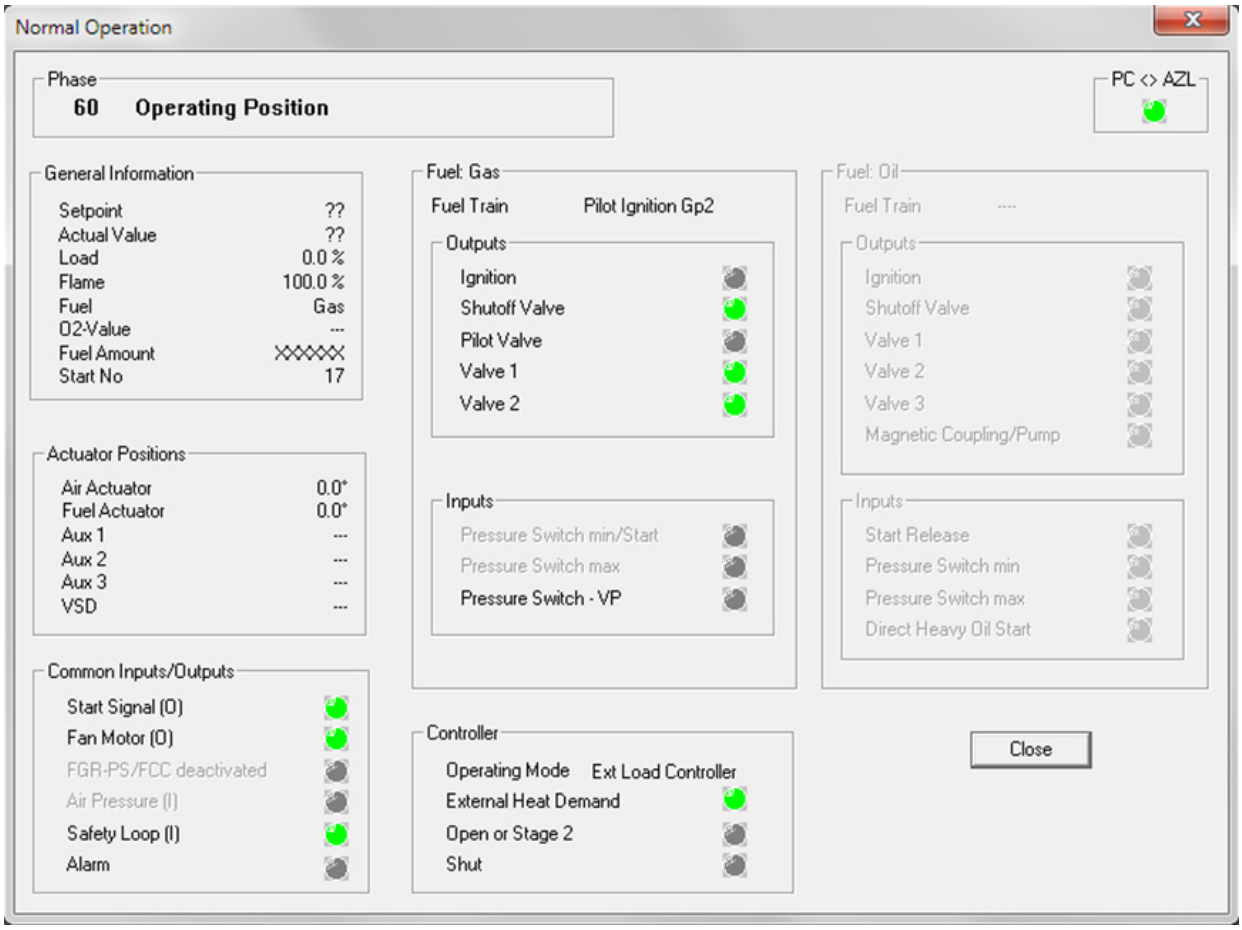

Figure 9-8.1: The ACS450 Dashboard

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Section 2	Wiring
Section 3	Parameters
Section 4	Commissioning
Section 5	VSD
Section 6	O_2 Trim
Section 7	Troubleshooting
Section 8	Modbus
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Appendix A	Application Guide
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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10-1: Introduction

The LMV51, LMV52, and AZL5 have software packages that are frequently updated with new parameters and features. The revision history for each of these software packages will be covered in Sections 10-2 through 10-4.

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10-2: LMV51 Software Version Updates

This section covers all of the revisions that were made to the LMV51 controller with each new software release. The software version of any LMV51 controller can be found using the following menu path:

Params & Display > BurnerControl > SW Version

The LMV51.1 also has a load controller with its own unique software version. The software version for the load controller can be found using the following menu path:

Params & Display > LoadController > SW Version

LMV51 Software Update: Version 0210 to 0220

The following updates were made with LMV51 software version 0220:

1. When the unit reaches the *Program stop* position, the AZL5 displays "*Programstop active".*

2. Alarm output X3-02.1 can be deactivated via parameter ***Alarm act/deact***. The current fault or lockout is still maintained on the AZL, but the 120V output is de-energized. Deactivation of the output remains active until a reset is made, another fault occurs, or a startup occurs.

3. A low oil pressure switch can now be activated when firing oil.

4. When firing oil, the oil safety valve output X6-03.3 de-energizes on completion of the afterburn time (end of phase 70). The fan output de-energizes after phase 79. Using parameter ***OilPumpCoupling***, it is now possible to choose between the described above (when using the magnetic clutch) or direct coupling of the oil pump. In the case of direct coupling, the oil safety valve must be connected to the output for the oil pump (X6-02.3). The oil safety is will always be controlled when the fan runs, plus another 15 seconds.

5. The evaluation of input *DWminOil* when using oil train "*Heavy oil with gas pilot"* has been moved from phase 38 to phase 44. *DWminOil* is only valued during the safety time after a delay time has elapsed.

6. The output signal to the air pressure switch test valve can be inverted using parameter ***Start/PS-Valve***. This output is only active when the fan operates.

7. If the burner operation is set to "*Manually on"*, the burner on / off contact (X5-03.1) acts as a shutoff device should an over-temperature situation occur. With the exception of operating mode 1 (ExtLC X5-03), the burner on / off contact can be deactivated if not being used as a shutoff device.

LMV51 Software Update: Version 0210 to 0220 (continued)

8. After a safety shutdown, the longer prepurge time ***PrepurgeSafeGas/Oil*** becomes active.

LMV51 Software Update: Version 0220 to 0230

The following update was made with LMV51 software version 0230:

1. After ignition, the actuators will drive to curve point 1 independent of whether or not the minimum load has been set to a higher value than the load of point 1. Once the actuators have reached point 1, they will then drive to the set minimum load.

LMV51 Software Update: Version 0230 to 0250

The following updates were made with LMV51 software version 0250:

The product numbers of the LMV5 changed as follows:

LMV51.0x0Bx → LMV51.0x0Cx
LMV51.1x0Bx → LMV51.1x0Cx
LMV51.200Ax → no modification

To operate an LMV5 with the software versions listed above, it is necessary to have AZL5 software version 0410 or higher installed. Using this software, all AZL5s can now be updated.

The passwords are now encoded. The following other changes were made to the LMV5 basic units:

1. Introduction of a preset load for testing the safety limit thermostat (***SLT-Testload Mod***, ***SLT Testload Stg***).

2. Introduction of a burner startup without prepurging (***Skip Prepurge Gas***, ***Skip Prepurge Oil***).

3. Prepurge times 1 (t30) and 3 (t34) can be set at the OEM level.

4. Introduction of a repetition counter at the OEM level for loss of flame during operation (***LossOfFlame***).

5. Alarm in the event of start prevention in standby mode (***ShutdwnStbyOnErr***). In the case of a start prevention with no call for heat, it has previously not been possible to set off an alarm. Now an alarm can also be triggered in standby mode.

6. The inputs for oil are no longer checked when firing on gas. Likewise, the inputs for gas are no longer checked when firing on oil.

LMV51 Software Update: Version 0230 to 0250 (continued)

7. The maximum filling and evacuation times for gas valve proving are now limited by the maximum permissible safety time for startup. In particular, this affects the burner control versions that use the American standard parameter set.

8. Introduction of max. load limitation at the user level (***UserMaxLoadMod***, ***UserMaxLoadStg***).

9. Hiding an adjustable load range aimed at reducing resonance phenomena in the burner/boiler/stack system (***LoadMaskLowLimit***, ***LoadMaskHighLimit***).

10. The fuel actuator can be deactivated (only with an LMV52).

11. A new flue gas recirculation (FGR) function (only with an LMV52). Actuator AUX3 can be employed for controlling the damper used for flue gas recirculation (FGR). To improve the burner's startup characteristics, only this actuator can be driven from its ignition position to the adjusted curve, either time-delayed or depending on the flue gas temperature.

12. A new option for no prepurge for gas burners (***Skip Prepurge Gas***). As per EN 676, the prepurge time can be skipped if a valve proving system is installed.

13. Changing the extraneous light test for OEMs. Now the OEM is able to skip the extraneous light test in the start sequence (***ExtranLightTest***).

14. The curve points can now be adjusted without actually running the actuators to the adjusted positions.

15. When running heavy oil, the high oil pressure switch can now be opened in phases 38 and 44 for the pressure switch reaction time.

LMV51 Software Update: Version 0250 to 0510

The microcomputer PCB was converted to the same microcomputer PCB as in the LMV52 (known as platform conversion). This means that from the date of the switchover, these variants will also have the additional hardware input X7-03.2 *(*start release gas or POC), which was previously only available for the LMV52.

Additionally, the assignment of the software functions in the LMV5 has also been rearranged, meaning that the release upgrade includes functions from higher LMV5 variants as well as completely new functions.

The following updates were made with LMV51 software version 0510:

1. Configuration of new input X7-03.2 for start release gas or for various POC via parameter ***StartReleaseGas****.*

LMV51 Software Update: Version 0250 to 0510 (continued)

2. The flue gas recirculation (FGR) pressure switch input X4-01.3 can be parameterized to not care in standby mode.

3. New configuration of load controller inputs X5-03.2 and X5-03.3 to act like an LMV3 via parameter ***Config X5-03***.

4. Connection of a pressure switch for valve proving (PS-VP) or POC.

5. Configuration of input X9-03.4 via parameter ***GasPressureMin*** can be set to *"deact xOGP"* to deactivate the input when firing oil.

6. Heavy oil direct start input X6-01.3 with more minimum temperature supervision options (phases 21-62, phases 38-62).

7. Air pressure supervision can be deactivated in standby mode by setting parameter ***AirPressureTest*** to "*deactInStby*".

8. Option to adjust the reaction time for loss of flame and the safety time in operation via parameter ***ReacTmeLossFlame***.

9. Configuration of input X5-03.3 via parameter ***Config X5-03*** to stop the startup sequence in phase 36 (driving to ignition position).

10. Using an air actuator and gas control valve, all modulating gas fuel trains can now also be used for burners with pneumatic or mechanical fuel air ratio control.

11. Parameter ***StartPoint Op*** available for setting which curve point the LMV5 drives to after lighting off.

12. Using parameter ***DriveLowfire Gas(Oil),*** drive to low fire may now start in phase 50.

13. Phases 50 and 52 are skipped if a non-pilot fuel train has been selected.

14. Manual output is unaffected by the load setting when programming the curve parameters, both via the AZL5 and Modbus.

15. With an external load controller at input X5-03, the integration time of the input signals is now established as a function of the ramp time.
Examples:

- For a 30-second ramp time, there will be a load increase of approx. 0.6% per cycle
- For a 60-second ramp time, there will be a load increase of approx. 0.3% per cycle

16. The minimum actuator step also applies when operating via Modbus or eBus remotely in order to protect the actuators.

17. Quick shutdown in multistage operation with a variable speed drive (VSD) is only performed if speed deviations are present that are above the parameterized threshold ***TolQuickShutdown***.

LMV51 Software Update: Version 0250 to 0510 (continued)

18. When using gas with the flue gas recirculation function (FGR) and oil without the FGR function, switchover to oil will not occur until the FGR actuator is closed.

19. When the air rate is adjusted, the message *Ramp time too fast "actuator name*" now appears.

20. The setting range for the valve proving test times (phases 81 and 83) were increased from 63 seconds to 63 minutes.

21. Only on LMV51.1 – Other values other than the load are now available from analog output X63.

Load Controller Software Update: Version 0140 to 0150

The following updates were made with LMV5 load controller software version 0150:

1. An auxiliary sensor can be added for cold start thermal shock protection.

2. Straightforward changeover of operation to internal load controller mode (IntLC). Using a potential-free contact at terminals X62.1 and X62.2, it is now possible to switch from other load controller modes to the internal load controller mode. The following operating modes can be switched over:

- IntLC X62 (mode 4) → IntLC (mode 2)
- ExtLC X62 (mode 5) → IntLC (mode 2)
- IntLC Bus (mode 3) → IntLC (mode 2)
- ExtLC Bus (mode 6) → IntLC (mode 2)
- ExtLC X5-03 (mode 1) → IntLC (mode 2)

3. Pt100 sensors in operating mode ExtLC Bus (mode 6) are now permitted.

4. New load controller functions for analog input and load output:

Manipulated variable input, modulating

- < 3 mA: Line interruption
- 4 mA / 2 Vdc: Low fire (minimum load)
- 20 mA / 10 Vdc: Nominal load (maximum load)

Load Controller Software Update: Version 0140 to 0150 (continued)

Load output, modulating

- < 3 mA: Line interruption
- 4 mA: 0% load
- xx mA: Low fire (minimum load)
- xx mA: Nominal load (maximum load)
- 20 mA: 100% load
- Shutting the burner down = no impact on signal.

Manipulated variable input, multistage burner

- Stage 1: 5 mA or 2.5 Vdc
- Stage 2: 10 mA or 5 Vdc
- Stage 3: 15 mA or 7.5 Vdc

Switching thresholds at:

- 7.5 mA and 12 mA with 0.5 mA hysteresis
- 3.75 Vdc and 6.25 Vdc with 0.25 Vdc hysteresis

Load output, multistage

- Burner off: 4 mA
- Stage 1: 5 mA
- Stage 2: 10 mA
- Stage 3: 15 mA

Load Controller Software Update: Version 0150 to 0160

The following updates were made with LMV5 load controller software version 0160:

1. The plausibility check at inputs X61 and X62 is not made anymore. This means that fast value changes at these inputs will no longer result in a safety shutdown.

Load Controller Software Update: Version 0160 to 0180

The following updates were made with LMV5 load controller software version 0180:

1. Analog inputs 2 and 3 (X61, X62) have two additional ranges added: 0-10 Vdc and 0-20 mA.

Load Controller Software Update: Version 0160 to 0180 (continued)

2. Analog output X63 has one additional range added: 0-20 mA.

3. The value of the analog output (e.g. load, temperatures, O2, etc.) can now be selected.

4. The measuring range for temperature input X60 added an additional option for Pt100, Pt1000, and Ni1000 sensors: 1562 °F [850 °C].

5. A new variable temperature range was added via parameter ***var. RangePtNi***.

6. Parameter ***MinActuatorStep*** also becomes active for external load controller modes.

Load Controller Software Update: Version 0180 to 0210

The following updates were made with LMV5 load controller software version 0210:

1. The starting point for *ThermalShockProtection* was increased from 0% output to minimum output. At the deactivation of *ThermalShockProtection,* the load controller is initiated with the current output. Previously, the LMV5 moved to low fire and then to the current load.

2. At the end of the thermal shock protection program, the current temperature acquired by the Ni/Pt1000 sensor programmed as an additional sensor is now updated. The change only applies to a Ni/Pt1000 sensor, not to a Ni/Pt100 sensor. The temperature is displayed by the AZL52/ Modbus.

3. When using flue gas recirculation (FGR) mode "*TCautoDeact"*, in the event of an error of the Pt/Ni1000 sensor, a lockout is not triggered.

10-3: LMV52 Software Version Updates

This section covers all of the revisions that were made to the LMV52 controller with each new software release. The software version of any LMV52 controller can be found using the following menu path:

Params & Display > BurnerControl > SW Version

The LMV52 also has a load controller with its own unique software version. The software version for the load controller can be found using the following menu path:

Params & Display > LoadController > SW Version

Finally, the LMV52 has a VSD module with its own unique software version. The software version for the VSD module can be found using the following menu path:

Params & Display > VSD Module > SW Version

LMV52 Software Update: Version 0130 to 0410

The following updates were made with LMV52 software version 0410:

The product numbers of the LMV5 changed as follows:

LMV52.2x0Ax → LMV52.2x0Bx

To operate an LMV5 with the software versions listed above, it is necessary to have AZL5 software version 0410 or higher installed. Using this software, all AZL5s can now be updated.

The passwords are now encoded. The following other changes were made to the LMV5 basic units:

1. Introduction of a preset load for testing the safety limit thermostat (***SLT-Testload Mod***, ***SLT Testload Stg***).

2. Introduction of a burner startup without prepurging (***Skip Prepurge Gas***, ***Skip Prepurge Oil***).

3. Prepurge times 1 (t30) and 3 (t34) can be set at the OEM level.

4. Introduction of a repetition counter at the OEM level for loss of flame during operation (***LossOfFlame***).

5. Alarm in the event of start prevention in standby mode (***ShutdwnStbyOnErr***). In the case of a start prevention with no call for heat, it has previously not been possible to set off an alarm. Now an alarm can also be triggered in standby mode.

LMV52 Software Update: Version 0130 to 0410 (continued)

6. The inputs for oil are no longer checked when firing on gas. Likewise, the inputs for gas are no longer checked when firing on oil.

7. The maximum filling and evacuation times for gas valve proving are now limited by the maximum permissible safety time for startup. In particular, this affects the burner control versions that use the American standard parameter set.

8. Introduction of max. load limitation at the user level (***UserMaxLoadMod***, ***UserMaxLoadStg***).

9. Hiding an adjustable load range aimed at reducing resonance phenomena in the burner/boiler/stack system (***LoadMaskLowLimit***, ***LoadMaskHighLimit***).

10. The fuel actuator can be deactivated (only with an LMV52).

11. A new flue gas recirculation (FGR) function (only with an LMV52). Actuator AUX3 can be employed for controlling the damper used for flue gas recirculation (FGR). To improve the burner's startup characteristics, only this actuator can be driven from its ignition position to the adjusted curve, either time-delayed or depending on the flue gas temperature.

12. A new option for no prepurge for gas burners (***Skip Prepurge Gas***). As per EN 676, the prepurge time can be skipped if a valve proving system is installed.

13. Changing the extraneous light test for OEMs. Now the OEM is able to skip the extraneous light test in the start sequence (***ExtranLightTest***).

14. The curve points can now be adjusted without actually running the actuators to the adjusted positions.

15. When running heavy oil, the high oil pressure switch can now be opened in phases 38 and 44 for the pressure switch reaction time.

LMV52 Software Update: Version 0410 to 0420

The following updates were made with LMV52 software version 0420:

1. Check of AZL5 software version changed to version 0360 or higher.

2. Handling of open / closed release contact changed.

3. O_2 sensor test delayed until test conditions are reached.

4. Plausibility check of run time test rectified.

5. Timing problem in connection with flying start of VSD rectified.

LMV52 Software Update: Version 0420 to 0450

The following updates were made with LMV52 software version 0450:

1. Abortion of speed test during operation by leaving the left operating position with controlled shutdown.

2. Implementation of functionality to reach the operating position after ignition via a curve point other than point 1 (***StartPoint Op***).

3. No more writing of diagnostic data in the ignition phases (not yet implemented with the VSD module).

4. Position evaluation of actuators and VSD in phases 20-22 removed.

5. Introduction of a timeout (ramp time) for opening the release contact when speed is not reached in standby and home run.

6. Evaluation of extraneous light during shutdown in phase 76 (second part of afterburn time) shifted.

7. Implementation of load adjustment with *ExtR-X5* and the fuel actuator is deactivated.

8. Response of start prevention changed when alarms are activated in standby and the QGO20 is not up to temperature.

LMV52 Software Update: Version 0450 to 0480

The following updates were made with LMV52 software version 0480:

1. Flame failure during safety time 2 (*TSA2*).

2. Message for flame failure during safety time 2 (*TSA2*) changed from "*Loss of flame during operation"* to "*No flame at the end of the safety time"*.

3. In the case of fuel trains with direct ignition (G, LO, HO), phases 50 (*TSA2*) and 52 (interval 2) are skipped.

4. Introduction of a minimum test time of 5 seconds for extraneous light during startup in phase 36 (driving to ignition position).

5. In the case of a flying start, the VSD test is skipped.

6. Parameter ***MinLoadGas*** at the service level is valued higher than parameter ***UserMaxLoadMod*** at the user level.

7. When deleting the curve parameters, *StartPoint Operation,* the value used for overwriting parameters was too high. This has been rectified with version 4.80.

LMV52 Software Update: Version 0450 to 0480 (continued)

8. A parasitic effect in the QRI2 flame scanner during the reset phase leads to a short signal pulse. Thus, flame evaluation during the reset is now delayed so the signal is ignored.

LMV52 Software Update: Version 0480 to 0510

The following updates were made with LMV52 software version 0510:

1. A new option for flame supervision via an external, safety-related flame safeguard.

2. Continuous pilot is available for fuel trains using a pilot. If activated, the pilot valve remains open through phase 62.

3. A new calculation process is available for O_2 pre-control. The ***Type ofAirChange*** parameter was enhanced to include the "*LambdaFact1"* setting option.

4. When setting the O_2 setpoint curve, the minimum intervals accepted by the LMV52 have been reduced as follows:

- Interval between O_2 ratio control curve and O_2 setpoint curve: from 1% to 0.1%
- Interval between O_2 setpoint curve and O_2 alarm curve: from 0.5% to 0.1%

5. In O_2 operating mode "*conAutoDeac*", when the O_2 falls below the O_2 alarm value, the LMV5 initially operates along the ratio control curves. O_2 trim control is only deactivated automatically once the ***NumMinUntilDeact*** repetition counter has elapsed. The minimum O_2 alarm remains active even once O_2 trim control has been deactivated.

6. Omission of the waiting time following interruptions to the power supply if the QGO20 cell temperature is greater than 1274 °F [690 °C] on startup.

7. O_2 trim control behavior can be altered using the ***O2TrimBehavior*** parameter.

8. Limitations of the O_2 controller manipulated variable are now available via new parameters ***O2MinManVariable*** and ***O2MaxManVariable***.

9. Activation / deactivation of O_2 trim control via an external contact can be configured at input X5-03.3 using parameter ***Config X5-03***.

10. The status of the O_2 controller can be displayed via data point *State O2 Ctrl*.

11. The O_2 maximum value alarm has been revised. It can now be the O_2 ratio control curve or a set value. This is programmed via parameters ***Type O2 MaxValue*** and ***O2 MaxValue***.

12. A new service timer for the O_2 sensor is now available. This can be adjusted via parameter ***O2SensServTim*** and reset via parameter ***O2SensServTimRes***.

13. In order to calculate the combustion efficiency, the supply air temperature sensor can now be connected to input X60 as well as to input X87 on the PLL52 which was already available.

LMV52 Software Update: Version 0510 to 1020

The following updates were made with LMV52 software version 1020:

1. New function: Temperature-compensated flue gas recirculation (FGR).

2. Driving to the low fire position from phase 50 is adjustable (***DriveLowfire Gas***, ***DriveLowfire Oil***).

3. Extended monitoring of the air pressure switch with new mode "*deactInStby".* When using this setting, the signal of the air pressure switch in standby is not evaluated. In case of continuous purging, only a start prevention is triggered and a message appears in place of a shutdown.

4. Extended monitoring of the air pressure switch for flue gas recirculation (FGR) with two new modes:
deactInStby - When using this setting, the signal of the air pressure switch for flue gas recirculation (FGR) in standby is not evaluated. In case of continuous purging, only a start prevention is triggered and a message appears in place of a shutdown.

PS VSD - When using this setting, the pressure switch for flue gas recirculation (FGR) must deliver an ON signal if the VSD speed lies above the speed set via parameter ***SP VSD PS on***.
If the VSD speed lies below the speed set via parameter ***SP VSD PS off,*** the pressure switch for flue gas recirculation (FGR) must deliver an OFF signal.

1. Specially designed for fiber mesh burners, various new start options have now been included for O_2 control and can be set via the ***Startmode*** parameter.

2. Long postpurge time (tn3) can be set up to 65,535 minutes via parameter ***PostpurgeT3Long***.

Load Controller Version Updates

All load controller version updates to the LMV52 were the same as the updates for the LMV51. See pages 6-8 in this section for details on the load controller software updates.

VSD Module Software Update: Version 0130 to 0140

The following updates were made with LMV52 VSD module software version 0140:

1. Opening of the release contact during shutdown can be set via parameter ***ReleaseContctVSD***. This enables the VSD module to use a DC break.

2. Quick shutdown of the burner when speed deviation exceeds parameter ***TolQuickShutdown***.

VSD Module Software Update: Version 0140 to 0150

The following updates were made with LMV5 VSD module software version 0150:

1. To avoid error code A9, diagnostic 18 (Page disrupted*)*, statistics data are now only stored in standby and operation.

2. In some cases, the correction offset for the speed setpoint was not reset after a safety shutdown. This could lead to error messages. The new version eliminates this effect.

3. Internal system tests have been modified, allowing the VSD test initialized by the LMV5 to be dropped.

4. Quick shutdown of the VSD is also affected in programming mode.

10-4: AZL5 Software Version Updates

This section covers all of the revisions that were made to the AZL5 with each new software release. The software version of any AZL5 module can be found using the following menu path:

Params & Display > AZL > SW Version

AZL5 Software Update: Version 0220 to 0250

The following updates were made with AZL5 software version 0250:

1. The software version of the flash memory has been changed from V02.20 to V02.50.

2. For the load controller inputs 1 / 2 / 4, the following new parameter names have been assigned:

- Inp1/2/4Selection → Sensor Select
- Inp1/4BerEnd → MeasureRangePtNi
- Inp2TempBerEnd → MRange TempSens
- Inp2PressBerEnd → MRange PressSens
- Inp3Config_I/U → Ext Inp X62 U/I
- Inp3MinSetpoint → Ext MinSetpoint
- Inp3MaxSetpoint → Ext MaxSetpoint

3. When reading fuel usage in liters, a blank has been introduced between the value and the unit.

4. The transfer of parameter copies from new LMV5 controllers to the backup memory of the AZL5 is prevented. Copying is not possible and a message is delivered.

5. The default settings of the following parameters have been changed:

- PrepurgeTmeGas: 15 seconds
- MaxTmeLowFire: 45 seconds
- PostpurgePosAir: 15°
- PostpurgePosAux1: 25°
- PostpurgePosAux3: 25°
- PostpurgePosAux3: 25°
- SD_Stage1On: -2%

AZL5 Software Update: Version 0220 to 0250 (continued)

6. The following name changes were made to the load controller operating modes:

- extLR → ExtLC X5-03
- intLR → IntLC
- intLR via BACS → IntLC Bus
- intLR BACS to → IntLC X62
- extLRanalg → ExtLC X62
- extLR via BACS → ExtLC Bus

7. New display text for actuator faults has been added. The AZL5 indicates a new fault carrying code 0x0E (too short ramp time):

- Too short ramp time, air actuator
- Too short ramp time, gas actuator
- Too short ramp time, oil actuator
- Too short ramp time, auxiliary actuator 1
- Too short ramp time, auxiliary actuator 2 (LMV52 only)
- Too short ramp time, auxiliary actuator 3 (LMV52 only)

AZL5 Software Update: Version 0250 to 0410

The following updates were made with AZL5 software version 0410:

1. In the case of error code 16 and very flat or steep curves, tolerances can occur in connection with the family of curves of the LMV5. This effect was eliminated from LMV52 controllers with software version 0120 and higher. This effect was eliminated from LMV52 controllers with software version 0250 and higher.

2. Monitoring of the microprocessor's power supply is now more tolerant.

3. Error code 1E, diagnostic code 10 would appear after standardization of the VSD when ramp times were set above 35 seconds. The problem has been eliminated.

4. Change of load controller mode 6 to 2: The output can now be changed.

5. Smallest adjustable prepurge value for VSD has been changed to 10%

6. VSD correction with speed deviations has been changed.

7. Using the PC tool, a parameter set can now be stored in a new LMV5.

8. Modbus setpoint W3 (writing after reset) has been corrected.

AZL5 Software Update: Version 0410 to 0420

The following updates were made with AZL5 software version 0420:

1. Display of additional temperature for steam boilers with thermal shock protection.
2. The system is now capable of handling imperial and metric units.
3. The Siemens AZL52 is supplied with English settings.
4. Over Modbus, the non-resettable fuel meters have been replaced by resettable ones.

The following new parameters are now available:

- Temperature acquired by the extra temperature sensor for over-temperature protection
- Flame signal (LMV51) / flame signal channel A (LMV52)
- Flame signal channel B (LMV52)

AZL5 Software Update: Version 0420 to 0430

The following updates were made with AZL5 software version 0430:

1. Introduction of the Cyrillic character set.

AZL5 Software Update: Version 0430 to 0450

The following updates were made with AZL5 software version 0450:

1. The load controller's switching thresholds now display absolute values as well, but the setting values are still relative values.
2. ***User MaxLoadMod*** is now limited by ***MinLoad*** and ***MaxLoad***.
3. Correction of Italian translation.
4. Transmission of pressure values via eBus has been corrected.
5. Access level to activate for the flame detector test has been changed to user-level.
6. Introduction of parameter ***StartPoint Op***.

AZL5 Software Update: Version 0450 to 0460

The following update was made with AZL5 software version 0460:

1. The effect of error message 3163 in communication with ACS450 has been rectified.

AZL5 Software Update: Version 0460 to 0480

The following updates were made with AZL5 software version 0480:

1. In connection with the new LMV52.4, only AZL5 units with software version 0480 and higher can be used. The AZL5 can also be used with all other types of LMV5. Due to the new parameters, the initially reserved storage space in the AZL5 had been exceeded. For this reason, specific product numbers had to be introduced for the LMV52.4.

2. Change to function *Modulating curve parameterization.* The temperature currently acquired by the flue gas recirculation (FGR) sensor is displayed if the flue gas recirculation (FGR) function is activated and the auxiliary 3 actuator has been selected for FGR.

3. New parameters ***OperationTempGas*** and ***OperationTempOil*** are available for reading and displaying the recorded flue gas recirculation (FGR) temperatures during commissioning.

4. Reading and display of the temperature currently acquired by the flue gas recirculation (FGR) sensor when the AZL5 is in interface mode. This is provided because the value is not displayed by the PC tool ACS450.

5. Support of the new flue gas recirculation (FGR) parameters.

6. The AZL5 accepts backup data from older software versions (both AZL5 and ACS450 backups).

7. To avoid misunderstandings, two names have been changed for the FGR operating mode:

- *Aux3onCurve* - When this operating mode is selected, the flue gas recirculation (FGR) function is deactivated and the auxiliary 3 actuator is driven to the ratio control curve. This means that if the auxiliary 3 actuator is used as a flue gas feedback actuator, flue gas would be recirculated.
- *deactMinpos* - Since the word *deact* was replaced by *Aux3oncurve,* the word *deact* is added here. This denotes that the auxiliary 3 actuator is driven to the minimum position so that no flue gas is recirculated (or only very small amounts).

8. The cold start thermal shock ON and OFF values are now also displayed as absolute values – in addition to the relative values.

AZL5 Software Update: Version 0480 to 0500

The following updates were made with AZL5 software version 0500:

1. Three new languages are available for the AZL52.09 (Cyrillic): Bulgarian, Romanian, and Turkish.

2. The display when cold start thermal shock protection is active has been enhanced. The display no longer alternates between "*Coldstart is activated"* and "*Warning*". Now instead of "*Warning*", a display showing the actual values (temperature / pressure) appears.

3. During interface mode, the actual values for pressure or temperature and flue gas recirculation (FGR) temperature are now displayed.

4. A message appears when speed standardization is started and the safety loop is open.

5. Display of the raw flame signals even for LMV51 controllers.

6. The combustion efficiency is transmitted via Modbus or eBus as the value "0" if a valid value cannot be calculated.

7. Support of the new functions for the LMV52.4 for fiber mesh burners.

8. The absolute values of the ***SD_ModOn*** and ***SD_ModOff*** activation / deactivation values for the load controller with the units *°F / PSI* are now displayed correctly.

9. The text displayed on the AZL5 when parameters are being uploaded from the LMV5 to the AZL5 has been changed from "*Backup is made*" to "*Backup is being made*" in order to avoid misunderstandings.

10. The text displayed on the AZL5 when parameters are being downloaded from the AZL5 to the LMV5 has been changed from "*Backup restore is carried out*" to "*Backup restore is being carried out*" in order to avoid misunderstandings.

11. Display text has been corrected for the O_2 trim control delay time. "*Delay Time…*" is now shown instead of "*Dela Time…*".

12. Italian display text for backup corrected from *eseguio* (incorrect) in *eseguito*.

13. Designation for *O2 guard (O2 limiter, O2 monitor*) changed to *O2 alarm* for English.

14. Support of all new and enhanced parameters.

15. On software version 0500 of the AZL5, the restoring of backup data from LMV5 devices with a larger scope of functions and with more parameters into LMV5 devices with a smaller scope of functions and fewer parameters is prevented.
Example:

- Backup file from an LMV52 cannot be restored into an LMV51
- Backup file from an LMV51 can be restored into an LMV52

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Section 3	Parameters
Section 4	Commissioning
Section 5	VSD
Section 6	O_2 Trim
Section 7	Troubleshooting
Section 8	Modbus
Section 9	ACS450
Section 10	Revision History
Appendix A	**Application Guide**
Appendix B*	Complimentary Products Guide

*Can be found at www.scccombustion.com.

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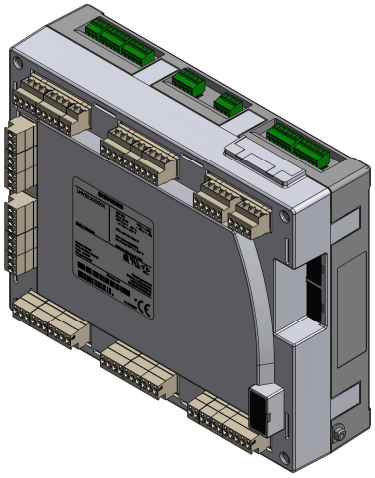
Appendix A:
LMV5 Application Guide



Description

The LMV5 Application Guide includes programming, wiring, and operation examples of the control system for the most common applications.

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Direct Start

Introduction

Direct start accelerates the startup sequence of the burner. If the LMV5 is configured for direct start, the following cases enable this feature:

- A call for heat is received during shutdown (phases 62-78)
- A fuel changeover is requested while the burner is in operation (phase 60) or shutdown (phases 62-78)

The LMV5 skips the remainder of postpurge and proceeds to prepurge without turning the blower off.

On every startup, the LMV5 tests the blower air switch for proper operation. The switch contacts are required to open during standby of the boiler and close during blower operation. With direct start, the blower does not turn off before startup begins. A 3-way solenoid valve must be installed using direct start to briefly divert air pressure to functionally test the blower air switch.

Procedure

1. Install and wire a 3-way solenoid valve as shown in Figure 1.

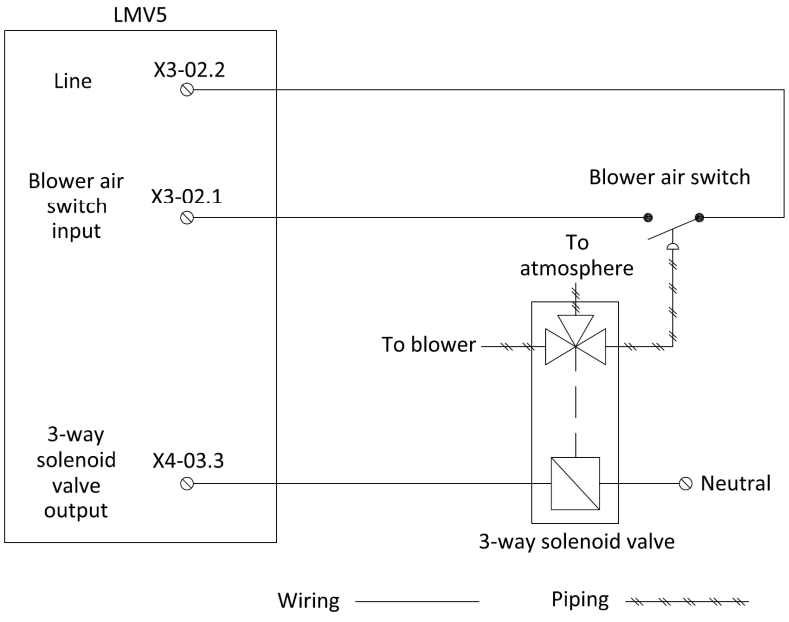


Figure 1: Wiring a 3-way Solenoid Valve for Direct Start

Direct Start (continued)

2. Program the LMV5 to utilize direct start through the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigGeneral > NormDirectStart = **DirectStart**

3. Configure "Start/PS-Valve" (output terminal X4-03.3) to energize the 3-way solenoid valve that diverts air pressure away from the blower air switch. This can be programmed two different ways:

   PS Relief – The solenoid valve is energized to divert air pressure away from the blower air switch in phase 79.

   PS Relief_inv – The solenoid valve is energized to expose the blower air switch to air pressure in every phase except phase 79.

   Program the "Start/PS-Valve" parameter through the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigIn/Output > Start/PS-Valve

4. When using direct start, the postpurge time of the boiler is split into two stages:

   PostpurgeT1Gas(Oil) – Defines the mandatory postpurge time (phase 74). If the direct start option is selected and a call for heat exists, the LMV5 will postpurge for this minimum amount of time.

   PostpurgeT3Gas(Oil) – Defines the optional postpurge time (phase 78). If the direct start option is selected and a call for heat exists, the LMV5 will skip this postpurge time and go directly into prepurge after the functional test of the blower air switch.

   By minimizing the mandatory postpurge time, PostpurgeT1Gas(Oil), the full benefits of direct start are achieved. Even with direct start enabled, the LMV5 retains a full prepurge before opening the fuel valves and starting up. The optional postpurge time, PostpurgeT3Gas(Oil), is the time required for the proper amount of air exchanges on a normal shutdown. Both of these postpurge times can be set through the following menu path:

   Params & Display > BurnerControl > Times > Times Shutdown

Direct Start (continued)

Operation

Direct start accelerates the startup sequence in the following instances:

- The LMV5 loses the call for heat (terminal X5-03.1), and regains it before or during postpurge (phase 62-78)

- The LMV5 receives a fuel changeover request (terminal X4-01.1 or X4-01.2) during burner operation (phase 60) or shutdown (phases 62-78)

If either of these situations occurs, the LMV5:

1. Drives to low fire (phase 62) and shuts the fuel valves.

2. Ensures the flame signal drops out during the afterburn time (phase 70).

3. Drives to postpurge position (phase 72) and performs its mandatory postpurge (PostpurgeT1Gas(Oil), phase 74).

4. Proceeds to phase 79 and either powers on or off the 3-way solenoid valve dependent upon the setting of parameter “Start/PS-Valve”. The LMV5 verifies the operation of the blower air switch via input terminal X3-02.1 during phase 79.

5. Drives directly to prepurge position (phase 24) and proceeds to startup as normal.

Hot Standby on a Steam Boiler with an RWF50 or RWF55

Introduction

Hot standby is recommended on multi-boiler systems to maintain one or more backup boilers close to operating temperature. Hot standby can be accomplished on an LMV5 with an RWF5x controller. The procedure and operation will be described for the following two methods:

- LMV5 with an RWF5x for hot standby control only
- LMV5 with an RWF55 for hot standby and load control

Table 2 describes the six different load controller operating modes in the LMV5.

Table 2: Description of LMV5 Load Controller Operating Modes

Label	Description	Setpoint	Upon X62.1 – X62.2 Contact Closure
ExtLC X5-03	External load control, firing rate from 3-position input	N/A	Change to "IntLC", setpoint W1
IntLC	Internal load control, setpoint set locally on LMV5	W1	Remain in "IntLC", setpoint W2
IntLC Bus	Internal load control, setpoint from Modbus command	W3	Change to "IntLC", setpoint W1
IntLC X62	Internal load control, setpoint from analog signal on terminal X62	Remote setpoint	
ExtLC X62	External load control, firing rate from analog signal on terminal X62	N/A	
ExtLC Bus	External load control, firing rate from Modbus command	N/A	

If any operating mode other than "IntLC" is used, a contact closure between terminals X62.1 and X62.2 will cause the LMV5 to revert back to operating mode "IntLC". This is necessary to achieve hot standby on an LMV5 using the RWF5x to control the hot standby only.

Hot Standby on a Steam Boiler with an RWF50 or RWF55 (continued)

LMV5 with an RWF5x for Hot Standby Control Only

Procedure

1. Wire the RWF5x to the LMV5 as shown in Figure 2.

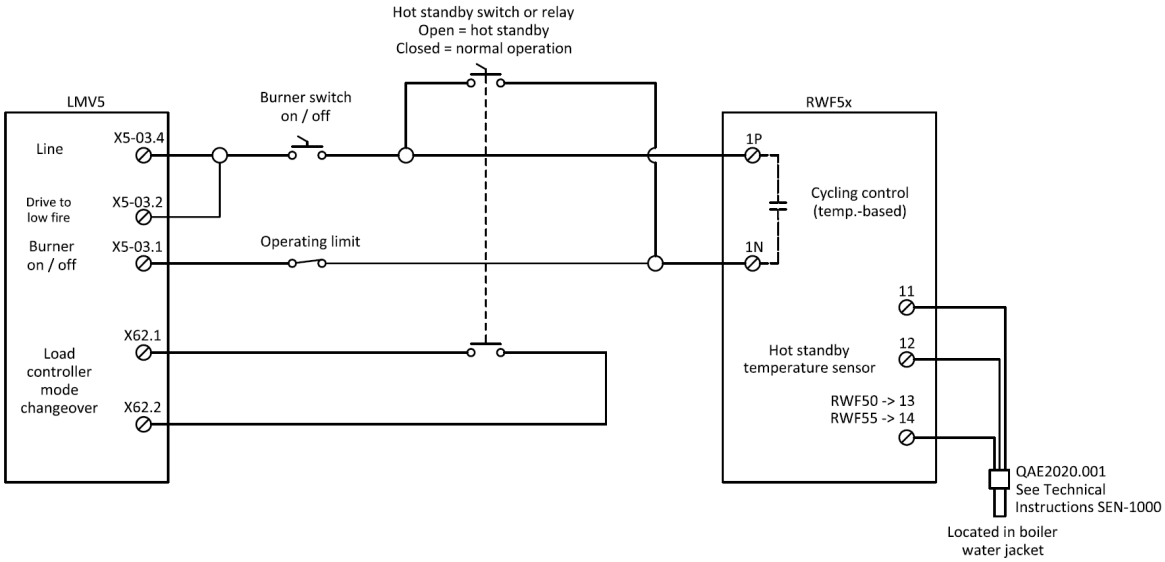


Figure 2: LMV5 to RWF5x Hot Standby Only Wiring

2. Set the LMV5 for load controller operating mode “ExtLC X5-03” through the following menu path:

   Params & Display > LoadController > Configuration > LC_OptgMode =
   ExtLC X5-03

3. Set the following parameters in the RWF5x controller. For more information, obtain Siemens Document No. U7866 for the RWF50 or Document No. U7867 for the RWF55 at www.scccombustion.com.

   ConF > Cntr > SPL = setpoint range lower limit
   ConF > Cntr > SPH = setpoint range upper limit
   OPr > SP1 = hot standby setpoint
   PArA > HYS1 = burner on for hot standby
   PArA > HYS3 = burner off for hot standby
   ConF > InP > InP1 > Sen1 = temperature sensor type

Hot Standby on a Steam Boiler with an RWF50 or RWF55 (continued)

Operation

1. When the hot standby switch is open, the LMV5 system is in hot standby mode. The burner will turn on and off based on the limits set in the RWF5x controller. The contact between X62.1 and X62.2 will be open. The LMV5 will be in operating mode “ExtLC X5-03” and looking for a 3-position input for its firing rate command. Since line power from terminal X5-03.4 has been directly connected to the terminal that decreases the firing rate (X5-03.2), the LMV5 will stay at low fire until the burner turns off based on the burner off point set in the RWF5x (PArA > HYS3).

2. When the hot standby switch is closed, the system is in normal operation and not in hot standby. The contact between X62.1 and X62.2 will close, causing the LMV5 to change to operating mode “IntLC”. The burner will be controlled based on the limits set in the LMV5.

Important Notes

1. Any RWF5x controller model will suffice for this hot standby option.

2. The RWF5x is operating only during hot standby mode.

3. The internal load controller of the LMV5 is used during normal operation.

Hot Standby on a Steam Boiler with an RWF50 or RWF55 (continued)

LMV5 with an RWF55 for Hot Standby and Load Control

Procedure

1. Wire the RWF55 to the LMV5 as shown in Figure 3.

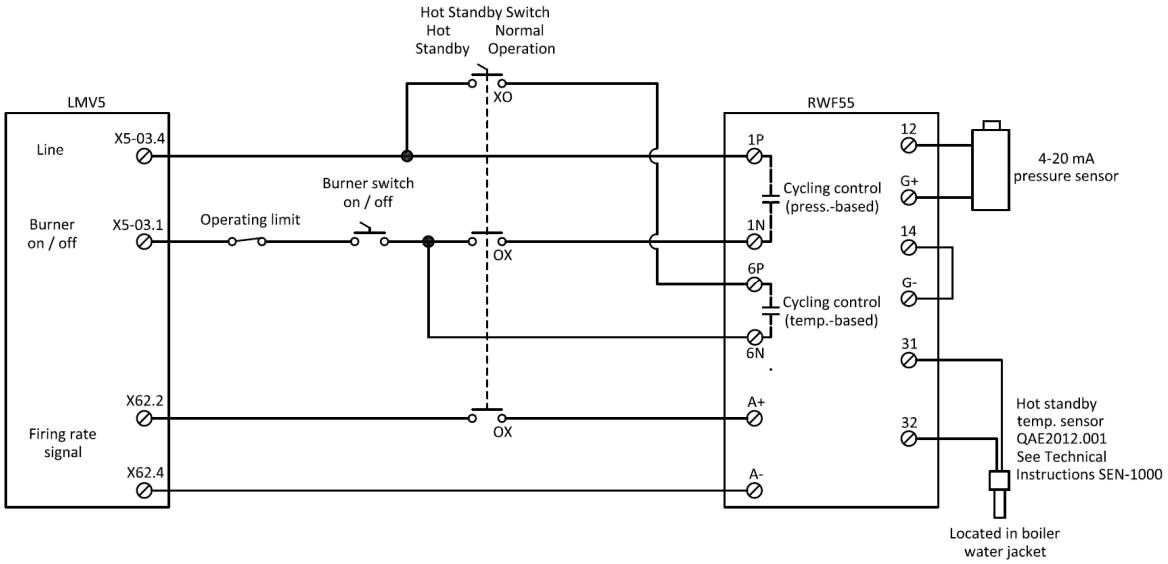


Figure 3: LMV5 to RWF55 Hot Standby and Load Control Wiring

2. Set the LMV5 for load controller operating mode “ExtLC X62” through the following menu path:

   Params & Display > LoadController > Configuration > LC_OptgMode = **ExtLC X62**

3. Set the load control input signal for 0-10 Vdc through the following menu path:

   Params & Display > LoadController > Configuration > Ext Inp X62 U/I = **0..10 V**

Hot Standby on a Steam Boiler with an RWF50 or RWF55 (continued)

4. Set the following parameters in the RWF55 controller. For more information, obtain Siemens Document No. U7867 for the RWF55 at www.scccombustion.com.

   ConF > Cntr > CtYP = 2
   ConF > Cntr > SPL = setpoint range lower limit
   ConF > Cntr > SPH = setpoint range upper limit
   OPr > SP1 = normal operation setpoint
   PArA > HYS1 = burner on for normal operation
   PArA > HYS3 = burner off for normal operation
   ConF > InP > InP1 > Sen1 = pressure sensor type
   ConF > InP > lnP1 > SCL1 = 0
   ConF > InP > InP1 > SCH1 = high end of the range of the pressure sensor
   ConF > InP > InP3 > Sen3 = temperature sensor type
   ConF > AF > FnCt = 12
   ConF > AF > AL = hot standby setpoint
   ConF > AF > HYSt = burner on / off for hot standby
   ConF > OutP > SiGn = 2

Operation

1. When the hot standby switch is set for hot standby, the LMV5 system is in hot standby mode. The burner will turn on and off based on the temperature limits set in the RWF55 controller for hot standby (ConF > AF). Since the signal to LMV5 terminal X62 is broken by the hot standby switch, the LMV5 stays at low fire until the burner turns off based on the burner off point set in the RWF55.

2. When the hot standby switch is set for normal operation, the system is in normal operation mode and not in hot standby. The burner will turn on and off based on the pressure limits set in the RWF55 controller for normal operation (PArA > HYS1 and PArA > HYS3). The signal to LMV5 terminal X62 determines the firing rate of the burner.

Important Notes

1. An RWF55 controller must be used for this hot standby option (not RWF50).

2. The RWF55 is operating as the load controller during normal operation as well as controlling the hot standby.

Low Fire Hold with a Temperature Switch

Introduction

Low fire hold assists in preventing boiler damage from thermal shock. A simple low fire hold with an LMV5 is accomplished through the use of a temperature switch. A temperature switch closes a contact which allows the burner to release to modulation. With proper wiring and parameter setup, this simple device will create an effective low fire hold with an LMV5 controller.

Table 3 describes the six different load controller operating modes in the LMV5.

Table 3: Description of LMV5 Load Controller Operating Modes

Label	Description	Setpoint	Upon X62.1 – X62.2 Contact Closure
ExtLC X5-03	External load control, firing rate from 3-position input	N/A	Change to "IntLC", setpoint W1
IntLC	Internal load control, setpoint set locally on LMV5	W1	Remain in "IntLC", setpoint W2
IntLC Bus	Internal load control, setpoint from Modbus command	W3	Change to "IntLC", setpoint W1
IntLC X62	Internal load control, setpoint from analog signal on terminal X62	Remote setpoint	
ExtLC X62	External load control, firing rate from analog signal on terminal X62	N/A	
ExtLC Bus	External load control, firing rate from Modbus command	N/A	

If any operating mode other than "IntLC" is used, a contact closure between terminals X62.1 and X62.2 will cause the LMV5 to revert back to operating mode "IntLC". This concept is necessary to achieve a low fire hold with a temperature switch.

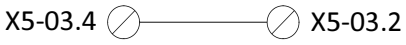
Low Fire Hold with a Temperature Switch (continued)

Procedure

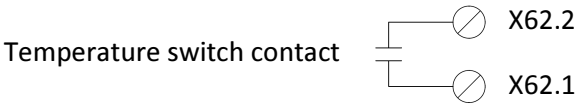
1. Set the LMV5 for load control operating mode “ExtLC X5-03” through the following menu path:

   Params & Display > LoadController > Configuration > LC_OptgMode = **ExtLC X5-03**

2. Wire a jumper between terminals X5-03.4 and X5-03.2 on the LMV5. Terminal X5-03.4 outputs 120 Vac at all times. When the LMV5 is in operating mode “ExtLC X5-03” and 120 Vac is on terminal X5-03.2, the LMV5’s firing rate decreases.



3. Wire the temperature switch contact between terminals X62.1 and X62.2 on the LMV5. This needs to be a normally-open contact that closes once the temperature of the boiler rises above the temperature setting on the temperature switch.



Operation

1. When the temperature of the boiler is below the temperature switch setting, the contact between X62.1 and X62.2 will be open. The LMV5 will be in operating mode “ExtLC X5-03”, waiting for a 3-position input for its firing rate command. Since line power from terminal X5-03.4 has been directly connected to the terminal that decreases the firing rate (X5-03.2), the LMV5 will remain at low fire.

2. Once the temperature rises above the temperature switch setting, the contact between X62.1 and X62.2 closes. The LMV5 changes to operating mode “IntLC” and modulates to maintain setpoint W1.

Low Fire Hold with an RWF55

Introduction

Low fire hold assists in preventing boiler damage from thermal shock. If an RWF55 is the external load controller with the LMV5, a low fire hold can be easily incorporated. With an RWF55, a low fire hold is accomplished by breaking the increase load signal to the LMV5. The wiring and setup for four cases will be described:

- Steam boiler with an RWF55 with analog output
- Hot water boiler with an RWF55 with analog output
- Steam boiler with an RWF55 with 3-position output
- Hot water boiler with an RWF55 with 3-position output

Table 4 describes the six different load controller operating modes in the LMV5.

Table 4: Description of LMV5 Load Controller Operating Modes

Label	Description	Setpoint	Upon X62.1 – X62.2 Contact Closure
ExtLC X5-03	External load control, firing rate from 3-position input	N/A	Change to "IntLC", setpoint W1
IntLC	Internal load control, setpoint set locally on LMV5	W1	Remain in "IntLC", setpoint W2
IntLC Bus	Internal load control, setpoint from Modbus command	W3	Change to "IntLC", setpoint W1
IntLC X62	Internal load control, setpoint from analog signal on terminal X62	Remote setpoint	
ExtLC X62	External load control, firing rate from analog signal on terminal X62	N/A	
ExtLC Bus	External load control, firing rate from Modbus command	N/A	

When executing a low fire hold with the RWF55, either "ExtLC X5-03" or "ExtLC X62" may be chosen for the LMV5's operating mode. The wiring and setup of the RWF55 differs slightly depending on the mode selected as shown on the following pages.

Low Fire Hold with an RWF55 (continued)

Procedure – Steam Boiler with an RWF55 with Analog Output

In the case of steam boilers, temperature sensors located in the boiler water jacket are recommended. Technical Instructions SEN-1000 provides additional information on temperature sensors.

1. Set the following parameters in the LMV5:

   Params & Display > LoadController > Configuration > LC_OptgMode = **ExtLC X62**
   Params & Display > LoadController > Configuration > Ext Inp X62 U/I = **0..20 mA**

2. Set the following parameters in the RWF55:

   ConF > Inp > Inp1 > SEn1 = signal type of pressure sensor
   ConF > Inp > Inp1 > SCL1 = 0
   ConF > Inp > Inp1 > SCH1 = high end of the range of the pressure sensor
   ConF > Inp > Inp3 > SEn3 = type of RTD being used for a belly sensor
   ConF > Cntr > CtYP = 2
   ConF > AF > FnCt = 11
   ConF > AF > AL = temperature to enable low fire hold
   ConF > AF > HYSt = deadband around low fire hold temperature
   ConF > OutP > FnCt = 4
   ConF > OutP > SiGn = 0

3. Wire the LMV5 and RWF55 as shown in Figure 4:

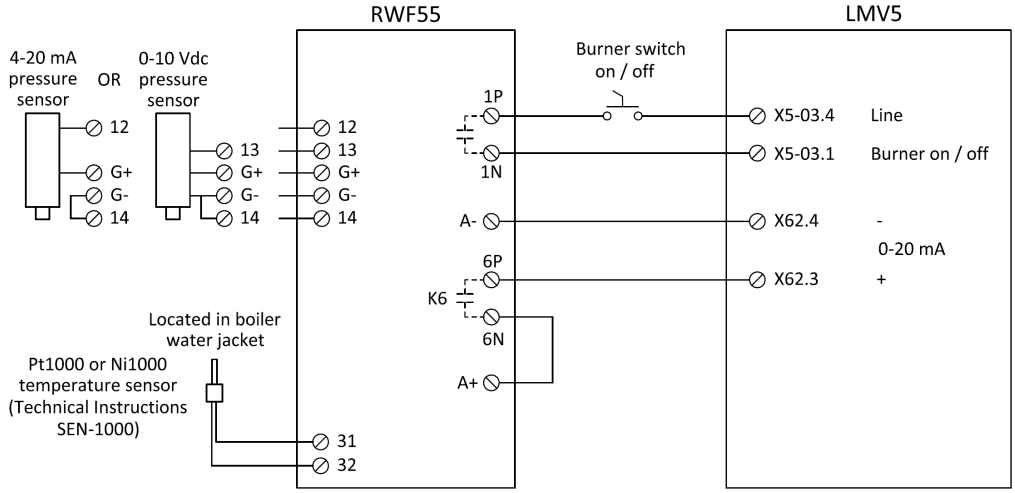


Figure 4: Low Fire Hold via Analog Output on a Steam Boiler

See page 19 for an example of the low fire hold operation.

Low Fire Hold with an RWF55 (continued)

Hot Water Boiler with an RWF55 with Analog Output

1. Set the following parameters in the LMV5:

   Params & Display > LoadController > Configuration > LC_OptgMode = **ExtLC X62**
   Params & Display > LoadController > Configuration > Ext Inp X62 U/I = **0..20 mA**

2. Set the following parameters in the RWF55:

   ConF > Inp > Inp1 > SEn1 = type of RTD being used for temperature sensor
   ConF > Cntr > CtYP = 2
   ConF > AF > FnCt = 7
   ConF > AF > AL = temperature to enable low fire hold
   ConF > AF > HYSt = deadband around low fire hold temperature
   ConF > OutP > FnCt = 4
   ConF > OutP > SiGn = 0

3. Wire the LMV5 and RWF55 as shown in Figure 5:

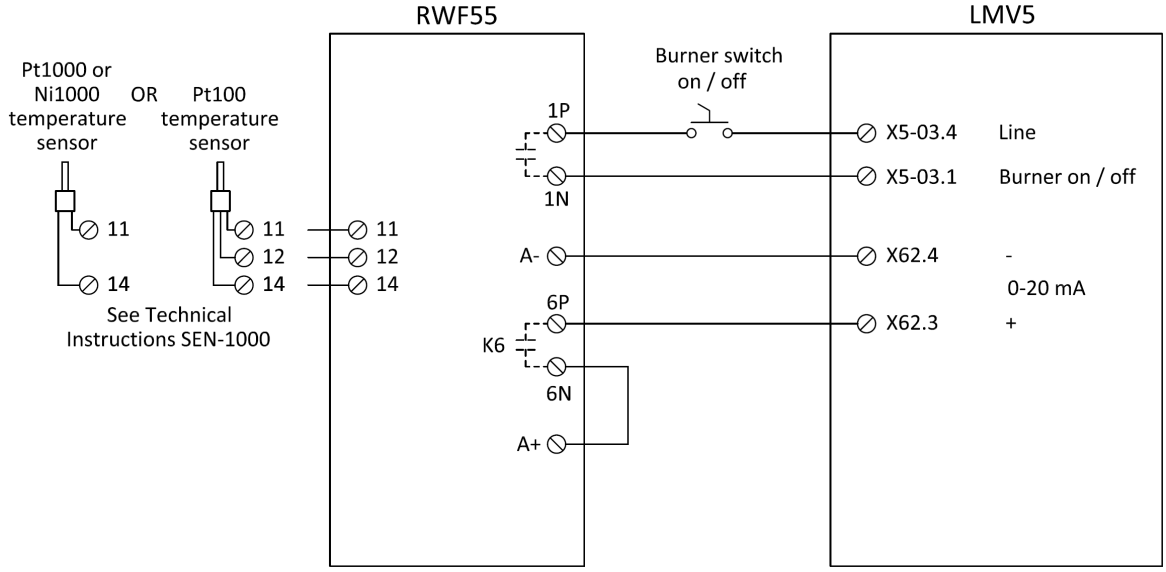


Figure 5: Low Fire Hold via Analog Output on a Hot Water Boiler

See page 19 for an example of the low fire hold operation.

Low Fire Hold with an RWF55 (continued)

Steam Boiler with an RWF55 with 3-position Output

In the case of steam boilers, temperature sensors located in the boiler water jacket are recommended. Technical Instructions SEN-1000 provides additional information on temperature sensors.

1. Set the following parameters in the LMV5:

   Params & Display > LoadController > Configuration > LC_OptgMode = **ExtLC X5-03**

2. Set the following parameters in the RWF55:

   ConF > Inp > Inp1 > SEn1 = signal type of pressure sensor being used
   ConF > Inp > Inp1 > SCL1 = 0
   ConF > Inp > Inp1 > SCH1 = high end of the range of the pressure sensor
   ConF > Inp > Inp3 > SEn3 = type of RTD being used for a belly sensor
   ConF > Cntr > CtYP = 1
   ConF > AF > FnCt = 11
   ConF > AF > AL = temperature to enable low fire hold
   ConF > AF > HYSt = deadband around low fire hold temperature

3. Wire the LMV5 and RWF55 as shown in Figure 6:

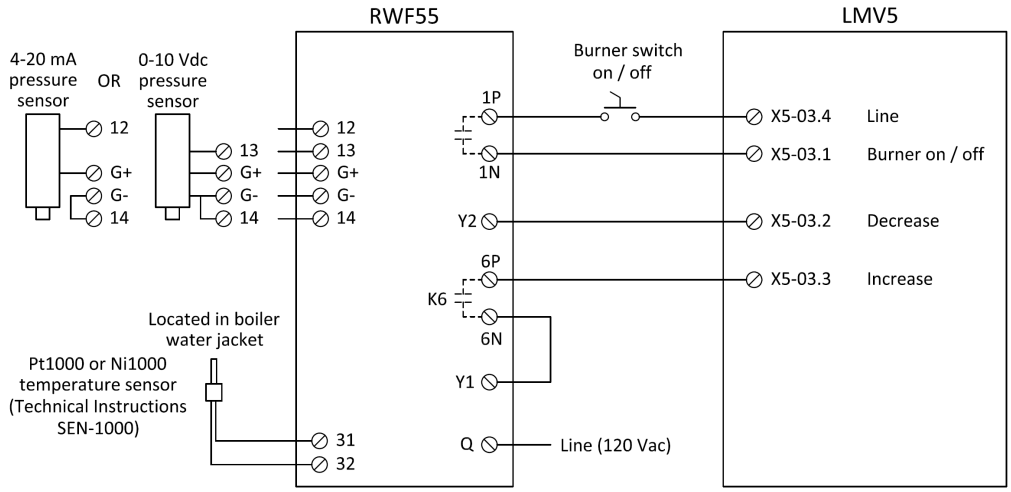


Figure 6: Low Fire Hold via 3-position Output on a Steam Boiler

See page 19 for an example of the low fire hold operation.

Low Fire Hold with an RWF55 (continued)

Hot Water Boiler with an RWF55 with 3-position Output

1. Set the following parameters in the LMV5:

   Params & Display > LoadController > Configuration > LC_OptgMode =
   ExtLC X5-03

2. Set the following parameters in the RWF55:

   ConF > Inp > Inp1 > SEn1 = type of RTD being used for temperature sensor
   ConF > Cntr > CtYP = 1
   ConF > AF > FnCt = 7
   ConF > AF > AL = temperature to enable low fire hold
   ConF > AF > HYSt = deadband around low fire hold temperature

3. Wire the LMV5 and RWF55 as shown in Figure 7:

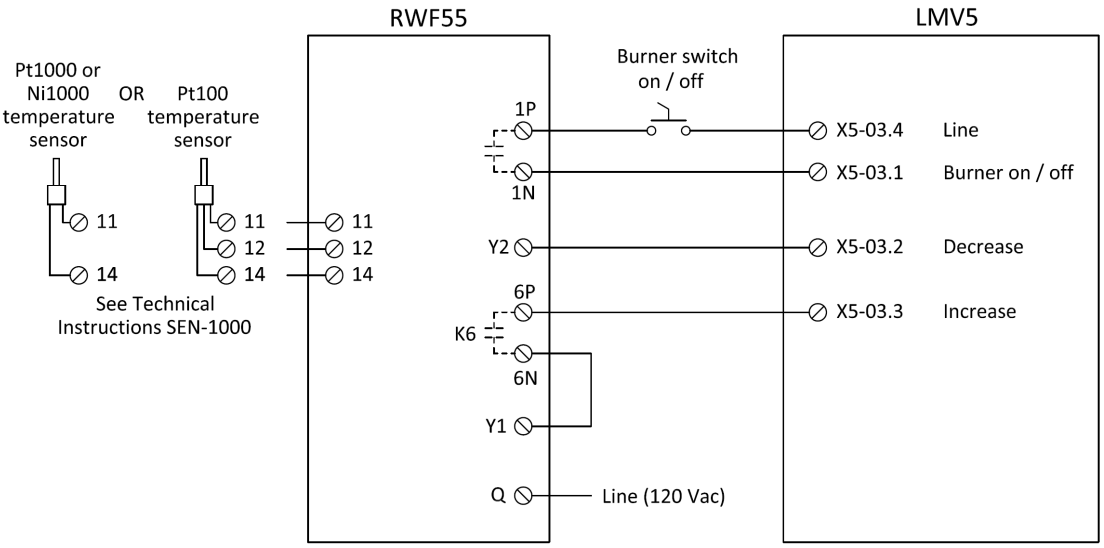


Figure 7: Low Fire Hold via 3-position Output on a Hot Water Boiler

See page 19 for an example of the low fire hold operation.

Low Fire Hold with an RWF55 (continued)

Operation

1. When the boiler temperature falls below the low fire hold temperature threshold (AL - 1/2 HYSt), contact K6 opens and prevents the LMV5 from increasing the firing rate. This is the case for either analog or 3-position output from the RWF55.

2. Once the boiler warms up above the low fire hold threshold (AL + 1/2 HYSt), contact K6 closes and the burner modulates according to the PID settings of the RWF55.

Example

Low fire hold threshold settings:

AL = 180
HYSt = 10

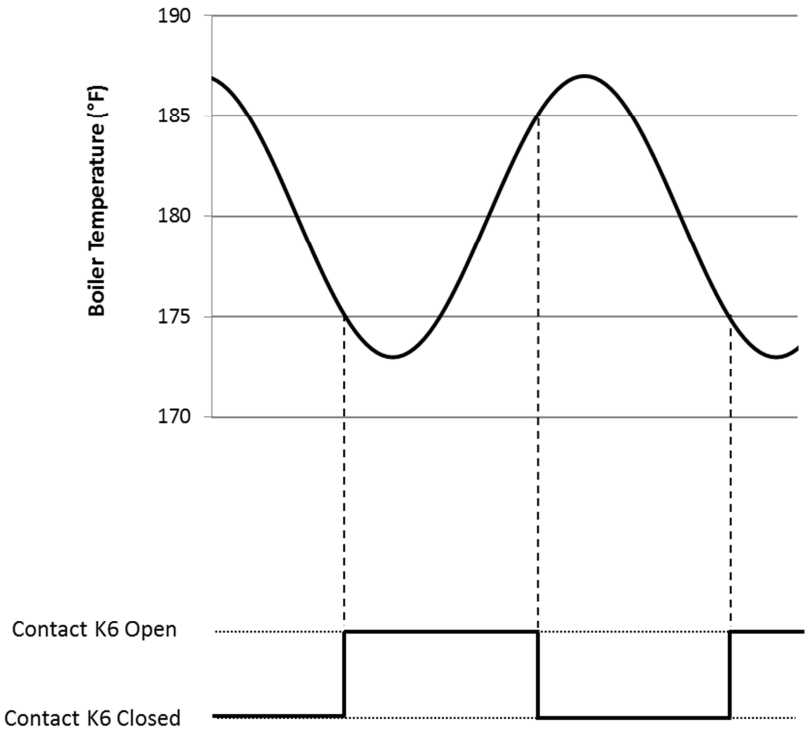


Figure 8: Behavior of Contact K6 when Using an RWF55 for Low Fire Hold

Pilot Valve Proving

Introduction

Valve proving detects if the main gas valves in a gas train are leaking. In addition to checking the main gas valves, the pilot valves may be tested for leakage as well. There are three options for performing pilot valve proving:

- Option 1: On Startup with SKP25's on both the Pilot and Main Gas Trains
- Option 2: On Startup, SKP25 on the Main Gas Train, Solenoid Valves on the Pilot Train
- Option 3: Pilot Valve Proving on Startup and Main Valve Proving on Shutdown

On the LMV5, valve proving of the main gas valves can be performed during startup, during shutdown, or during both startup and shutdown of the boiler. If pilot valve proving is added using Option 1 or Option 2, valve proving must be performed during startup of the boiler only. If pilot valve proving is added using Option 3, valve proving must be performed during both startup and shutdown of the boiler.

Pilot valve proving can be performed on any LMV52. Pilot valve proving can be performed on any LMV51 with a date code of 140131xxxx (Jan 31, 2014) or later.

Procedure

1. The valve proving type can be set in the LMV5 through the following menu path:

   Params & Display > BurnerControl > ValveProving > ValveProvingType

   For Option 1 or Option 2, this must be set for "VP startup". For Option 3, this must be set for "VP stup/shd".

2. In addition to setting the valve proving type, input terminal X9-03.2 must be set for a valve proving pressure switch input. This can be done through the following menu path:

   Params & Display > BurnerControl > ValveProving > Config_PS-VP/CPI = **PS-VP**

Pilot Valve Proving (continued)

3. The times for each of the four stages of valve proving need to be set. To do so, use the following menu paths in the LMV5:

   Params & Display > BurnerControl > ValveProving > VP_EvacTme
   Params & Display > BurnerControl > ValveProving > VP_TmeAtmPress
   Params & Display > BurnerControl > ValveProving > VP_FillTme
   Params & Display > BurnerControl > ValveProving > VP_Tme_GasPress

   "VP_EvacTme" is the time that the downstream valve is energized in order to evacuate the chamber between the upstream and downstream valves (phase 80). This is typically set to 3 seconds, but should not be set any less than the opening time of the valves.

   "VP_FillTme" is the time that the upstream valve is energized in order to pressurize the chamber between the upstream and downstream valves (phase 82). This is typically set to 3 seconds, but should not be set any less than the opening time of the valves.

   "VP_TmeAtmPress" is the time that both the upstream and downstream valves are closed to test the leakage rate of the upstream valve (phase 81). "VP_Tme_GasPress" is the time that both the upstream and downstream valves are closed to test the leakage rate of the downstream valve (phase 83). Both of these times should be set to the same value. These times can be calculated using the following equation:

$$t_{test} = \frac{(P_i - P_{set}) \times V \times 3600}{P_{atm} \times Q_{leak}}$$

   t_{test} = Time for setting parameters "VP_TmeAtmPress" and "VP_Tme_GasPress" in seconds
   P_i = Inlet gas pressure (pressure upstream of both valves) in PSIG
   P_{set} = Gas pressure setting on pressure switch in PSIG (should be set for half of P_i)
   P_{atm} = Atmospheric pressure downstream of both valves in PSIA (typically 14.7 PSI)
   V = Volume between the gas valves to be tested in ft^3
   Q_{leak} = Allowable leakage rate in ft^3/hr

   For Option 3, these times should be calculated independently for the pilot and main valves, and the larger of the calculated times should be used as the parameter setting.

4. Parameter "PreIgnitionTGas" should be set for its default of 2 seconds. This parameter can be found at the following menu path in the LMV5:

   Params & Display > BurnerControl > Times > TimesStartup1 > PreIgnitionTGas

Pilot Valve Proving (continued)

Option 1: On Startup with SKP25's on both the Pilot and Main Gas Trains

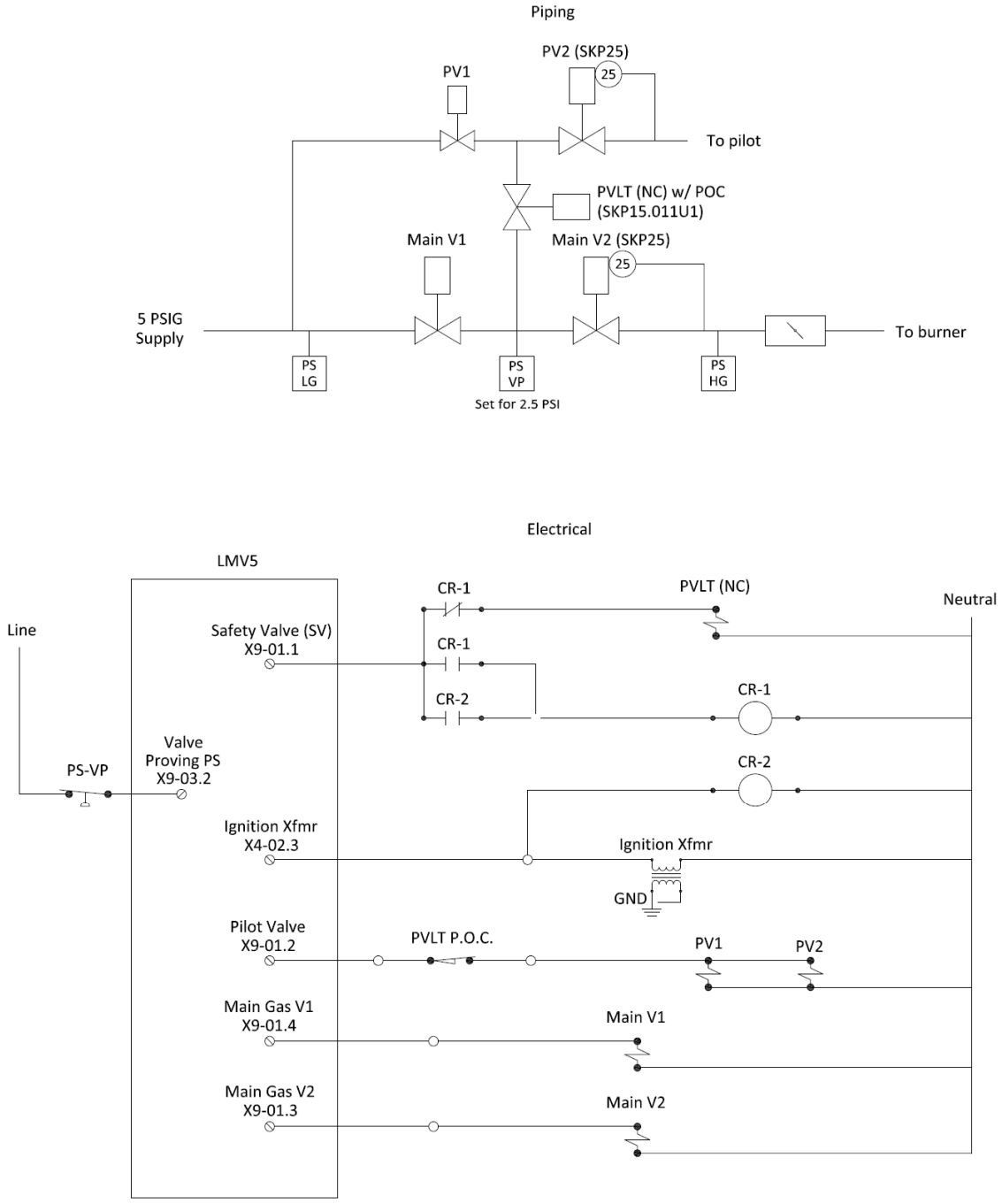


Figure 9: Option 1 Piping and Electrical Schematics

Pilot Valve Proving (continued)

Option 1 Sequence of Operation

1. The LMV5 is in standby. All valves are closed and all relay contacts are as shown in the electrical schematic.

2. The LMV5 receives a call for heat. The SV terminal (X9-01.1) energizes before the blower, energizing the PVLT (Pilot Valve Leak Test). The PVLT opens, and connects the volumes between the pilot valves and main valves. The PVLT POC switch also opens, preventing the operation of the pilot valves.

3. During prepurge, the main valve proving sequence takes place as normal. The PS-VP (Pressure Switch - Valve Proving) is wired to terminal X9-03.2 as normal. The setpoint of the PS-VP should be set for half of the inlet pressure.

4. The LMV5 drives to ignition position. The ignition transformer output (X4-02.3) energizes, thereby energizing the CR-1 coil, and latching the coil from the power supplied from X9-01.1. At the same time, one of the CR-1A contacts opens, thereby closing the PVLT valve and closing the PVLT POC switch. Note that the PVLT POC switch must be closed before the pilot valves open.

5. The LMV5 continues light off and runs as normal, with the CR-1 coil latched in and the PVLT valve closed.

6. Upon shutdown, the SV terminal (X9-01.1) de-energizes, which un-latches the circuit. The PVLT valve remains closed until the next start up.

Option 1 Important Notes

1. The proof of closure switch on the PVLT ensures that gas is unable to flow between the pilot and main valves before the pilot attempts to light.

2. All four valves are tested at the inlet pressure, which is the pressure that they normally operate at. The PS-VP should be set for half of the inlet pressure which provides a valid test for all four valves.

3. Valve proving must be done on startup only.

Pilot Valve Proving (continued)

Option 2: On Startup, SKP25 on the Main Gas Train, Solenoid Valves on the Pilot Train

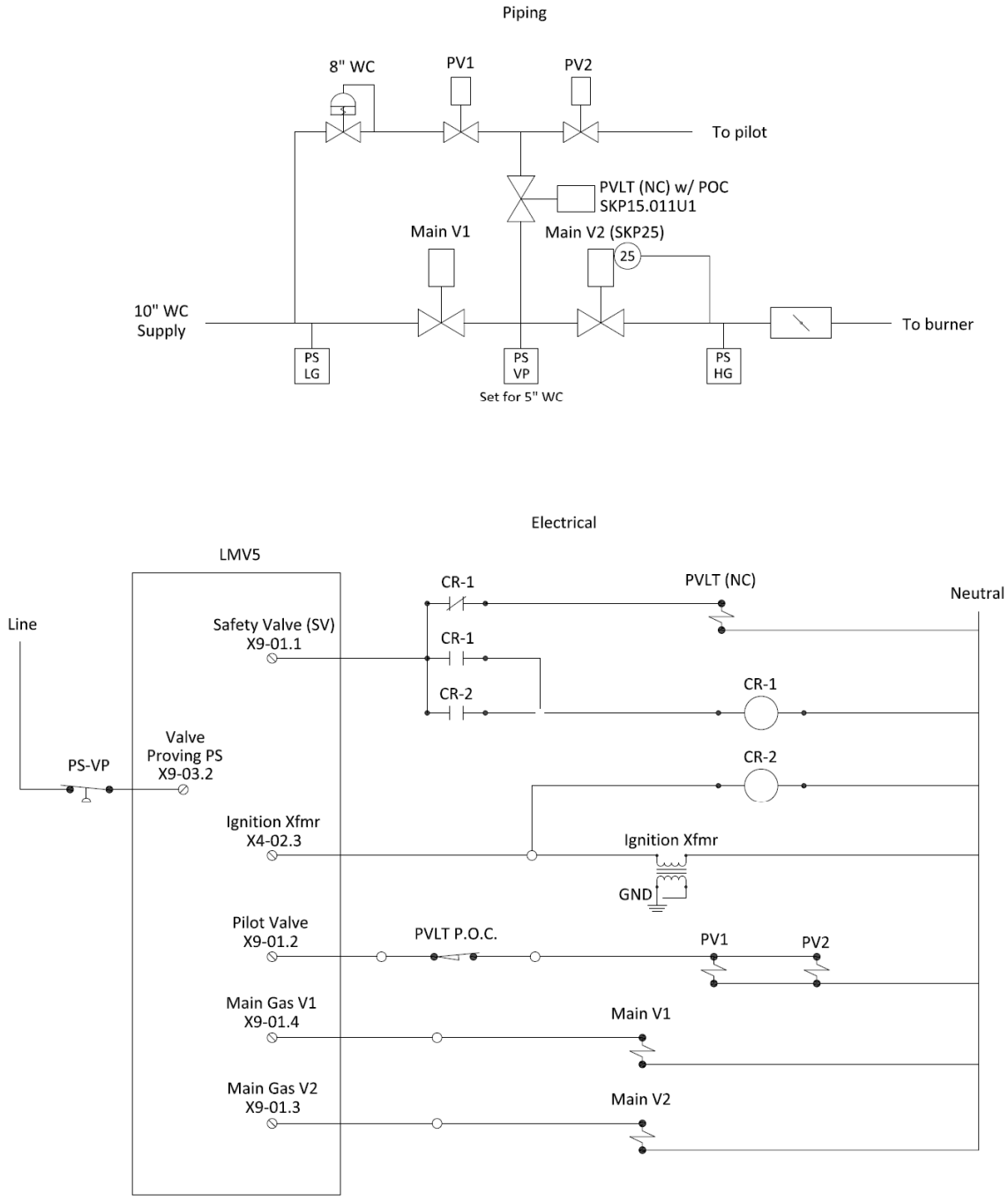


Figure 10: Option 2 Piping and Electrical Schematics

Pilot Valve Proving (continued)

Option 2 Sequence of Operation

1. The LMV5 is in standby. All valves are closed and all relay contacts are as shown in the electrical schematic.

2. The LMV5 receives a call for heat. The SV terminal (X9-01.1) energizes before the blower, energizing the PVLT (Pilot Valve Leak Test). The PVLT opens, and connects the volumes between the pilot valves and main valves. The PVLT POC switch also opens, preventing the operation of the pilot valves.

3. During prepurge, the main valve proving sequence takes place as normal. The PS-VP (Pressure Switch - Valve Proving) is wired to terminal X9-03.2 as normal. The setpoint of the PS-VP should be set for half of the inlet pressure.

4. The LMV5 drives to ignition position. The ignition transformer output (X4-02.3) energizes, thereby energizing the CR-1 coil, and latching the coil from the power supplied from X9-01.1. At the same time, one of the CR-1A contacts opens, thereby closing the PVLT valve and closing the PVLT POC switch. Note that the PVLT POC switch must be closed before the pilot valves open.

5. The LMV5 continues light off and runs as normal, with the CR-1 coil latched in and the PVLT valve closed.

6. Upon shutdown, the SV terminal (X9-01.1) de-energizes, which un-latches the circuit. The PVLT valve remains closed until the next start up.

Option 2 Important Notes

1. The proof of closure switch on the PVLT ensures that gas is unable to flow between the pilot and main valves before the pilot attempts to light.

2. Inlet pressure and pilot pressure must be similar (within ~30%) to have a valid test for all four valves.

3. Valve proving must be done on startup only.

Pilot Valve Proving (continued)

Option 3: Pilot Valve Proving on Startup and Main Valve Proving on Shutdown

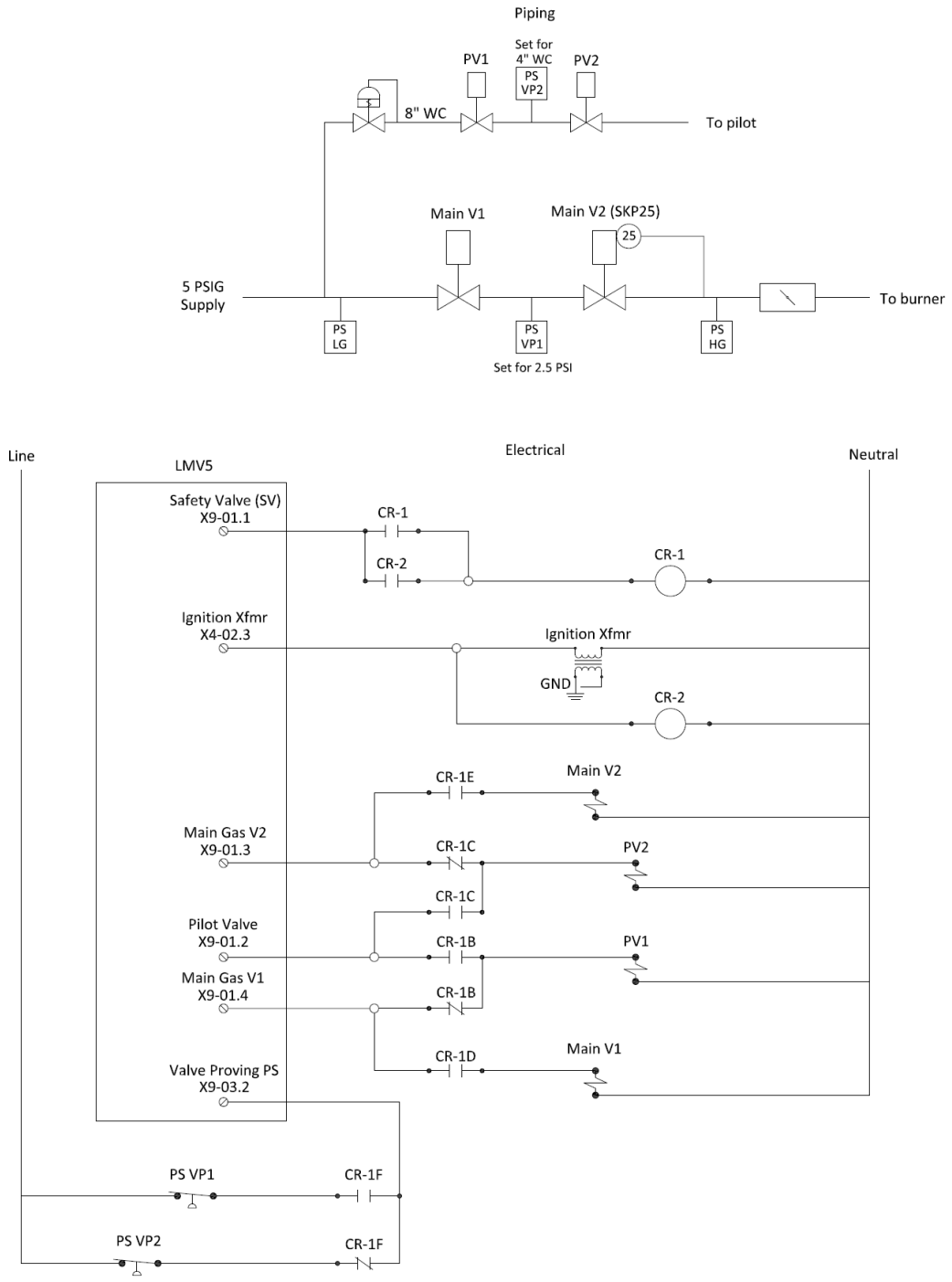


Figure 11: Option 3 Piping and Electrical Schematics

Pilot Valve Proving (continued)

Option 3 Sequence of Operation

1. The LMV5 is in standby. All valves are closed and all relay contacts are as shown in the electrical schematic. Main gas valve V1 terminal X9-01.4 is effectively connected to PV1, and main gas valve V2 terminal X9-01.3 is effectively connected to PV2.

2. The LMV5 receives a call for heat. The SV terminal (X9-01.1) energizes before the blower, which has no effect. The LMV5 drives to prepurge position.

3. During prepurge, the valve proving sequence takes place on the pilot valves only. PS-VP2 (the Pressure Switch Valve Proving between the pilots) is effectively connected to the valve proving terminal (X9-03.2). The setpoint of PS-VP2 should be set for half of the inlet pressure to the pilot valves.

4. The LMV5 drives to ignition position. The ignition transformer output (X4-02.3) energizes, thereby energizing the CR-1 coil, and latching the coil from the power supplied from X9-01.1. The main gas valve V1 terminal (X9-01.4) is connected to main gas valve V1, and the main gas valve V2 terminal (X9-01.3) is connected to main gas valve V2. The pilot valve terminal (X9-01.2) is connected to both PV1 and PV2. Also, PS-VP1 is now connected to the valve proving terminal (X9-03.2).

5. The LMV5 continues to light off and runs as normal, with the CR-1 coil latched in.

6. Upon shutdown, the LMV5 proceeds directly into valve proving on shutdown. The SV terminal (X9-01.1) is still energized, so the main valves will go through valve proving using PS-VP1. The setpoint of PS-VP1 should be set for half of the main inlet pressure.

7. After valve proving on shutdown is complete, the SV terminal (X9-01.1) de-energizes and the CR-1 circuit unlatches.

Option 3 Important Notes

1. Separate pressure switches for the pilot valves and main valves are required.

2. All four valves are tested independently.

3. Valve proving must be done on both startup and shutdown of the boiler.

Purge Proving

Introduction

Purge proving verifies either a differential air pressure switch or an air damper end switch is in the correct position before purge begins. This can be accomplished in two different ways:

- A differential pressure switch to verify proper air flow through the boiler. Once the proper differential pressure is achieved, the prepurge position has been verified and the purge begins.
- An end switch on the air damper. Once the air damper has moved to its fully open position, the end switch closes and the purge begins.

The following procedure for purge proving on the LMV5 uses an additional two-pole relay with either a differential pressure switch or an air damper end switch.

NOTE: Do not perform purge proving if using direct start on the LMV5!

Procedure

The following procedure uses either a differential pressure switch or an air damper end switch for purge proving on the LMV5. For the rest of this procedure, either switch will be referred to as a "proving switch".

1. Wire the LMV5, proving switch, and two-pole relay as shown below in Figure 12.

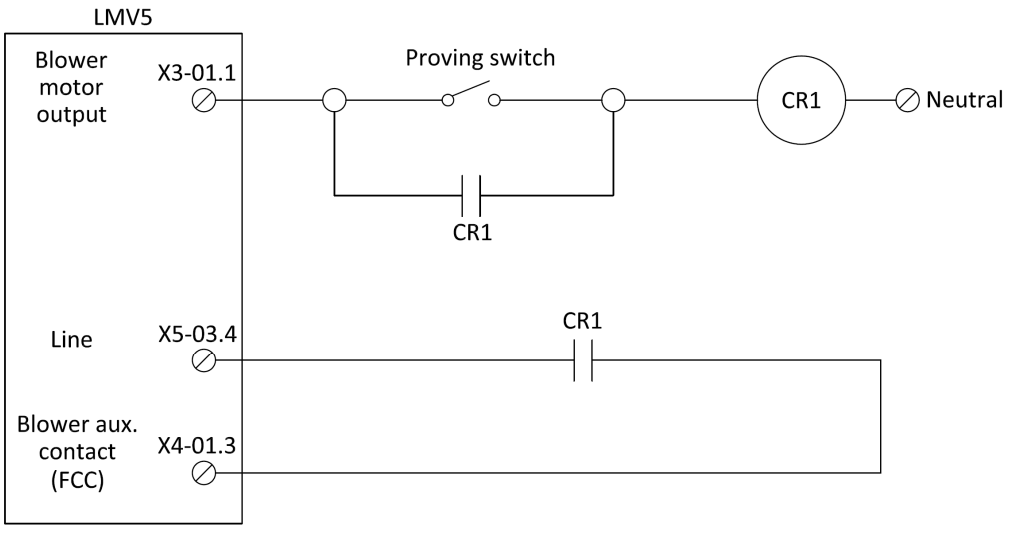


Figure 12: LMV5 Purge Proving Wiring Diagram

Purge Proving

2. Input X4-01.3 on the LMV5 must be configured for a blower auxiliary contact. This can be set through the following menu path in the LMV5:

   Params & Display > BurnerControl > Configuration > ConfigIn/Output > FGR-PS/FCC = **FCC**

Operation

1. In phase 22, the blower motor output (X3-01.1) energizes, powering the common side of the proving switch. **Note: Since the blower motor may never turn off when using direct start, purge proving cannot be used in conjunction with direct start on the LMV5.**

2. By the end of phase 24, the blower auxiliary contact input (X4-01.3) must be energized or the LMV5 will lockout on a “fan contactor contact” (FCC) fault.

3. Once the proving switch makes, relay CR1 energizes and the two normally-open contacts close.

4. The contact wired in parallel with the proving switch latches power to relay CR1 as long as the blower is on.

5. The other contact wired off of line terminal X5-03.4 completes the circuit to the blower auxiliary contact input (X4-01.3). At this point, the purge proving is complete and the LMV5 will progress to phase 30 (prepurge).

Remote Setpoint

Introduction

The LMV5 can be configured to accept either a local setpoint or a remote setpoint. A remote setpoint takes an analog input and converts it into a setpoint. On the LMV5, terminal X62 can be wired and configured to accept a variety of signals for a remote setpoint. The following steps describe the procedure for setting up a remote setpoint on the LMV5.

Procedure

1. Log in to the LMV5 with either the service or OEM level password.

2. The LMV5 must be set for a load controller operating mode of "IntLC X62". The LMV5 will utilize the internal PID loop, but will also respond to a remote setpoint from an analog signal on terminal X62. To set the load controller operating mode to "IntLC X62", use the following menu path:

   Params & Display > LoadController > Configuration > LC_OptgMode = **IntLC X62**

3. Configure the type of analog signal which will be input to terminal X62. Four options are available: 0-10 Vdc, 2-10 Vdc, 0-20 mA, or 4-20 mA. Use the following menu path to set the input type for terminal X62:

   Params & Display > LoadController > Configuration > Ext Inp X62 U/I

   NOTE: For the remainder of this section, all examples will use a 4-20 mA signal.

4. The analog input must be scaled appropriately depending on the desired setpoint limits for the remote setpoint. The LMV5 predefines what setpoint a 4 mA signal indicates. Conversely, the LMV5 must be programmed with the desired setpoint for a 20 mA signal. Then, the setpoint will be scaled linearly for any signal between 4 and 20 mA.

   <u>Low Setpoint Scaling</u>
   When operating on pressure, a 4 mA signal **always** translates to a 0 psi setpoint.
   When operating on temperature, a 4 mA signal **always** translates to a 32°F setpoint.

   <u>High Setpoint Scaling</u>
   The high end of the setpoint scaling depends on the sensor type wired to terminals X60 or X61. There are three possibilities for sensor type: a pressure sensor wired to terminal X61, a temperature sensor wired to terminal X60, or a temperature transmitter wired to terminal X61.

Remote Setpoint (continued)

Pressure Sensor Wired to Terminal X61

When operating on pressure, a 20 mA signal translates to the value programmed into parameter "MRange PressSens". Parameter "MRange PressSens" can be accessed through the following menu path:

Params & Display > LoadController > Configuration > MRange PressSens

This value should not be changed as it is used to scale the high end of the pressure sensor connected to terminal X61. This should simply be noted for later calculations.

Temperature Sensor Wired to Terminal X60

When operating on temperature via an RTD wired on terminal X60, a 20 mA signal translates to the value programmed into parameter "MeasureRangePtNi". This parameter can be set for 302°F, 752°F, or 1562°F. It is recommended for best resolution that this is set to 302°F unless a setpoint over 302°F is desired. Note that if "MeasureRangePtNi" is exceeded, a temperature sensor fault will occur. Parameter "MesaureRangePtNi" can be accessed through the following menu path:

Params & Display > LoadController > Configuration > MeasureRangePtNi

Temperature Transmitter Wired to Terminal X61

When operating on temperature via an analog input on terminal X61, a 20 mA signal translates to the value programmed into parameter "MRange TempSens". Parameter "MRange TempSens" can be accessed through the following menu path:

Params & Display > LoadController > Configuration > MRange TempSens

This value should not be changed as it is used to scale the high end of the temperature sensor connected to terminal X61. This should simply be noted for later calculations.

5. Finally, upper and lower setpoint limits can be programmed using parameters "Ext MinSetpoint" and "Ext MaxSetpoint". These parameters are percentages of the range from the low setpoint limit to the high setpoint limit. As a formula, these parameters should be set using the following method:

$$Ext\ MinSetpoint = \frac{Desired\ Low\ Setpoint - Low\ Setpoint\ Scale}{High\ Setpoint\ Scale - Low\ Setpoint\ Scale}$$

$$Ext\ MaxSetpoint = \frac{Desired\ High\ Setpoint - Low\ Setpoint\ Scale}{High\ Setpoint\ Scale - Low\ Setpoint\ Scale}$$

Remote Setpoint (continued)

"Ext MinSetpoint" and "Ext MaxSetpoint" are found through the following menu path:

Params & Display > LoadController > Configuration

These parameters do not re-scale the input, but provide hard upper and lower limits on the setpoint. The following is an example on how these parameters may be utilized.

Example: Pressure Sensor Wired to Terminal X61

LC_OptgMode = IntLC X62
Ext Inp X62 U/I = 4..20 mA
MRange PressSens = 200 psi
Desired remote setpoint range = 100-150 psi

A 4-20 mA signal on terminal X62 scales the setpoint from 0-200 psi. Parameters "Ext MinSetpoint" and "Ext MaxSetpoint" need to be utilized to get the appropriate setpoint range.

$$Ext\ MinSetpoint = \frac{100\ psi - 0\ psi}{200\ psi - 0\ psi} = \frac{100}{200} = 50\%$$

$$Ext\ MaxSetpoint = \frac{150\ psi - 0\ psi}{200\ psi - 0\ psi} = \frac{150}{200} = 75\%$$

With these parameters set, the following input signals will scale the setpoint accordingly:

4 - 12 mA = 100 psi (limited by "Ext MinSetpoint")
12 - 16 mA = 100 - 150 psi
16 - 20 mA = 150 psi (limited by "Ext MaxSetpoint")

Remote Setpoint (continued)

Example: Temperature Sensor Wired to Terminal X60

LC_OptgMode = IntLC X62
Ext Inp X62 U/I = 4..20 mA
MeasureRangePtNi = 302 °F
Desired remote setpoint range = 180-270 °F

A 4-20 mA signal on terminal X62 scales the setpoint from 32-302 °F. Parameters “Ext MinSetpoint” and “Ext MaxSetpoint” need to be utilized to get the appropriate setpoint range.

$$Ext\ MinSetpoint = \frac{180°\mathrm{F} - 32°\mathrm{F}}{302°\mathrm{F} - 32°\mathrm{F}} = \frac{148}{270} = 55\%$$

$$Ext\ MaxSetpoint = \frac{270°\mathrm{F} - 32°\mathrm{F}}{302°\mathrm{F} - 32°\mathrm{F}} = \frac{238}{270} = 88\%$$

With these parameters set, the following input signals will scale the setpoint accordingly:

4 – 12.8 mA = 180 °F (limited by “Ext MinSetpoint”)
12.8 – 18.1 mA = 180 - 270 °F
18.1 - 20 mA = 270 °F (limited by “Ext MaxSetpoint”)

Remote Setpoint (continued)

Example: Temperature Transmitter Wired to Terminal X61

LC_OptgMode = IntLC X62
Ext Inp X62 U/I = 4..20 mA
MRange TempSens = 300 °F
Desired remote setpoint range = 200-240 °F

A 4-20 mA signal on terminal X62 scales the setpoint from 32-300 °F. Parameters “Ext MinSetpoint” and “Ext MaxSetpoint” need to be utilized to get the appropriate setpoint range.

$$Ext\ MinSetpoint = \frac{200°\mathrm{F} - 32°\mathrm{F}}{302°\mathrm{F} - 32°\mathrm{F}} = \frac{168}{270} = 62\%$$

$$Ext\ MaxSetpoint = \frac{240°\mathrm{F} - 32°\mathrm{F}}{302°\mathrm{F} - 32°\mathrm{F}} = \frac{208}{270} = 77\%$$

With these parameters set, the following input signals will scale the setpoint accordingly:

4 – 13.9 mA = 200 °F (limited by “Ext MinSetpoint”)
13.9 – 16.3 mA = 200 - 240 °F
16.3 - 20 mA = 240 °F (limited by “Ext MaxSetpoint”)

VFD Bypass

Introduction

When using an LMV52 with a variable frequency drive (VFD), it may be beneficial to bypass the VFD and run the motor at full speed. There are typically two reasons for doing this:

- On a single fuel system, it is desired to have the ability to run without the VFD, typically in the event of a VFD malfunction.
- On a dual fuel system, it is desired to use the VFD with one fuel (typically gas) but not the other fuel (typically oil).

The following pages provide the information to apply a VFD bypass on either a single or dual fuel system. For the single fuel system, the fuel is assumed to be gas. For the dual fuel system, it will be assumed that the main fuel is gas and the secondary fuel is oil.

VFD Bypass (continued)

To bypass the VFD on a single fuel system, both gas and oil settings in the LMV52 need to be utilized. One fuel will be set up to run with the VFD, while the other fuel is set up to run without the VFD. For the rest of this procedure, it will be assumed that a VFD is being used when running gas and not being used when running oil. Since only one fuel (gas) is being operated on both gas and oil settings, the AGM60 switching module will be used to change over all necessary inputs and outputs when the LMV52 switches between fuels.

Single Fuel Procedure

1. Wire the VFD and motor contactor contacts as shown in Figure 13.

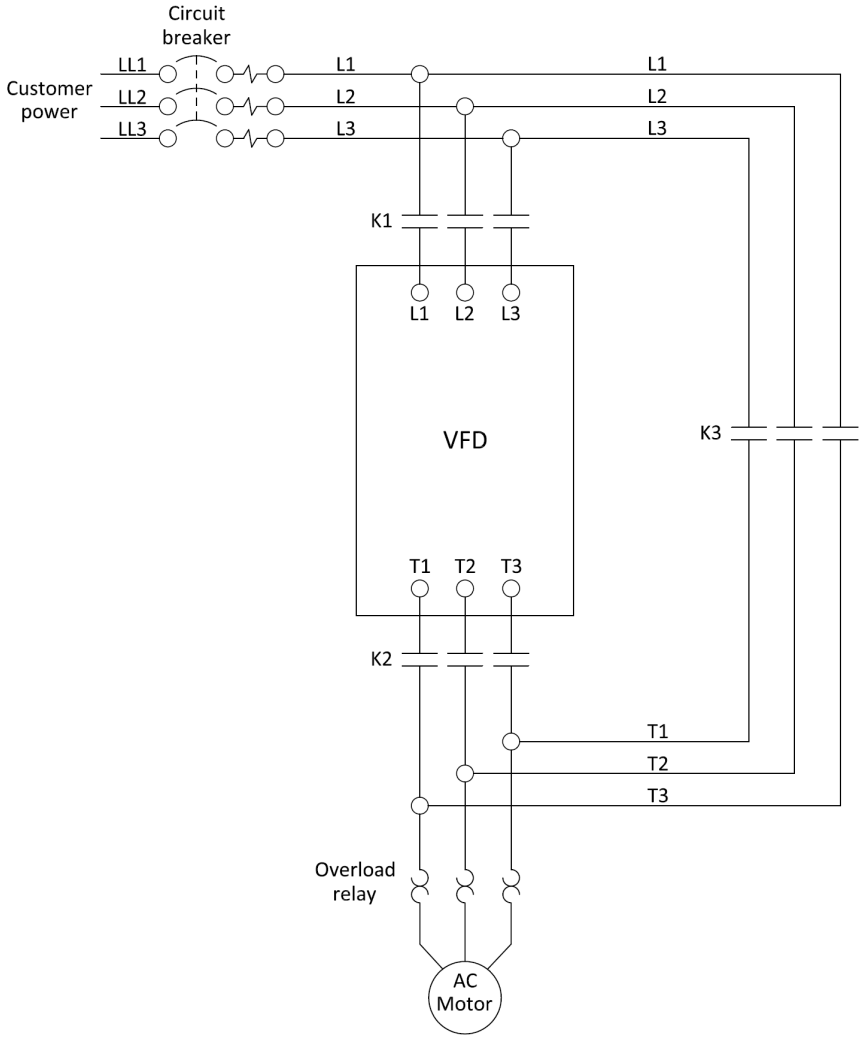


Figure 13: VFD Wiring for Single Fuel VFD Bypass

VFD Bypass (continued)

2. Wire the LMV52, AGM60, and motor contactor coils as shown in Figure 14.

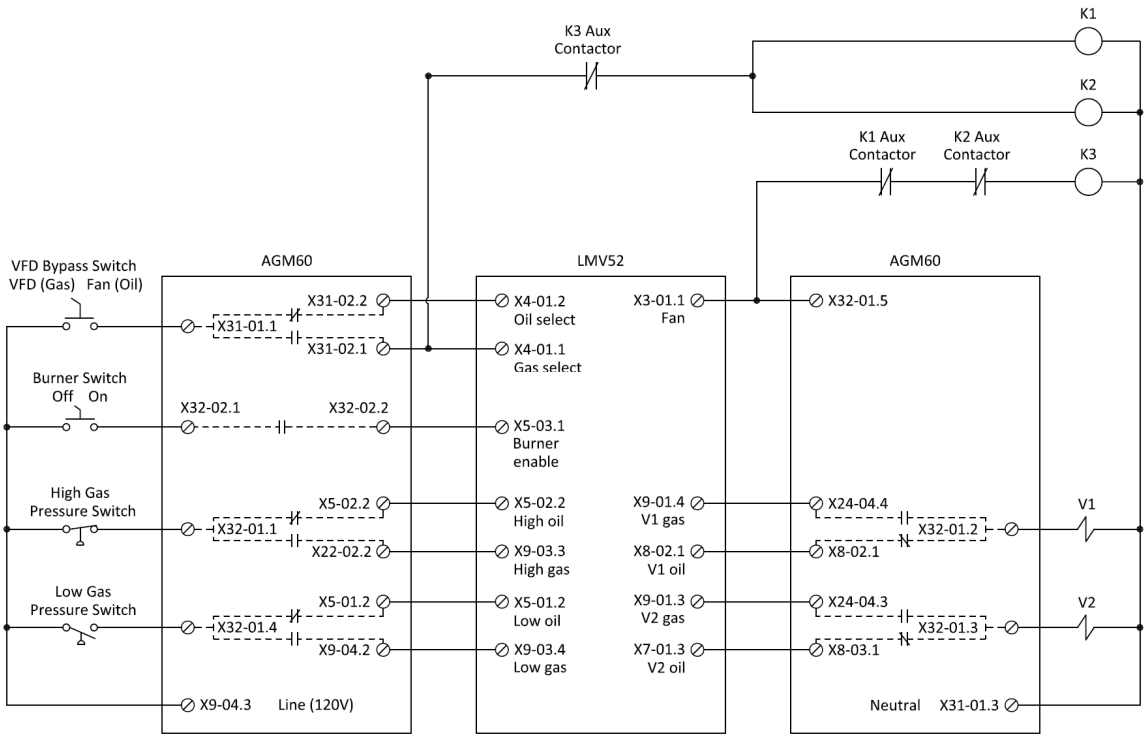


Figure 14: LMV52 and AGM60 Wiring for Single Fuel VFD Bypass

3. Set parameter "NumFuelActuators" to 1 since only one actuator will be used to operate both fuels. This parameter can be set using the following menu path:

   Params & Display > RatioControl > NumFuelActuators = **1**

4. Ensure the VFD is activated on gas, and deactivated on oil. This can be done through the following menu paths:

   Params & Display > RatioControl > Gas Settings > VSD = **activated**
   Params & Display > RatioControl > Oil Settings > VSD = **deactivated**

5. Ensure the LMV52 is not set up for continuous purge. This can be done through the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigGeneral > ContinuousPurge = **deactivated**

VFD Bypass (continued)

Single Fuel Operation

1. When the "VFD Bypass Switch" is in VFD mode, motor contactors K1 and K2 are energized. Power flows through the VFD to the motor. Bypass contactor K3 remains de-energized. The fuel select terminal (X31-01.1) on the AGM60 is de-energized, so the LMV52 runs gas. All inputs and outputs are connected through the AGM60 to the LMV52 gas terminals.

2. When the "VFD Bypass Switch" is in Fan mode, motor contactors K1 and K2 are de-energized and no power flows to the VFD. Power runs directly to the motor through bypass contactor K3 once the fan output (X3-01.1) is energized in phase 22. The fuel select terminal (X31-01.1) on the AGM60 is energized, so the LMV52 runs oil. All inputs and outputs are connected through the AGM60 to the LMV52 oil terminals.

3. If the "VFD Bypass Switch" is switched during operation, the LMV52 immediately loses its call for heat and goes through its shutdown sequence. When the fan output (X3-01.1) de-energizes after phase 78, terminal X32-01.5 on the AGM60 becomes de-energized, causing the switchover of all inputs and outputs connected through the AGM60 and the motor contactors.

   Note: Even though this is a single fuel system running gas, the LMV52 display will state it is running oil when the "VFD Bypass Switch" is in Fan mode.

VFD Bypass (continued)

Dual Fuel Procedure

1. Wire the LMV52, VFD, and motor contactors as shown in Figure 15.

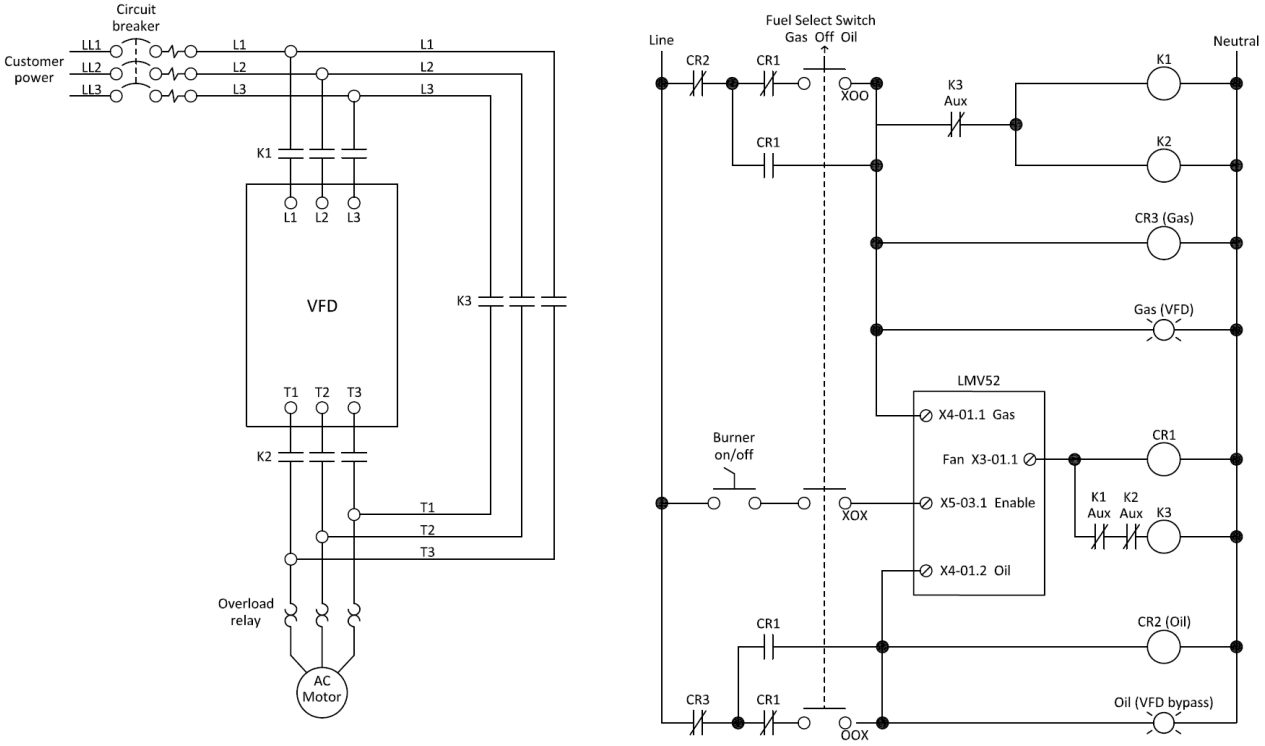


Figure 15: Wiring for a Dual Fuel VFD Bypass

2. Ensure the VFD is activated on gas, and deactivated on oil. This can be done through the following menu paths:

   Params & Display > RatioControl > Gas Settings > VSD = **activated**
   Params & Display > RatioControl > Oil Settings > VSD = **deactivated**

3. Ensure the LMV52 is not set up for continuous purge. This can be done through the following menu path:

   Params & Display > BurnerControl > Configuration > ConfigGeneral > ContinuousPurge = **deactivated**

VFD Bypass (continued)

Dual Fuel Operation

1. When the “Fuel Select Switch” is in gas mode, the coil for CR3 is energized, preventing the LMV52 from running oil. Motor contactors K1 and K2 are energized and power flows through the VFD to the motor. Auxiliary contactors on K1 and K2 prevent motor contactor K3 from energizing. The gas select terminal (X4-01.1) on the LMV52 is energized, and the LMV52 operates on gas.

2. When the “Fuel Select Switch” is in oil mode, the coil for CR2 is energized which prevents the LMV52 from running gas. Motor contactors K1 and K2 are de-energized and no power flows to the VFD. Power runs directly to the motor through bypass contactor K3 once the fan output (X3-01.1) is energized in phase 22. An auxiliary contactor on K3 prevents motor contactors K1 and K2 from energizing. The oil select terminal (X4-01.2) on the LMV52 is energized, and the LMV52 operates on oil.

3. When the “Fuel Select Switch” is in off mode, terminal X5-03.1 is de-energized, preventing the LMV52 from running.

4. Once the fan turns on in phase 22 while running either fuel, the coil for CR1 is energized. The normally open contacts for CR1 close, latching the current fuel in place until the fan turns off after phase 78.

5. If direct start is activated and a fuel changeover is required, turn the “Fuel Select Switch” to off. Wait for the LMV52 to get back to standby (phase 12). Switch the “Fuel Select Switch” to the desired fuel.

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Technical Instructions

Document No. LV5-1000

July 10, 2015

Allen-Bradley

PowerFlex® 40

Adjustable Frequency AC Drive

FRN 1.xx - 6.xx

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at **http://www.rockwellautomation.com/literature**) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Shock Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

Burn Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be at dangerous temperatures.

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The information below summarizes the changes to the PowerFlex 40 *User Manual* since the April 2008 release.

Manual Updates

Description of New or Updated Information	Page(s)
Description of A056 revised.	3-17
Description of A059/A062 revised.	3-19
Fault description for F3 revised.	4-3
A table row for electrical specifications added.	A-4
Graphic for the “Network Wiring” section revised.	C-1
Second last paragraph in the “Network Wiring” section revised.	C-2
Text in the “Writing (06) Logic Command Data” section revised.	C-4
Frequency source for logic command 001 of bits 14, 13, and 12 corrected.	C-4
Text in the “Writing (06) Reference” section revised.	C-5

Parameter Updates

The following parameters have been updated with firmware version 6.xx.

Parameter	Number	Description	Page
[Relay Out Sel]	A055	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-16
[Relay Out Sel]	A058, A061	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-18

The information below summarizes the changes to the PowerFlex 40 *User Manual* since the January 2007 release.

Manual Updates

Description of New or Updated Information	Page(s)
Input description and attention text for Multiple Digital Input Connection example corrected.	1-22
New method of changing speed reference for IP66, NEMA/UL Type 4X rated drives described.	2-2
Description for Up Arrow and Down Arrow keys revised.	2-4
Fault description for F3 revised.	4-3
Graphic for the “Network Wiring” section revised.	C-1
Descriptions for bits 6, 7, and 15 of register address 8192 (Logic Command) updated.	C-4
New information on reading register address 8192 added.	C-4
New information on reading register address 8193 added.	C-5
Graphic for the “Connecting an RS-485 Network” section corrected.	D-4
New method for inverting sign of PID error added.	F-6

New Parameter

The following parameter has been added with firmware version 5.xx.

Parameter	Number	Description	Page
[PID Invert Error]	A167	New	3-44

Parameter Updates

The following parameters have been updated with firmware version 5.xx.

Parameter	Number	Description	Page
[Control Source]	d012	Options 7 and 8 added.	3-5
[Start Source]	P036	Description revised for option 6.	3-10
[Relay Out Sel]	A055	Description revised for option 20.	3-16
[Relay Out Level]	A056	Description revised.	3-17
[Opto Outx Sel]	A058, A061	Description revised for option 20.	3-18
[Opto Outx Level]	A059, A062	Description revised.	3-19
[Internal Freq]	A069	Default value for IP66, NEMA/ UL Type 4X drives is 0.0 Hz. Default value for IP20 rated drives is 60.0 Hz.	3-22
[PID Trim Hi]	A130	Description revised.	3-38
[PID Trim Lo]	A131	Description revised.	3-38

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Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex 40 Adjustable Frequency AC Drive.

For information on...	See page...
Who Should Use this Manual?	P-1
Reference Materials	P-1
Manual Conventions	P-2
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Who Should Use this Manual?

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices. In addition, you must have an understanding of the parameter settings and functions.

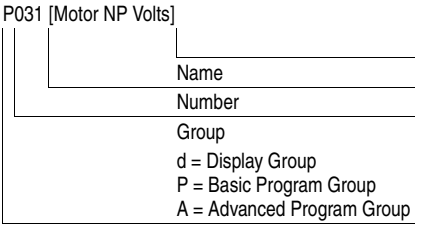
Reference Materials

The following manuals are recommended for general drive information:

Title	Publication	Available Online at ...
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001...	**www.rockwellautomation.com/literature**
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001...	
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1	
A Global Reference Guide for Reading Schematic Diagrams	100-2.10	
Guarding Against Electrostatic Damage	8000-4.5.2	

Manual Conventions

- In this manual we refer to the PowerFlex 40 Adjustable Frequency AC Drive as; drive, PowerFlex 40 or PowerFlex 40 Drive.
- Parameter numbers and names are shown in this format:



- The following words are used throughout the manual to describe an action:

Word	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not Recommended

Drive Frame Sizes

Similar PowerFlex 40 drive sizes are grouped into frame sizes to simplify spare parts ordering, dimensioning, etc. A cross reference of drive catalog numbers and their respective frame sizes is provided in Appendix B.

General Precautions

ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. Before working on drive, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.

Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, “Guarding Against Electrostatic Damage” or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: The bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.
1. Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes;
2. Actual deceleration times can be longer than commanded deceleration times
However, a “Stall Fault” is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, the bus regulator must be disabled (see parameter A117). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases.

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12 (1)	13-14
22B	**-**	**A**	**1P5**	**N**	**1**	**1**	**4**	**AA**
Drive	Dash	Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type	Optional

Code	
22B	PowerFlex 40

Code	Version
3	No Brake IGBT
4	Standard

Code	Rating
0	Not Filtered
1	Filtered

Code	Voltage	Ph.
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Interface Module
1	Fixed Keypad

Code	Purpose
AA thru ZZ	Reserved for custom firmware

Code	Enclosure
N	Panel Mount - IP20, NEMA/UL Type Open
C	Panel Mount - IP66, NEMA/UL Type 4X
F	Flange Mount - IP20, NEMA/UL Type Open
H	Replacement Plate Drive - IP20, NEMA/UL Type Open - *Contact factory for ordering information.*

Output Current @ 100-120V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
6P0	6.0	1.1 (1.5)

Output Current @ 200-240V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
8P0	8.0	1.5 (2.0)
012	12	2.2 (3.0)
017	17.5	3.7 (5.0)
024	24	5.5 (7.5)
033	33	7.5 (10)

Output Current @ 380-480V 50/60 Hz Input

Code	Amps	kW (HP)
1P4	1.4	0.4 (0.5)
2P3	2.3	0.75 (1.0)
4P0	4.0	1.5 (2.0)
6P0	6.0	2.2 (3.0)
010	10.5	4.0 (5.0)
012	12	5.5 (7.5)
017	17	7.5 (10)
024	24	11 (15)

Output Current @ 500-600V 50/60 Hz Input

Code	Amps	kW (HP)
1P7	1.7	0.75 (1.0)
3P0	3.0	1.5 (2.0)
4P2	4.2	2.2 (3.0)
6P6	6.6	4.0 (5.0)
9P9	9.9	5.5 (7.5)
012	12.2	7.5 (10)
019	19	11 (15)

(1) Position 12 of the Catalog Number now indicates drive type. All PowerFlex 40 drives are equipped with RS485 communication.

Additional accessories, options and adapters are available. See Appendix B for details.

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 40 Drive.

For information on...	See page
Opening the Cover	1-1
Mounting Considerations	1-3
AC Supply Source Considerations	1-5
General Grounding Requirements	1-7

For information on...	See page
Fuses and Circuit Breakers	1-8
Power Wiring	1-10
I/O Wiring Recommendations	1-14
EMC Instructions	1-25

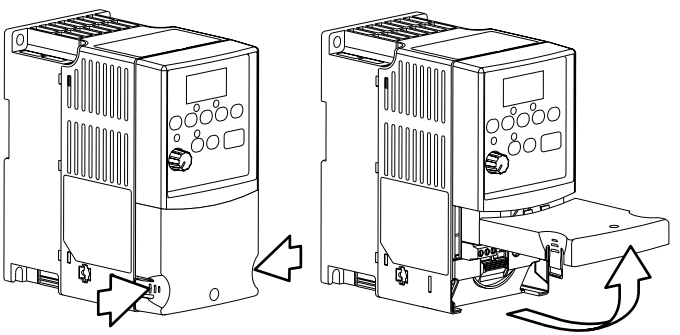
Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Opening the Cover

IP20, NEMA/UL Type Open

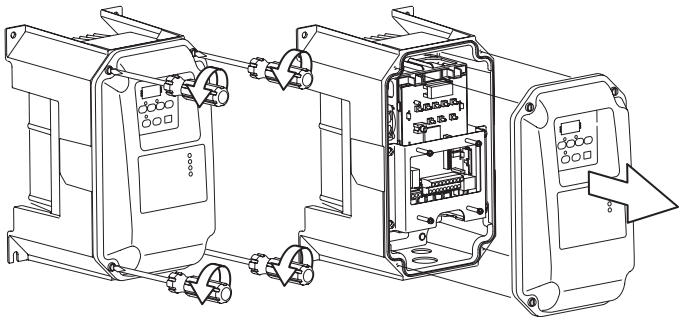
1. Press and hold in the tabs on each side of the cover.
2. Pull the cover out and up to release.



IP66, NEMA/UL Type 4X

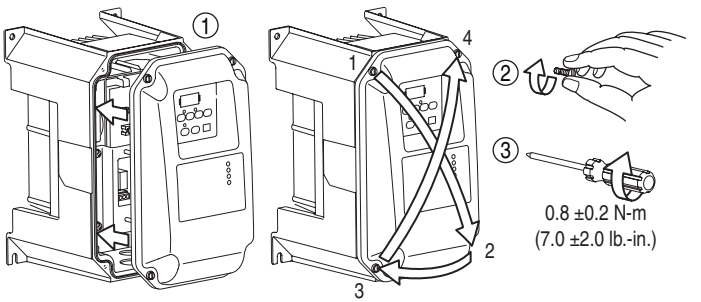
ATTENTION: To avoid an electric shock hazard, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)] and wait three minutes for capacitors to discharge before removing the external cover. Once the cover is removed, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the DC– and DC+ terminals on the Power Terminal Block (refer to page 1-13 for Power Terminal descriptions). The voltage must be zero.

1. Loosen the four captive cover screws.
2. Pull cover straight off chassis.



IP66, NEMA/UL Type 4X Cover Installation

1. Squarely align the cover on the chassis.
2. Lightly tighten the four captive cover screws.
3. Torque the cover screws using an alternating pattern.



Mounting Considerations

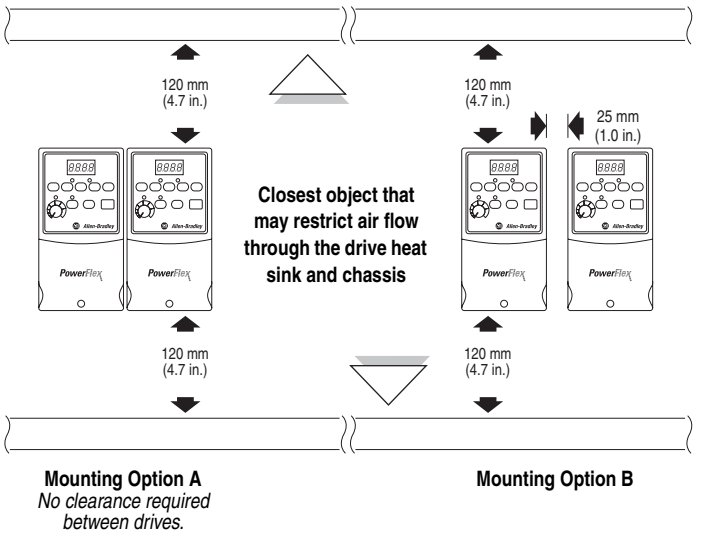
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque	DIN Rail
B	M4 (#8-32)	1.56-1.96 N-m (14-17 lb.-in.)	35 mm
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)	–
B (IP66, Type 4X)	M6 (#12-24)	3.95-4.75 N-m (35-42 lb.-in.)	–

- Protect the cooling fan by avoiding dust or metallic particles.
- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight.

Minimum Mounting Clearances

Refer to Appendix B for mounting dimensions.



Ambient Operating Temperatures

Table 1.A Enclosure and Clearance Requirements

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances
Minimum	Maximum		
-10°C (14°F)	40°C (104°F)	IP20, NEMA/UL Type Open	Use Mounting Option A
		IP66, NEMA/UL Type 4X	Use Mounting Option A
		IP30, NEMA/UL Type 1(1)	Use Mounting Option B
	50°C (122°F)	IP20, NEMA/UL Type Open	Use Mounting Option B

(1) Rating requires installation of the PowerFlex 40 IP30, NEMA/UL Type 1 option kit.

Debris Protection

A plastic top panel is included with the drive. Install the panel to prevent debris from falling through the vents of the drive housing during installation. Remove the panel for IP20, NEMA/UL Type Open applications.

Storage

- Store within an ambient temperature range of -40° to +85°C.
- Store within a relative humidity range of 0% to 95%, non-condensing.
- Do not expose to a corrosive atmosphere.

AC Supply Source Considerations

Ungrounded Distribution Systems

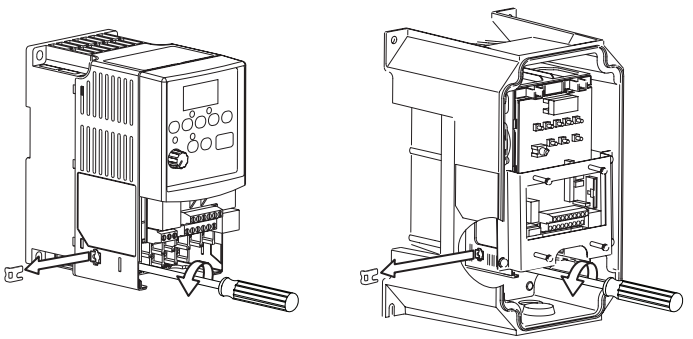
ATTENTION: PowerFlex 40 drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the Figures 1.1 and 1.2.

1. Turn the screw counterclockwise to loosen.
2. Pull the jumper completely out of the drive chassis.
3. Tighten the screw to keep it in place.

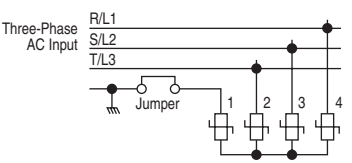
Figure 1.1 Jumper Location (Typical)



IP20, NEMA/UL Type Open **IP66, NEMA/UL Type 4X**

Important: Tighten screw after jumper removal.

Figure 1.2 Phase to Ground MOV Removal



Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see Appendix A). Listed in Table 1.B are certain input power conditions which may cause component damage or reduction in product life. If any of the conditions exist, as described in Table 1.B, install one of the devices listed under the heading *Corrective Action* on the line side of the drive.

Important: Only one device per branch circuit is required. It should be mounted closest to the branch and sized to handle the total current of the branch circuit.

Table 1.B Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance) Greater than 120 kVA supply transformer	• Install Line Reactor(2) • or Isolation Transformer • or Bus Inductor – 5.5 & 11 kW (7.5 & 15 HP) drives only
Line has power factor correction capacitors Line has frequent power interruptions Line has intermittent noise spikes in excess of 6000V (lightning)	• Install Line Reactor • or Isolation Transformer
Phase to ground voltage exceeds 125% of normal line to line voltage Ungrounded distribution system	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
240V open delta configuration (stinger leg)(1)	• Install Line Reactor

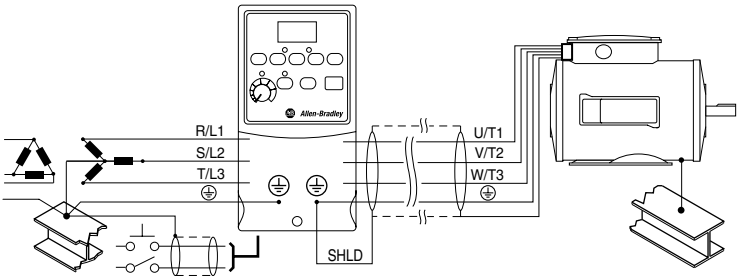
(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the “stinger leg,” “high leg,” “red leg,” etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. Refer to Table B.D for specific line reactor part numbers.

(2) Refer to Appendix B for accessory ordering information.

General Grounding Requirements

The drive Safety Ground - ⏚ (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

Figure 1.3 Typical Grounding



Ground Fault Monitoring

If a system ground fault monitor (RCD) is to be used, only Type B (adjustable) devices should be used to avoid nuisance tripping.

Safety Ground - ⏚ (PE)

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

Motor Ground

The motor ground must be connected to one of the ground terminals on the drive.

Shield Termination - SHLD

Either of the safety ground terminals located on the power terminal block provides a grounding point for the motor cable shield. The **motor cable** shield connected to one of these terminals (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal. The conduit box option may be used with a cable clamp for a grounding point for the cable shield.

When shielded cable is used for **control and signal wiring**, the shield should be grounded at the source end only, not at the drive end.

RFI Filter Grounding

Using single phase drives with integral filter, or an external filter with any drive rating, may result in relatively high ground leakage currents. Therefore, the **filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded** (bonded) to the building power distribution ground. Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections. The integrity of all connections should be periodically checked.

Fuses and Circuit Breakers

The PowerFlex 40 does not provide branch short circuit protection. This product should be installed with either input fuses or an input circuit breaker. National and local industrial safety regulations and/or electrical codes may determine additional requirements for these installations.

ATTENTION: To guard against personal injury and/or equipment damage caused by improper fusing or circuit breaker selection, use only the recommended line fuses/circuit breakers specified in this section.

Fusing

The PowerFlex 40 has been UL tested and approved for use with input fuses. The ratings in the table that follows are the minimum recommended values for use with each drive rating. The devices listed in this table are provided to serve as a guide.

Bulletin 140M (Self-Protected Combination Controller)/UL489 Circuit Breakers

When using Bulletin 140M or UL489 rated circuit breakers, the guidelines listed below must be followed in order to meet the NEC requirements for branch circuit protection.

- Bulletin 140M can be used in single and group motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

Table 1.C Minimum Recommended Branch Circuit Protective Devices

Voltage Rating	**Drive Rating** *kW (HP)*	**Fuse Rating**[1] *Amps*	**140M Motor Protectors**[2] *Catalog No.*	**Recommended MCS Contactors** *Catalog No.*
120V AC – 1-Phase	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	15 35 40	140M-C2E-C16 140M-D8E-C20 140M-F8E-C32	100-C12 100-C23 100-C37
240V AC – 1-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0)	10 20 30 40	140M-C2E-B63 140M-C2E-C16 140M-D8E-C20 140M-F8E-C32	100-C09 100-C12 100-C23 100-C37
240V AC – 3-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 3.7 (5.0) 5.5 (7.5) 7.5 (10.0)	6 10 15 25 30 40 60	140M-C2E-B40 140M-C2E-C10 140M-C2E-C16 140M-C2E-C16 140M-F8E-C25 140M-F8E-C32 140M-G8E-C45	100-C07 100-C09 100-C12 100-C23 100-C23 100-C37 100-C60
480V AC – 3-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0) 5.5 (7.5) 7.5 (10.0) 11 (15)	3 6 10 15 20 25 30 50	140M-C2E-B25 140M-C2E-B40 140M-C2E-B63 140M-C2E-C10 140M-C2E-C16 140M-D8E-C20 140M-D8E-C20 140M-F8E-C32	100-C07 100-C07 100-C09 100-C09 100-C23 100-C23 100-C23 100-C43
600V AC – 3-Phase	0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0) 5.5 (7.5) 7.5 (10.0) 11 (15)	6 6 10 15 20 25 40	140M-C2E-B25 140M-C2E-B40 140M-C2E-B63 140M-C2E-C10 140M-C2E-C16 140M-C2E-C16 140M-D8E-C25	100-C09 100-C09 100-C09 100-C09 100-C16 100-C23 100-C30

(1) Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

(2) Refer to the Bulletin 140M Motor Protectors *Selection Guide*, publication 140M-SG001… to determine the frame and breaking capacity required for your application.

Power Wiring

ATTENTION: National Codes and standards (NEC, VDE, BSI, etc.) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

ATTENTION: To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled. This will help minimize the possible shock hazard from “cross coupled” power leads.

Motor Cable Types Acceptable for 200-600 Volt Installations

A variety of cable types are acceptable for drive installations. For many installations, unshielded cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 0.3 meters (1 foot) for every 10 meters (32.8 feet) of length. In all cases, long parallel runs must be avoided. Do not use cable with an insulation thickness less than 15 mils (0.4 mm/0.015 in.). Do not route more than three sets of motor leads in a single conduit to minimize “cross talk”. If more than three drive/motor connections per conduit are required, shielded cable must be used.
UL installations in 50°C ambient must use 600V, 75°C or 90°C wire.
UL installations in 40°C ambient should use 600V, 75°C or 90°C wire.
Use copper wire only. Wire gauge requirements and recommendations are based on 75 degree C. Do not reduce wire gauge when using higher temperature wire.

Unshielded

THHN, THWN or similar wire is acceptable for drive installation in dry environments provided adequate free air space and/or conduit fill rates limits are provided. **Do not use THHN or similarly coated wire in wet areas**. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

Shielded/Armored Cable

Shielded cable contains all of the general benefits of multi-conductor cable with the added benefit of a copper braided shield that can contain much of the noise generated by a typical AC Drive. Strong consideration for shielded cable should be given in installations with sensitive equipment such as weigh scales, capacitive proximity switches and other devices that may be affected by electrical noise in the distribution system. Applications with large numbers of drives in a similar location, imposed EMC regulations or a high degree of communications / networking are also good candidates for shielded cable.

Shielded cable may also help reduce shaft voltage and induced bearing currents for some applications. In addition, the increased impedance of shielded cable may help extend the distance that the motor can be located from the drive without the addition of motor protective devices such as terminator networks. Refer to Reflected Wave in "Wiring and Grounding Guidelines for PWM AC Drives," publication DRIVES-IN001A-EN-P.

Consideration should be given to all of the general specifications dictated by the environment of the installation, including temperature, flexibility, moisture characteristics and chemical resistance. In addition, a braided shield should be included and be specified by the cable manufacturer as having coverage of at least 75%. An additional foil shield can greatly improve noise containment.

A good example of recommended cable is Belden® 295xx (xx determines gauge). This cable has four (4) XLPE insulated conductors with a 100% coverage foil and an 85% coverage copper braided shield (with drain wire) surrounded by a PVC jacket.

Other types of shielded cable are available, but the selection of these types may limit the allowable cable length. Particularly, some of the newer cables twist 4 conductors of THHN wire and wrap them tightly with a foil shield. This construction can greatly increase the cable charging current required and reduce the overall drive performance. Unless specified in the individual distance tables as tested with the drive, these cables are not recommended and their performance against the lead length limits supplied is not known.

Recommended Shielded Wire

Location	Rating/Type	Description
Standard (Option 1)	600V, 90°C (194°F) XHHW2/RHW-2 Anixter B209500-B209507, Belden 29501-29507, or equivalent	• Four tinned copper conductors with XLPE insulation. • Copper braid/aluminum foil combination shield and tinned copper drain wire. • PVC jacket.
Standard (Option 2)	Tray rated 600V, 90°C (194°F) RHH/RHW-2 Anixter OLF-7xxxxx or equivalent	• Three tinned copper conductors with XLPE insulation. • 5 mil single helical copper tape (25% overlap min.) with three bare copper grounds in contact with shield. • PVC jacket.
Class I & II; Division I & II	Tray rated 600V, 90°C (194°F) RHH/RHW-2 Anixter 7V-7xxxx-3G or equivalent	• Three bare copper conductors with XLPE insulation and impervious corrugated continuously welded aluminum armor. • Black sunlight resistant PVC jacket overall. • Three copper grounds on #10 AWG and smaller.

Reflected Wave Protection

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). See Table 1.D for recommendations.

The reflected wave data applies to all frequencies 2 to 16 kHz.

For 240V ratings, reflected wave effects do not need to be considered.

Table 1.D Maximum Cable Length Recommendations

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only**(1)
	1000 Vp-p	15 meters (49 feet)
	1200 Vp-p	40 meters (131 feet)
	1600 Vp-p	170 meters (558 feet)

(1) Longer cable lengths can be achieved by installing devices on the output of the drive. Consult factory for recommendations.

Output Disconnect

The drive is intended to be commanded by control input signals that will start and stop the motor. A device that routinely disconnects then reapplies output power to the motor for the purpose of starting and stopping the motor should not be used. If it is necessary to disconnect power to the motor with the drive outputting power, an auxiliary contact should be used to simultaneously disable drive control run commands.

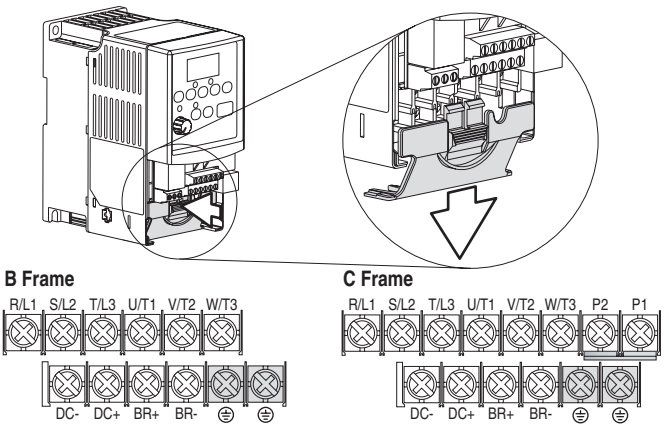
Power Terminal Block

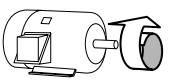
The power terminal block is covered by a finger guard. To remove:

1. Press in and hold the locking tab.
2. Slide finger guard down and out.

Replace the finger guard when wiring is complete.

Figure 1.4 Power Terminal Block (Typical)



Terminal (1)	Description
R/L1, S/L2	1-Phase Input
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1
V/T2	To Motor V/T2 =  Switch any two motor leads to change forward direction.
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection (C Frame drives only.) The C Frame drive is shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected.
DC+, DC-	DC Bus Connection
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground - PE

(1) **Important:** Terminal screws may become loose during shipment. Ensure that all terminal screws are tightened to the recommended torque before applying power to the drive.

Table 1.E Power Terminal Block Specifications

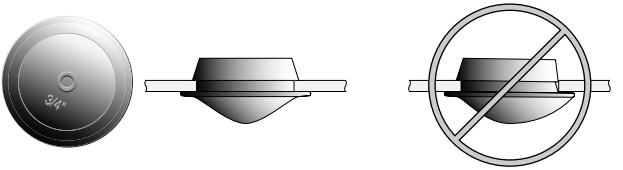
Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
B	5.3 mm^2 (10 AWG)	1.3 mm^2 (16 AWG)	1.7-2.2 N-m (16-19 lb.-in.)
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9-3.7 N-m (26-33 lb.-in.)

(1) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

IP66, NEMA/UL Type 4X Installations

Use the plugs supplied with IP66, NEMA/UL Type 4X rated drives to seal unused holes in the conduit entry plate.

Important: Completely seat the plug inner rim for the best seal.



I/O Wiring Recommendations

Motor Start/Stop Precautions

ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If used, the input device must not exceed one operation per minute or drive damage can occur.

ATTENTION: The drive start/stop control circuitry includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required to remove the AC line to the drive. When the AC line is removed, there will be a loss of any inherent regenerative braking effect that might be present - the motor will coast to a stop. An auxiliary braking method may be required.

Important points to remember about I/O wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control and signal wires should be separated from power wires by at least 0.3 meters (1 foot).

Important: I/O terminals labeled “Common” are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference.

ATTENTION: Driving the 4-20mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Control Wire Types

Table 1.F Recommended Control and Signal Wire(1)

Wire Type(s)(2)	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18 AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18 AWG), 3 conductor, shielded for remote pot only.	

(1) If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

(2) Stranded or solid wire.

I/O Terminal Block

Table 1.G I/O Terminal Block Specifications

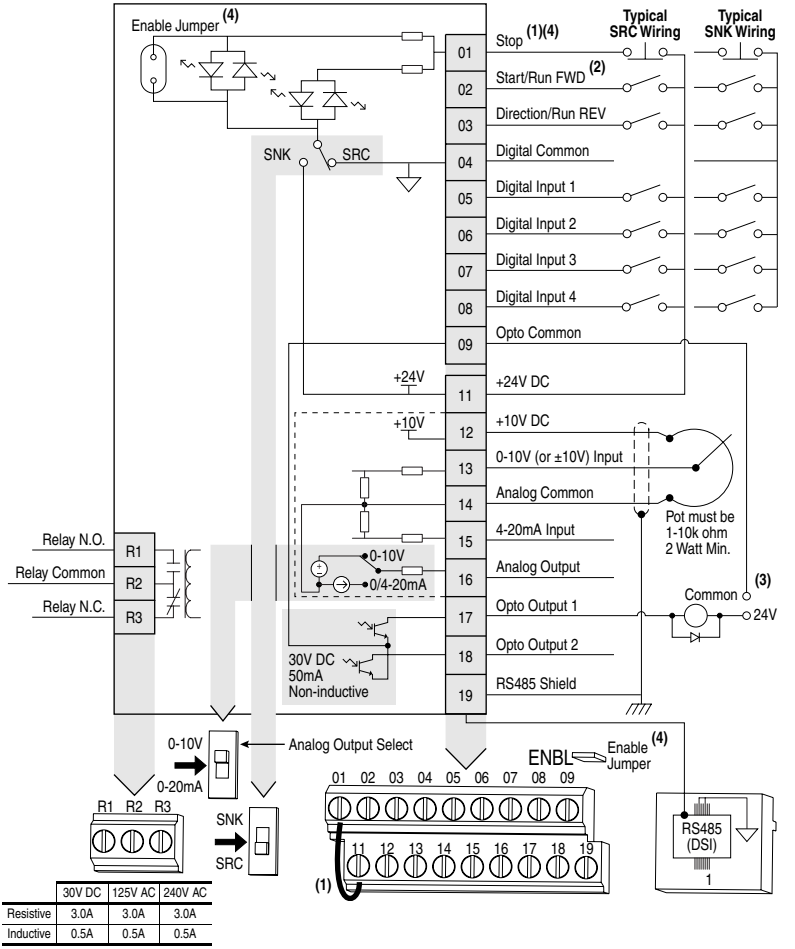
Frame	Maximum Wire Size (3)	Minimum Wire Size (3)	Torque
B & C	1.3 mm^2 (16 AWG)	0.2 mm^2 (24 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(3) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 meters (100 feet). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common must be connected to ground terminal/protective earth. If using the RS485 (DSI) port, I/O Terminal 16 should also be connected to ground terminal/protective earth.

Figure 1.5 Control Wiring Block Diagram



	30V DC	125V AC	240V AC
Resistive	3.0A	3.0A	3.0A
Inductive	0.5A	0.5A	0.5A

(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to "3-Wire" or "Momt FWD/REV" control. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [Stop Mode].

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037(4)
2-Wire	Per P037	Coast
Momt FWD/REV	Per P037	Per P037(4)
RS485 Port	Per P037	Coast

Important: The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) When using an opto output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.

(4) When the ENBL enable jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation.

Table 1.H Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
R1	Relay N.O.	Fault	Normally open contact for output relay.	A055
R2	Relay Common	–	Common for output relay.	
R3	Relay N.C.	Fault	Normally closed contact for output relay.	A055

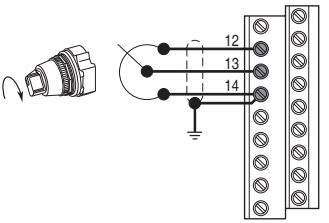
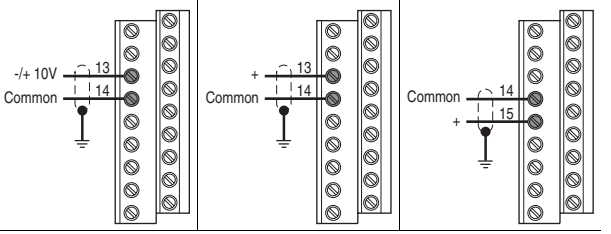
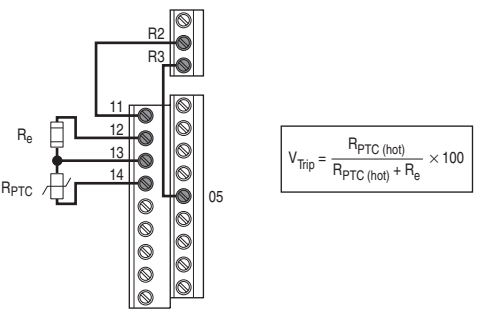
Analog Output Select DIP Switch	0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].
Sink/Source DIP Switch	Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

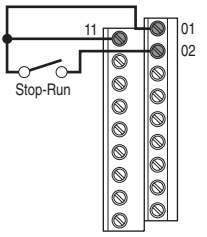
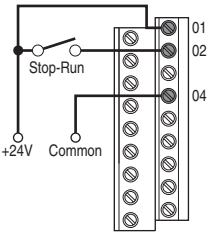
01	Stop (1)	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.	P036 (1)
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default.	P036, P037
03	Direction/Run REV	Not Active	To disable reverse operation, see A095 [Reverse Disable].	P036, P037, A095
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.	
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].	A051
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].	A052
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].	A053
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].	A054
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.	
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.	
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.	P038
13	±10V In (2)	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.	P038, A051-A054, A123, A132
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.	
15	4-20mA In (2)	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).	P038, A051-A054, A132
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To covert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	A065, A066
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]	A058, A059, A064
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]	A061, A062, A064
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.	

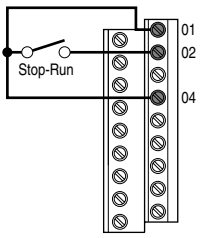
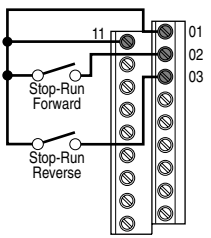
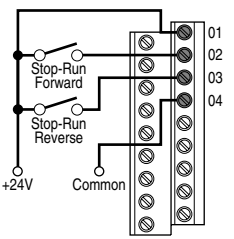
(1) See Footnotes (1) and (4) on page 1-16.

(2) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously. Inputs may be used independently for speed control or jointly when operating in PID mode.

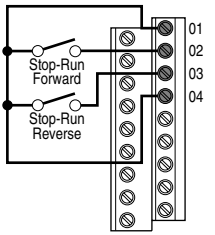
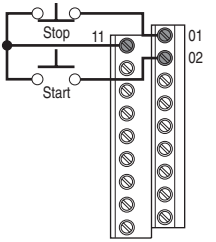
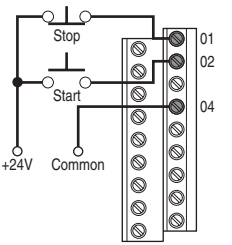
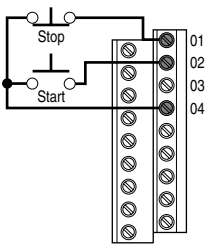
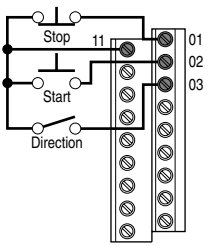
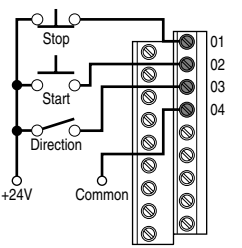
I/O Wiring Examples

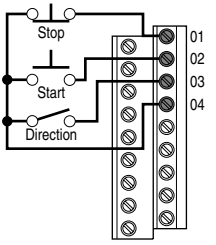
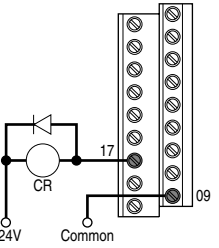
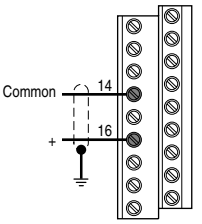
<table>
<tr><th>Input/Output</th><th colspan="3">Connection Example</th></tr>
<tr><td>Potentiometer
1-10k Ohm Pot. Recommended
(2 Watt minimum)</td><td colspan="3">P038 [Speed Reference] = 2 “0-10V Input”
 
</td></tr>
<tr><td rowspan="2">Analog Input
0 to +10V, 100k ohm impedance
4-20 mA, 250 ohm impedance</td><td>Bipolar
P038 [Speed Reference] = 2 “0-10V Input” and A123 [10V Bipolar Enbl] = 1 “Bi-Polar In”</td><td>Unipolar (Voltage)
P038 [Speed Reference] = 2 “0-10V Input”</td><td>Unipolar (Current)
P038 [Speed Reference] = 3 “4-20mA Input”</td></tr>
<tr><td> 
</td></tr>
<tr><td>Analog Input, PTC
For Drive Fault</td><td colspan="3">Wire the PTC and External Resistor (typically matched to the PTC Hot Resistance) to I/O Terminals 12, 13, 14.
Wire R2/R3 Relay Output (SRC) to I/O Terminals 5 & 11.
A051 [Digital In1 Sel] = 3 “Aux Fault”
A055 [Relay Out Sel] = 10 “Above Anlg V”
A056 [Relay Out Level] = % Voltage Trip
 
</td></tr>
</table>

<table>
<tr><th>Input/Output</th><th colspan="2">Connection Example</th></tr>
<tr><td rowspan="2">2 Wire SRC Control - Non-Reversing
P036 [Start Source] = 2, 3 or 4
Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode].
If desired, a User Supplied 24V DC power source can be used. Refer to the “External Supply (SRC)” example.</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

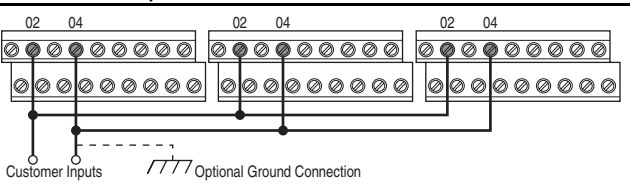
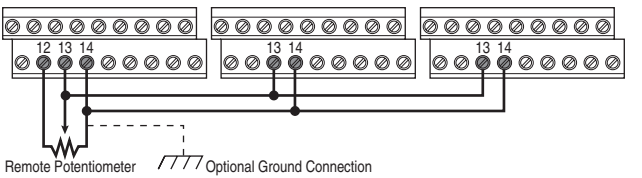
Each digital input draws 6 mA.</td></tr>
<tr><td>2 Wire SNK Control - Non-Reversing</td><td colspan="2">Internal Supply (SNK)
 
</td></tr>
<tr><td rowspan="2">2 Wire SRC Control - Run FWD/Run REV
P036 [Start Source] = 2, 3 or 4
Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode].
If both Run Forward and Run Reverse inputs are closed at the same time, an undetermined state could occur.</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

Each digital input draws 6 mA.</td></tr>
</table>

Input/Output	Connection Example	
2 Wire SNK Control - Run FWD/Run REV	Internal Supply (SNK) 	
3 Wire SRC Control - Non-Reversing P036 [Start Source] = 1 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode].	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
3 Wire SNK Control - Non-Reversing	Internal Supply (SNK) 	
3 Wire SRC Control - Reversing P036 [Start Source] = 1 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode]. I/O Terminal 03 determines direction.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.

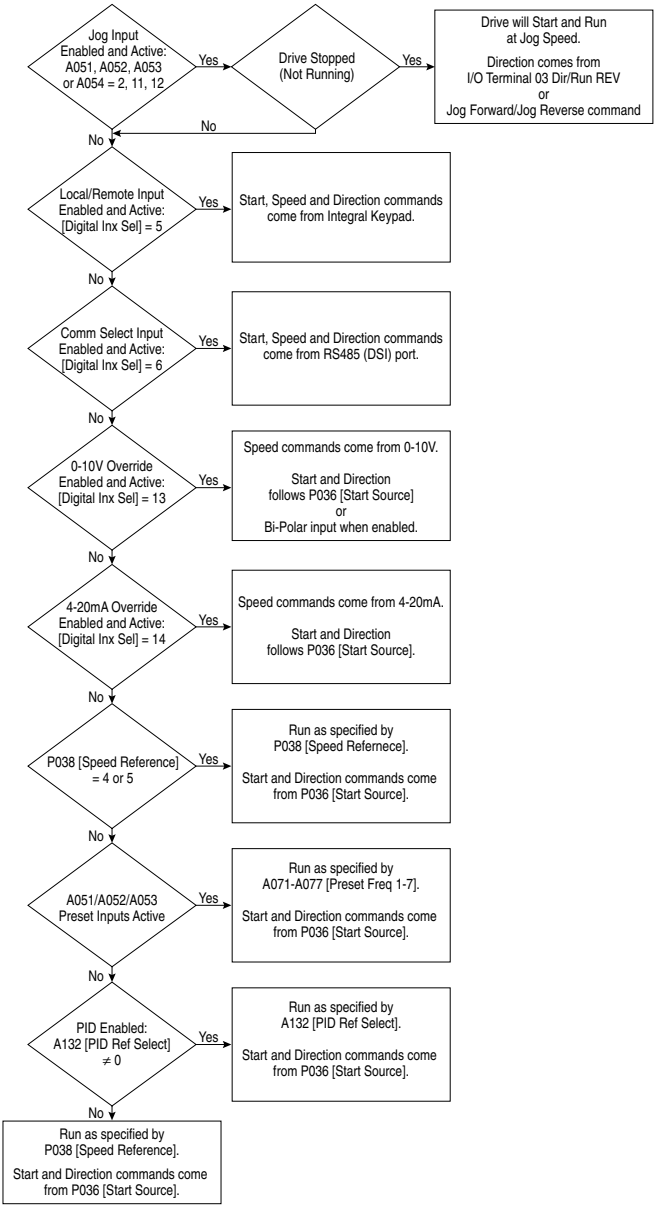
Input/Output	Connection Example
3 Wire SNK Control - Reversing	Internal Supply (SNK) 
Opto Output (1 & 2) A058 [Opto Out1 Sel] determines Opto-Output 1 (I/O Terminal 17) operation. A061 [Opto Out2 Sel] determines Opto-Output 2 (I/O Terminal 18) operation. When using Opto-Output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.	Opto-Output 1  Each Opto-Output is rated 30V DC 50 mA (Non-inductive).
Analog Output A065 [Analog Out Sel] determines analog output type and drive conditions. 0-10V, 1k ohm minimum 0-20mA/4-20mA, 525 ohm maximum	A065 [Analog Out Sel] = 0 through 14 The Analog Output Select DIP Switch must be set to match the analog output signal mode set in A065 [Analog Out Sel]. 

Typical Multiple Drive Connection Examples

Input/Output	Connection Example
Multiple Digital Input Connections Customer Inputs can be wired per External Supply (SRC) examples on 1-19 and 1-20.	 When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect I/O Terminal 04 common together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of I/O Terminal 04 should be connected. **ATTENTION:** Digital inputs on multiple drives should **not** be tied together when using SNK (Internal Supply) mode. In SNK mode, if power is removed from one drive, inadvertent operation of other drives that share the same I/O Common connection may occur.
Multiple Analog Connections	 When connecting a single potentiometer to multiple drives it is important to connect I/O Terminal 14 common together for all drives. I/O Terminal 14 common and I/O Terminal 13 (potentiometer wiper) should be daisy-chained to each drive. All drives must be powered up for the analog signal to be read correctly.

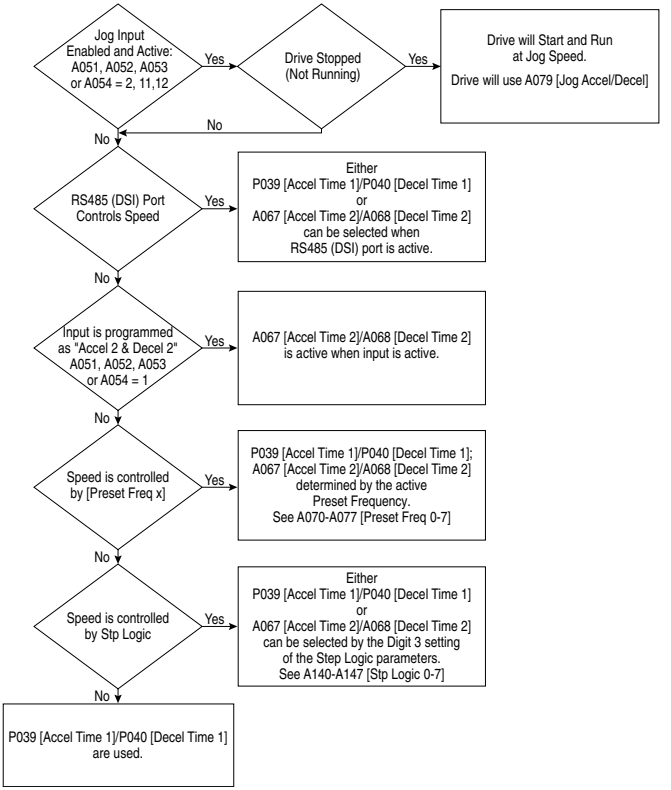
Start and Speed Reference Control

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. See the chart below for the override priority.



Accel/Decel Selection

The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P039 [Accel Time 1] and P040 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, RS485 (DSI) communications and/or parameters. See the chart below for the override priority.



EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User Manual.

CE Declarations of Conformity are available online at: **http://www.ab.com/certification/ce/docs**.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

General Notes

- If the plastic top panel is removed or the optional conduit box is not installed, the drive must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The motor cable should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents.
- Use of line filters in ungrounded systems is not recommended.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Essential Requirements for CE Compliance

Conditions 1-3 listed below **must be** satisfied for PowerFlex drives to meet the requirements of **EN61800-3**.

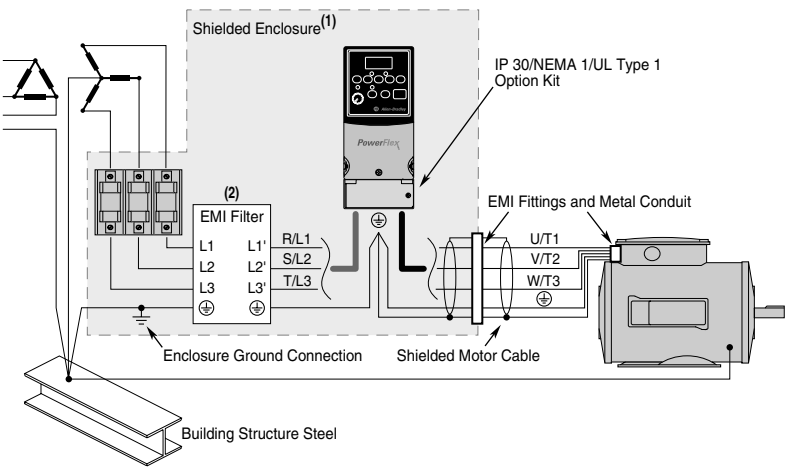
1. Grounding as described in Figure 1.6. Refer to page 1-8 for additional grounding recommendations.
2. Output power, control (I/O) and signal wiring must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.
3. Allowable cable length in Table 1.I is not exceeded.

Table 1.I Allowable Cable Length

Filter Type	EN61800-3 First Environment Restricted Distribution or Second Environment (2)	EN61800-3 First Environment Unrestricted Distribution (3)
Integral	10 meters (33 feet)	1 meter (3 feet)
External - S Type(1)	10 meters (33 feet)	1 meter (3 feet)
External - L Type(1)	100 meters (328 feet)	5 meters (16 feet)

(1) Refer to Appendix B for details on optional external filters.
(2) Equivalent to EN55011 Class A.
(3) Equivalent to EN55011 Class B.

Figure 1.6 Connections and Grounding



(1) First Environment Unrestricted Distribution installations require a shielded enclosure. Keep wire length as short as possible between the enclosure entry point and the EMI filter.
(2) Integral EMI filters are available on 240V, 1-Phase drives.

EN61000-3-2

- 0.75 kW (1 HP) 240V 1-Phase and 3-Phase drives and 0.37 kW (0.5 HP) 240V 1-Phase drives are suitable for installation on a private low voltage power network. Installations on a public low voltage power network may require additional external harmonic mitigation.
- Other drive ratings meet the current harmonic requirements of EN61000-3-2 without additional external mitigation.

Notes:

Start Up

This chapter describes how to start up the PowerFlex 40 Drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

Important: Read the *General Precautions* section before proceeding.

ATTENTION: Power must be applied to the drive to perform the following start-up procedures. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed**. **Remove All Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the drive. Correct the malfunction before continuing.

Prepare For Drive Start-Up

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See Figure 1.5 on page 1-16 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. If the control scheme is changed to Sink (SNK), the jumper must be removed from I/O Terminals 01 and 11 and installed between I/O Terminals 01 and 04.

❑ **5.** Verify that the Stop input is present or the drive will not start.

Important: If I/O Terminal 01 is used as a stop input, the jumper between I/O Terminals 01 and 11 must be removed.

Applying Power to the Drive

❑ **6.** Apply AC power and control voltages to the drive.

❑ **7.** Familiarize yourself with the integral keypad features (see page 2-4) before setting any Program Group parameters.

If a fault appears on power up, refer to Fault Descriptions on page 4-3 for an explanation of the fault code.

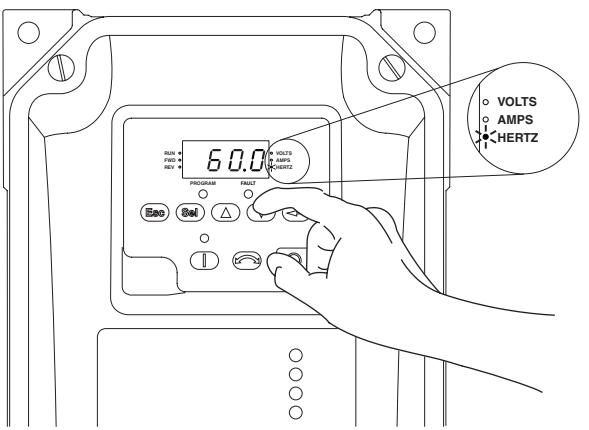
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, change direction and control speed directly from the integral keypad.

Important: To disable reverse operation, see A095 [Reverse Disable].

Changing the Speed Reference of an IP66, NEMA/UL Type 4X rated drive

When a Display Group parameter, for example, d001 [Output Freq] is displayed, and P038 [Speed Ref] is set to A069 [Internal Freq], you can change the internal frequency using the Up Arrow and Down Arrow keys.



When the internal frequency is being adjusted, its value is displayed and the Hertz LED flashes. Any changes are saved immediately. The display then returns to the Display Group parameter previously shown.

TIP: By default, the speed reference of an IP66, NEMA/UL Type 4X rated drive is set to the internal frequency, A069 [Internal Freq].

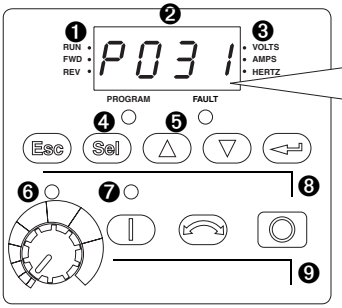
TIP: You can also change the speed reference by editing the parameter A069 [Internal Freq] in program mode. For details on how to enter the program mode, see Viewing and Editing Parameters on page 2-5.

Note: The default value of A069 [Internal Freq] is 0 Hz. For IP20 rated PowerFlex 40 drives, the default value of this parameter is 60 Hz.

Variable Torque Fan/Pump Applications

For improved motor tuning performance when using a premium efficient motor on a variable torque load, set A084 [Boost Select] to option 2 “35.0, VT”.

Integral Keypad



Menu	Description
d	**Display Group (View Only)** Consists of commonly viewed drive operating conditions.
P	**Basic Program Group** Consists of most commonly used programmable functions.
A	**Advanced Program Group** Consists of remaining programmable functions.
F	**Fault Designator** Consists of list of codes for specific fault conditions. Displayed only when fault is present.

No.	LED	LED State	Description
❶	Run/Direction Status	Steady Red	Indicates drive is running and commanded motor direction.
		Flashing Red	Drive has been commanded to change direction. Indicates actual motor direction while decelerating to zero.
❷	Alphanumeric Display	Steady Red	Indicates parameter number, parameter value, or fault code.
		Flashing Red	Single digit flashing indicates that digit can be edited. All digits flashing indicates a fault condition.
❸	Displayed Units	Steady Red	Indicates the units of the parameter value being displayed.
❹	Program Status	Steady Red	Indicates parameter value can be changed.
❺	Fault Status	Flashing Red	Indicates drive is faulted.
❻	Pot Status	Steady Green	Indicates potentiometer on Integral Keypad is active.(1)
❼	Start Key Status	Steady Green	Indicates Start key on Integral Keypad is active. The Reverse key is also active unless disabled by A095 [Reverse Disable].

No.	Key	Name	Description
❽	Esc	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Sel	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	▲ ▼	Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit. Used to adjust internal frequency of IP66, NEMA/UL Type 4X rated drives *only* when a Display Group parameter is shown and P038 [Speed Reference] is set to internal frequency, A069 [Internal Freq].
	↵	Enter	Advance one step in programming menu. Save a change to a parameter value.
❾		Potentiometer(1)	Used to control speed of drive. Default is active. Controlled by parameter P038 [Speed Reference].
		Start	Used to start the drive. Default is active. Controlled by parameter P036 [Start Source].
		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P036 [Start Source] and A095 [Reverse Disable].
		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) IP66, NEMA/UL Type 4X rated drives are not equipped with a potentiometer.

Viewing and Editing Parameters

The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.
The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Program Group parameter.

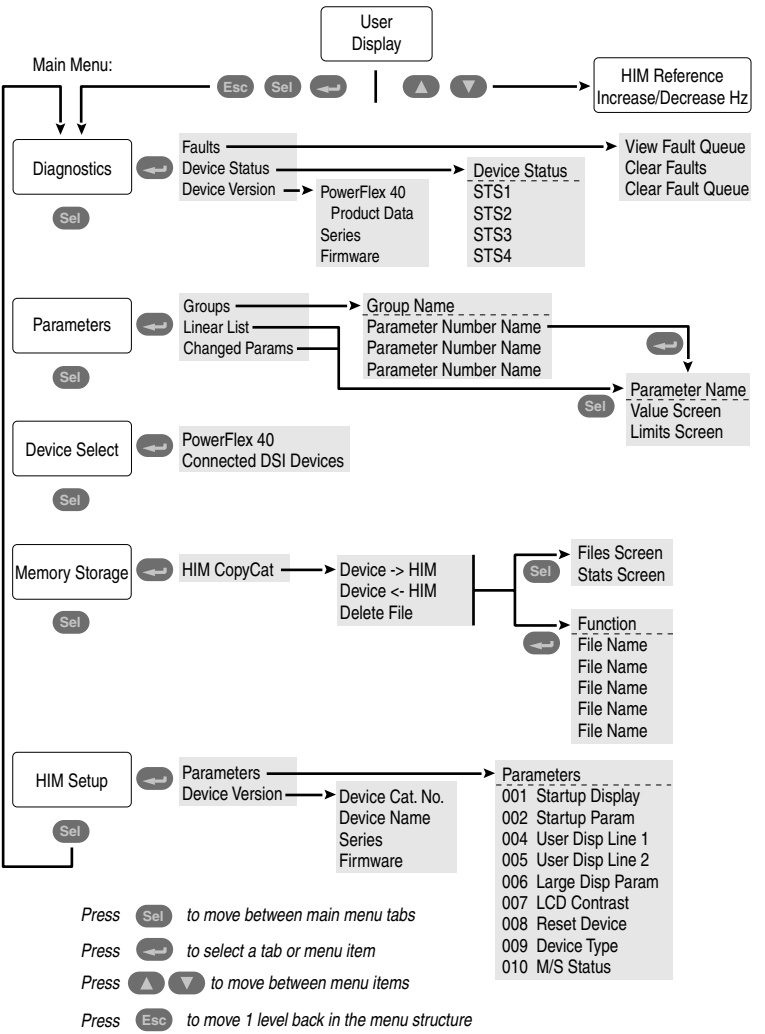
Step	Key(s)	Example Displays
1. When power is applied, the last user-selected Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of d001 [Output Freq] with the drive stopped.)		
2. Press Esc once to display the Display Group parameter number shown on power-up. The parameter number will flash.	Esc	
3. Press Esc again to enter the group menu. The group menu letter will flash.	Esc	
4. Press the Up Arrow or Down Arrow to scroll through the group menu (d, P and A).	▲ or ▼	
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or Sel	
6. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	▲ or ▼	
7. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or Sel	
8. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or Sel	
9. Press the Up Arrow or Down Arrow to change the parameter value. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	▲ or ▼	
10. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off. Or Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	Esc ↵	
11. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu. If pressing Esc does not change the display, then d001 [Output Frequency] is displayed. Press Enter or Sel to enter the group menu.	Esc	

The Basic Program Group (page 3-9) contains the most commonly changed parameters.

Remote HIM Menu Structure

The Menu Structure below can be accessed through the following Human Interface Module options:

HIM Option	Catalog Number
Remote Panel Mount Small, LCD Display	22-HIM-C2S
Remote Handheld, LCD Display	22-HIM-A3



Diagnostics Menu

When a fault trips the drive, use this menu to access detailed data about the drive.

Option	Description
Faults	View fault queue or fault information, clear faults or clear fault queue.
Device Status	View status information about the drive or peripheral.
Device Version	View the firmware version and hardware series of components.

Parameters Menu

Use this menu to access drive parameters. Parameters can be displayed in groups, in a linear list, or only those changed from their defaults.

Device Select Menu

Use this menu to access the drive or peripheral that the drive is to access.

Memory Storage Menu

Drive data can be saved to, or recalled from HIM sets.
HIM sets are files stored in permanent nonvolatile HIM memory.

Option	Description
HIM Copycat Device -> HIM Device <- HIM	Save data to a HIM set or load data from a HIM set to active drive memory. A maximum of 5 HIM set can be stored.
Delete File	Delete a HIM set.

HIM Setup Menu

The HIM and drive have features that you can customize.

Option	Description
Parameters	Access parameters in HIM to set display options.
Device Version	View HIM version, hardware series and firmware version

Notes:

Programming and Parameters

Chapter 3 provides a complete listing and description of the PowerFlex 40 parameters. Parameters are programmed (viewed/edited) using the integral keypad. As an alternative, programming can also be performed using DriveExplorer™ or DriveExecutive™ software, a personal computer and a serial converter module. Refer to Appendix B for catalog numbers.

For information on...	See page...
About Parameters	3-1
Parameter Organization	3-2
Basic Program Group	3-9
Advanced Program Group	3-14
Parameter Cross Reference – by Name	3-45

About Parameters

To configure a drive to operate in a specific way, drive parameters may have to be set. Three types of parameters exist:

- **ENUM**
  ENUM parameters allow a selection from 2 or more items. Each item is represented by a number.
- **Numeric Parameters**
  These parameters have a single numerical value (i.e. 0.1 Volts).
- **Bit Parameters**
  Bit parameters have four individual bits associated with features or conditions. If the bit is 0, the feature is off or the condition is false. If the bit is 1, the feature is on or the condition is true.

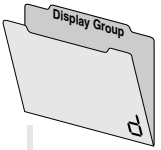
Some parameters are marked as follows.

= Stop drive before changing this parameter.

= 32 bit parameter. Parameters marked 32 bit will have two parameter numbers when using RS485 communications and programming software.

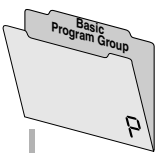
Parameter Organization

Refer to page 3-45 for an alphabetical listing of parameters.



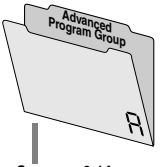
See page 3-3

Output Freq	d001
Commanded Freq	d002
Output Current	d003
Output Voltage	d004
DC Bus Voltage	d005
Drive Status	d006
Fault 1 Code	d007
Fault 2 Code	d008
Fault 3 Code	d009
Process Display	d010
Control Source	d012
Contrl In Status	d013
Dig In Status	d014
Comm Status	d015
Control SW Ver	d016
Drive Type	d017
Elapsed Run Time	d018
Testpoint Data	d019
Analog In 0-10V	d020
Analog In 4-20mA	d021
Output Power	d022
Output Power Fctr	d023
Drive Temp	d024
Counter Status	d025
Timer Status	d026
Stp Logic Status	d028
Torque Current	d029



See page 3-9

Motor NP Volts	P031
Motor NP Hertz	P032
Motor OL Current	P033
Minimum Freq	P034
Maximum Freq	P035
Start Source	P036
Stop Mode	P037
Speed Reference	P038
Accel Time 1	P039
Decel Time 1	P040
Reset To Defalts	P041
Voltage Class	P042
Motor OL Ret	P043



See page 3-14

Digital In1 Sel	A051
Digital In2 Sel	A052
Digital In3 Sel	A053
Digital In4 Sel	A054
Relay Out Sel	A055
Relay Out Level	A056
Opto Out1 Sel	A058
Opto Out1 Level	A059
Opto Out2 Sel	A061
Opto Out2 Level	A062
Opto Out Logic	A064
Analog Out Sel	A065
Analog Out High	A066
Accel Time 2	A067
Decel Time 2	A068
Internal Freq	A069
Preset Freq 0	A070
Preset Freq 1	A071
Preset Freq 2	A072
Preset Freq 3	A073
Preset Freq 4	A074
Preset Freq 5	A075
Preset Freq 6	A076
Preset Freq 7	A077
Jog Frequency	A078
Jog Accel/Decel	A079
DC Brake Time	A080
DC Brake Level	A081
DB Resistor Sel	A082
S Curve %	A083
Boost Select	A084
Start Boost	A085
Break Voltage	A086
Break Frequency	A087
Maximum Voltage	A088
Current Limit 1	A089
Motor OL Select	A090
PWM Frequency	A091
Auto Rstrt Tries	A092
Auto Rstrt Delay	A093
Start At PowerUp	A094
Reverse Disable	A095
Flying Start En	A096
Compensation	A097
SW Current Trip	A098
Process Factor	A099
Fault Clear	A100
Program Lock	A101
Testpoint Sel	A102
Comm Data Rate	A103
Comm Node Addr	A104
Comm Loss Action	A105

See page 3-14

Comm Loss Time	A106
Comm Format	A107
Language	A108
Anlg Out Setpt	A109
Anlg In 0-10V Lo	A110
Anlg In 0-10V Hi	A111
Anlg In4-20mA Lo	A112
Anlg In4-20mA Hi	A113
Slip Hertz @ FLA	A114
Process Time Lo	A115
Process Time Hi	A116
Bus Reg Mode	A117
Current Limit 2	A118
Skip Frequency	A119
Skip Freq Band	A120
Stall Fault Time	A121
Analog In Loss	A122
10V Bipolar Enbl	A123
Var PWM Disable	A124
Torque Perf Mode	A125
Motor NP FLA	A126
Autotune	A127
IR Voltage Drop	A128
Flux Current Ref	A129
PID Trim Hi	A130
PID Trim Lo	A131
PID Ref Sel	A132
PID Feedback Sel	A133
PID Prop Gain	A134
PID Integ Time	A135
PID Diff Rate	A136
PID Setpoint	A137
PID Deadband	A138
PID Preload	A139
Stp Logic 0	A140
Stp Logic 1	A141
Stp Logic 2	A142
Stp Logic 3	A143
Stp Logic 4	A144
Stp Logic 5	A145
Stp Logic 6	A146
Stp Logic 7	A147
Stp Logic Time 0	A150
Stp Logic Time 1	A151
Stp Logic Time 2	A152
Stp Logic Time 3	A153
Stp Logic Time 4	A154
Stp Logic Time 5	A155
Stp Logic Time 6	A156
Stp Logic Time 7	A157
EM Brk Off Delay	A160
EM Brk On Delay	A161
MOP Reset Sel	A162
DB Threshold	A163
Comm Write Mode	A164
Anlg Loss Delay	A165
Analog In Filter	A166
PID Invert Error	A167

Display Group

d001 [Output Freq]

Related Parameter(s): d002, d010, P034, P035, P038

Output frequency present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d002 [Commanded Freq]

Related Parameter(s): d001, d013, P034, P035, P038

Value of the active frequency command. Displays the commanded frequency even if the drive is not running.

Important: The frequency command can come from a number of sources. Refer to Start and Speed Reference Control on page 1-23 for details.

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d003 [Output Current]

The output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

d004 [Output Voltage]

Related Parameter(s): P031, A084, A088

Output voltage present at terminals T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0/Drive Rated Volts
	Display:	1 VAC

d005 [DC Bus Voltage]

Present DC bus voltage level.

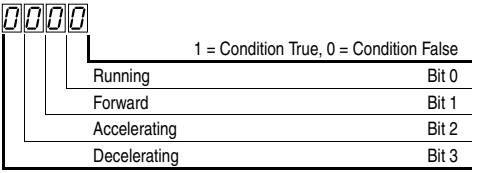
Values	Default:	Read Only
	Min/Max:	Based on Drive Rating
	Display:	1 VDC

Display Group *(continued)*

d006 [Drive Status]

Related Parameter(s): A095

Present operating condition of the drive.



Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d007 [Fault 1 Code]
d008 [Fault 2 Code]
d009 [Fault 3 Code]

A code that represents a drive fault. The codes will appear in these parameters in the order they occur (d007 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once.

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	F2/F122
	Display:	F1

d010 [Process Display]

Related Parameter(s): d001, A099

32 bit parameter.

The output frequency scaled by A099 [Process Factor].

Output Freq x Process Factor = Process Display

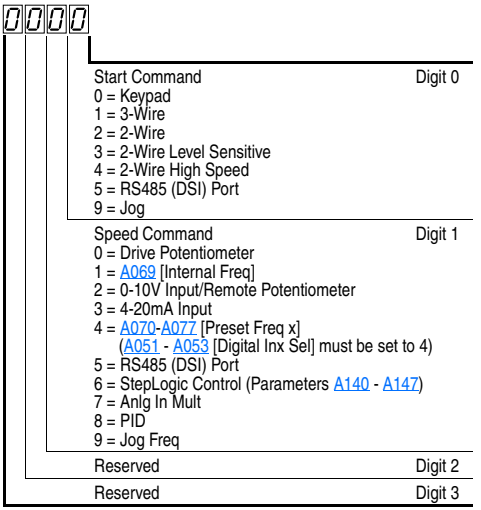
Values	Default:	Read Only
	Min/Max:	0.00/9999
	Display:	0.01 – 1

Display Group *(continued)*

d012 [Control Source]

Related Parameter(s): P036, P038, A051-A054

Displays the active source of the Start Command and Speed Command which are normally defined by the settings of P036 [Start Source] and P038 [Speed Reference] but may be overridden by digital inputs. Refer to the flowcharts on pages 1-23 and 1-24 for details.



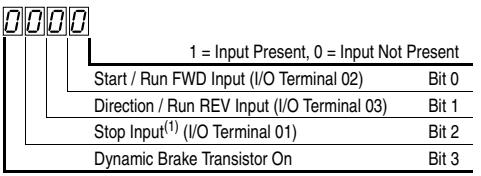
Values	Default:	Read Only
	Min/Max:	0/9
	Display:	1

d013 [Contrl In Status]

Related Parameter(s): d002, P034, P035

Status of the control terminal block control inputs.

Important: Actual control commands may come from a source other than the control terminal block.



(1) The stop input must be present in order to start the drive.
When this bit is a 1 the drive can be started.
When this bit is a 0 the drive will stop.

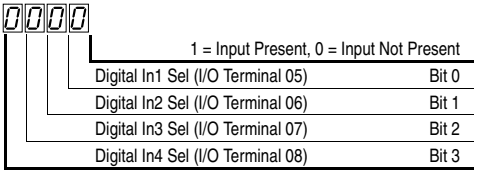
Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

Display Group *(continued)*

d014 [Dig In Status]

Related Parameter(s): A051-A054

Status of the control terminal block digital inputs.

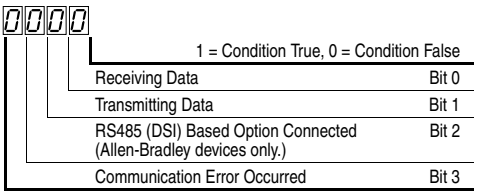


Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d015 [Comm Status]

Related Parameter(s): A103-A107

Status of the communications ports.



Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d016 [Control SW Ver]

Main Control Board software version.

Values	Default:	Read Only
	Min/Max:	1.00/99.99
	Display:	0.01

d017 [Drive Type]

Used by Rockwell Automation field service personnel.

Values	Default:	Read Only
	Min/Max:	1001/9999
	Display:	1

Display Group *(continued)*

d018 [Elapsed Run Time]

Accumulated time drive is outputting power. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/9999 Hrs
	Display:	1 = 10 Hrs

d019 [Testpoint Data]

Related Parameter(s): A102

The present value of the function selected in A102 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1 Hex

d020 [Analog In 0-10V]

Related Parameter(s): A110, A111

The present value of the voltage at I/O Terminal 13 (100.0% = 10 volts).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d021 [Analog In 4-20mA]

Related Parameter(s): A112, A113

The present value of the current at I/O Terminal 15 (0.0% = 4mA, 100.0% = 20mA).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d022 [Output Power]

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power × 2)
	Display:	0.01 kW

d023 [Output Powr Fctr]

The angle in electrical degrees between motor voltage and motor current.

Values	Default:	Read Only
	Min/Max:	0.0/180.0 deg
	Display:	0.1 deg

Display Group *(continued)*

d024 [Drive Temp]

Present operating temperature of the drive power section.

Values	Default:	Read Only
	Min/Max:	0/120 degC
	Display:	1 degC

d025 [Counter Status]

The current value of the counter when counter is enabled.

Values	Default:	Read only
	Min/Max:	0/9999
	Display:	1

d026 [Timer Status]

32 32 bit parameter.

The current value of the timer when timer is enabled.

Values	Default:	Read Only
	Min/Max:	0.0/9999 Secs
	Display:	0.1 Secs

d028 [Stp Logic Status]

When P038 [Speed Reference] is set to 6 “Stp Logic”, this parameter will display the current step of the StepLogic profile as defined by parameters A140-A147 [Stp Logic x].

Values	Default:	Read Only
	Min/Max:	0/7
	Display:	1

d029 [Torque Current]

The current value of the motor torque current.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

Basic Program Group

P031 [Motor NP Volts]

Related Parameter(s): d004, A084, A085, A086, A087

Stop drive before changing this parameter.

Set to the motor nameplate rated volts.

Values	Default:	Based on Drive Rating
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

P032 [Motor NP Hertz]

Related Parameter(s): A084, A085, A086, A087, A090

Stop drive before changing this parameter.

Set to the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/400 Hz
	Display:	1 Hz

P033 [Motor OL Current]

Related Parameter(s): A055, A058, A061, A089, A090, A098, A114, A118

Set to the maximum allowable motor current.

The drive will fault on an F7 Motor Overload if the value of this parameter is exceeded by 150% for 60 seconds.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

P034 [Minimum Freq]

Related Parameter(s): d001, d002, d013, P035, A085, A086, A087, A110, A112

Sets the lowest frequency the drive will output continuously.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

P035 [Maximum Freq]

Related Parameter(s): d001, d002, d013, P034, A065, A078, A085, A086, A087, A111, A113

Stop drive before changing this parameter.

Sets the highest frequency the drive will output.

Values	Default:	60 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

Basic Program Group *(continued)*

P036 [Start Source]

Related Parameter(s): d012, P037

Stop drive before changing this parameter.

Sets the control scheme used to start the drive.

Refer to Start and Speed Reference Control on page 1-23 for details about how other drive settings can override the setting of this parameter.

Important: For all settings except option 3, the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power or fault condition.

Options	**0**	"Keypad" (Default)	• Integral keypad controls drive operation. • I/O Terminal 1 "Stop" = coast to stop. • When active, the Reverse key is also active unless disabled by A095 [Reverse Disable].
	1	"3-Wire"	I/O Terminal 1 "Stop" = stop according to the value set in P037 [Stop Mode].
	2	"2-Wire"	I/O Terminal 1 "Stop" = coast to stop.
	3	"2-W Lvl Sens"	Drive will restart after a "Stop" command when: • Stop is removed and • Start is held active

ATTENTION: Hazard of injury exists due to unintended operation. When P036 [Start Source] is set to option 3, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).

	4	"2-W Hi Speed"	**Important:** There is greater potential voltage on the output terminals when using this option. • Outputs are kept in a ready-to-run state. The drive will respond to a "Start" command within 10 ms. • I/O Terminal 1 "Stop" = coast to stop.
	5	"Comm Port"	• Remote communications. Refer to Appendix C for details. • I/O Terminal 1 "Stop" = coast to stop.
	6	"Momt FWD/REV"	• Drive will start after a momentary input from either the Run FWD Input (I/O Terminal 02) or the Run REV Input (I/O Terminal 03). • I/O Terminal 1 "Stop" = coast to stop.

Basic Program Group *(continued)*

P037 [Stop Mode]

Related Parameter(s): P036, A080, A081, A082, A105, A160

Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below.

Important: I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].

Hardware Enable Circuitry

By default, I/O Terminal 01 is a coast to stop input. The status of the input is interpreted by drive software. If the application requires the drive to be disabled without software interpretation, a "dedicated" hardware enable configuration can be utilized. This is accomplished by removing the ENBL enable jumper on the control board. In this case, the drive will always coast to a stop regardless of the settings of P036 [Start Source] and P037 [Stop Mode].

Options	**0**	"Ramp, CF"(1) (Default)	Ramp to Stop. "Stop" command clears active fault.
	1	"Coast, CF"(1)	Coast to Stop. "Stop" command clears active fault.
	2	"DC Brake, CF"(1)	DC Injection Braking Stop. "Stop" command clears active fault.
	3	"DCBrkAuto,CF"(1)	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A080 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped. "Stop" command clears active fault.
	4	"Ramp"	Ramp to Stop.
	5	"Coast"	Coast to Stop.
	6	"DC Brake"	DC Injection Braking Stop.
	7	"DC BrakeAuto"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A080 [DC Brake Time]. OR • Drive shuts off if current limit is exceeded.
	8	"Ramp+EM B,CF"	Ramp to Stop with EM Brake Control. "Stop" Command clears active fault.
	9	"Ramp+EM Brk"	Ramp to Stop with EM Brake Control.

(1) Stop input also clears active fault.

Basic Program Group *(continued)*

P038 [Speed Reference] Related Parameter(s): d001, d002, d012, d020, d021, P039, P040, A051-A054, A069, A070-A077, A110-A113, A123, A132, A140-A147, A150-A157

Sets the source of the speed reference to the drive.

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 [PID Ref Sel] is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

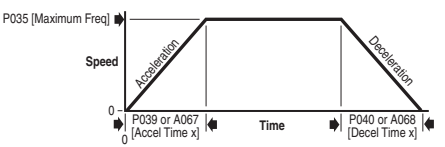
Options	**0**	"Drive Pot" (Default)	Frequency command from the potentiometer on the integral keypad. **Important:** This option is not available with IP66, NEMA/UL Type 4X rated drives. Internal frequency command comes from A069 [Internal Freq].
	1	"InternalFreq" (IP66, NEMA/UL Type 4X Default)	Internal frequency command from A069 [Internal Freq]. Must be set when using MOP function.
	2	"0-10V Input"	External frequency command from the 0-10V or ±10V analog input or remote potentiometer.
	3	"4-20mA Input"	External frequency command from the 4-20mA analog input.
	4	"Preset Freq"	External frequency command as defined by A070 - A077 [Preset Freq x] when A051 - A054 [Digital Inx Sel] are programmed as "Preset Frequencies" and the digital inputs are active.
	5	"Comm Port"	External frequency command from the communications port. Refer to Appendix C for details.
	6	"Stp Logic"	External frequency command as defined by A070 - A077 [Preset Freq x] and A140 - A147 [Stp Logic x].
	7	"Anlg In Mult"	External frequency command as defined by the product of the analog inputs (shown in d020 [Analog In 0-10V] and d021 [Analog In 4-20mA]). [Analog In 0-10V] × [Analog In 4-20mA] = Speed Command Example: 100% × 50% = 50%

P039 [Accel Time 1] Related Parameter(s): P038, P040, A051-A054, A067, A070-A077, A140-A147

Sets the rate of acceleration for all speed increases.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



Basic Program Group *(continued)*

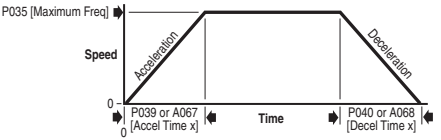
P040 [Decel Time 1]

Related Parameter(s): P038, P039, A051-A054, A068, A070-A077, A140-A147

Sets the rate of deceleration for all speed decreases.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



P041 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameter values to factory defaults.

Options	**0**	"Ready/Idle" (Default)	
	1	"Factory Rset"	• After the reset function is complete, this parameter will set itself back to "0". • Causes an F48 Params Defaulted fault.

P042 [Voltage Class]

Stop drive before changing this parameter.

Sets the voltage class of 600V drives.

Options	**2**	"Low Voltage"	480V
	3	"High Voltage" (Default)	600V

P043 [Motor OL Ret]

Related Parameter(s): P033

Enables/disables the Motor Overload Retention function. When Enabled, the value held in the motor overload counter is saved at power-down and restored at power-up. A change to this parameter setting resets the counter.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group

A051 [Digital In1 Sel]
(I/O Terminal 05)
A052 [Digital In2 Sel]
(I/O Terminal 06)
A053 [Digital In3 Sel]
(I/O Terminal 07)
A054 [Digital In4 Sel]
(I/O Terminal 08)

Related Parameter(s): d012, d014, P038, P039, P040, A067, A068, A070-A077, A078, A079, A118, A140-A147

Stop drive before changing this parameter.

Selects the function for the digital inputs. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

Options	**0**	"Not Used"	Terminal has no function but can be read over network communications via d014 [Dig In Status].
	1	"Acc & Dec 2"	• When active, A067 [Accel Time 2] and A068 [Decel Time 2] are used for all ramp rates except Jog. • Can only be tied to one input. Refer to the flowchart on page 1-24 for more information on Accel/Decel selection.
	2	"Jog"	• When input is present, drive accelerates according to the value set in A079 [Jog Accel/Decel] and ramps to the value set in A078 [Jog Frequency]. • When input is removed, drive ramps to a stop according to the value set in A079 [Jog Accel/Decel]. • A valid "Start" command will override this input.
	3	"Aux Fault"	When enabled, an F2 Auxiliary Input fault will occur when the input is removed.
	4	"Preset Freq" (A051 & A052 Default)	Refer to A070 - A077 [Preset Freq x]. **Important:** Digital Inputs have priority for frequency control when programmed as Preset Speed and are active. Refer to the flowchart on page 1-23 for more information on speed reference control priority.
	5	"Local" (A053 Default)	When active, sets integral keypad as start source and potentiometer on the integral keypad as speed source. **Important:** Speed source for IP66, NEMA/UL Type 4X rated drives comes from A069 [Internal Freq].
	6	"Comm Port"	• When active, sets communications device as default start/speed command source. • Can only be tied to one input.
	7	"Clear Fault"	When active, clears an active fault.
	8	"RampStop,CF"	Causes drive to immediately ramp to a stop regardless of how P037 [Stop Mode] is set.
	9	"CoastStop,CF"	Causes drive to immediately coast to a stop regardless of how P037 [Stop Mode] is set.
	10	"DCInjStop,CF"	Causes drive to immediately begin a DC Injection stop regardless of how P037 [Stop Mode] is set.
	11	"Jog Forward" (A054 Default)	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.
	12	"Jog Reverse"	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.

A051 - A054 Options (Cont.)	**13** "10V In Ctrl"	Selects 0-10V or ±10V control as the frequency reference. Start source is not changed.
	14 "20mA In Ctrl"	Selects 4-20mA control as the frequency reference. Start source is not changed.
	15 "PID Disable"	Disables PID function. Drive uses the next valid non-PID speed reference.
	16 "MOP Up"	Increases the value of A069 [Internal Freq] at the current Accel rate if P038 [Speed Reference] is set to 1 "InternalFreq". For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	17 "MOP Down"	Decreases the value of A069 [Internal Freq] at the current Decel rate if P038 [Speed Reference] is set to 1 "InternalFreq". For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	18 "Timer Start"	Clears and starts the timer function. May be used to control the relay or opto outputs.
	19 "Counter In"	Starts the counter function. May be used to control the relay or opto outputs.
	20 "Reset Timer"	Clears the active timer.
	21 "Reset Countr"	Clears the active counter.
	22 "Rset Tim&Cnt"	Clears the active timer and counter.
	23 "Logic In1"	Logic function input number 1. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	24 "Logic In2"	Logic function input number 2. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	25 "Current Lmt2"	When active, A118 [Current Limit 2] determines the drive current limit level.
	26 "Anlg Invert"	Inverts the scaling of the analog input levels set in A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] or A112 [Anlg In4-20mA Lo] and A113 [Anlg In4-20mA Hi].
	27 "EM Brk Rlse"	If EM brake function is enabled, this input releases the brake.

ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

Advanced Program Group *(continued)*

A055 [Relay Out Sel]

Related Parameter(s): P033, A056, A092, A140-A147, A150-A157, A160, A161

Sets the condition that changes the state of the output relay contacts.

Options			
	0	"Ready/Fault" (Default)	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A056 [Relay Out Level]. • Use A056 to set threshold. **Important:** Value for A056 [Relay Out Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A056 [Relay Out Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A056 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	18	"Above PF Ang"	• Power Factor angle has exceeded the value set in A056 [Relay Out Level]. • Use A056 to set threshold.

A055 Options (Cont.)	**19** "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.) With FRN 4.01 and later, the logic command word bit 15 has full control of A056. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A056 [Relay Out Level].
	24 "MsgControl"	With FRN 4.01 and later, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.)

A056 [Relay Out Level]

Related Parameter(s): A055

32 bit parameter.

Sets the trip point for the digital output relay if the value of A055 [Relay Out Sel] is 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A055 is set to 20, the logic command word bit 15 has full control of A056.

A055 Setting	A056 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A058 [Opto Out1 Sel]
A061 [Opto Out2 Sel]

Related Parameter(s): P033, A059, A062, A092, A122, A123, A160, A161, A140-A147, A150-A157

Determines the operation of the programmable opto outputs.

Options	**0**	"Ready/Fault"	Opto outputs are active when power is applied. This indicates that the drive is ready for operation. Opto outputs are inactive when power is removed or a fault occurs.
	1	"At Frequency" (A061 Default)	Drive reaches commanded frequency.
	2	"MotorRunning" (A058 Default)	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold. **Important:** Value for A059 or A062 [Opto Outx Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A059 or A062 [Opto Outx Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A059 or A062 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.

A058, A061 Options (Cont.)	**18** "Above PF Ang"	• Power Factor angle has exceeded the value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	19 "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.) With FRN 4.01 and later: Setting this option for A058 means the logic command word bit 6 has full control of A059. Setting this option for A059 means the logic command word bit 7 has full control of A062. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A059 or A062 [Opto Outx Level].
	24 "MsgControl"	With FRN 4.01 and later: Enables the output to be controlled over the network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.)

A059 [Opto Out1 Level]
A062 [Opto Out2 Level]

Related Parameter(s): A058, A061

32 32 bit parameter.

Determines the on/off point for the opto outputs when A058 or A061 [Opto Outx Sel] is set to option 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A058 is set to 20, the logic command word bit 6 has full control of A059 and when the value of A061 is set to 20, bit 7 has full control of A062.

A058 & A061 Setting	A059 & A062 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A064 [Opto Out Logic]

Determines the logic (Normally Open/NO or Normally Closed/NC) of the opto outputs.

A064 Option	Opto Out1 Logic	Opto Out2 Logic
0	NO (Normally Open)	NO (Normally Open)
1	NC (Normally Closed)	NO (Normally Open)
2	NO (Normally Open)	NC (Normally Closed)
3	NC (Normally Closed)	NC (Normally Closed)

Values	Default:	0
	Min/Max:	0/3
	Display:	1

A065 [Analog Out Sel]

Related Parameter(s): P035, A066

Sets the analog output signal mode (0-10V, 0-20mA, or 4-20mA). The output is used to provide a signal that is proportional to several drive conditions.

Option	Output Range	Minimum Output Value	Maximum Output Value A066 [Analog Out High]	DIP Switch Position	Related Parameter
0 “OutFreq 0-10”	0-10V	0V = 0 Hz	P035 [Maximum Freq]	0-10V	d001
1 “OutCurr 0-10”	0-10V	0V = 0 Amps	200% Drive Rated Output Current	0-10V	d003
2 “OutVolt 0-10”	0-10V	0V = 0 Volts	120% Drive Rated Output Volts	0-10V	d004
3 “OutPowr 0-10”	0-10V	0V = 0 kW	200% Drive Rated Power	0-10V	d022
4 “TstData 0-10”	0-10V	0V = 0000	65535 (Hex FFFF)	0-10V	d019
5 “OutFreq 0-20”	0-20mA	0 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
6 “OutCurr 0-20”	0-20mA	0 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
7 “OutVolt 0-20”	0-20mA	0 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
8 “OutPowr 0-20”	0-20mA	0 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
9 “TstData 0-20”	0-20mA	0 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
10 “OutFreq 4-20”	4-20mA	4 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
11 “OutCurr 4-20”	4-20mA	4 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
12 “OutVolt 4-20”	4-20mA	4 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
13 “OutPowr 4-20”	4-20mA	4 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
14 “TstData 4-20”	4-20mA	4 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
15 “OutTorq 0-10”	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V	d029
16 “OutTorq 0-20”	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
17 “OutTorq 4-20”	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
18 “Setpnt 0-10”	0-10V	0V = 0%	100.0% Setpoint Setting	0-10V	A109
19 “Setpnt 0-20”	0-20 mA	0 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
20 “Setpnt 4-20”	4-20 mA	4 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
21 “MinFreq 0-10”	0-10V	0V = Min. Freq	P035 [Maximum Freq]	0-10V	d001
22 “MinFreq 0-20”	0-20 mA	0 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001
23 “MinFreq 4-20”	4-20 mA	4 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001

Values	Default:	0
	Min/Max:	0/23
	Display:	1

Advanced Program Group *(continued)*

A066 [Analog Out High]

Related Parameter(s): A065

Scales the Maximum Output Value for the A065 [Analog Out Sel] source setting.

Examples:

A066 Setting	A065 Setting	A065 Max. Output Value
50%	1 “OutCurr 0-10”	5V for 200% Drive Rated Output Current
90%	8 “OutPowr 0-20”	18mA for 200% Drive Rated Power

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

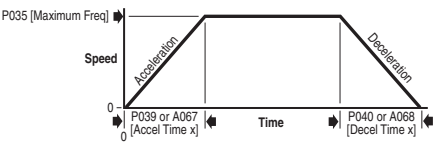
A067 [Accel Time 2]

Related Parameter(s): P039, A051-A054, A070-A077, A140-A147

When active, sets the rate of acceleration for all speed increases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	20.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



Advanced Program Group *(continued)*

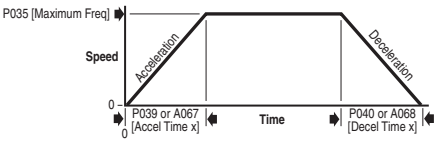
A068 [Decel Time 2]

Related Parameter(s): P040, A051-A054, A070-A077, A140-A147

When active, sets the rate of deceleration for all speed decreases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	20.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



A069 [Internal Freq]

Related Parameter(s): P038, A162

Provides the frequency command to the drive when P038 [Speed Reference] is set to 1 “Internal Freq”. When enabled, this parameter will change the frequency command in “real time” using the integral keypad Up Arrow or Down Arrow when in program mode.

Important: Once the desired command frequency is reached, the Enter key must be pressed to store this value to EEPROM memory. If the ESC key is used before the Enter key, the frequency will return to the original value following the normal accel/decel curve.

If A051 - A054 [Digital Inx Sel] is set to 16 “MOP Up” or 17 “MOP Down” this parameter acts as the MOP frequency reference.

Values	Default:	60.0 Hz for IP20 rated drives 0.0 Hz for IP66, NEMA/UL Type 4X drives
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A070 [Preset Freq 0](1)
A071 [Preset Freq 1]
A072 [Preset Freq 2]
A073 [Preset Freq 3]
A074 [Preset Freq 4]
A075 [Preset Freq 5]
A076 [Preset Freq 6]
A077 [Preset Freq 7]

Related Parameter(s): P038, P039, P040, A051-A053, A067, A068, A140-A147, A150-A157

Values	A070 Default:(1)	0.0 Hz
	A071 Default:	5.0 Hz
	A072 Default:	10.0 Hz
	A073 Default:	20.0 Hz
	A074 Default:	30.0 Hz
	A075 Default:	40.0 Hz
	A076 Default:	50.0 Hz
	A077 Default:	60.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Provides a fixed frequency command value when A051 - A053 [Digital Inx Sel] is set to 4 “Preset Frequencies”.

An active preset input will override speed command as shown in the flowchart on page 1-23.

(1) To activate A070 [Preset Freq 0] set P038 [Speed Reference] to option 4 “Preset Freq 0-3”.

Input State of Digital In 1 (I/O Terminal 05 when A051 = 4)	Input State of Digital In 2 (I/O Terminal 06 when A052 = 4)	Input State of Digital In 3 (I/O Terminal 07 when A053 = 4)	Frequency Source	Accel / Decel Parameter Used(2)
0	0	0	A070 [Preset Freq 0]	[Accel Time 1] / [Decel Time 1]
1	0	0	A071 [Preset Freq 1]	[Accel Time 1] / [Decel Time 1]
0	1	0	A072 [Preset Freq 2]	[Accel Time 2] / [Decel Time 2]
1	1	0	A073 [Preset Freq 3]	[Accel Time 2] / [Decel Time 2]
0	0	1	A074 [Preset Freq 4]	[Accel Time 1] / [Decel Time 1]
1	0	1	A075 [Preset Freq 5]	[Accel Time 1] / [Decel Time 1]
0	1	1	A076 [Preset Freq 6]	[Accel Time 2] / [Decel Time 2]
1	1	1	A077 [Preset Freq 7]	[Accel Time 2] / [Decel Time 2]

(2) When a Digital Input is set to “Accel 2 & Decel 2”, and the input is active, that input overrides the settings in this table.

A078 [Jog Frequency]

Related Parameter(s): P035, A051-A054, A079

Sets the output frequency when a jog command is issued.

Values	Default:	10.0 Hz
	Min/Max:	0.0/[Maximum Freq]
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A079 [Jog Accel/Decel]

Related Parameter(s): A078, A051-A054

Sets the acceleration and deceleration time when a jog command is issued.

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs

A080 [DC Brake Time]

Related Parameter(s): P037, A081

Sets the length of time that DC brake current is "injected" into the motor. Refer to parameter A081 [DC Brake Level].

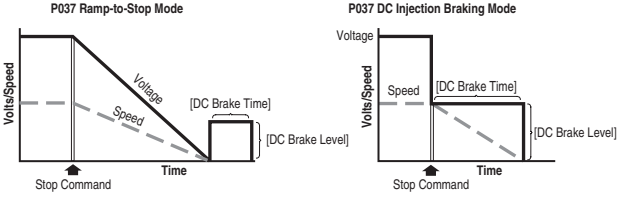
Values	Default:	0.0 Secs
	Min/Max:	0.0/99.9 Secs (A setting of 99.9 = Continuous)
	Display:	0.1 Secs

A081 [DC Brake Level]

Related Parameter(s): P037, A080

Defines the maximum DC brake current, in amps, applied to the motor when P037 [Stop Mode] is set to either "Ramp" or "DC Brake".

Values	Default:	Drive Rated Amps × 0.05
	Min/Max:	0.0/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps



ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

ATTENTION: This feature should not be used with synchronous or permanent magnet motors. Motors may be demagnetized during braking.

Advanced Program Group *(continued)*

A082 [DB Resistor Sel]

Related Parameter(s): P037

Stop drive before changing this parameter.

Enables/disables external dynamic braking.

Setting	Min/Max
0	"Disabled"
1	"Normal RA Res" (5% Duty Cycle) – Refer to Table B.C on page B-2.
2	"NoProtection" (100% Duty Cycle)
3-99	"x%Duty Cycle" Limited (3% – 99% of Duty Cycle)

The drive is able to provide full braking indefinitely. Braking power is limited by the external DB resistor. When this parameter is set to 1 "Normal RA Res" and an appropriate resistor is used (see selection Table B.C), the drive provides calculated resistor overload protection. However, the drive cannot protect against a brake IGBT failure.

ATTENTION: A risk of fire exists if external braking resistors are not protected. The external resistor package must be self-protected from over temperature or the protective circuit shown in Figure B.9 on page B-13, or equivalent, must be supplied.

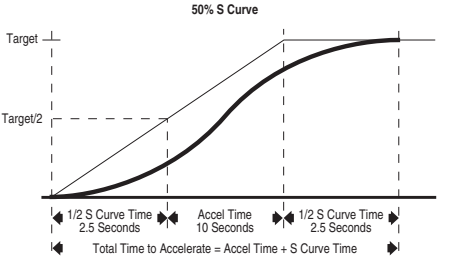
Values	Default:	0
	Min/Max:	0/99
	Display:	1

A083 [S Curve %]

Sets the percentage of acceleration or deceleration time that is applied to the ramp as S Curve. Time is added, 1/2 at the beginning and 1/2 at the end of the ramp.

Values	Default:	0% (Disabled)
	Min/Max:	0/100%
	Display:	1%

Example:
Accel Time = 10 Seconds
S Curve Setting = 50%
S Curve Time = 10 × 0.5 = 5 Seconds
Total Time = 10 + 5 = 15 Seconds



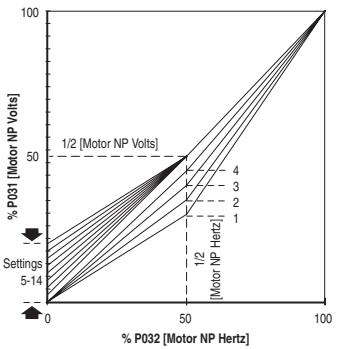
Advanced Program Group *(continued)*

A084 [Boost Select]

Related Parameter(s): d004, P031, P032, A085, A086, A087, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve.
Active when A125 [Torque Perf Mode] = 0 "V/Hz".
Drive may add additional voltage unless Option 5 is selected.

Options	**0**	"Custom V/Hz"	
	1	"30.0, VT"	Variable Torque (Typical fan/pump curves.)
	2	"35.0, VT"	
	3	"40.0, VT"	
	4	"45.0, VT"	
	5	"0.0 no IR"	Constant Torque
	6	"0.0"	
	7	"2.5, CT" [Default for 4.0, 5.5, 7.5 & 11 kW (5.0, 7.5, 10 & 15 HP) Drives]	
	8	"5.0, CT" (Default)	
	9	"7.5, CT"	
	10	"10.0, CT"	
	11	"12.5, CT"	
	12	"15.0, CT"	
	13	"17.5, CT"	
	14	"20.0, CT"	



Advanced Program Group *(continued)*

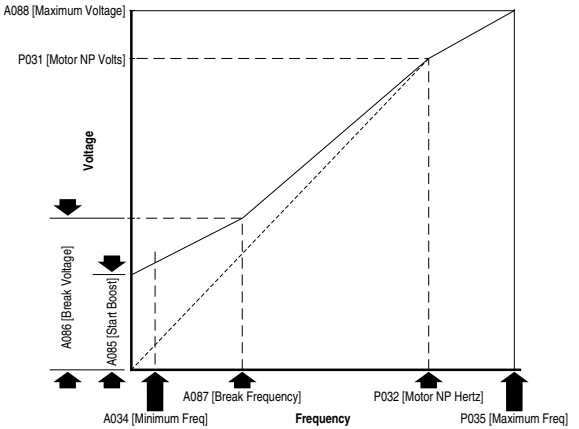
A085 [Start Boost]

Related Parameter(s): P031, P032, P034, P035, A084, A086, A087, A088, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”.

Drive may add additional voltage unless Option 5 is selected.

Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	0.1%



A086 [Break Voltage]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A087, A088, A125

Sets the frequency where break voltage is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A087 [Break Frequency]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A086, A088, A125

Sets the frequency where break frequency is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	15.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A088 [Maximum Voltage]

Related Parameter(s): d004, A085, A086, A087

Sets the highest voltage the drive will output.

Values	Default:	Drive Rated Volts
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

A089 [Current Limit 1]

Related Parameter(s): P033, A118

Maximum output current allowed before current limiting occurs.

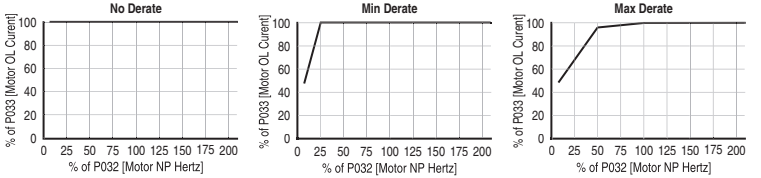
Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/Drive Rated Amps × 1.8
	Display:	0.1 Amps

A090 [Motor OL Select]

Related Parameter(s): P032, P033

Drive provides Class 10 motor overload protection. Settings 0-2 select the derating factor for the I^2t overload function.

Options	**0**	"No Derate" (Default)
	1	"Min Derate"
	2	"Max Derate"



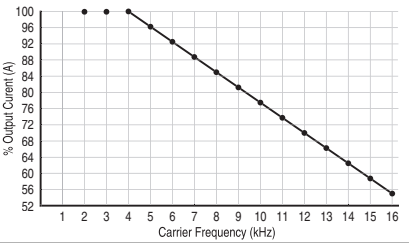
A091 [PWM Frequency]

Related Parameter(s): A124

Sets the carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting.

Important: Ignoring derating guidelines can cause reduced drive performance.

Values	Default:	4.0 kHz
	Min/Max:	2.0/16.0 kHz
	Display:	0.1 kHz



Advanced Program Group *(continued)*

A092 [Auto Rstrt Tries]

Related Parameter(s): A055, A058, A061, A093

Sets the maximum number of times the drive attempts to reset a fault and restart.

Clear a Type 1 fault and restart the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [Auto Rstrt Delay] to "0".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Values	Default:	0
	Min/Max:	0/9
	Display:	1

A093 [Auto Rstrt Delay]

Related Parameter(s): A092

Sets the time between restart attempts when A092 [Auto Rstrt Tries] is set to a value other than zero.

Values	Default:	1.0 Secs
	Min/Max:	0.0/300.0 Secs
	Display:	0.1 Secs

A094 [Start At PowerUp]

Stop drive before changing this parameter.

Enables/disables a feature that allows a Start or Run command to automatically cause the drive to resume running at commanded speed after drive input power is restored. Requires a digital input configured for Run or Start and a valid start contact.

This parameter will not function if parameter P036 [Start Source] is set to 4 "2-W High Speed".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group *(continued)*

A095 [Reverse Disable]

Related Parameter(s): d006

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed. The reverse command may come from a digital command, the keypad or a serial command. All reverse inputs including two-wire Run Reverse will be ignored with reverse disabled.

Options	**0**	"Rev Enabled" (Default)
	1	"Rev Disabled"

A096 [Flying Start En]

Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

A097 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	**0**	"Disabled"	
	1	"Electrical" (Default)	Some drive/motor combinations have inherent instabilities which are exhibited as non-sinusodial motor currents. This setting attempts to correct this condition.
	2	"Mechanical"	Some motor/load combinations have mechanical resonances which can be excited by the drive current regulator. This setting slows down the current regulator response and attempts to correct this condition.
	3	"Both"	

A098 [SW Current Trip]

Related Parameter(s): P033

Enables/disables a software instantaneous (within 100 ms) current trip.

Values	Default:	0.0 (Disabled)
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

A099 [Process Factor]

Related Parameter(s): d010

Scales the output frequency value displayed by d010 [Process Display].

Output Freq x Process Factor = Process Display

Values	Default:	30.0
	Min/Max:	0.1/999.9
	Display:	0.1

Advanced Program Group *(continued)*

A100 [Fault Clear]

Stop drive before changing this parameter.

Resets a fault and clears the fault queue. Used primarily to clear a fault over network communications.

Options	**0**	"Ready/Idle" (Default)	
	1	"Reset Fault"	
	2	"Clear Buffer"	(Parameters d007-d009 [Fault x Code])

A101 [Program Lock]

Protects parameters against change by unauthorized personnel.

Options	**0**	"Unlocked" (Default)
	1	"Locked"

A102 [Testpoint Sel]

Related Parameter(s): d019

Used by Rockwell Automation field service personnel.

Values	Default:	400
	Min/Max:	0/FFFF
	Display:	1 Hex

A103 [Comm Data Rate]

Related Parameter(s): d015

Sets the serial port rate for the RS485 (DSI) port.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19.2K"
	5	"38.4K"

A104 [Comm Node Addr]

Related Parameter(s): d015

Sets the drive node address for the RS485 (DSI) port if using a network connection.

Important: Power to drive must be cycled before any changes will affect drive operation.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

Advanced Program Group *(continued)*

A105 [Comm Loss Action]

Related Parameter(s): d015, P037, A106

Selects the drive's response to a loss of the communication connection or excessive communication errors.

Options	**0**	"Fault" (Default)	Drive will fault on an F81 Comm Loss and coast to stop.
	1	"Coast Stop"	Stops drive via coast to stop.
	2	"Stop"	Stops drive via P037 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.

A106 [Comm Loss Time]

Related Parameter(s): d015, A105

Sets the time that the drive will remain in communication loss before implementing the option selected in A105 [Comm Loss Action].

Values	Default:	5.0 Secs
	Min/Max:	0.1/60.0 Secs
	Display:	0.1 Secs

A107 [Comm Format]

Related Parameter(s): d015

Selects the protocol (RTU only), data bits (8 data bits only), parity (None, Even, Odd), and stop bits (1 stop bit only) used by the RS485 port on the drive.

Refer to Appendix C for details on using the drive communication features.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"RTU 8-N-1" (Default)
	1	"RTU 8-E-1"
	2	"RTU 8-O-1"
	3	"RTU 8-N-2"
	4	"RTU 8-E-2"
	5	"RTU 8-O-2"

A108 [Language]

Selects the language displayed by the remote communications option.

Options	**1**	"English" (Default)
	2	"Français"
	3	"Español"
	4	"Italiano"
	5	"Deutsch"
	6	"Reserved"
	7	"Português"
	8	"Reserved"
	9	"Reserved"
	10	"Nederlands"

Advanced Program Group *(continued)*

A109 [Anlg Out Setpt]

Related Parameter(s): A065

When A065 [Analog Out Sel] is set to option 18, 19 or 20, this parameter sets the percentage of analog output desired.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

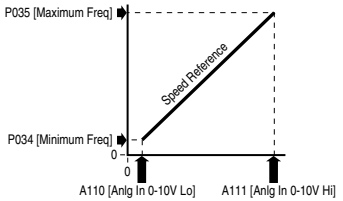
A110 [Anlg In 0-10V Lo]

Related Parameter(s): d020, P034, P038, A122

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 0-10V input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value larger than A111 [Anlg In 0-10V Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%



A111 [Anlg In 0-10V Hi]

Related Parameter(s): d020, P035, P038, A122, A123

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 0-10V input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value smaller than A110 [Anlg In 0-10V Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A112 [Anlg In4-20mA Lo]

Related Parameter(s): d021, P034, P038

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 4-20mA input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value larger than A113 [Anlg In4-20mA Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Advanced Program Group *(continued)*

A113 [Anlg In4-20mA Hi]

Related Parameter(s): d021, P035, P038

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 4-20mA input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value smaller than A112 [Anlg In4-20mA Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A114 [Slip Hertz @ FLA]

Related Parameter(s): P033

Compensates for the inherent slip in an induction motor. This frequency is added to the commanded output frequency based on motor current.

Values	Default:	2.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A115 [Process Time Lo]

Related Parameter(s): d010, P034

Scales the time value when the drive is running at P034 [Minimum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A116 [Process Time Hi]

Related Parameter(s): d010, P035

Scales the time value when the drive is running at P035 [Maximum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A117 [Bus Reg Mode]

Controls the operation of the drive voltage regulation, which is normally operational at decel or when the bus voltage rises.

Refer to the Attention statement on page P-3 for important information on bus regulation.

Options	**0**	"Disabled"
	1	"Enabled" (Default)

A118 [Current Limit 2]

Related Parameter(s): P033, A051-A054, A089

Maximum output current allowed before current limiting occurs. This parameter is only active if A051 - A054 [Digital Inx Sel] is set to 25 "Current Lmt2" and is active.

Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A119 [Skip Frequency]

Related Parameter(s): A120

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

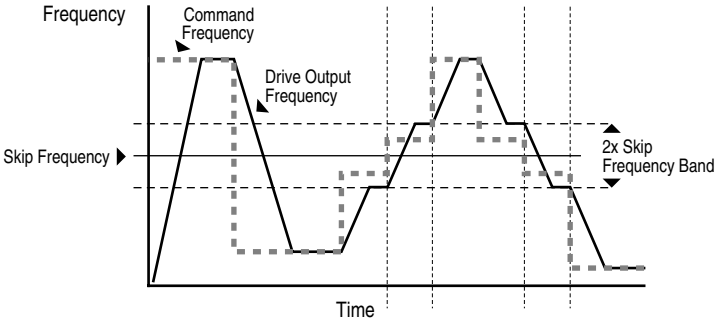
A120 [Skip Freq Band]

Related Parameter(s): A119

Determines the bandwidth around A119 [Skip Frequency]. A120 [Skip Frequency Band] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A121 [Stall Fault Time]

Sets the time that the drive will remain in stall mode before a fault is issued.

Options	**0**	"60 Seconds" (Default)
	1	"120 Seconds"
	2	"240 Seconds"
	3	"360 Seconds"
	4	"480 Seconds"
	5	"Flt Disabled"

Advanced Program Group *(continued)*

A122 [Analog In Loss]

Related Parameter(s): A110, A111, A132

Selects drive action when an input signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3mA. If using a 0-10V analog input, set A110 [Anlg In 0-10V Lo] to a minimum of 20% (i.e. 2 volts).

Options	**0**	"Disabled" (Default)	
	1	"Fault (F29)"	F29 Analog Input Loss
	2	"Stop"	Uses P037 [Stop Mode]
	3	"Zero Ref"	Drive runs at zero speed reference.
	4	"Min Freq Ref"	Drive runs at minimum frequency.
	5	"Max Freq Ref"	Drive runs at maximum frequency.
	6	"Int Freq Ref"	Drive runs at internal frequency.

A123 [10V Bipolar Enbl]

Related Parameter(s): P038, A111

Enables/disables bipolar control. In bipolar mode direction is commanded by the sign of the reference.

Options	**0**	"Uni-Polar In" (Default)	0 to 10V only
	1	"Bi-Polar In"	±10V

A124 [Var PWM Disable]

Related Parameter(s): A091

Stop drive before changing this parameter.

Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A091 [PWM Frequency].

Disabling this feature when low frequency conditions exist may result in IGBT stress and nuisance tripping.

Options	**0**	"Enabled" (Default)	
	1	"Disabled"	

A125 [Torque Perf Mode]

Related Parameter(s): A084, A085, A086, A087, A127

Stop drive before changing this parameter.

Enables/disables sensorless vector control operation.

Options	**0**	"V/Hz"	
	1	"Sensrls Vect" (Default)	

A126 [Motor NP FLA]

Related Parameter(s): A127

Set to the motor nameplate rated full load amps.

Values	Default:	Drive Rated Amps
	Min/Max:	0.1/(Drive Rated Amps × 2)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A127 [Autotune]

Related Parameter(s): A125, A126, A128, A129

Stop drive before changing this parameter.

Provides an automatic method for setting A128 [IR Voltage Drop] and A129 [Flux Current Ref], which affect sensorless vector performance. Parameter A126 [Motor NP FLA] must be set to the motor nameplate full load amps before running the Autotune procedure.

Options	**0**	"Ready/Idle" (Default)
	1	"Static Tune"
	2	"Rotate Tune"

"Ready" (0) = Parameter returns to this setting following a "Static Tune" or "Rotate Tune."

"Static Tune" (1) = A temporary command that initiates a non-rotational motor stator resistance test for the best possible automatic setting of A128 [IR Voltage Drop]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required operate the drive in normal mode. Used when motor cannot be uncoupled from the load.

"Rotate Tune" (2) = A temporary command that initiates a "Static Tune" followed by a rotational test for the best possible automatic setting of A129 [Flux Current Ref]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required to operate the drive in normal mode. **Important:** Used when motor is uncoupled from the load. Results may not be valid if a load is coupled to the motor during this procedure.

ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, it is recommended that the motor be disconnected from the load before proceeding.

If the Autotune routine fails, an F80 SVC Autotune fault is displayed.

A128 [IR Voltage Drop]

Related Parameter(s): A127

Value of volts dropped across the resistance of the motor stator.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/230.0 VAC
	Display:	0.1 VAC

A129 [Flux Current Ref]

Related Parameter(s): A127

Value of amps for full motor flux.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/[Motor NP FLA]
	Display:	0.01 Amps

Advanced Program Group *(continued)*

A130 [PID Trim Hi]

Sets the maximum positive value that is added to the speed reference when PID trim is used.

Values	Default:	60.0
	Min/Max:	0.0/400.0
	Display:	0.1

A131 [PID Trim Lo]

Sets the maximum positive value that is subtracted from the PID reference when PID trim is used.

Values	Default:	0.0
	Min/Max:	0.0/400.0
	Display:	0.1

A132 [PID Ref Sel]

Related Parameter(s): P038, A122

Stop drive before changing this parameter.

Enables/disables PID mode and selects the source of the PID reference. Refer to Appendix F for details.

Options	**0**	"PID Disabled" (Default)
	1	"PID Setpoint"
	2	"0-10V Input"
	3	"4-20mA Input"
	4	"Comm Port"
	5	"Setpnt, Trim"
	6	"0-10V, Trim"
	7	"4-20mA, Trim"
	8	"Comm, Trim"

A133 [PID Feedback Sel]

Select the source of the PID feedback. Refer to Appendix F for details.

Options	**0**	"0-10V Input" (Default)	The PID will not function with a bipolar input. Negative voltages are treated as 0 volts.
	1	"4-20mA Input"	
	2	"Comm Port"	

A134 [PID Prop Gain]

Sets the value for the PID proportional component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01
	Min/Max:	0.00/99.99
	Display:	0.01

Advanced Program Group *(continued)*

A135 [PID Integ Time]

Sets the value for the PID integral component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.1 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A136 [PID Diff Rate]

Sets the value for the PID differential component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01 (1/Secs)
	Min/Max:	0.00/99.99 (1/Secs)
	Display:	0.01 (1/Secs)

A137 [PID Setpoint]

Provides an internal fixed value for process setpoint when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A138 [PID Deadband]

Sets the lower limit of the PID output.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A139 [PID Preload]

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A140 [Stp Logic 0]
A141 [Stp Logic 1]
A142 [Stp Logic 2]
A143 [Stp Logic 3]
A144 [Stp Logic 4]
A145 [Stp Logic 5]
A146 [Stp Logic 6]
A147 [Stp Logic 7]

Related Parameter(s): P038, P039, P040, A051-A054, A055, A058, A061, A067, A068, A070-A077, A150-A157

Stop drive before changing this parameter.

Values	Default:	00F1
	Min/Max:	0001/bAFF
	Display:	4 Digits

Parameters A140-A147 are only active if P038 [Speed Reference] is set to 6 “Stp Logic”.

These parameters can be used to create a custom profile of frequency commands. Each “step” can be based on time, status of a Logic input or a combination of time and the status of a Logic input.

Digits 0-3 for each [Stp Logic x] parameter must be programmed according to the desired profile.

A Logic input is established by setting a digital input, parameters A051 - A054 [Digital Inx Sel], to 23 “Logic In1” and/or 24 “Logic In2”.

A time interval between steps can be programmed using parameters A150 - A157 [Stp Logic Time x]. See the table below for related parameters.

The speed for any step is programmed using parameters A070 - A077 [Preset Freq x].

StepLogic Parameter (Active when P038 = 6 “Stp Logic”)	Related Preset Frequency Parameter (Can be activated independent of StepLogic Parameters)	Related StepLogic Time Parameter (Active when A140-A147 Digit 0 or 1 are set to 1, b, C, d or E)
A140 [Stp Logic 0]	A070 [Preset Freq 0]	A150 [Stp Logic Time 0]
A141 [Stp Logic 1]	A071 [Preset Freq 1]	A151 [Stp Logic Time 1]
A142 [Stp Logic 2]	A072 [Preset Freq 2]	A152 [Stp Logic Time 2]
A143 [Stp Logic 3]	A073 [Preset Freq 3]	A153 [Stp Logic Time 3]
A144 [Stp Logic 4]	A074 [Preset Freq 4]	A154 [Stp Logic Time 4]
A145 [Stp Logic 5]	A075 [Preset Freq 5]	A155 [Stp Logic Time 5]
A146 [Stp Logic 6]	A076 [Preset Freq 6]	A156 [Stp Logic Time 6]
A147 [Stp Logic 7]	A077 [Preset Freq 7]	A157 [Stp Logic Time 7]

How StepLogic Works
The StepLogic sequence begins with a valid start command. A normal sequence always begins with A140 [Stp Logic 0].

Digit 0: Logic For Next Step
This digit defines the logic for the next step. When the condition is met the program advances to the next step. Step 0 follows Step 7. Example: Digit 0 is set 3. When “Logic In2” becomes active, the program advances to the next step.

Digit 1: Logic to Jump to a Different Step
For all settings other than F, when the condition is met, the program overrides Digit 0 and jumps to the step defined by Digit 2.

Digit 2: Different Step to Jump
When the condition for Digit 1 is met, the Digit 2 setting determines the next step or to end the program.

Digit 3: Step Settings

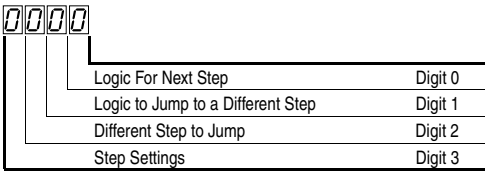
This digit defines what accel/decel profile the speed command will follow and the direction of the command for the current step. In addition, if a relay or opto output (parameters A055, A058 and A061) is set to 15 “StpLogic Out”, this parameter can control the status of that output.

Any StepLogic parameter can be programmed to control a relay or opto output, but you can not control different outputs based on the condition of different StepLogic commands.

StepLogic Settings

The logic for each function is determined by the four digits for each StepLogic parameter. The following is a listing of the available settings for each digit.

Refer to Appendix E for details.



Digit 3 Settings

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Digit 2 Settings

0 = Jump to Step 0
1 = Jump to Step 1
2 = Jump to Step 2
3 = Jump to Step 3
4 = Jump to Step 4
5 = Jump to Step 5
6 = Jump to Step 6
7 = Jump to Step 7
8 = End Program (Normal Stop)
9 = End Program (Coast to Stop)
A = End Program and Fault (F2)

Digit 1 and Digit 0 Settings

0 = Skip Step (Jump Immediately)
1 = Step Based on [Stp Logic Time x]
2 = Step if “Logic In1” is Active
3 = Step if “Logic In2” is Active
4 = Step if “Logic In1” is Not Active
5 = Step if “Logic In2” is Not Active
6 = Step if either “Logic In1” or “Logic In2” is Active
7 = Step if both “Logic In1” and “Logic In2” is Active
8 = Step if neither “Logic In1” or “Logic In2” is Active
9 = Step if “Logic In1” is Active and “Logic In2” is Not Active
A = Step if “Logic In2” is Active and “Logic In1” is Not Active
b = Step after [Stp Logic Time x] and “Logic In1” is Active
C = Step after [Stp Logic Time x] and “Logic In2” is Active
d = Step after [Stp Logic Time x] and “Logic In1” is Not Active
E = Step after [Stp Logic Time x] and “Logic In2” is Not Active
F = Do Not Step/Ignore Digit 2 Settings

Advanced Program Group *(continued)*

A150 [Stp Logic Time 0]
A151 [Stp Logic Time 1]
A152 [Stp Logic Time 2]
A153 [Stp Logic Time 3]
A154 [Stp Logic Time 4]
A155 [Stp Logic Time 5]
A156 [Stp Logic Time 6]
A157 [Stp Logic Time 7]

Related Parameter(s): P038, A055, A058, A061, A070-A077, A140-A147

Sets the time to remain in each step if the corresponding StpLogic command word is set to “Step after Time”.

Values	Default:	30.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A160 [EM Brk Off Delay]

Related Parameter(s): P037

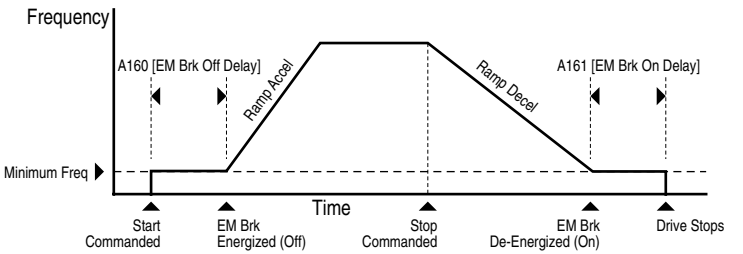
Sets the time the drive remains at minimum frequency before the relay or an opto output is energized and the drive ramps to the commanded frequency.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 “Ramp+EM B,CF” or 9 “Ramp+EM Brk” to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 “EM Brk Cntrl” to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs



Advanced Program Group *(continued)*

A161 [EM Brk On Delay]

Related Parameter(s): P037

Sets the time the drive remains at minimum frequency before the relay or an opto output is de-energizing and the drive stops.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 “Ramp+EM B,CF” or 9 “Ramp+EM Brk” to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 “EM Brk Cntrl” to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs

A162 [MOP Reset Sel]

Related Parameter(s): A069

Set the drive to save the current MOP reference command.

Options	**0**	“Zero MOP Ref”	This option clamps A069 [Internal Freq] at 0.0 Hz when the drive is not running.
	1	“Save MOP Ref” (Default)	Reference is saved in A069 [Internal Freq].

A163 [DB Threshold]

Related Parameter(s): P037, A080, A081, A082

Sets the DC bus Voltage Threshold for Dynamic Brake operation. If the DC bus voltage falls below the value set in this parameter, the Dynamic Brake will not turn on. Lower values will make the Dynamic Braking function more responsive but may result in nuisance Dynamic Brake activation.

Values	Default	100.0%
	Min/Max:	0.0/110.0%
	Display:	0.0%

ATTENTION: Equipment damage may result if this parameter is set a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 100% should be carefully evaluated to ensure that the dynamic brake resistor’s wattage rating is not exceeded. In general, values less than 90% are not needed. This parameter’s setting is especially important if parameter A082 [DB Resistor Sel] is set to 2 “No Protection”.

Advanced Program Group *(continued)*

A164 [Comm Write Mode]

Determines whether parameter changes made over communication port are saved and stored in Non-Volatile Storage (NVS) or RAM only. If they are stored in RAM, the values will be lost at power-down.

Options	**0**	"Save" (Default)
	1	"RAM Only"

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless A164 [Comm Write Mode] is set to option 1.

A165 [Anlg Loss Delay]

Related Parameter(s): A122

Sets the length of time after power-up during which the drive will not detect an analog signal loss. The drive response to an analog signal loss is set in A122 [Analog In Loss].

Values	Default:	0.0 Secs
	Min/Max:	0.0/20.0 Secs
	Display:	0.1 Secs

A166 [Analog In Filter]

Sets level of additional filtering of the analog input signals. A higher number increases filtering and decreases bandwidth. Each setting doubles the applied filtering (1 = 2x filter, 2 = 4x filter, etc...). No additional filtering is applied when set to "0".

Values	Default:	0
	Min/Max:	0/14
	Display:	1

A167 [PID Invert Error]

When set to "Inverted", changes the sign of the PID error. This causes an increase in the drive output frequency with PID Feedback greater than PID Setpoint, and a decrease in drive output frequency with PID Feedback less than PID Setpoint.

Options	**0**	"Not Inverted" (Default)
	1	"Inverted"

Parameter Cross Reference – by Name

Parameter Name	No.	Group
10V Bipolar Enbl	A123	Advanced Program
Accel Time 1	P039	Basic Program
Accel Time 2	A067	Advanced Program
Analog In 0-10V	d020	Display
Analog In 4-20mA	d021	Display
Analog In Filter	A166	Advanced Program
Analog In Loss	A122	Advanced Program
Analog Out High	A066	Advanced Program
Analog Out Sel	A065	Advanced Program
Anlg In 0-10V Hi	A111	Advanced Program
Anlg In 0-10V Lo	A110	Advanced Program
Anlg In4-20mA Hi	A113	Advanced Program
Anlg In4-20mA Lo	A112	Advanced Program
Anlg Loss Delay	A166	Advanced Program
Anlg Out Setpt	A109	Advanced Program
Auto Rstrt Delay	A093	Advanced Program
Auto Rstrt Tries	A092	Advanced Program
Autotune	A127	Advanced Program
Boost Select	A084	Advanced Program
Break Frequency	A087	Advanced Program
Break Voltage	A086	Advanced Program
Bus Reg Mode	A117	Advanced Program
Comm Data Rate	A103	Advanced Program
Comm Format	A107	Advanced Program
Comm Loss Action	A105	Advanced Program
Comm Loss Time	A106	Advanced Program
Comm Node Addr	A104	Advanced Program
Comm Status	d015	Display
Comm Write Mode	A164	Advanced Program
Commanded Freq	d002	Display
Compensation	A097	Advanced Program
Contrl In Status	d013	Display
Control Source	d012	Display
Control SW Ver	d016	Display
Counter Status	d025	Display
Current Limit x	A089, A118	Advanced Program
DB Resistor Sel	A082	Advanced Program
DB Threshold	A163	Advanced Program
DC Brake Level	A081	Advanced Program
DC Brake Time	A080	Advanced Program
DC Bus Voltage	d005	Display
Decel Time 1	P040	Basic Program
Decel Time 2	A068	Advanced Program
Dig In Status	d014	Display
Digital Inx Sel	A051-A054	Advanced Program
Drive Status	d006	Display
Drive Temp	d024	Display
Drive Type	d017	Display
Elapsed Run Time	d018	Display
EM Brk Off Delay	A160	Advanced Program
EM Brk On Delay	A161	Advanced Program
Fault Clear	A100	Advanced Program
Fault x Code	d007-d009	Display
Flux Current Ref	A129	Advanced Program
Flying Start En	A096	Advanced Program
Internal Freq	A069	Advanced Program
IR Voltage Drop	A128	Advanced Program
Jog Accel/Decel	A079	Advanced Program
Jog Frequency	A078	Advanced Program
Language	A108	Advanced Program
Maximum Freq	P035	Basic Program
Maximum Voltage	A088	Advanced Program
Minimum Freq	P034	Basic Program
MOP Reset Sel	A162	Advanced Program
Motor NP FLA	A126	Advanced Program
Motor NP Hertz	P032	Basic Program
Motor NP Volts	P031	Basic Program
Motor OL Current	P033	Basic Program
Motor OL Ret	P043	Basic Program
Motor OL Select	A090	Advanced Program
Opto Out Logic	A064	Advanced Program
Opto Outx Level	A059, A062	Advanced Program
Opto Outx Sel	A058, A061	Advanced Program
Output Current	d003	Display
Output Freq	d001	Display
Output Power	d022	Display
Output Powr Fctr	d023	Display
Output Voltage	d004	Display
PID Deadband	A138	Advanced Program
PID Diff Rate	A136	Advanced Program
PID Feedback Sel	A133	Advanced Program
PID Integ Time	A135	Advanced Program
PID Invert Error	A167	Advanced Program
PID Preload	A139	Advanced Program
PID Prop Gain	A134	Advanced Program
PID Ref Sel	A132	Advanced Program
PID Setpoint	A137	Advanced Program
PID Trim Hi	A130	Advanced Program
PID Trim Lo	A131	Advanced Program
Preset Freq x	A070-A077	Advanced Program
Process Display	d010	Display
Process Factor	A099	Advanced Program
Process Time Hi	A116	Advanced Program
Process Time Lo	A115	Advanced Program
Program Lock	A101	Advanced Program
PWM Frequency	A091	Advanced Program
Relay Out Level	A056	Advanced Program
Relay Out Sel	A055	Advanced Program
Reset To Defalts	P041	Basic Program
Reverse Disable	A095	Advanced Program
S Curve %	A083	Advanced Program
Skip Freq Band	A120	Advanced Program
Skip Frequency	A119	Advanced Program
Slip Hertz @ FLA	A114	Advanced Program
Stp Logic Status	d028	Display
Stp Logic x	A140-A147	Advanced Program
Stp Logic Time x	A150-A157	Advanced Program
Speed Reference	P038	Basic Program
Stall Fault Time	A121	Advanced Program
Start At PowerUp	A094	Advanced Program
Start Boost	A085	Advanced Program
Start Source	P036	Basic Program
Stop Mode	P037	Basic Program
SW Current Trip	A098	Advanced Program

Parameter Name	No.	Group
Testpoint Data	d019	Display
Testpoint Sel	A102	Advanced Program
Timer Status	d026	Display
Torque Current	d029	Display
Torque Perf Mode	A125	Advanced Program
Var PWM Disable	A124	Advanced Program
Voltage Class	P042	Basic Program

Troubleshooting

Chapter 4 provides information to guide you in troubleshooting the PowerFlex 40 drive. Included is a listing and description of drive faults (with possible solutions, when applicable).

For information on...	See page...	For information on...	See page...
Drive Status	4-1	Fault Descriptions	4-3
Faults	4-1	Common Symptoms and Corrective Actions	4-5

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral keypad.

LED Indications

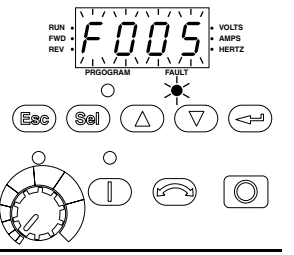
See page 2-4 for information on drive status indicators and controls.

Faults

A fault is a condition that stops the drive. There are two fault types.

Type	Fault Description	
①	Auto-Reset/Run	When this type of fault occurs, and A092 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A093 [Auto Rstrt Delay], begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
②	Non-Resetable	This type of fault may require drive or motor repair, or is caused by wiring or programing errors. The cause of the fault must be corrected before the fault can be cleared.

Fault Indication

Condition	Display
Drive is indicating a fault. The integral keypad provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator Press the Escape key to regain control of the integral keypad.	

Manually Clearing Faults

Step	Key(s)
1. Press Esc to acknowledge the fault. The fault information will be removed so that you can use the integral keypad. Access d007 [Fault 1 Code] to view the most recent fault information. 2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared. See Table 4.A. 3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P037 [Stop Mode] is set to a value between “0” and “3”. • Cycle drive power. • Set A100 [Fault Clear] to “1” or “2”. • Cycle digital input if A051-A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.	

Automatically Clearing Faults

Option / Step
Clear a Type 1 fault and restart the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to a value other than “0”.
Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to “0”.

Auto Restart (Reset/Run)

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. This allows remote or “unattended” operation. Only certain faults are allowed to be reset. Certain faults (Type 2) that indicate possible drive component malfunction are not resettable.

Caution should be used when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Table 4.A Fault Types, Descriptions and Actions

No.	Fault	Type[1]	Description	Action
F2	Auxiliary Input	①	Auxiliary input interlock is open.	1. Check remote wiring. 2. Verify communications programming for intentional fault.
F3	Power Loss	②	Excessive DC Bus voltage ripple.	1. Monitor the incoming line for phase loss or line imbalance. 2. Check input line fuse.
F4	UnderVoltage	①	DC bus voltage fell below the minimum value.	Monitor the incoming AC line for low voltage or line power interruption.
F5	OverVoltage	①	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
F6	Motor Stalled	①	Drive is unable to accelerate motor.	Increase P039 - A067 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit 1].
F7	Motor Overload	①	Internal electronic overload trip.	1. An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. 2. Verify A084 [Boost Select] setting
F8	Heatsink OvrTmp	①	Heatsink temperature exceeds a predefined value.	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40° C (104° F) for IP30, NEMA UL Type 1 installations or 50°C (122°F) for IP20/Open type installations. 2. Check fan.
F12	HW OverCurrent	②	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A084 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	②	A current path to earth ground has been detected at one or more of the drive output terminals.	Check the motor and external wiring to the drive output terminals for a grounded condition.
F29	Analog Input Loss	①	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with A122 [Analog In Loss].	1. Check parameters. 2. Check for broken/loose connections at inputs.

(1) See page 4-1 for a description of fault types.

No.	Fault	Type(1)	Description	Action
F33	Auto Rstrt Tries	②	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A092 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	②	A phase to ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd			
F40	Phase W to Gnd			
F41	Phase UV Short	②	Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive if fault cannot be cleared.
F42	Phase UW Short			
F43	Phase VW Short			
F48	Params Defaulted		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
F63	SW OverCurrent	①	Programmed A098 [SW Current Trip] has been exceeded.	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	②	Drive rating of 150% for 1 minute or 200% for 3 seconds has been exceeded.	Reduce load or extend Accel Time.
F70	Power Unit	②	Failure has been detected in the drive power section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.
F71	Net Loss		The communication network has faulted.	1. Cycle power. 2. Check communications cabling. 3. Check network adapter setting. 4. Check external network status.
F80	SVC Autotune		The autotune function was either cancelled by the user or failed.	Restart procedure.
F81	Comm Loss	②	RS485 (DSI) port stopped communicating.	1. If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. 2. Check connection. 3. An adapter was intentionally disconnected. 4. Turn off using A105 [Comm Loss Action].

No.	Fault	Type(1)	Description	Action
F100	Parameter Checksum	②	The checksum read from the board does not match the checksum calculated.	Set P041 [Reset To Defalts] to option 1 “Reset Defaults”.
F122	I/O Board Fail	②	Failure has been detected in the drive control and I/O section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.

(1) See page 4-1 for a description of fault types.

Common Symptoms and Corrective Actions

Motor does not Start.

Cause(s)	Indication	Corrective Action
No output voltage to the motor.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects. Check the motor. • Verify that the motor is connected properly. Check the control input signals. • Verify that a Start signal is present. If 2-Wire control is used, verify that either the Run Forward or Run Reverse signal is active, but not both. • Verify that I/O Terminal 01 is active. • Verify that P036 [Start Source] matches your configuration. • Verify that A095 [Reverse Disable] is not prohibiting movement.
Improper boost setting at initial start-up.	None	Set A084 [Boost Select] to option 2 “35.0, VT”.
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A100 [Fault Clear] to option 1 “Clear Faults”. • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.

Drive does not Start from Start or Run Inputs wired to the terminal block.

Cause(s)	Indication	Corrective Action
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A100 [Fault Clear] to option 1 “Clear Faults”. • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.
Incorrect programming. • P036 [Start Source] is set to option 0 “Keypad” or option 5 “RS485 (DSI) Port”. • A051 - A054 [Digital Inx Sel] is set to option 5 “Local” and the input is active.	None	Check parameter settings.
Incorrect input wiring. See 1-18 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	Wire inputs correctly and/or install jumper.
Incorrect Sink/Source DIP switch setting.	None	Set switch to match wiring scheme.

Drive does not Start from Integral Keypad.

Cause(s)	Indication	Corrective Action
Integral keypad is not enabled.	Green LED above Start key is not illuminated.	• Set parameter P036 [Start Source] to option 0 “Keypad”. • Set parameter A051 - A054 [Digital Inx Sel] to option 5 “Local” and activate the input.
I/O Terminal 01 “Stop” input is not present.	None	Wire inputs correctly and/or install jumper.

Drive does not respond to changes in speed command.

Cause(s)	Indication	Corrective Action
No value is coming from the source of the command.	The drive "Run" indicator is lit and output is 0 Hz.	• Check d012 [Control Source] for correct source. • If the source is an analog input, check wiring and use a meter to check for presence of signal. • Check d002 [Commanded Freq] to verify correct command.
Incorrect reference source is being selected via remote device or digital inputs.	None	• Check d012 [Control Source] for correct source. • Check d014 [Dig In Status] to see if inputs are selecting an alternate source. Verify settings for A051 - A054 [Digital Inx Sel]. • Check P038 [Speed Reference] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 1-23.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P039 [Accel Time 1] or A067 [Accel Time 2].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	Compare d003 [Output Current] with A089 [Current Limit 1]. Remove excess load or reprogram P039 [Accel Time 1] or A067 [Accel Time 2]. Check for improper A084 [Boost Select] setting.
Speed command source or value is not as expected.	None	Verify d002 [Commanded Freq]. Check d012 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	Check P035 [Maximum Freq] to insure that speed is not limited by programming.
Torque performance does not match motor characteristics.	None	Set motor nameplate full load amps in parameter A126 [Motor NP FLA]. Perform A127 [Autotune] "Static Tune" or "Rotate Tune" procedure. Set A125 [Torque Perf Mode] to option 0 "V/Hz".

Motor operation is unstable.

Cause(s)	Indication	Corrective Action
Motor data was incorrectly entered.	None	1. Correctly enter motor nameplate data into P031, P032 and P033. 2. Enable A097 [Compensation]. 3. Use A084 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Digital input is not selected for reversing control.	None	Check [Digital Inx Sel] (See page 3-14). Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring. (See page 1-17)
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.
Reverse is disabled.	None	Check A095 [Reverse Disable].

Drive does not power up.

Cause(s)	Indication	Corrective Action
No input power to drive.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects.
Jumper between I/O Terminals P2 and P1 not installed and/or DC Bus Inductor not connected.	None	Install jumper or connect DC Bus Inductor.

Supplemental Drive Information

For information on...	See page...
Drive, Fuse & Circuit Breaker Ratings	A-1
Specifications	A-2

Drive, Fuse & Circuit Breaker Ratings

The tables on the following pages provide drive ratings and recommended AC line input fuse and circuit breaker information. Both types of short circuit protection are acceptable for UL and IEC requirements. Sizes listed are the recommended sizes based on 40 degree C and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

If fuses are chosen as the desired protection method, refer to the recommended types listed below. If available amp ratings do not match the tables provided, the closest fuse rating that exceeds the drive rating should be chosen.

- IEC – BS88 (British Standard) Parts 1 & 2 (1), EN60269-1, Parts 1 & 2, type gG or equivalent should be used.
- UL – UL Class CC, T or J must be used. (2)

Circuit Breakers

Refer to listings in the following tables for recommended circuit breakers (inverse time or instantaneous trip) and 140M Self-Protecting Motor Starters.

(1) Typical designations include, but may not be limited to the following; Parts 1 & 2: AC, AD, BC, BD, CD, DD, ED, EFS, EF, FF, FG, GF, GG, GH.

(2) Typical designations include; Type CC - KTK-R, FNQ-R
Type J - JKS, LPJ
Type T - JJS, JJN

Specifications

Drive Ratings								
Catalog Number[1]	Output Ratings		Input Ratings			Branch Circuit Protection		
	kW (HP)	Amps	Voltage Range	kVA	Amps	Fuses	140M Motor Protectors[3]	Contactors
100 - 120V AC (±10%) – 1-Phase Input, 0 - 230V 3-Phase Output								
22B-V2P3x104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12
22B-V5P0x104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23
22B-V6P0x104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37
200 - 240V AC (±10%) – 1-Phase[2] Input, 0 - 230V 3-Phase Output								
22B-A2P3x104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09
22B-A5P0x104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12
22B-A8P0x104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23
22B-A012x104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37
200 - 240V AC (±10%) – 3-Phase Input, 0 - 230V 3-Phase Output								
22B-B2P3x104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07
22B-B5P0x104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09
22B-B8P0x104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12
22B-B012x104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23
22B-B017x104	3.7 (5.0)	17.5	180-264	8.6	21.0	30	140M-F8E-C25	100-C23
22B-B024x104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37
22B-B033x104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-G8E-C45	100-C60
380 - 480V AC (±10%) – 3-Phase Input, 0 - 460V 3-Phase Output								
22B-D1P4x104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07
22B-D2P3x104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07
22B-D4P0x104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09
22B-D6P0x104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09
22B-D010x104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23
22B-D012x104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23
22B-D017x104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23
22B-D024x104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43
460 - 600V AC (±10%) – 3-Phase Input, 0 - 575V 3-Phase Output								
22B-E1P7x104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09
22B-E3P0x104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09
22B-E4P2x104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-C2E-B63	100-C09
22B-E6P6x104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-C2E-C10	100-C09
22B-E9P9x104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-C2E-C16	100-C16
22B-E012x104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-C2E-C16	100-C23
22B-E019x104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-D8E-C25	100-C30

(1) In the Catalog Numbers listed "x" represents enclosure type. Specifications are valid for all enclosure types. IP66, NEMA/UL Type 4X drive ratings are only available as Frame B drives. Refer to Table B.B.

(2) 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114. Filter option is not available for IP66, NEMA/UL Type 4X rated drives.

(3) Refer to the Bulletin 140M Motor Protectors *Selection Guide*, publication 140M-SG001… to determine the frame and breaking capacity required for your application.

Input/Output Ratings

Output Frequency: 0-400 Hz (Programmable)
Efficiency: 97.5% (Typical)

Approvals

UL508C c UL CSA 22.2
CE EMC Directive 89/336
LV: EN 50178, EN 60204
EMC: EN 61800-3, EN 50081-1, EN 50082-2

Digital Control Inputs (Input Current = 6mA)

SRC (Source) Mode:	SNK (Sink) Mode:
18-24V = ON	0-6V = ON
0-6V = OFF	18-24V = OFF

Analog Control Inputs

4-20mA Analog: 250 ohm input impedance
0-10V DC Analog: 100k ohm input impedance
External Pot: 1-10k ohms, 2 Watt minimum

Control Output

Programmable Output (form C relay)	*Opto Outputs*	*Analog Outputs (10 bit)*
Resistive Rating: 3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC	30V DC, 50mA	0-10V, 1k ohm Min.
Inductive Rating: 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC	Non-inductive	4-20mA, 525 ohm Max.

Fuses and Circuit Breakers

Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.
Recommended Circuit Breakers: HMCP circuit breakers or equivalent.

Protective Features

Motor Protection: I^2t overload protection - 150% for 60 Secs, 200% for 3 Secs (Provides Class 10 protection)

Overcurrent: 200% hardware limit, 300% instantaneous fault

Over Voltage: 100-120V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 150V AC incoming line)
200-240V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 290V AC incoming line)
380-460V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)
460-600V AC Input – Trip occurs at 1005V DC bus voltage (equivalent to 711V AC incoming line)

Under Voltage: 100-120V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 75V AC incoming line)
200-240V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 150V AC incoming line)
380-480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)
460-600V AC Input – If P042 = 3 “High Voltage” trip occurs at 487V DC bus voltage (344V AC incoming line);
If P042 = 2 “Low Voltage” trip occurs at 390V DC bus voltage (275V AC incoming line)

Control Ride Through: Minimum ride through is 0.5 Secs - typical value 2 Secs

Faultless Power Ride Through: 100 milliseconds

Dynamic Braking

Internal brake IGBT included with all ratings except when no brake is specified.
Refer to Appendix B for DB resistor ordering information.

Category	Specification	
Environment	Altitude:	1000 m (3300 ft) max. without derating
	Maximum Surrounding Air Temperature without derating:	
	IP20, NEMA/UL Type Open:	–10 to 50° C (14 to 122° F)
	IP30, NEMA/UL Type 1:	–10 to 40° C (14 to 104° F)
	Flange Mount:	Heatsink: –10 to 40° C (14 to 104° F) Drive: –10 to 50° C (14 to 122° F)
	IP66, NEMA/UL Type 4X:	–10 to 40° C (14 to 104° F)
	Cooling Method	
	Convection:	0.4 kW (0.5 HP) drives
	Fan:	All other drive ratings and 0.4 kW (0.5 HP) 1-Phase drives with Integral “S Type” EMC Filter
	Storage Temperature:	–40 to 85 degrees C (–40 to 185 degrees F)
	Atmosphere:	**Important:** Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.
	Relative Humidity:	0 to 95% non-condensing
	Shock (operating):	15G peak for 11ms duration (±1.0ms)
	Vibration (operating):	1G peak, 5 to 2000 Hz
Control	Carrier Frequency	2-16 kHz. Drive rating based on 4 kHz.
	Frequency Accuracy	
	Digital Input:	Within ±0.05% of set output frequency.
	Analog Input:	Within 0.5% of maximum output frequency, 10-Bit resolution
	Analog Output:	±2% of full scale, 10-Bit resolution
	Speed Regulation - Open Loop with Slip Compensation:	±1% of base speed across a 60:1 speed range.
	Stop Modes:	Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve.
	Accel/Decel:	Two independently programmable accel and decel times. Each time may be programmed from 0 - 600 seconds in 0.1 second increments.
	Intermittent Overload:	150% Overload capability for up to 1 minute 200% Overload capability for up to 3 seconds
	Electronic Motor Overload Protection:	Class 10 protection with speed sensitive response and power-down overload retention function.
Electrical	Voltage Tolerance:	100-120V ±10% 200-240V ±10% 380-480V ±10% 460-600V ±10%
	Frequency Tolerance:	48-63 Hz
	Input Phases:	Three-phase input provides full rating. Single-phase operation provides 35% rated current.
	Displacement Power Factor:	0.98 across entire speed range
	Maximum Short Circuit Rating:	100,000 Amps Symmetrical
	Actual Short Circuit Rating:	Determined by AIC Rating of installed fuse/circuit breaker
	Transistor Type:	Insulated Gate Bipolar Transistor (IGBT)

PowerFlex 40 Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	kW (HP)	External Watts	Internal Watts	Total Watts Loss
100–120V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (1.5)	58	22	80
200–240V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (2.0)	63	22	85
	2.2 (3.0)	100	25	125
	3.7 (5.0)	150	30	180
	5.5 (7.5)	200	35	235
	7.5 (10)	265	40	305
380–480V	0.4 (0.5)	17	18	35
	0.75 (1.0)	30	20	50
	1.1 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	3.7 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300
460–600V	0.75 (1.0)	30	20	50
	1.5 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	4.0 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300

Notes:

Accessories and Dimensions

Product Selection

Table B.A Catalog Number Description

22B	-	A	1P5	N	1	1	4
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type

Table B.B PowerFlex 40 Drives

Drive Ratings				IP20, NEMA/UL Type Open		IP20 Flange Mount[1]	IP66, NEMA/UL Type 4X
Input Voltage	kW	HP	Output Current	Catalog Number	Frame Size	Catalog Number	Catalog Number
120V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-V2P3N104	B	22B-V2P3F104	22B-V2P3C104
	0.75	1.0	5.0A	22B-V5P0N104	B	22B-V5P0F104	22B-V5P0C104
	1.1	1.5	6.0A	22B-V6P0N104	B	22B-V6P0F104	22B-V6P0C104
240V 50/60 Hz 1-Phase With Integral "S Type" EMC Filter	0.4	0.5	2.3A	22B-A2P3N114	B	–	–
	0.75	1.0	5.0A	22B-A5P0N114	B	–	–
	1.5	2.0	8.0A	22B-A8P0N114	B	–	–
	2.2	3.0	12.0A	22B-A012N114	C	–	–
240V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-A2P3N104	B	22B-A2P3F104	22B-A2P3C104
	0.75	1.0	5.0A	22B-A5P0N104	B	22B-A5P0F104	22B-A5P0C104
	1.5	2.0	8.0A	22B-A8P0N104	B	22B-A8P0F104	22B-A8P0C104
	2.2	3.0	12.0A	22B-A012N104	C	22B-A012F104	–
240V 50/60 Hz 3-Phase No Filter	0.4	0.5	2.3A	22B-B2P3N104	B	22B-B2P3F104	22B-B2P3C104
	0.75	1.0	5.0A	22B-B5P0N104	B	22B-B5P0F104	22B-B5P0C104
	1.5	2.0	8.0A	22B-B8P0N104	B	22B-B8P0F104	22B-B8P0C104
	2.2	3.0	12.0A	22B-B012N104	B	22B-B012F104	22B-B012C104
	3.7	5.0	17.5A	22B-B017N104	B	22B-B017F104	22B-B017C104
	5.5	7.5	24.0A	22B-B024N104	C	22B-B024F104	–
	7.5	10.0	33.0A	22B-B033N104	C	22B-B033F104	–
480V 50/60 Hz 3-Phase No Filter	0.4	0.5	1.4A	22B-D1P4N104	B	22B-D1P4F104	22B-D1P4C104
	0.75	1.0	2.3A	22B-D2P3N104	B	22B-D2P3F104	22B-D2P3C104
	1.5	2.0	4.0A	22B-D4P0N104	B	22B-D4P0F104	22B-D4P0C104
	2.2	3.0	6.0A	22B-D6P0N104	B	22B-D6P0F104	22B-D6P0C104
	4.0	5.0	10.5A	22B-D010N104	B	22B-D010F104	22B-D010C104
	5.5	7.5	12.0A	22B-D012N104	C	22B-D012F104	–
	7.5	10.0	17.0A	22B-D017N104	C	22B-D017F104	–
	11.0	15.0	24.0A	22B-D024N104	C	22B-D024F104 [2]	–
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	1.7A	22B-E1P7N104	B	22B-E1P7F104	22B-E1P7C104
	1.5	2.0	3.0A	22B-E3P0N104	B	22B-E3P0F104	22B-E3P0C104
	2.2	3.0	4.2A	22B-E4P2N104	B	22B-E4P2F104	22B-E4P2C104
	4.0	5.0	6.6A	22B-E6P6N104	B	22B-E6P6F104	22B-E6P6C104
	5.5	7.5	9.9A	22B-E9P9N104	C	22B-E9P9F104	–
	7.5	10.0	12.0A	22B-E012N104	C	22B-E012F104	–
	11.0	15.0	19.0A	22B-E019N104	C	22B-E019F104	–

(1) Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

(2) Requires use of external DC Bus Inductor or AC Line Reactor. See Table B.E for details.

Table B.C Dynamic Brake Modules

Drive Ratings				
Input Voltage	**kW**	**HP**	**Minimum Resistance Ω**	**Catalog Number (1) (2)**
120V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.1	1.5	48	AK-R2-091P500
240V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
240V 50/60 Hz 3-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
	3.7	5.0	19	AK-R2-047P500
	5.5	7.5	13	AK-R2-030P1K2
	7.5	10.0	10	AK-R2-030P1K2
480V 50/60 Hz 3-Phase	0.4	0.5	97	AK-R2-360P500
	0.75	1.0	97	AK-R2-360P500
	1.5	2.0	97	AK-R2-360P500
	2.2	3.0	97	AK-R2-120P1K2
	4.0	5.0	77	AK-R2-120P1K2
	5.5	7.5	55	AK-R2-120P1K2
	7.5	10.0	39	AK-R2-120P1K2
	11.0	15.0	24	AK-R2-120P1K2 (3)
600V 50/60 Hz 3-Phase	0.75	1.0	120	AK-R2-360P500
	1.5	2.0	120	AK-R2-360P500
	2.2	3.0	82	AK-R2-120P1K2
	4.0	5.0	82	AK-R2-120P1K2
	5.5	7.5	51	AK-R2-120P1K2
	7.5	10.0	51	AK-R2-120P1K2
	11.0	15.0	51	AK-R2-120P1K2 (3)

(1) The resistors listed in this tables are rated for 5% duty cycle.

(2) Use of Rockwell resistors is always recommended. The resistors listed have been carefully selected for optimizing performance in a variety of applications. Alternative resistors may be used, however care must be taken when making a selection. Refer to the P*owerFlex Dynamic Braking Resistor Calculator*, publication PFLEX-AT001.

(3) Requires two resistors wired in parallel.

Table B.D Bulletin 1321-3R Series Line Reactors

Input Voltage	kW	HP	Fundamental Amps	Maximum Continuous Amps	Inductance mh	Watts Loss	Catalog Number (1)
240V 50/60 Hz 3-Phase	0.4	0.5	4	6	12.0	21 W	1321-3R4-D
	0.75	1.0	8	12	3.0	29 W	1321-3R8-B
	1.5	2.0	8	12	1.5	19.5 W	1321-3R8-A
	2.2	3.0	12	18	1.25	26 W	1321-3R12-A
	3.7	5.0	18	27	0.8	36 W	1321-3R18-A
	5.5	7.5	25	37.5	0.5	48 W	1321-3R25-A
	7.5	10.0	35	52.5	0.4	49 W	1321-3R35-A
480V 50/60 Hz 3-Phase	0.4	0.5	2	3	20.0	11.3 W	1321-3R2-B
	0.75	1.0	4	6	9.0	20 W	1321-3R4-C
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	8	12	5.0	25.3 W	1321-3R8-C
	4.0	5.0	12	18	2.5	31 W	1321-3R12-B
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	18	27	1.5	43 W	1321-3R18-B
	11.0	15.0	25	37.5	1.2	52 W	1321-3R25-B
600V 50/60 Hz 3-Phase	0.75	1.0	2	3	20.0	11.3 W	1321-3R2-B
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	4	6	6.5	20 W	1321-3R4-B
	4.0	5.0	8	12	5.0	25.3 W	1321-3R8-C
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	12	18	2.5	31 W	1321-3R12-B
	11.0	15.0	18	27	1.5	43 W	1321-3R18-B

(1) Catalog numbers listed are for 3% impedance open style units. NEMA Type 1 and 5% impedance reactor types are also available. Refer to publication 1321-TD001….

Table B.E DC Bus Inductors

Input Voltage	kW	HP	Amps	Inductance mh	MTE Catalog Number (2)
240V 50/60 Hz 3-Phase	5.5	7.5	32	0.85	32RB001
	7.5	10.0	40	0.5	40RB001
480V 50/60 Hz 3-Phase	5.5	7.5	18	3.75	18RB004
	7.5	10.0	25	4.0	25RB005
	11.0	15.0	32	2.68	32RB003
600V 50/60 Hz 3-Phase	5.5	7.5	12	6.0	12RB004
	7.5	10.0	18	6.0	18RB005
	11.0	15.0	25	4.0	25RB005

(2) Use MTE RB Series or equivalent inductors.

Table B.F EMC Line Filters

Drive Ratings			S Type Filter Catalog Number (1)	L Type Filter Catalog Number (4)
Input Voltage	kW	HP		
120V 50/60 Hz 1-Phase	0.4	0.5	–	22-RF018-BL
	0.75	1.0	–	22-RF018-BL
	1.1	1.5	–	22-RF018-BL
240V 50/60 Hz 1-Phase	0.4	0.5	(2)	22-RF018-BL
	0.75	1.0	(2)	22-RF018-BL
	1.5	2.0	(2)	22-RF018-BL
	2.2	3.0	(2)	22-RF025-CL
240V 50/60 Hz 3-Phase	0.4	0.5	22-RF021-BS(3)	22-RF021-BL
	0.75	1.0	22-RF021-BS(3)	22-RF021-BL
	1.5	2.0	22-RF021-BS(3)	22-RF021-BL
	2.2	3.0	22-RF021-BS(3)	22-RF021-BL
	3.7	5.0	22-RF021-BS(3)	22-RF021-BL
	5.5	7.5	22-RF034-CS	22-RF034-CL
	7.5	10.0	22-RF034-CS	22-RF034-CL
480V 50/60 Hz 3-Phase	0.4	0.5	22-RF012-BS	22-RF012-BL
	0.75	1.0	22-RF012-BS	22-RF012-BL
	1.5	2.0	22-RF012-BS	22-RF012-BL
	2.2	3.0	22-RF012-BS	22-RF012-BL
	4.0	5.0	22-RF012-BS	22-RF012-BL
	5.5	7.5	22-RF018-CS	22-RF018-CL
	7.5	10.0	22-RF018-CS	22-RF018-CL
	11.0	15.0	22-RF026-CS	22-RF026-CL
600V 50/60 Hz 3-Phase	0.75	1.0	–	22-RF8P0-BL
	1.5	2.0	–	22-RF8P0-BL
	2.2	3.0	–	22-RF8P0-BL
	4.0	5.0	–	22-RF8P0-BL
	5.5	7.5	–	22-RF015-CL
	7.5	10.0	–	22-RF015-CL
	11.0	15.0	–	22-RF024-CL

(1) This filter is suitable for use with a cable length of at least 10 meters (33 feet) for Class A and 1 meter for Class B environments.

(2) These ratings can be ordered with internal “S Type” filters. Refer to the Catalog Number explanation on page P-4 and Table B.B for details.

(3) Filter must be Series B or later.

(4) This filter is suitable for use with a cable length of at least 100 meters for Class A and 5 meters for Class B environments.

Table B.G Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog Number
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2S
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2
LCD Display, Remote Handheld	Digital speed control Full numeric keypad CopyCat capable IP30 (NEMA Type 1) Includes 1.0 meter cable Panel mount with optional Bezel Kit	22-HIM-A3
Bezel Kit	Panel mount for LCD Display, Remote Handheld unit, IP30 (NEMA Type 1)	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 Meter (3.3 Feet) 2.9 Meter (9.51 Feet)	22-HIM-H10 22-HIM-H30

Table B.H IP30/NEMA 1/UL Type 1 Kit

Item	Description	Drive Frame	Catalog Number
IP30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	B	22-JBAB
		C	22-JBAC
IP30/NEMA 1/UL Type 1 Kit for Communication Option	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes communication option conduit box with mounting screws and plastic top panel.	B	22-JBCB
		C	22-JBCC

Table B.I Communication Option Kits and Accessories

Item	Description	Catalog Number
Communication Adapters	Embedded communication options for use with the PowerFlex 4-Class drives. Requires a Communication Adapter Cover (IP20, NEMA/UL Type 1 only. Ordered Separately) BACnet® ControlNet™ DeviceNet™ EtherNet/IP™ LonWorks® PROFIBUS™ DP	 22-COMM-B 22-COMM-C 22-COMM-D 22-COMM-E 22-COMM-L 22-COMM-P
External DSI™ Communications Kit	External mounting kit for 22-COMM communication options	22-XCOMM-DC-BASE
External Comms Power Supply	Optional 100-240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1
Compact I/O Module	Three channel.	1769-SM2
Communication Adapter Cover	Cover that houses the DeviceNet Communication Adapter (IP20, NEMA/UL Type 1 only) B Frame Drive C Frame Drive	 22B-CCB 22B-CCC
Serial Converter Module (RS485 to RS232)	Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive software. Includes: DSI to RS232 serial converter (1) 1203-SFC serial cable (1) 22-RJ45CBL-C20 cable (1) DriveExplorer Lite CD (1)	22-SCM-232
DSI Cable	2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 meter serial cable with a locking low profile connector to connect to the serial converter and a 9-pin sub-miniature D female connector to connect to a computer.	1203-SFC
Null Cable Converter	For use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Splitter Cable	RJ45 one to two port splitter cable	AK-U0-RJ45-SC1
Terminating Resistors	RJ45 120 Ohm resistors (2 pieces)	AK-U0-RJ45-TR1
Terminal Block	RJ45 Two position terminal block (5 pieces)	AK-U0-RJ45-TB2P
DriveExplorer Software (CD-ROM) Version 3.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online. Compatibility: Windows 95, 98, ME, NT 4.0 (Service Pack 3 or later), 2000, XP and CE[1]	9306-4EXP01ENE
DriveExecutive software (CD-ROM) Version 1.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online and offline. Compatibility: Windows 98, ME, NT 4.0 (Service Pack 3 or later), 2000 and XP	9303-4DTE01ENE

(1) See www.ab.com/drives/driveexplorer.htm for supported devices.

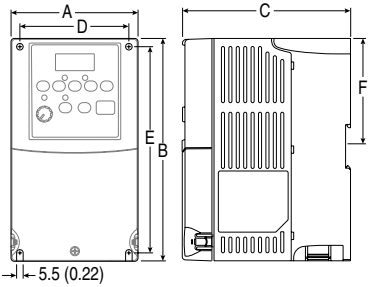
Product Dimensions

Table B.J PowerFlex 40 Frames – Ratings are in kW and (HP)

Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase	480V AC – 3-Phase	600V AC – 3-Phase
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 3.7 (5.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 4.0 (5.0) 1.5 (2.0)	0.75 (1.0) 2.2 (3.0) 1.5 (2.0) 4.0 (5.0)
C(1)		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)	5.5 (7.5) 11.0 (15.0) 7.5 (10.0)	5.5 (7.5) 11.0 (15.0) 7.5 (10.0)

(1) IP66, NEMA/UL Type 4X rated drives are not availble in Frame C drive ratings.

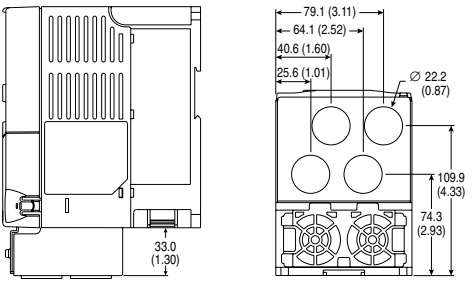
Figure B.1 IP20, NEMA/UL Type Open



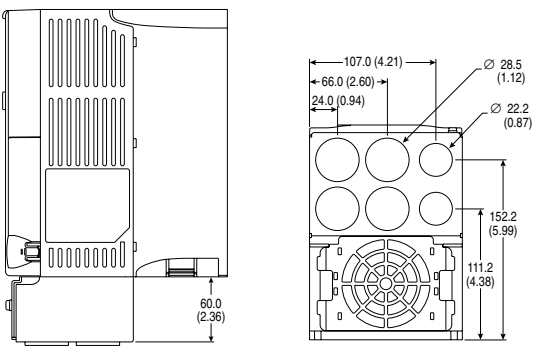
Dimensions are in millimeters and (inches).
Weights are in kilograms and (pounds).

Frame	A	B	C	D	E	F	Ship Weight
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	–	4.3 (9.5)

Figure B.2 IP30, NEMA/UL Type 1 Option Kit without Communication Option

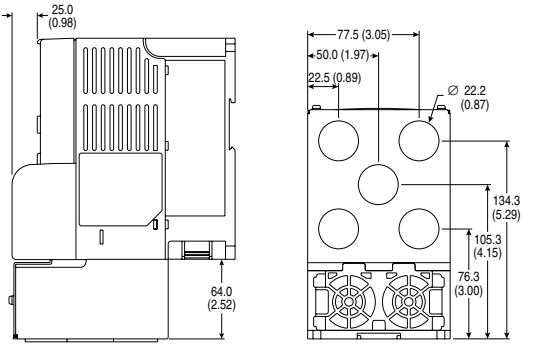


Frame B - 22-JBAB

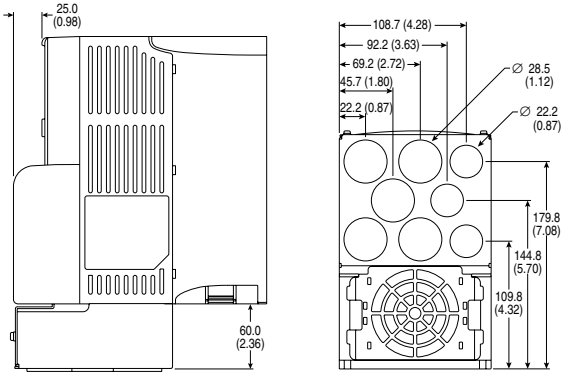


Frame C - 22-JBAC

Figure B.3 IP30, NEMA/UL Type 1 Option Kit with Communication Option – Dimensions are in millimeters and (inches)

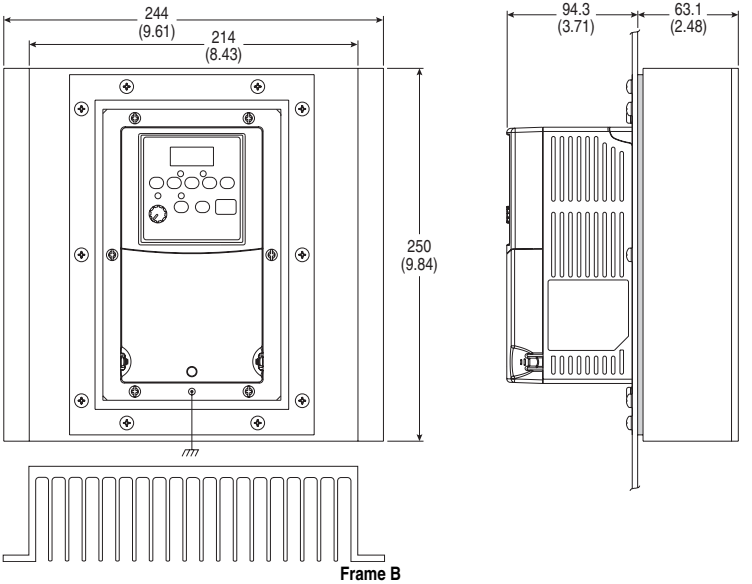


Frame B - 22-JBCB

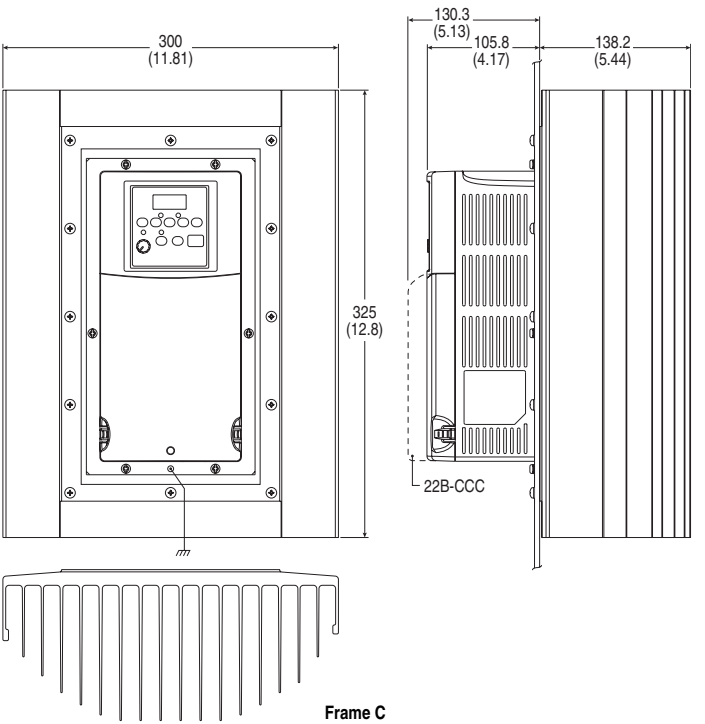


Frame C - 22-JBCC

Figure B.4 PowerFlex 40 Flange Mount Drives – Dimensions are in millimeters and (inches)

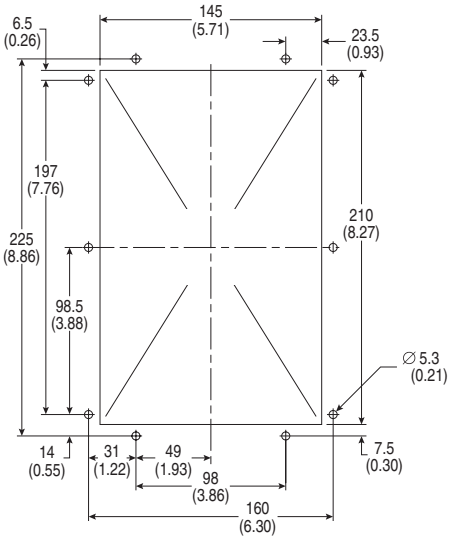


Frame B

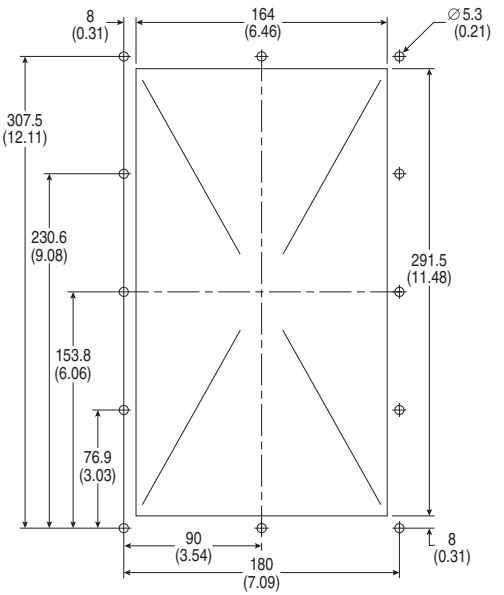


Frame C

Figure B.5 PowerFlex 40 Flange Mount Cutout Dimensions – Dimensions are in millimeters and (inches)

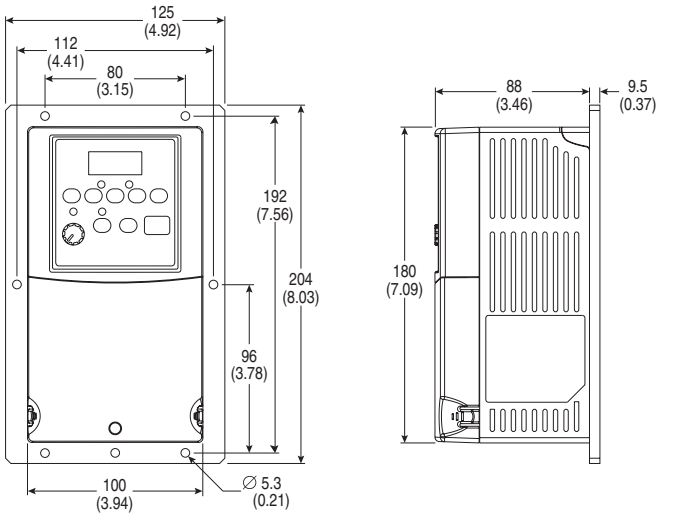


Frame B

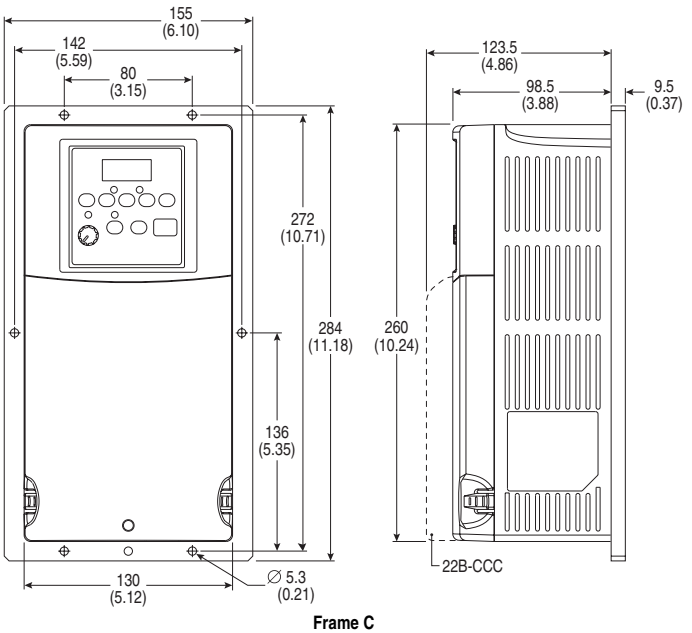


Frame C

Figure B.6 PowerFlex 40 Replacement Plate Drive Dimensions – Dimensions are in millimeters and (inches)

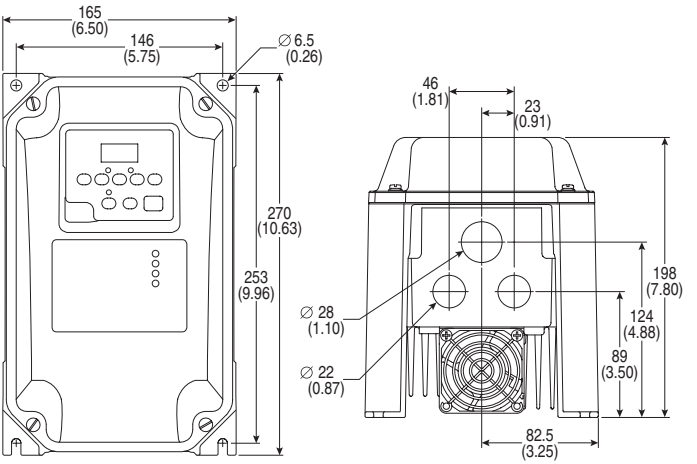


Frame B



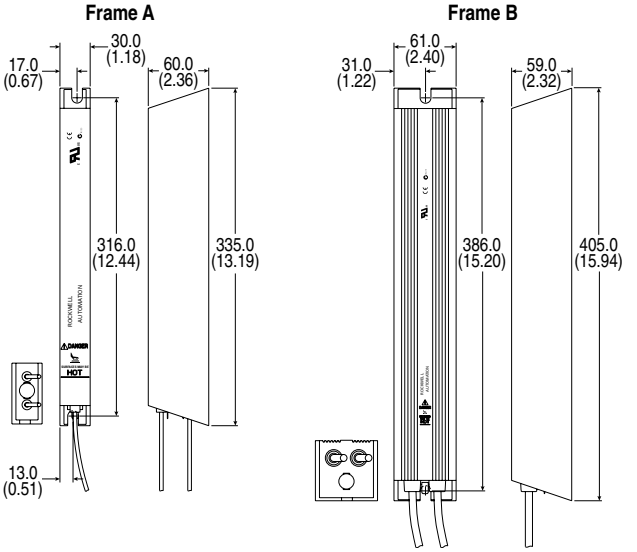
Frame C

Figure B.7 IP66, NEMA Type/UL Type 4X – Dimensions are in millimeters and (inches) Weights are in kilograms and (pounds).



Weight
5.2 (11.5)

Figure B.8 Dynamic Brake Modules – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Frame	Catalog Number	Weight
A	AK-R2-091P500, AK-R2-047P500, AK-R2-360P500	1.1 (2.5)
B	AK-R2-030P1K2, AK-R2-120P1K2	2.7 (6)

Figure B.9 Recommended External Brake Resistor Circuitry

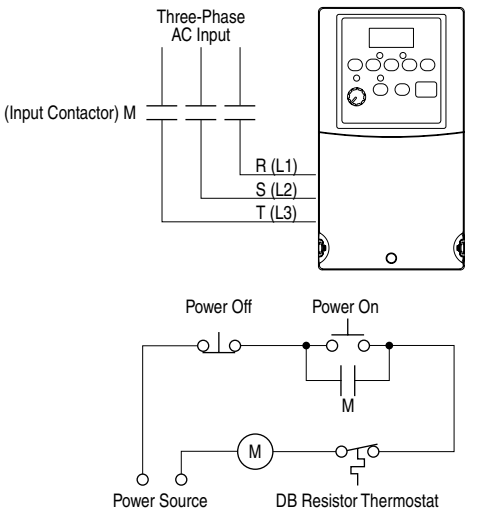
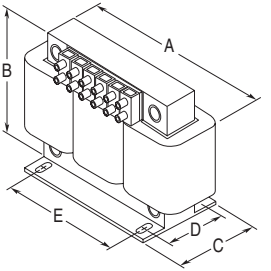


Figure B.10 Bulletin 1321-3R Series Line Reactors – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Catalog Number	A	B	C	D	E	Weight
1321-3R2-A	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R2-B	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-A	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-B	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-C	112 (4.40)	104 (4.10)	86 (3.38)	60 (2.35)	37 (1.44)	2.3 (5)
1321-3R4-D	112 (4.40)	104 (4.10)	92 (3.62)	66 (2.60)	37 (1.44)	2.7 (6)
1321-3R8-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.1 (7)
1321-3R8-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.6 (8)
1321-3R8-C	152 (6.00)	127 (5.00)	85 (3.35)	63 (2.48)	51 (2.00)	4.9 (11)
1321-3R12-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.1 (9)
1321-3R12-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.5 (10)
1321-3R18-A	152 (6.00)	133 (5.25)	79 (3.10)	54 (2.13)	51 (2.00)	4.1 (9)
1321-3R18-B	152 (6.00)	133 (5.25)	86 (3.40)	63 (2.48)	51 (2.00)	5.4 (12)
1321-3R25-A	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	4.9 (11)
1321-3R35-A	193 (7.60)	146 (5.76)	91 (3.60)	66 (2.60)	76 (3.00)	6.3 (14)

Figure B.11 Frame B EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF8P0-BL, 22-RF012-BS, -BL (Series B); 22-RF018-BS; 22-RF021-BS, -BL

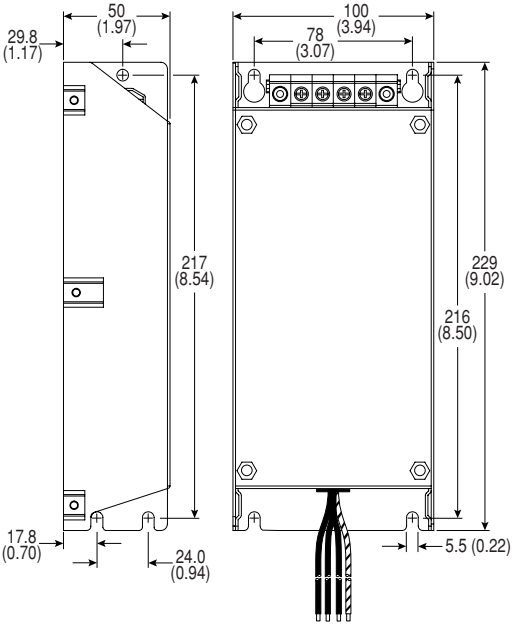


Figure B.12 Frame C EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF018-CS, -CL; 22-RF025-CL; 22-RF026-CS, -CL; 22-RF034-CS, -CL

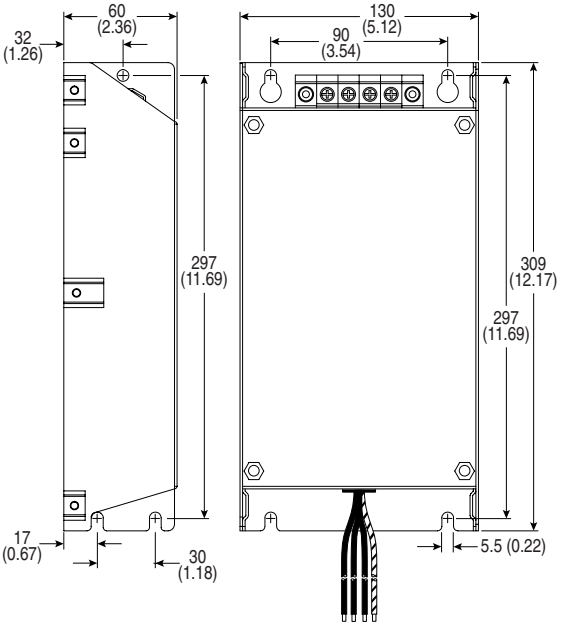
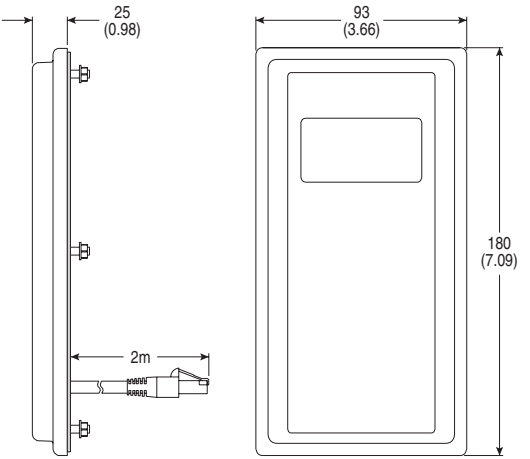


Figure B.13 Remote (Panel Mount) Small HIM – Dimensions are in millimeters and (inches) Catalog Number: 22-HIM-C2S



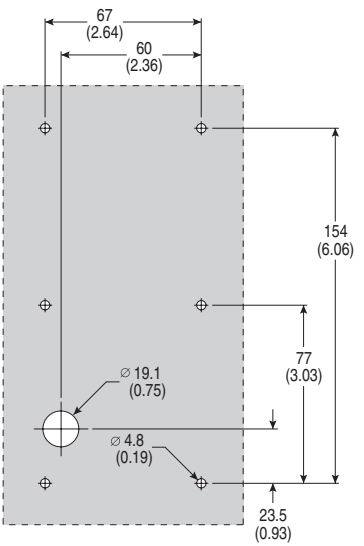
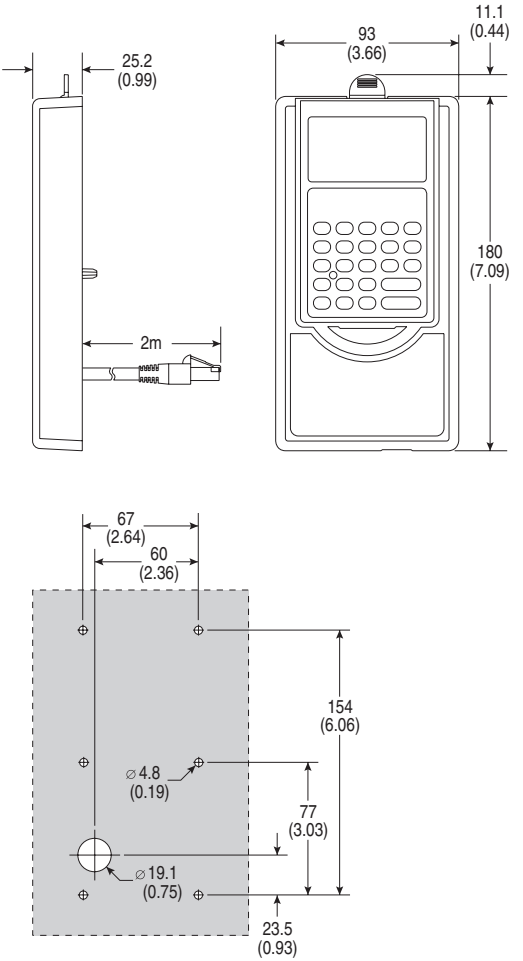
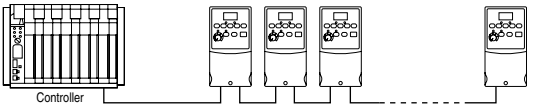


Figure B.14 NEMA Type 1 Bezel – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-B1



RS485 (DSI) Protocol

PowerFlex 40 drives support the RS485 (DSI) protocol to allow efficient operation with Rockwell Automation peripherals. In addition, some Modbus functions are supported to allow simple networking. PowerFlex 40 drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

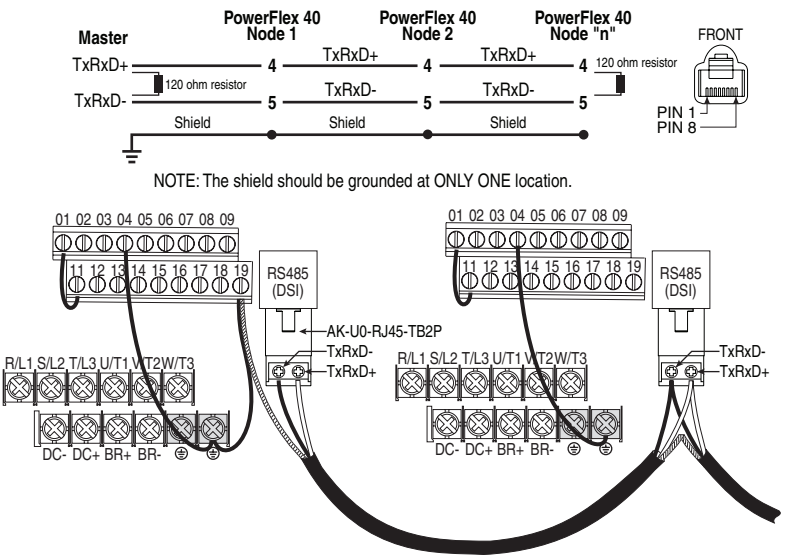


For information regarding DeviceNet or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

Figure C.1 Network Wiring Diagram



Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 40 RJ45 socket must not be connected because they contain power, etc. for other Rockwell Automation peripheral devices.

Wiring terminations on the master controller will vary depending on the master controller used and “TxRxD+” and “TxRxD-” are shown for illustration purposes only. Refer to the master controller’s user manual for network terminations. Note that there is no standard for the “+” and “-” wires, and consequently Modbus device manufacturers interpret them differently. If you have problems with initially establishing communications, try swapping the two network wires at the master controller.

Standard RS485 wiring practices apply.

- Termination resistors need to be applied at each end of the network cable.
- RS485 repeaters may need to be used for long cable runs, or if greater than 32 nodes are needed on the network.
- Network wiring should be separated from power wires by at least 0.3 meters (1 foot).
- Network wiring should only cross power wires at a right angle.

I/O Terminal 19 on the PowerFlex 40 is connected to the metal shield around the RJ45 connector. It is recommended to ground this terminal (there are two PE terminals on the drive). See Table 1.H for more information.

Network Common is internally tied to I/O Terminal 04 (Digital Common). Tying I/O Terminal 04 to PE ground may improve noise immunity in some applications.

Parameter Configuration

The following PowerFlex 40 parameters are used to configure the drive to operate on a network.

Parameter	Details	Reference
P036 [Start Source]	Set to 5 "RS485 (DSI) Port" if Start is controlled from the network.	Page 3-10
P038 [Speed Reference]	Set to 5 "RS485 (DSI) Port" if the Speed Reference is controlled from the network.	Page 3-12
A103 [Comm Data Rate]	Sets the data rate for the RS485 (DSI) Port. All nodes on the network must be set to the same data rate.	Page 3-31
A104 [Comm Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	Page 3-31
A105 [Comm Loss Action]	Selects the drive's response to communication problems.	Page 3-32
A106 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements A105 [Comm Loss Action].	Page 3-32
A107 [Comm Format]	Sets the transmission mode, data bits, parity and stop bits for the RS485 (DSI) Port. All nodes on the network must be set to the same setting.	Page 3-32

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 40 drives supports some of the Modbus function codes.

Modbus Function Code (Decimal)	Command
03	Read Holding Registers
06	Preset (Write) Single Register
16 (10 Hexadecimal)	Preset (Write) Multiple Registers

Important: Modbus devices can be 0-based (registers are numbered starting at 0) or 1-based (registers are numbered starting at 1). Depending on the Modbus Master used, the register addresses listed on the following pages may need to be offset by +1. For example, Logic Command may be register address 8192 for some master devices (e.g. ProSoft 3150-MCM SLC Modbus scanner) and 8193 for others (e.g. PanelViews).

Writing (06) Logic Command Data

The PowerFlex 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8192 (Logic Command). P036 [Start Source] must be set to 5 “RS485 (DSI) Port” in order to accept the commands.

In addition to being written, register address 8192 can be read using Function Code 03.

Logic Command		
Address (Decimal)	**Bit(s)**	**Description**
8192	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5,4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 1. Note: This bit controls the output when the value of parameter A058 is set to 20.
	7	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 2. Note: This bit controls the output when the value of parameter A061 is set to 20.
	9,8	00 = No Command
		01 = Accel Rate 1 Enable
		10 = Accel Rate 2 Enable
		11 = Hold Accel Rate Selected
	11,10	00 = No Command
		01 = Decel Rate 1 Enable
		10 = Decel Rate 2 Enable
		11 = Hold Decel Rate Selected
	14,13,12	000 = No Command
		001 = Freq. Source = P038 [Speed Reference]
		010 = Freq. Source = A069 [Internal Freq]
		011 = Freq. Source = Comms (Addr 8193)
		100 = A070 [Preset Freq 0]
		101 = A071 [Preset Freq 1]
		110 = A072 [Preset Freq 2]
		111 = A073 [Preset Freq 3]
	15	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates C-form relay. Note: This bit controls the output when the value of parameter A055 is set to 20.

Writing (06) Reference

The Speed Reference to a PowerFlex 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8193 (Reference). P038 [Speed Reference] must be set to 5 “RS485 (DSI) Port” in order to accept the Speed Reference.

In addition to being written, register address 8193 can be read using Function Code 03.

Reference	
Address (Decimal)	**Description**
8193	A decimal value entered as xxx.x where the decimal point is fixed. For example, a decimal “100” equals 10.0 Hz and “543” equals 54.3 Hz.

Reading (03) Logic Status Data

The PowerFlex 40 Logic Status data can be read via the network by sending Function Code 03 reads to register address 8448 (Logic Status).

Logic Status		
Address (Decimal)	**Bit(s)**	**Description**
8448	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	1 = Alarm, 0 = No Alarm
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Reference Controlled by Comm
	10	1 = Operation Cmd Controlled by Comm
	11	1 = Parameters have been locked
	12	Digital Input 1 Status
	13	Digital Input 2 Status
	14	Digital Input 3 Status(1)
	15	Digital Input 4 Status(1)

(1) This status is available only with firmware revision FRN 2.xx and higher.

Reading (03) Feedback

The Feedback (Output Frequency) from the PowerFlex 40 drive can be read via the network by sending Function Code 03 reads to register address 8451 (Feedback).

Feedback[2]	
Address (Decimal)	**Description**
8451	A xxx.x decimal value where the decimal point is fixed. For example, a decimal "123" equals 12.3 Hz and "300" equals 30.0 Hz.

(2) Returns the same data as Reading (03) Parameter d001 [Output Freq].

Reading (03) Drive Error Codes

The PowerFlex 40 Error Code data can be read via the network by sending Function Code 03 reads to register address 8449 (Drive Error Codes).

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
8449	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	29	Analog Input Loss
	33	Auto Restart Tries
	38	Phase U to Ground Short
	39	Phase V to Ground Short
	40	Phase W to Ground Short
	41	Phase UV Short
	42	Phase UW Short
	43	Phase VW Short
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	80	AutoTune Fail
	81	Communication Loss
	100	Parameter Checksum Error
	122	I/O Board Fail

Reading (03) and Writing (06) Drive Parameters

To access drive parameters, the Modbus register address equals the parameter number. For example, a decimal “1” is used to address Parameter d001 [Output Freq] and decimal “39” is used to address Parameter P039 [Accel Time 1].

Additional Information

Refer to **http://www.ab.com/drives/** for additional information.

Notes:

RJ45 DSI Splitter Cable

The PowerFlex 40 drive provides a RJ45 port to allow the connection of a single peripheral device. The RJ45 DSI Splitter Cable can be used to connect a second DSI peripheral device to the drive.

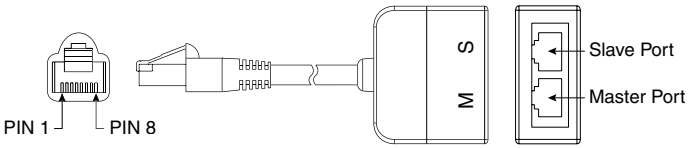
Connectivity Guidelines

ATTENTION: Risk of injury or equipment damage exists. The peripherals may not perform as intended if these Connectivity Guidelines are not followed. Precautions should be taken to follow these Connectivity Guidelines.

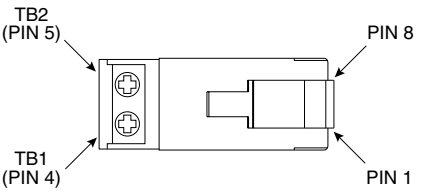
- Two peripherals maximum can be attached to a drive.
- If a single peripheral is used, it must be connected to the Master port (M) on the splitter and configured for “Auto” (default) or “Master.” Parameter 9 [Device Type] on the DSI / MDI keypads and Parameter 1 [Adapter Cfg] on the Serial Converter are used to select the type (Auto / Master / Slave).
- **Do not use the RJ45 Splitter Cable with a drive that has an internal network communication adapter installed.** Since only one additional peripheral can be added, the second peripheral can be connected directly to the RJ45 port on the drive. The internal Comm is always the Master, therefore the external peripheral must be configured as “Auto” (for temporary connections) or “Slave” (for permanent connections).
- If two peripherals will be powered up at the same time, one must be configured as the “Master” and connected to the Master port (M) and the other must be connected as the “Slave” and connected to the Slave port (S).

DSI Cable Accessories

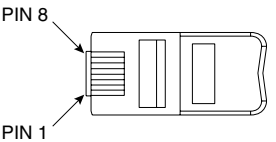
RJ45 Splitter Cable – Catalog Number: AK-U0-RJ45-SC1



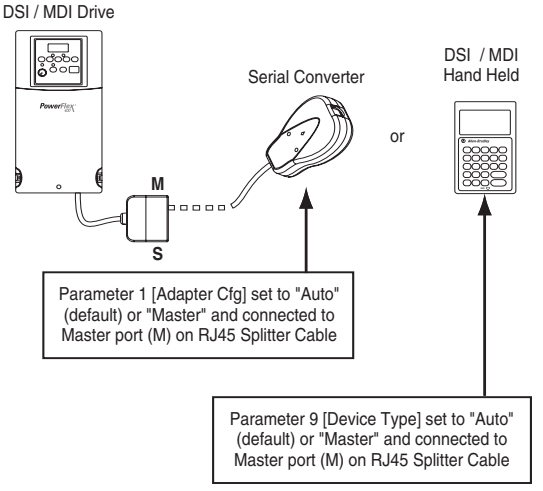
RJ45 Two-Position Terminal Block Adapter –
Catalog Number: AK-U0-RJ45-TB2P



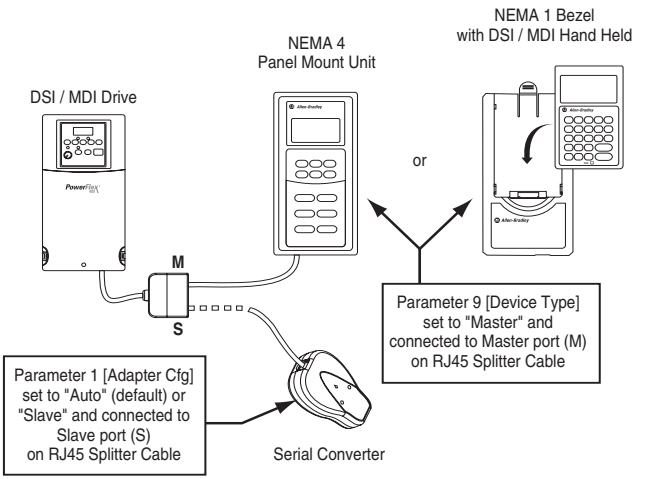
RJ45 Adapter with Integrated Termination Resistor –
Catalog Number: AK-U0-RJ45-TR1



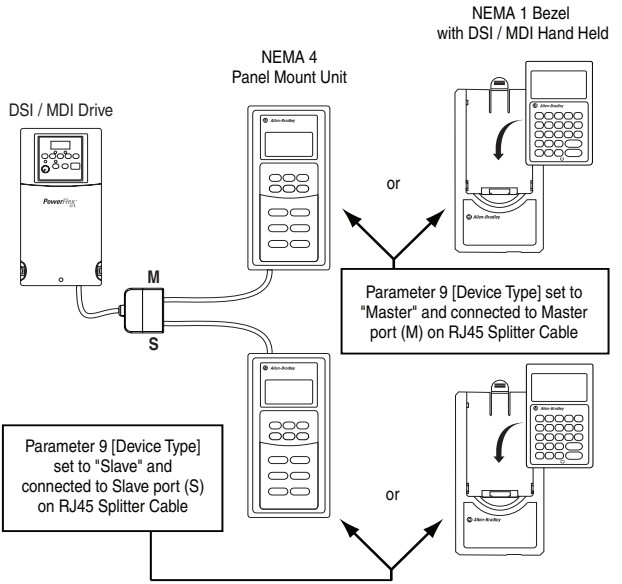
Connecting One Temporary Peripheral



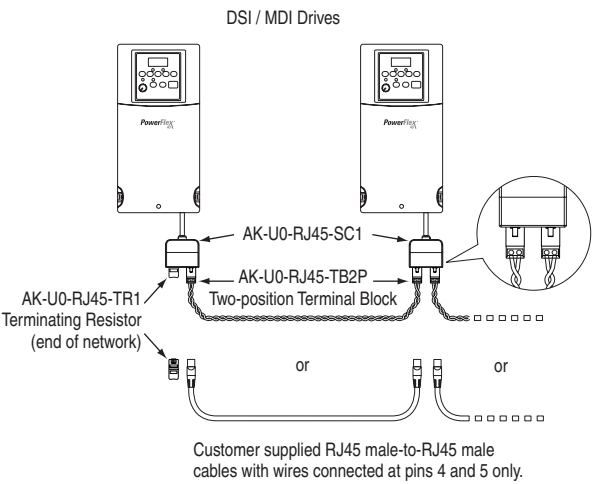
Connecting One Temporary Peripheral and One Permanent Peripheral



Connecting Two Permanent Peripherals



Connecting an RS-485 Network



Both the Master (M) and Slave (S) ports on the RJ45 Splitter Cable operate as standard RS-485 ports in this configuration.

StepLogic™, Basic Logic and Timer/Counter Functions

Four PowerFlex 40 logic functions provide the capability to program simple logic functions without a separate controller.

- StepLogic Function

  Steps through up to eight preset speeds based on programmed logic. Programmed logic can include conditions that need to be met from digital inputs programmed as “Logic In1” and “Logic In2” before stepping from one preset speed to the next. A timer is available for each of the eight steps and is used to program a time delay before stepping from one preset speed to the next. The status of a digital output can also be controlled based on the step being executed.

- Basic Logic Function

  Up to two digital inputs can be programmed as “Logic In1” and/or “Logic In2”. A digital output can be programmed to change state based on the condition of one or both inputs based on basic logic functions such as AND, OR, NOR. The basic logic functions can be used with or without StepLogic.

- Timer Function

  A digital input can be programmed for “Timer Start”. A digital output can be programmed as a “Timer Out” with an output level programmed to the desired time. When the timer reaches the time programmed into the output level the output will change state. The timer can be reset via a digital input programmed as “Reset Timer”.

- Counter Function

  A digital input can be programmed for “Counter In”. A digital output can be programmed as “Counter Out” with an output level programmed to the desired number of counts. When the counter reaches the count programmed into the output level the output will change state. The counter can be reset via a digital input programmed as “Reset Counter”.

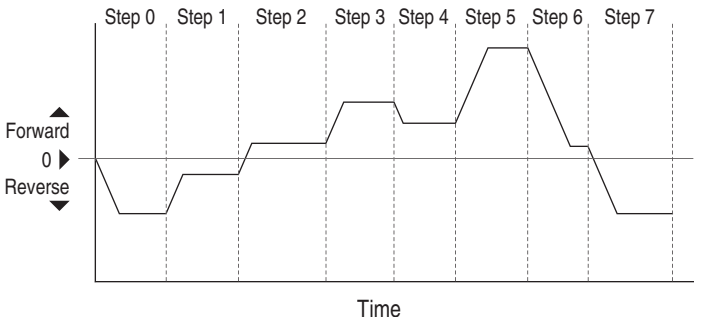
StepLogic Using Timed Steps

To activate this function, set parameter P038 [Speed Reference] to 6 “Stp Logic”. Three parameters are used to configure the logic, speed reference and time for each step.

- Logic is defined using parameters A140-A147 [Stp Logic x].
- Preset Speeds are set with parameters A070-A077 [Preset Freq x].
- Time of operation for each step is set with parameters A150-A157 [Stp Logic Time x].

The direction of motor rotation can be forward or reverse.

Figure E.1 Using Timed Steps



StepLogic Sequence

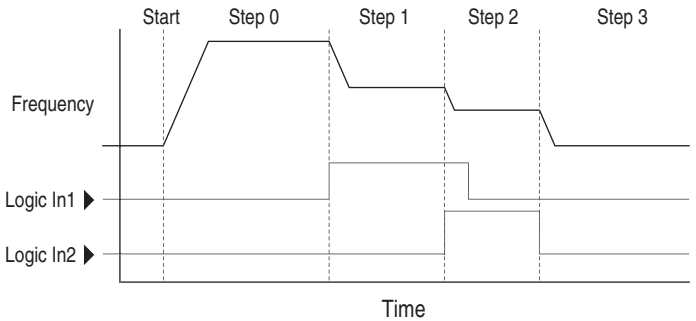
- Sequence begins with a valid start command.
- A normal sequence begins with Step 0 and transition to the next step when the corresponding StepLogic time has expired.
- Step 7 is followed by Step 0
- Sequence repeats until a stop is issued or a fault condition occurs.

StepLogic Using Basic Logic Functions

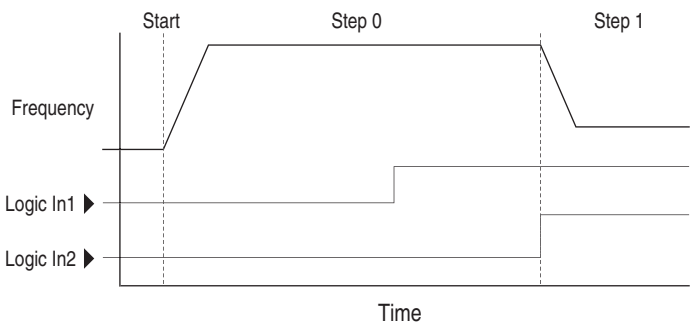
Digital input and digital output parameters can be configured to use logic to transition to the next step. Logic In1 and Logic In2 are defined by programming parameters A051-A054 [Digital Inx Sel] to option 23 “Logic In1” or option 24 “Logic In2”.

Example

- Run at Step 0.
- Transition to Step 1 when Logic In1 is true.
  Logic senses the edge of Logic In1 when it transitions from off to on. Logic In1 is not required to remain “on”.
- Transition to Step 2 when both Logic In1 and Logic In2 are true.
  The drive senses the level of both Logic In1 and Logic In2 and transitions to Step 2 when both are on.
- Transition to Step 3 when Logic In2 returns to a false or off state.
  Inputs are not required to remain in the “on” condition except under the logic conditions used for the transition from Step 2 to Step 3.



The step time value and the basic logic may be used together to satisfy machine conditions. For instance, the step may need to run for a minimum time period and then use the basic logic to trigger a transition to the next step.



Timer Function

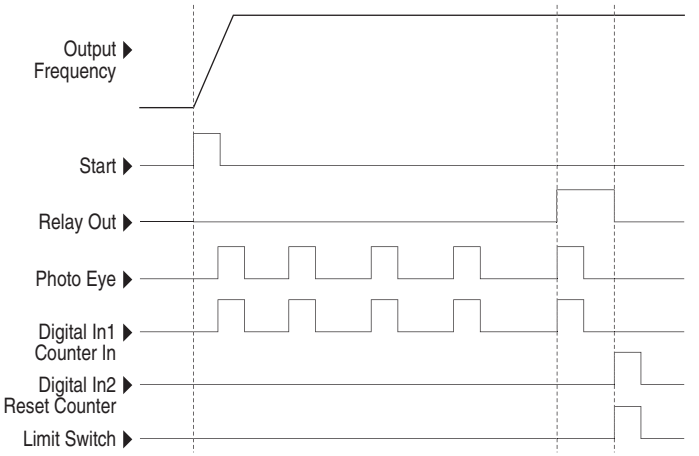
Digital inputs and outputs control the timer function and are configured with parameters A051-A054 [Digital Inx Sel] set to 18 “Timer Start” and 20 “Reset Timer”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired time in seconds.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to option 16 “Timer Out” and causes the output to change state when the preset level is reached.

Example

- Drive starts up and accelerates to 30 Hz.
- After 30Hz has been maintained for 20 seconds, a 4-20mA analog input becomes the reference signal for speed control.
- The timer function is used to select a preset speed with a 20 second run time that overrides the speed reference while the digital input is active.
- Parameters are set to the following options:
  - P038 [Speed Reference] = 3 “4-20mA Input”
  - A051 [Digital In1 Sel] = 4 “Preset Freq”
  - A052 [Digital In2 Sel] = 18 “Timer Start”
  - A055 [Relay Out Sel] = 16 “Timer Out”
  - A056 [Relay Out Level] = 20.0 Secs
  - A071 [Preset Freq 1] = 30.0 Hz
- The control terminal block is wired such that a start command will also trigger the timer start.
- The relay output is wired to I/O Terminal 05 (Digital Input 1) so that it forces the input on when the timer starts.
- After the timer is complete, the output is turned off releasing the preset speed command. The drive defaults to following the analog input reference as programmed.



Note that a “Reset Timer” input is not required for this example since the “Timer Start” input both clears and starts the timer.

Counter Function

Digital inputs and outputs control the counter function and are configured with parameters A051-A054 [Digital Inx Sel] set to 19 “Counter In” and 21 “Reset Counter”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired count value.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to 17 “Counter Out” which causes the output to change state when the level is reached.

Example

- A photo eye is used to count packages on a conveyor line.
- An accumulator holds the packages until 5 are collected.
- A diverter arm redirects the group of 5 packages to a bundling area.
- The diverter arm returns to its original position and triggers a limit switch that resets the counter.
- Parameters are set to the following options:
  - A051 [Digital In1 Sel] set to 19 to select “Counter In”
  - A052 [Digital In2 Sel] set to 21 to select “Reset Counter”
  - A055 [Relay Out Sel] set to 17 to select “Counter Out”
  - A056 [Relay Out Level] set to 5.0 (counts)

StepLogic Parameters

Table E.A Code Descriptions for Parameters A140-A147

Digit 3	Digit 2	Digit 1	Digit 0
0	0	F	1

Table E.B Digit 3 – Defines the action during the step currently executing.

Setting	Accel/Decel Parameters Used	StepLogic Output State	Commanded Direction
0	1	Off	FWD
1	1	Off	REV
2	1	Off	No Output
3	1	On	FWD
4	1	On	REV
5	1	On	No Output
6	2	Off	FWD
7	2	Off	REV
8	2	Off	No Output
9	2	On	FWD
A	2	On	REV
b	2	On	No Output

Table E.C Digit 2 – Defines what step to jump to or how to end program when the logic conditions specified in Digit 1 are met.

Setting	Logic
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Table E.D Digit 1 – Defines what logic must be met to jump to a step other than the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if “Logic In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Do not step OR no “jump to”, so use Digit 0 logic	IGNORE

Table E.E Digit 0 – Defines what logic must be met to jump to the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if “Logic In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Use logic programmed in Digit 1	IGNORE

PID Set Up

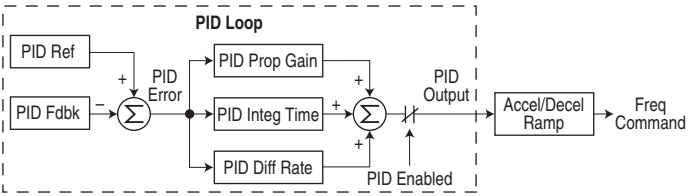
PID Loop

The PowerFlex 40 has a built-in PID (proportional, integral, differential) control loop. The PID loop is used to maintain a process feedback (such as pressure, flow or tension) at a desired set point. The PID loop works by subtracting the PID feedback from a reference and generating an error value. The PID loop reacts to the error, based on the PID Gains, and outputs a frequency to try to reduce the error value to 0. To enable the PID loop, parameter A132 [PID Ref Sel] must be set to an option other than 0 “PID Disabled”.

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

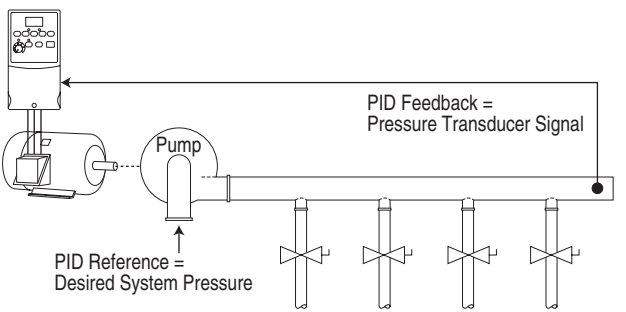
Exclusive Control

In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A132 [PID Ref Sel] is set to option 1, 2, 3 or 4. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



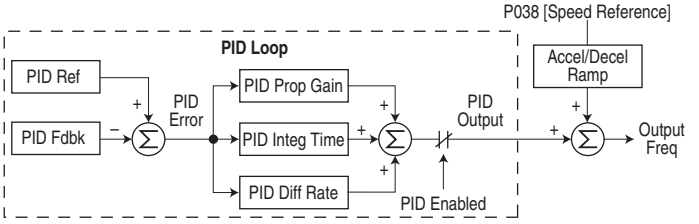
Example

- In a pumping application, the PID Reference equals the Desired System Pressure set point.
- The Pressure Transducer signal provides PID Feedback to the drive. Fluctuations in actual system pressure, due to changes in flow, result in a PID Error value.
- The drive output frequency increases or decreases to vary motor shaft speed to correct for the PID Error value.
- The Desired System Pressure set point is maintained as valves in the system are opened and closed causing changes in flow.
- When the PID Control Loop is disabled, the Commanded Speed is the Ramped Speed Reference.



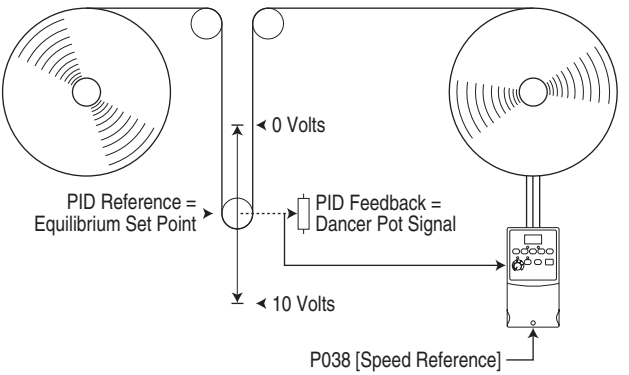
Trim Control

In Trim Control, the PID Output is added to the Speed Reference. In Trim mode, the output of the PID loop bypasses the accel/decel ramp as shown. Trim Control is used when A132 [PID Ref Sel] is set to option 5, 6, 7 or 8.



Example

- In a winder application, the PID Reference equals the Equilibrium set point.
- The Dancer Pot signal provides PID Feedback to the drive. Fluctuations in tension result in a PID Error value.
- The Master Speed Reference sets the wind/unwind speed.
- As tension increases or decreases during winding, the Speed Reference is trimmed to compensate. Tension is maintained near the Equilibrium set point.



PID Reference and Feedback

Parameter A132 [PID Ref Sel] is used to enable the PID mode (A132 ¦ 0 “PID Disabled”) and to select the source of the PID Reference. If A132 [PID Ref Sel] is not set to 0 “PID Disabled”, PID can still be disabled by select programmable digital input options (parameters A051-A054) such as “Jog”, “Local” or “PID Disable”.

Table F.A A132 [PID Ref Sel] Options

Option	Description
0 “PID Disabled”	Disables the PID loop (default setting)
1 “PID Setpoint“	Selects Exclusive Control. A137 [PID Setpoint] will be used to set the value of the PID Reference
2 “0-10V Input”	Selects Exclusive Control. Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
3 “4-20mA Input”	Selects Exclusive Control. Selects the 4-20mA Input.
4 “Comm Port”	Selects Exclusive Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.
5 “Setpnt, Trim”	Selects Trim Control. A137 [PID Setpoint] will be used to set the value of the PID Reference.
6 “0-10V, Trim”	Selects Trim Control. Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
7 “4-20mA, Trim”	Selects Trim Control. Selects the 4-20mA Input.
8 “Comm, Trim”	Selects Trim Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.

A133 [PID Feedback Sel] is used to select the source of the PID feedback.

Table F.B A133 [PID Feedback Sel] Options

Option	Description
0 “0-10V Input”	Selects the 0-10V Input (default setting). Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
1 “4-20mA Input“	Selects the 4-20mA Input.
2 “Comm Port”	The reference word from a communication network (see Appendix C of the PowerFlex 40 User Manual for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Feedback. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% Feedback. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% Feedback.

Analog PID Reference Signals

Parameters A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] are used to scale or invert an analog PID Reference.

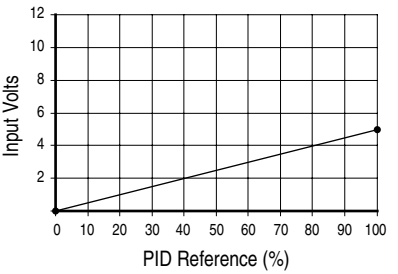
Important: Firmware version FRN 2.xx also allows PID Feedback scaling from an analog input.

Examples

Scale Function

For a 0-5 volt signal, the following parameter settings are used so that a 0 volt signal = 0% PID Reference and a 5 volt signal = 100% PID Reference.

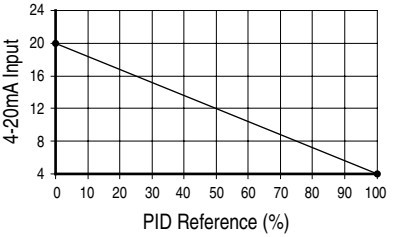
- A110 [Anlg In 0-10V Lo] = 0.0%
- A111 [Anlg In 0-10V Hi] = 50.0%
- A132 [PID Ref Sel] = 0 “0-10V Input”



Invert Function

For a 4-20mA signal, the following parameter settings are used so that a 20mA signal = 0% PID Reference and a 4mA signal = 100% PID Reference.

- A112 [Anlg In 4-20mA Lo] = 100.0%
- A113 [Anlg In 4-20mA Hi] = 0.0%
- A132 [PID Ref Sel] = 3 “4-20mA Input”



Alternatively, you can set the value of A167 [PID Invert Error] to 1 to change the sign of the PID error. See A167 [PID Invert Error] in Chapter 3 for more details.

PID Deadband

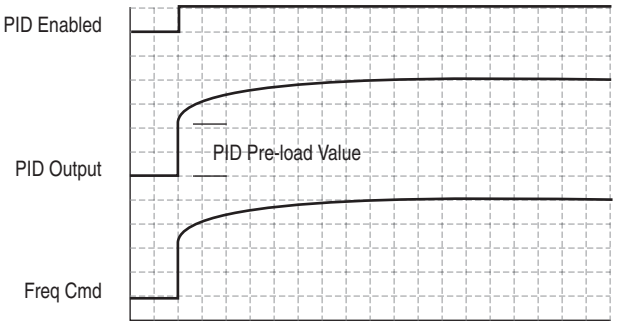
Parameter A138 [PID Deadband] is used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- [PID Deadband] is set to 5.0
- The PID Reference is 25.0%
- The PID Regulator will not act on a PID Error that falls between 20.0 and 30.0%

PID Preload

The value set in A139 [PID Preload], in Hertz, will be pre-loaded into the integral component of the PID at any start or enable. This will cause the drive's frequency command to initially jump to that preload frequency, and the PID loop starts regulating from there.



PID Limits

A130 [PID Trim Hi] and A131 [PID Trim Lo] are used to limit the PID output and are only used in trim mode. [PID Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID Trim Lo] sets the reverse frequency limit for the PID output in trim mode. Note that when the PID reaches the Hi or Lo limit, the PID regulator stops integrating so that windup does not occur.

PID Gains

The proportional, integral, and differential gains make up the PID regulator.

- A134 [PID Prop Gain]
  The proportional gain (unitless) affects how the regulator reacts to the magnitude of the error. The proportional component of the PID regulator outputs a speed command proportional to the PID error. For example, a proportional gain of 1 would output 100% of max frequency when the PID error is 100% of the analog input range. A larger value for [PID Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID Prop Gain] to 0.00 disables the proportional component of the PID loop.

- A135 [PID Integ Time]
  The integral gain (units of seconds) affects how the regulator reacts to error over time and is used to get rid of steady state error. For example, with an integral gain of 2 seconds, the output of the integral gain component would integrate up to 100% of max frequency when the PID error is 100% for 2 seconds. A larger value for [PID Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID Integ Time] to 0 disables the integral component of the PID loop.

- A136 [PID Diff Rate]
  The Differential gain (units of 1/seconds) affects the rate of change of the PID output. The differential gain is multiplied by the difference between the previous error and current error. Thus, with a large error the D has a large effect and with a small error the D has less of an effect. This parameter is scaled so that when it is set to 1.00, the process response is 0.1% of [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID Diff Rate] makes the differential term have more of an effect and a small value makes it have less of an effect. In many applications, the D gain is not needed. Setting [PID Diff Rate] to 0.00 (factory default) disables the differential component of the PID loop.

Guidelines for Adjusting the PID Gains

1. Adjust the proportional gain. During this step it may be desirable to disable the integral gain and differential gain by setting them to 0. After a step change in the PID Feedback:
   - If the response is too slow increase A134 [PID Prop Gain].
   - If the response is too quick and/or unstable (see Figure F.1), decrease A134 [PID Prop Gain].
   - Typically, A134 [PID Prop Gain] is set to some value below the point where the PID begins to go unstable.
2. Adjust the integral gain (leave the proportional gain set as in Step 1). After a step change in the PID Feedback:
   - If the response is too slow (see Figure F.2), or the PID Feedback does not become equal to the PID Reference, decrease A135 [PID Integ Time].
   - If there is a lot of oscillation in the PID Feedback before settling out (see Figure F.3), increase A135 [PID Integ Time].
3. At this point, the differential gain may not be needed. However, if after determining the values for A134 [PID Prop Gain] and A135 [PID Integ Time]:
   - Response is still slow after a step change, increase A136 [PID Diff Rate].
   - Response is still unstable, decrease A136 [PID Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

Figure F.1 Unstable

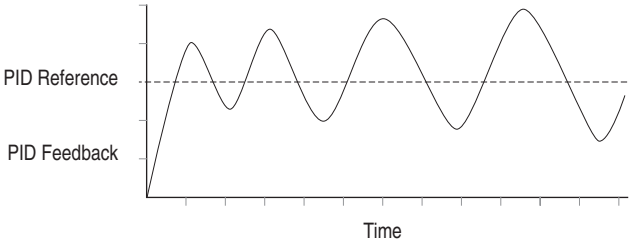


Figure F.2 Slow Response – Over Damped

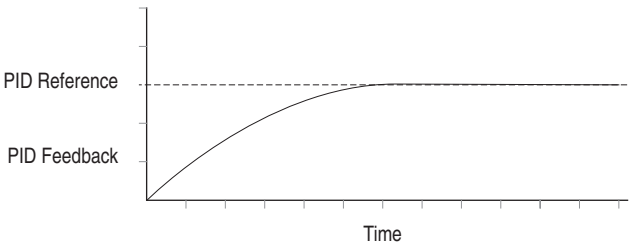


Figure F.3 Oscillation – Under Damped

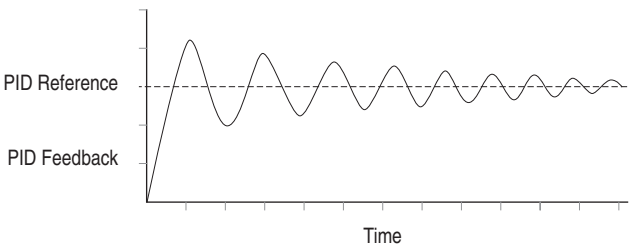
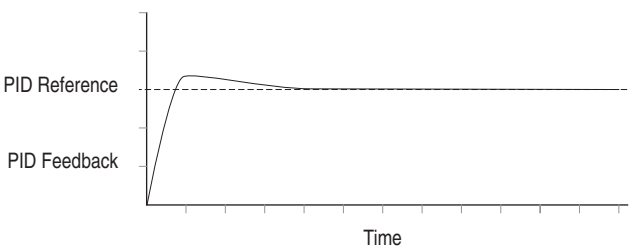


Figure F.4 Good Response – Critically Damped



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Notes:

U.S. Allen-Bradley Drives Technical Support
Tel: (1) 262.512.8176, Fax: (1) 262.512.2222, Email: support@drives.ra.rockwell.com, Online: www.ab.com/support/abdrives

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Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
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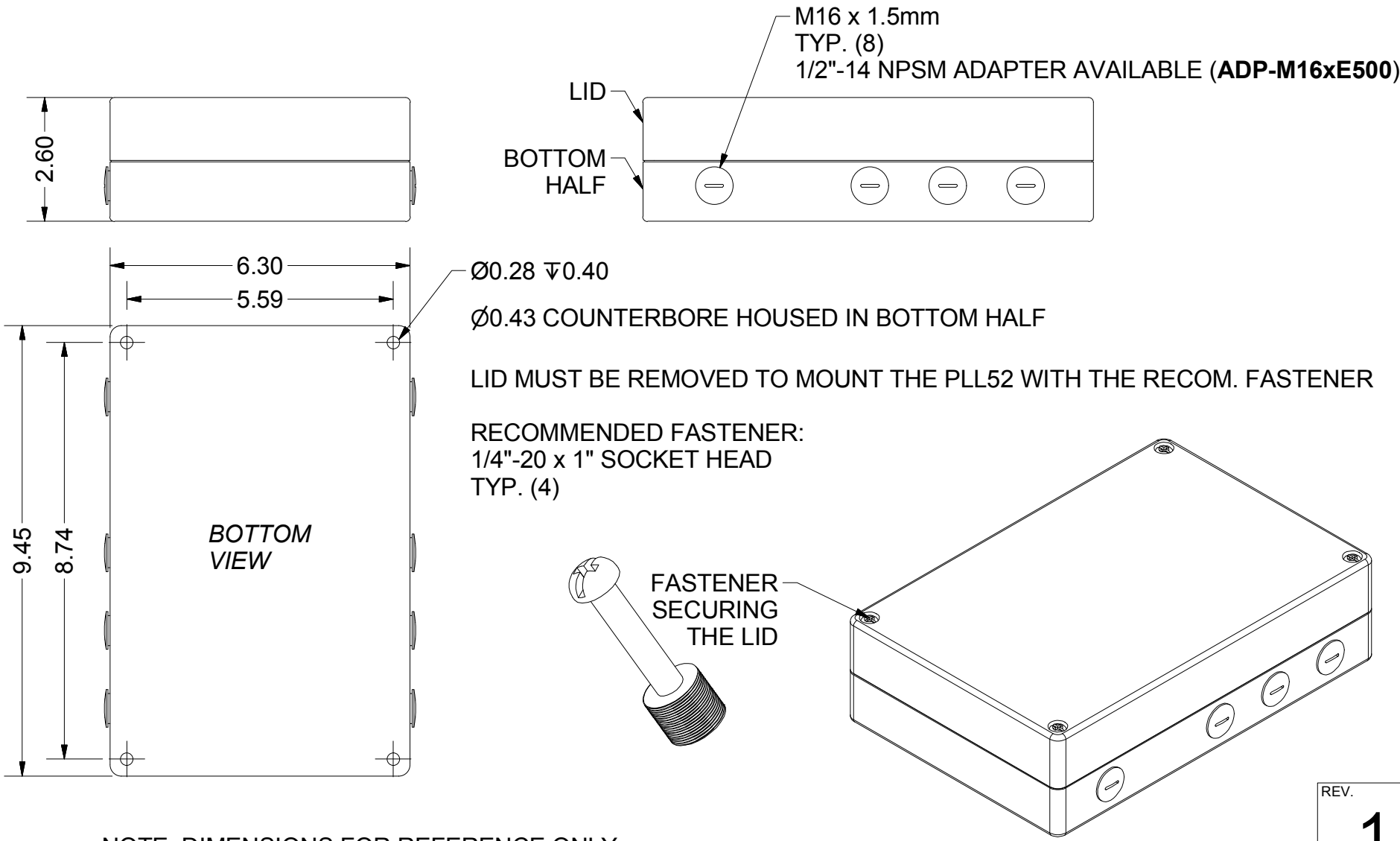
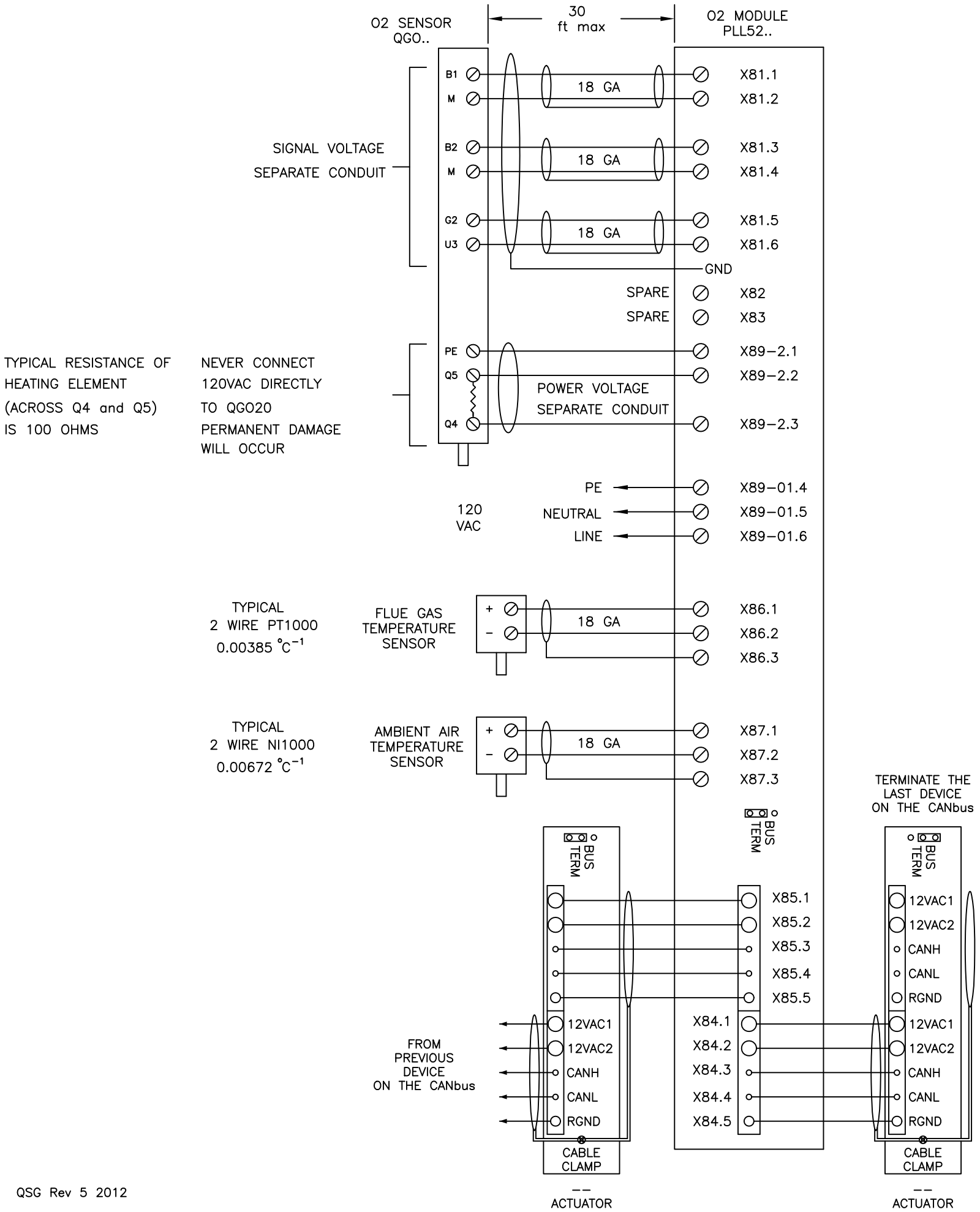


NOTE: DIMENSIONS FOR REFERENCE ONLY

REV. 1

MATERIAL	SCC Inc.	DESCRIPTION	
FINISH	Elk Grove Village, IL 60007 PH# 224-366-8445	O2 Trim CANbus Interface	
TOLERANCES (UNLESS OTHERWISE SPECIFIED) FRACT. +/- 0/00 .XX +/- 0.01 .XXX +/- 0.005 ANG. +/- 0.5˚ ALL DIMENSIONS IN INCHES UNLESS NOTED	ENGINEER / DRAWN BY: DAG / CHECKED BY	DATE ORIGINATED: 1/7/2013	SHEET: 1 of 1 / SCALE: 1/3
This Drawing and all information contained in this Drawing is the Property of SCC Inc.		PART / DRAWING #: PLL52.110A100	

O2 MODULE

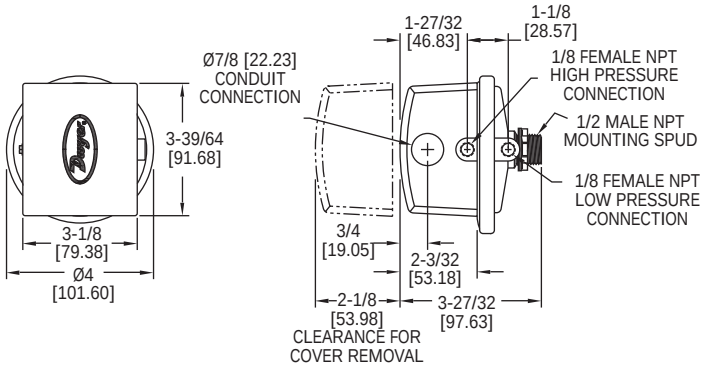

O2 SENSOR
QGO..
30
ft max
O2 MODULE
PLL52..
B1
M
B2
M
G2
U3
18 GA
18 GA
18 GA
X81.1
X81.2
X81.3
X81.4
X81.5
X81.6
SIGNAL VOLTAGE
SEPARATE CONDUIT
GND
SPARE
SPARE
X82
X83
PE
Q5
Q4
X89–2.1
X89–2.2
X89–2.3
POWER VOLTAGE
SEPARATE CONDUIT
TYPICAL RESISTANCE OF
HEATING ELEMENT
(ACROSS Q4 and Q5)
IS 100 OHMS
NEVER CONNECT
120VAC DIRECTLY
TO QGO20
PERMANENT DAMAGE
WILL OCCUR
120
VAC
PE
NEUTRAL
LINE
X89–01.4
X89–01.5
X89–01.6
TYPICAL
2 WIRE PT1000
0.00385 °C⁻¹
FLUE GAS
TEMPERATURE
SENSOR
+
–
18 GA
X86.1
X86.2
X86.3
TYPICAL
2 WIRE NI1000
0.00672 °C⁻¹
AMBIENT AIR
TEMPERATURE
SENSOR
+
–
18 GA
X87.1
X87.2
X87.3
TERMINATE THE
LAST DEVICE
ON THE CANbus
BUS
TERM
BUS
TERM
BUS
TERM
X85.1
X85.2
X85.3
X85.4
X85.5
12VAC1
12VAC2
CANH
CANL
RGND
X84.1
X84.2
X84.3
X84.4
X84.5
12VAC1
12VAC2
CANH
CANL
RGND
FROM
PREVIOUS
DEVICE
ON THE CANbus
CABLE
CLAMP
CABLE
CLAMP
ACTUATOR
ACTUATOR

Series 1800 Low Differential Pressure Switches for General Industrial Service

Specifications — Installation and Operating Instructions

Model 1823 pressure switch. UL and CSA Listed, FM and CENELEC approved.

Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

One of our most popular pressure switches. Combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side.

***Model 1823 shown; (1823 replaces 1820, 1821 and 1822 which are similar).**

Environmental (MIL) Switch

Unlisted Model 1820 can be furnished with special snap switch sealed against the environment for high humidity and/or for government applications. Similar to standard Model 1823 except dead band is slightly greater. Specify Model 1820 (Range No.) "MIL" in ordering.

SERIES 1823 SWITCHES — OPERATING RANGES & DEADBANDS

Model Number	Operating Range, Inches W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.10
1823-80	9 to 85	1.30	3.0

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult Factory.
Temperature Limits: -30 to 180°F (-34 to 82.2°C). 1823-00, -20 to 180°F (-28.9 to 82.2°C).
Pressure Limits: 10 psig (68.95 kPa) continuous, 25 psig (172.4 kPa) surge.
Switch Type: Single-pole double-throw (SPDT).
Repeatability: ±2%.
Electrical Rating: 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @125 VAC, 1/4 HP @ 250 VAC, 60 Hz. De-rate to 10 A for operation at high cycle rates.
Electrical Connections: 3 screw type, common, normally open and normally closed.
Process Connections: 1/8˝ female NPT.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Set Point Adjustment: Screw type inside mounting spud.
Weight: 1 lb, 5 oz (595 g).
Agency Approvals: CE, UL, CSA, FM.

DWYER INSTRUMENTS, INC.
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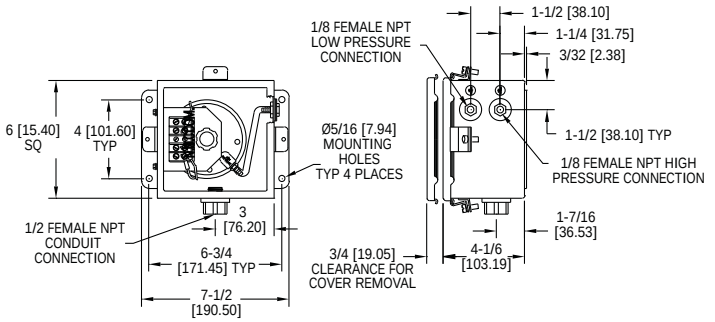
Phone: 219/879-8000 www.dwyer-inst.com
Fax: 219/872-9057 e-mail: info@dwyer-inst.com

INSTALLATION

1. Select a location free form excessive vibration and where oil or water will not drip upon the switch. See special housings for unusual conditions.
2. **While not required, positioning the pressure connections down is recommended.** Mount the switch with the diaphragm in a vertical plane. Switch with the diaphragm in a vertical plane. Switch must be recalibrated for each change in operating position.
3. Connect switch to source of pressure differential. Metal tubing with 1/4" O.D. is recommended but any tubing system which will not restrict the air flow is satisfactory. Note that the low pressure connection may be made to the 1/2" spud at the back of the switch if desired. If so connected, drill 1/16" diameter holes in the Spring Retainer flange and the head of Adjustment Screw to provide opening to the switch interior and plug the other low pressure connection.
4. Electrical connections to the standard single pole, double throw snap switch are provided by means of screw terminals marked "common", "norm open", and "norm closed". The normally open contacts close and the normally closed contact open when pressure increases beyond the set point.
5. Switch loads should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with high load inductance or rapid cycle rates. whenever and application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonged switch life.

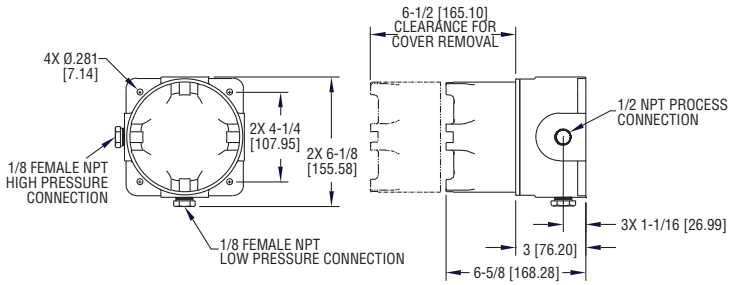
ADJUSTMENT

1. If the switch has been factory preset, check the set-point before placing in service to assure it has not shifted in transit.
2. If switching has not been preset or it is desired to change the point, observe the following procedure:
   a. To adjust the set point turn the slotted Adjustment Screw clockwise to increase the set point and counterclockwise to decrease the set point.
   b. The following is a recommended procedure for calibrating or checking calibration: Use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point slowly. Note the manometer and pressure switch will have different response characteristics due to different internal volumes, lengths of tubing, oil drainage, etc. Be certain switch is checked in position it will assume in use, i.e. vertical, horizontal, etc.



Weatherproof Enclosure

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5-1/2 lb (2.5 kg). Switch must be installed at factory. Specify "WP" in addition to switch catalog number.



Explosion-Proof Housing

Cast iron base and aluminum dome cover. Approximate weight 7-1/2 lb (3.4 kg). Specify "EXPL" in addition to switch catalog number. Rated Class I, Groups C & D, Div. 1. Class II, Groups E, F, & G, Div. 1.

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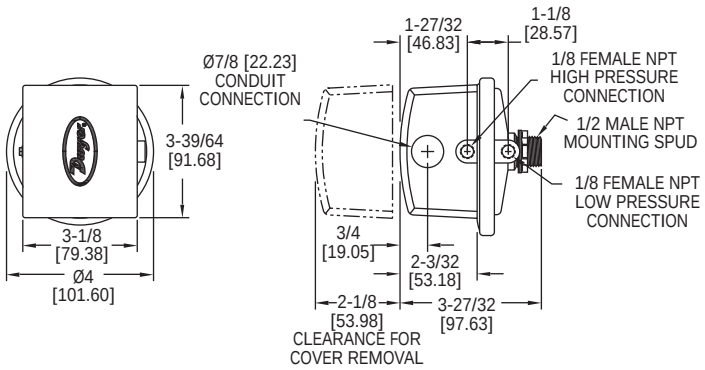
SERIE 1800 Interruptor Para Baja Presión Diferencial

Model 1823 pressure switch. UL and CSA Listed, FM approved.

Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

Uno de nuestros mas populares interruptores de presión. Combina un pequeño tamaño y bajo precio, con una repetibilidad del 2%, exactitud suficiente para las aplicaciones con mas demanda. El ajuste del punto de operación en un extremo, permite instalar el interruptor de un lado en las pared o tablero, permitiendo acceso al tornillo de ajuste.

Interruptor para Ambiente Húmedo (MIL)

El modelo 1820 puede ser fabricado son un sello especial a prueba de intemperie, o para aplicaciones con alta humedad. Similar al modelo 1823, excepto que la banda de operación es mayor.

Especifique el modelo 1820 (Rango No.) “Mil” en su orden.

Model Number	Operating Range, Inches W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.10
1823-80	9 to 85	1.30	3.0

Especificaciones:
Interruptor de presión diferencial operado por diafragma de 4”, para activar un interruptor de presión tipo simple polo doble tiro. El diafragma esta controlado por un resorte calibrado que se puede ajustar para fijar la presión diferencial exacta a la cual el interruptor actuara. El movimiento del diagragma es transmitido al botón del interruptor por un medio mecánico. Interruptor Dwyer Instruments, Inc. Catalogo No. 1823-__ __ para el rango de operación requerido.

SPECIFICATIONS
Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult Factory.
Temperature Limits: -30 to 180°F (-34 to 82.2°C). 1823-00, -20 to 180°F (-28.9 to 82.2°C).
Pressure Limits: 10 psig (68.95 kPa) continuous, 25 psig (172.4 kPa) surge.
Switch Type: Single-pole double-throw (SPDT).
Repeatability: ±2%.
Electrical Rating: 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @125 VAC, 1/4 HP @ 250 VAC, 60 Hz. De-rate to 10 A for operation at high cycle rates.
Electrical Connections: 3 screw type, common, normally open and normally closed.
Process Connections: 1/8˝ female NPT.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Set Point Adjustment: Screw type inside mounting spud.
Weight: 1 lb, 5 oz (595 g).
Agency Approvals: CE, UL, CSA, FM.

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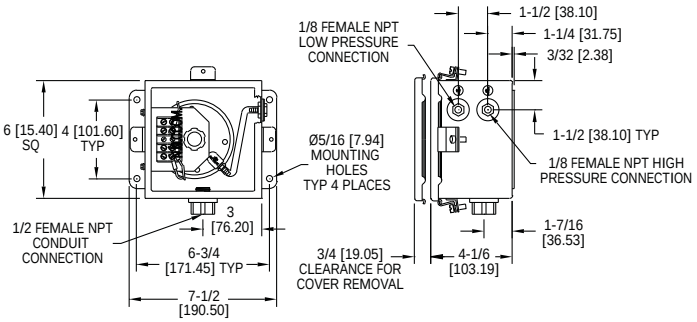
INSTALACIÓN:

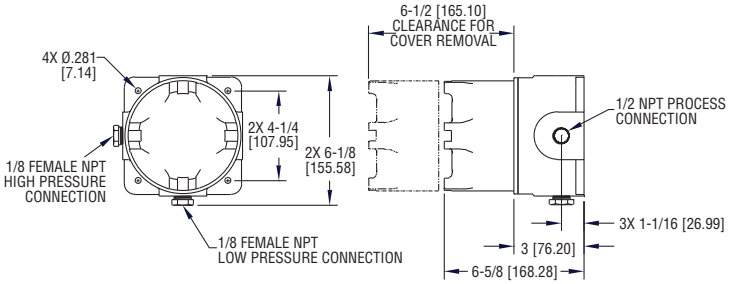
1. Seleccione una ubicación libre de vibración excesiva, en donde el agua o aceite no entre al interruptor. Revise encapsulados especiales para aplicaciones especiales.
2. Mientras no se requiera otra, las conexión de presión inferior es recomendada. Monte el interruptor con el diafragma en posición vertical, el interruptor debe recalibrarse para cada cambio de posición.
3. Conecte el interruptor a la fuente de presión diferencial. Tubo metálico con diámetro de 1/4" es recomendado, pero cualquier sistema de tubería que no restrinja el flujo de aire es bueno.
4. Conexiones eléctricas estándar de los interruptores SPDT, común, NA y NC. Los contactos cambian cuando se incrementa la presión del punto de operación.
5. La carga del interruptor no debe exceder los 15 Amp. Especificados. Las capacidades decrecen con altas cargas inductivas y ciclos rápidos de actuación, por lo que en estos casos los limites de corriente deben ser 10 Amp. 0 menores para incrementar la vida del interruptor.

AJUSTES:

1. Si el interruptor ha sido calibrado en fabrica, revise el punto de operación antes de ponerlo en servico.
2. De lo contrario, siga los siguientes pasos:
   A. Para ajustar el punto de operación, gire el tornillo de calibración en sentido de las manecillas del reloj para aumentar el valor y en contra de las manecillas del reloj para dis minuir el valor del punto de operación.
   B. Lo siguiente se recomienda para calibrar o revisar la calibración: Use una T con tres mangueras plásticas, tan pequeñas como sean posible. Conecte una manguera al interruptor de presión, otra al manómetro y por la tercera aplique la presión de esta forma podrá ajustar el interruptor a la presión requerida lo mas exacto posible.



Encapsulado a Prueba de Intemperie
Encapsulado de acero para condiciones húmedas y/o aceitosas, soporta pruebas de 200 horas de spray salino, pesa 5-1/2 libras. El interruptor debe ser instalado en la planta al momento de su fabricación. Especifique "WP" mas el modelo del interruptor en catalogo.



Encapsulado a Prueba de Explosión
Encapsulado a base de Hierro y Aluminio, pesa aproximadamente 7-1/2 libras. Especifique "EXPL" mas modelo del interruptor en catalogo.

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Allanson
ENVIRONMENTAL ELECTRICS

Industrial Gas Transformers

Ferromagnetic, Single Pole, One End Ground Models

These devices are designed for CONSTANT DUTY and provide the most reliable ignition source for commercial/industrial gas applications.

Absolute Maximum Ratings Model #	**1092**	**1112**	**1196**	**542**
Input Supply Voltage (V)	120	240	240	120
Input Supply Frequency (Hz)	50/60	60	50	60
Primary Voltage - Amperes (VA)	150	150	150	265
Secondary Voltage (RMS)	6000	6000	6000	10000
Secondary Short Circuit Current (mA)	25/20	20	20	23
Storage Temperature (degrees C)	-40 to +80	-40 to +80	-40 to +80	-40 to +80
Operating Temperature (degrees C)	-30 to +40	-30 to +40	-30 to +40	-30 to +40
Operating Relative Humidity (%)	90	90	90	90
Loading Air Gap (inches)	1/16 - 1/8	1/16 - 1/8	1/16 - 1/8	1/16 - 1/8

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Phone: 631-293-3880 | Fax 1-631-293-3470

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325 SERIES

Lever Acting Design

Maxitrol's 325 Series pounds to inches regulators are for use on residential, commercial, and industrial applications.
The 325 Series features a high leverage valve linkage assembly to deliver positive dead-end lock-up. The regulators are capable of precise control from full flow down to pilot flow.

325-3

NOTE: The 325-9 will be available 2Q2014.

Specifications

Pipe Sizes ..... 3/8″ to 2″ threaded connections with NPT or ISO7-1 threads.

Housing Material ..... 325-3, 325-5, 325-7A, 325-9: aluminum.

Mounting ..... Suitable for multi-positional mounting. If ball check vent limiting device is installed, mount in an upright position only.
NOTE: All Maxitrol gas pressure regulators should be installed and operated in accordance with Maxitrol Safety Warning Instructions (see GPR_MI_EN.ES or GPR_CSA_MI_EN.FR).

Certifications ..... 325-3, 325-5: ANSI Z21.18/CSA 6.3 Gas Appliance Pressure Regulators.

Gas Types ..... Suitable for natural, manufactured, mixed gases, liquefied petroleum gases, and LP gas-air mixtures.

Maximum Inlet Pressure ..... CSA Certified: 325-3, 325-5: 2 psi (13.8 kPa), 5 psi (34.5 kPa)
Maxitrol Tested: 325-3, 325-5, 325-7A, 325-9: 10 psi (69 kPa)
With Vent Limiter 12A09, 12A39, or 12A49 Installed:
325-3, 325-5, 325-7A, 325-9: 5 psi (34.5 kPa) - Natural, 2 psi (13.8 kPa) - LP

Emergency Exposure Limits .....65 psi (450 kPa) (inlet side only)

Maximum Individual Load ..... Largest single appliance served by the regulator: 325-3: 100,000 Btu/h;
325-5: 325,000 Btu/h; 325-7A: 1,250,000 Btu/h, 325-9: 2,250,000 Btu/h

Capacity .....Total load of multiple appliances combined: 325-3: 150,000 Btu/h;
325-5: 325,000 Btu/h; 325-7A: 1,250,000 Btu/h; 325-9: 2,250,000 Btu/h
NOTE: Capacities are used to determine the maximum multiple appliance load. The largest single appliance served by the regulator should not exceed the maximum individual load specified above.

Ambient Temperature Ranges .....-40 to 205°F (-40 to 96°C)

Minimum Regulation..... Suitable for pilot flow applications. Ⓟ (Circle P) (0.15 CFH NG), ▽P (Delta P) 0.50 CFH NG).

Imblue Technology™..... 325-3, 325-5, 325-7A, 325-9 models may be ordered with Imblue Technology™. Imblue Technology™ increases corrosion resistance and provides extra protection against the elements for regulators used in outdoor applications. Add suffix letter "B" to model number when ordering.

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Capacities: based on 1" w.c. pressure drop, from set point**

Capacities expressed in CFH (m^3/h) @ 0.64 sp gr gas

Model	Pipe Size	Outlet Pressure Set Point	CSA MAX CFH	Operating Inlet Pressure					
				0.5 psi (3.4 kPa)	0.75 psi (5.2 kPa)	1 psi (6.9 kPa)	2 psi (13.8 kPa)	5 psi (34.5 kPa)	10 psi (69.0 kPa)
325-3	3/8" x 3/8" 1/2" x 1/2"	4.0" w.c. (1.0 kPa)	150 (4.2)	160 (4.5)	190 (5.4)	220 (6.2)	220 (6.2)	300 (8.5)	320 (9.1)
		7.0" w.c. (1.7 kPa)	150 (4.2)	120 (3.4)	150 (4.2)	180 (5.1)	220 (6.2)	290 (8.2)	320 (9.1)
		10.0" w.c. (2.5 kPa)	150 (4.2)	100 (2.8)	120 (3.4)	150 (4.2)	220 (6.2)	280 (7.9)	320 (9.1)
325-5	1/2" x 1/2" 3/4" x 3/4" 1" x 1"	4.0" w.c. (1.0 kPa)	325 (9.2)	340 (9.6)	390 (11.0)	450 (12.7)	560 (15.9)	680 (19.3)	750 (21.2)
		7.0" w.c. (1.7 kPa)	325 (9.2)	260 (7.4)	360 (10.2)	410 (11.6)	530 (15.0)	680 (19.3)	750 (21.2)
		10.0" w.c. (2.5 kPa)	325 (9.2)	240 (6.8)	320 (9.1)	360 (10.2)	300 (8.5)	650 (18.4)	750 (21.2)
325-7A	1 1/4" x 1 1/4" 1 1/2" x 1 1/2"	4.0" w.c. (1.0 kPa)	—	850 (24.0)	1060 (30.0)	1190 (33.7)	1600 (45.3)	2090 (59.2)	2190 (62.0)
		7.0" w.c. (1.7 kPa)	—	780 (22.0)	950 (26.9)	1060 (30.0)	1500 (42.5)	1860 (52.7)	2060 (58.3)
		10.0" w.c. (2.5 kPa)	—	650 (18.4)	860 (24.4)	990 (28.0)	1300 (36.8)	1620 (45.9)	2060 (58.3)
325-9	1 1/2" x 1 1/2" 2" x 2"	4.0" w.c. (1.0 kPa)	—	1815 (51.4)	2075 (58.8)	2250 (63.7)	2660 (75.3)	3550 (100.5)	3750 (106.2)
		7.0" w.c. (1.7 kPa)	—	1430 (40.5)	1660 (47.0)	1960 (55.5)	2570 (72.8)	3420 (96.8)	3750 (106.2)
		10.0" w.c. (2.5 kPa)	—	1275 (36.1)	1450 (41.1)	1720 (48.7)	2160 (61.2)	3150 (89.2)	3750 (106.2)

NOTE: Maximum Individual Load: 325-3(B) is 100 CFH (2.8 m^3/h); 325-5(B) is 325 CFH (9.2 m^3/h); 325-7A(B) is 1250 CFH (35.4 m^3/h); 325-9(B) is 2250 CFH (63.7). Approval based on use as an appliance regulator. **Set points (in CFH): 325-3(B) = 50; 325-5(B) = 150; 325-7A(B) = 500; 325-9(B)=1000.

See pages 58-59 for Regulator Sizing Requirements and Examples.

Pressure Drop: 0.64 sp gr gas expressed in CFH (m^3/h) (for system pressure drop calculations)

Model	7.0" w.c. (1.7 kPa)	0.5 psi (3.4 kPa)	0.75 psi (5.2 kPa)	1 psi (6.9 kPa)	2 psi (13.8 kPa)
325-3	145 (4.0)	204 (5.8)	250 (7.0)	289 (8.2)	—
325-5	400 (11.3)	550 (15.6)	670 (19.0)	770 (21.8)	—
325-7A	815 (23.1)	1149 (32.5)	1405 (39.8)	1624 (46.0)	2305 (65.3)
325-9	1360 (38.5)	2113 (59.8)	2557 (72.4)	2949 (83.5)	4059 (114.8)

Spring Selection Chart: inches w.c. (kPa) unless noted

Model Number	CSA Certified				Standard Spring	Other Springs Available			
	2 psi (13.8 kPa)		5 psi (34.5 kPa)						
325-3	5 to 9 (1.25 to 2.25) Plated	7 to 11 (1.7 to 2.7) White	6 to 10 (1.5 to 2.5) Plated	7 to 11 (1.7 to 2.7) White	4 to 12 (1.0 to 3.0) Violet	2 to 6 (0.5 to 1.5) Plated	10 to 22 (2.5 to 5.5) Red	15 to 30 (3.7 to 7.5) Yellow	1 to 2 psi (6.9 to 13.9) Tagged
325-5	5 to 9 (1.25 to 2.25) Plated	7 to 11 (1.7 to 2.7) White	6 to 10 (1.5 to 2.5) Plated	7 to 11 (1.7 to 2.7) White	4 to 12 (1.0 to 3.0) Violet	2 to 6 (0.5 to 1.5) Plated	10 to 22 (2.5 to 5.5) Red	15 to 30 (3.7 to 7.5) Yellow	1 to 2 psi (6.9 to 13.9) Tagged
325-7A	—	—	—	—	4 to 12 (1.0 to 3.0) Violet	2 to 5 (0.5 to 1.5) Plated	10 to 22 (2.5 to 5.5) Red	15 to 30 (3.7 to 7.5) Yellow	20 to 42 (5.0 to 10.4) Black
325-9	—	—	—	—	4 to 12 (1.0 to 3.0) Violet	2 to 5 (0.5 to 1.5) Plated	10 to 22 (2.5 to 5.5) Red	15 to 30 (3.7 to 7.5) Yellow	20 to 42 (5.0 to 10.4) Black

NOTE: See pages 56-57 for complete Spring Selection Chart.

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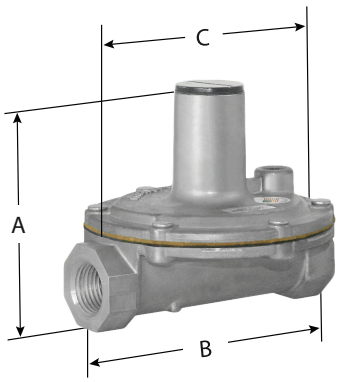
325 SERIES
Lever Acting Design

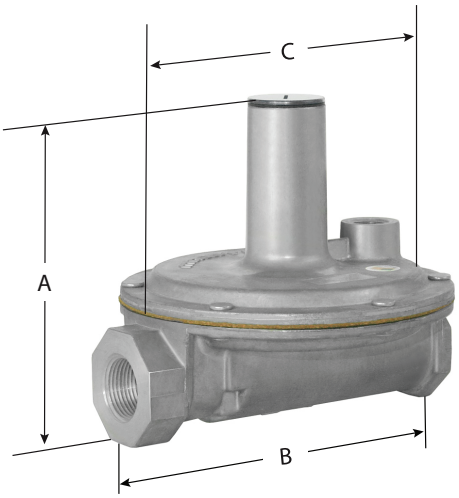
Dimensions

Model	Pipe Size	Vent Connection	Swing Radius	Dimensions		
				A	B	C
325-3	3/8″, 1/2″	1/8″ NPT	3″ (76 mm)	3.5″ (89 mm)	4.2″ (108 mm)	3.9″ (98 mm)
325-5	1/2″, 3/4″, 1″	3/8″ NPT	4.9″ (124 mm)	5.3″ (133 mm)	5.9″ (149 mm)	5.4″ (138 mm)
325-7A	1 1/4″, 1 1/2″	1/2″ NPT	6.1″ (156 mm)	7.3″ (184 mm)	8″ (203 mm)	7″ (178 mm)
325-9	1 1/2″, 2″	1/2″ NPT	7.8″ (198 mm)	9.4″ (239 mm)	10.8″ (274 mm)	9.1″ (231 mm)

NOTE: Dimensions are maximums and to be used only as an aid in designing clearance for the valve. Actual production dimensions may vary somewhat from those shown.



325-3



325-5

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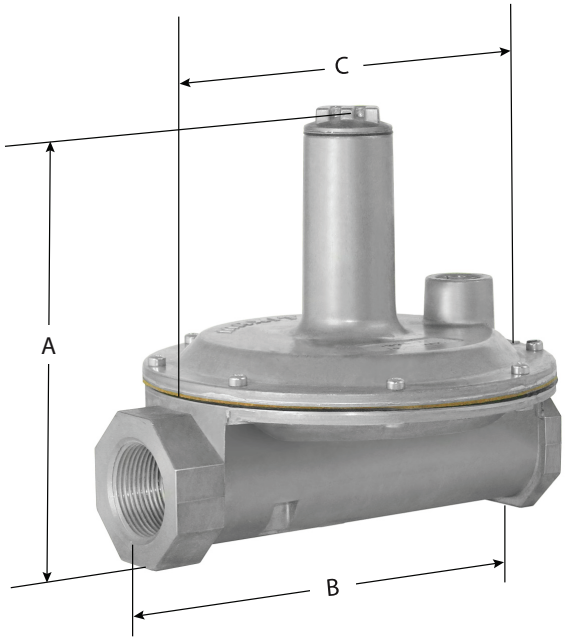
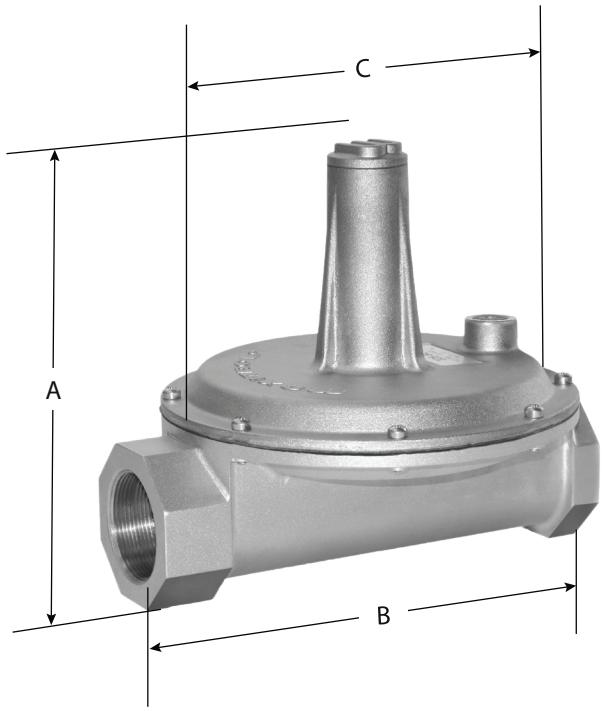
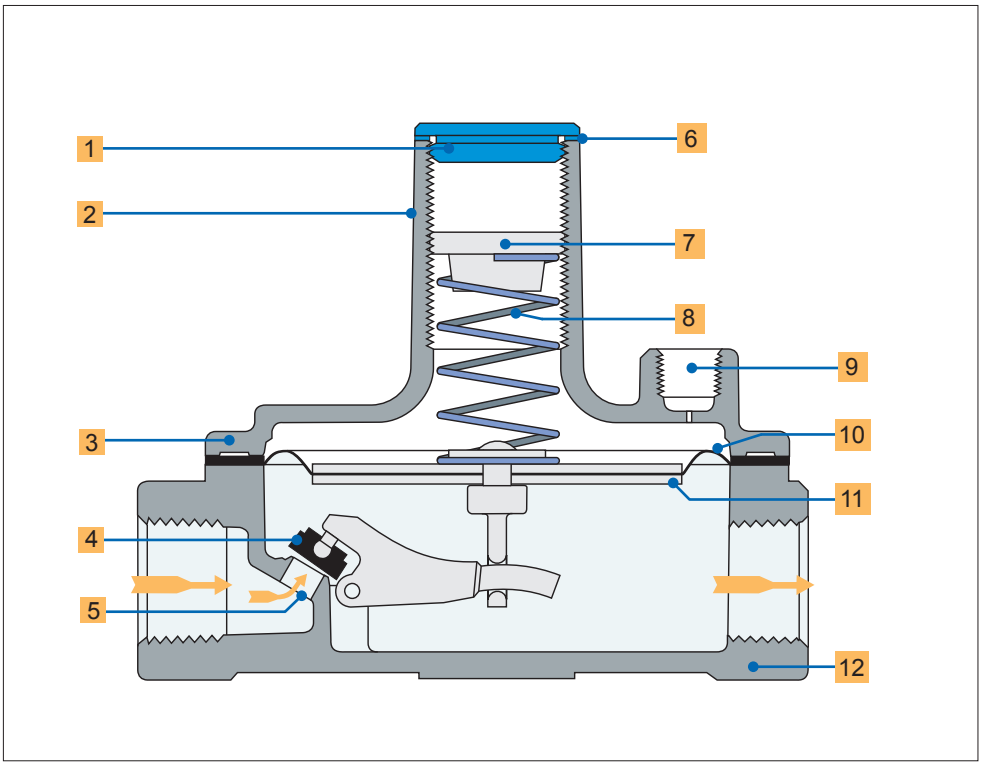


325-7A



325-9

Lever Acting Design



1	Seal Cap
2	Stack
3	Top Housing
4	Rubber Valve
5	Valve Seat
6	Seal Cap Gasket
7	Adjusting Screw
8	Spring
9	Vent Connection
10	Diaphragm
11	Diaphragm Plates
12	Bottom Housing

NOTE: Diagrams are graphical representations only and may differ from actual product.

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Installation & Maintenance Instructions

2–WAY INTERNAL PILOT–OPERATED SOLENOID VALVES

NORMALLY CLOSED OPERATION – 3/4″, 1″, 1–1/4″, 1–1/2″ OR 2″ NPT

SERIES

8215

Form No.V5996R5

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Causes of Improper Operation, and Coil Replacement.

DESCRIPTION

Series 8215 valves are 2–way normally closed internal pilot–operated solenoid valves. Valve bodies are made of rugged aluminum with trim and internal parts made of steel and stainless steel. Series 8215 valves may be provided with a general purpose or explosionproof solenoid enclosure.

OPERATION

Normally Closed: Valve is closed when solenoid is de–energized; open when energized.

Note: No minimum operating pressure differential required.

INSTALLATION

⚠ **CAUTION: Not all valves are approved for fuel gas service. Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.**

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to chart below. Check catalog number prefix on nameplate to determine maximum temperatures.

Construction	Coil Class	Catalog Number Prefix	Max. Ambient Temp°F	Max. Fluid Temp°F
AC Construction	F	FT	125	125
	H	HT	140	140
DC Construction	B or H	None or HT	77	77

Positioning

Valve must be mounted with solenoid vertical and upright.

Piping

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

⚠ **CAUTION: To avoid damage to the valve body, DO NOT OVERTIGHTEN PIPE CONNECTIONS. If Teflon* tape, paste, spray or similar lubricant is used, use extra care when tightening due to reduced friction.**

IMPORTANT: To protect the solenoid valve, install a strainer or filter, suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601 and 8602 for strainers.

MAINTENANCE

⚠ **WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area before servicing the valve.**

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean valve strainer or filter when cleaning the valve.

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Preventive Maintenance

- Keep the medium flowing through the valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete rebuild kit.

Causes of Improper Operation

- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage:** Disassemble valve and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area before servicing the valve.

NOTE: Determine valve construction AC (Figure 1 on page 3) or DC (Figure 2 on page 4) then proceed as follows:

1. Remove solenoid enclosure, see separate installation and maintenance instructions.
2. For AC Construction, unscrew solenoid base sub−assembly. For DC Construction, unscrew solenoid base sub−assembly with special wrench adapter provided in ASCO Rebuild Kit. For wrench adapter only, order kit No.K218−949. NOTE: For alternate type open end wrench, order kit No.K168−146−1 which is available for solenoid base sub−assembly removal or replacement.
3. Remove bonnet screws, valve bonnet, bonnet gasket, core/diaphragm sub−assembly and body gasket.
4. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild kit.

Valve Reassembly

1. Lubricate bonnet gasket and body gasket with a light coat of DOW CORNING® 200 Fluid lubricant or an equivalent high−grade silicone fluid.
2. Apply a light coat of RemGrit TFL 50® Dry Lubricant to:
    - Valve seat
    - Valve body flange where diaphragm assembly contacts the valve body and body gasket.
    - Internal surface of valve bonnet where diaphragm assembly contacts bonnet when valve is in the energized (open position).

IMPORTANT: If valve has been disassembled for inspection and cleaning only and a Rebuild Kit is not being installed, lubricate the following with RemGrit TFL 50® Dry Lubricant:

- Diaphragm assembly on both sides.
- Main disc base of core/diaphragm sub−assembly.
- Pilot disc at base of core assembly.

⚠ CAUTION: Do not distort hanger spring between core assembly and diaphragm assembly when lubricating pilot disc.

3. Replace body gasket and core/diaphragm sub−assembly with closing spring attached. Locate bleed hole in core/diaphragm sub−assembly approximately 30° from the valve inlet.
4. Replace valve bonnet and bonnet screws (6). Torque screws in a crisscross manner to 100 ±10 in−lbs [11,3 ± 1,1 Nm].
5. For AC construction, replace bonnet gasket and solenoid base sub−assembly. Torque solenoid base sub−assembly to 45 ± 5 ft−lbs [61,1 ± 6,8 Nm] For DC construction refer to separate "Solenoid Installation and Maintenance Instructions" for lubrication instructions; then install bonnet gasket, housing and solenoid base sub−assembly. Torque solenoid base sub−assembly to 30 ± 5 ft−lbs [40,7 ± 6,8 Nm].
6. Replace solenoid (see separate instructions) and make electrical hookup.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

7. Restore line pressure and electrical power supply to valve.
8. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic *click* signifies the solenoid is operating.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded views are supplied in Rebuild Kits.

● When Ordering Rebuild Kits for ASCO Valves, order the Rebuild Kit number stamped on the valve nameplate.
+ If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

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Torque Chart

Part Name	Torque Value	Torque Value in Newton–Meters
Solenoid Base Sub–Assembly	45 ± 5 ft.–lbs	61,1 ± 6,8
Bonnet Screws	100 ± 10 in–lbs	11,3 ±1,1

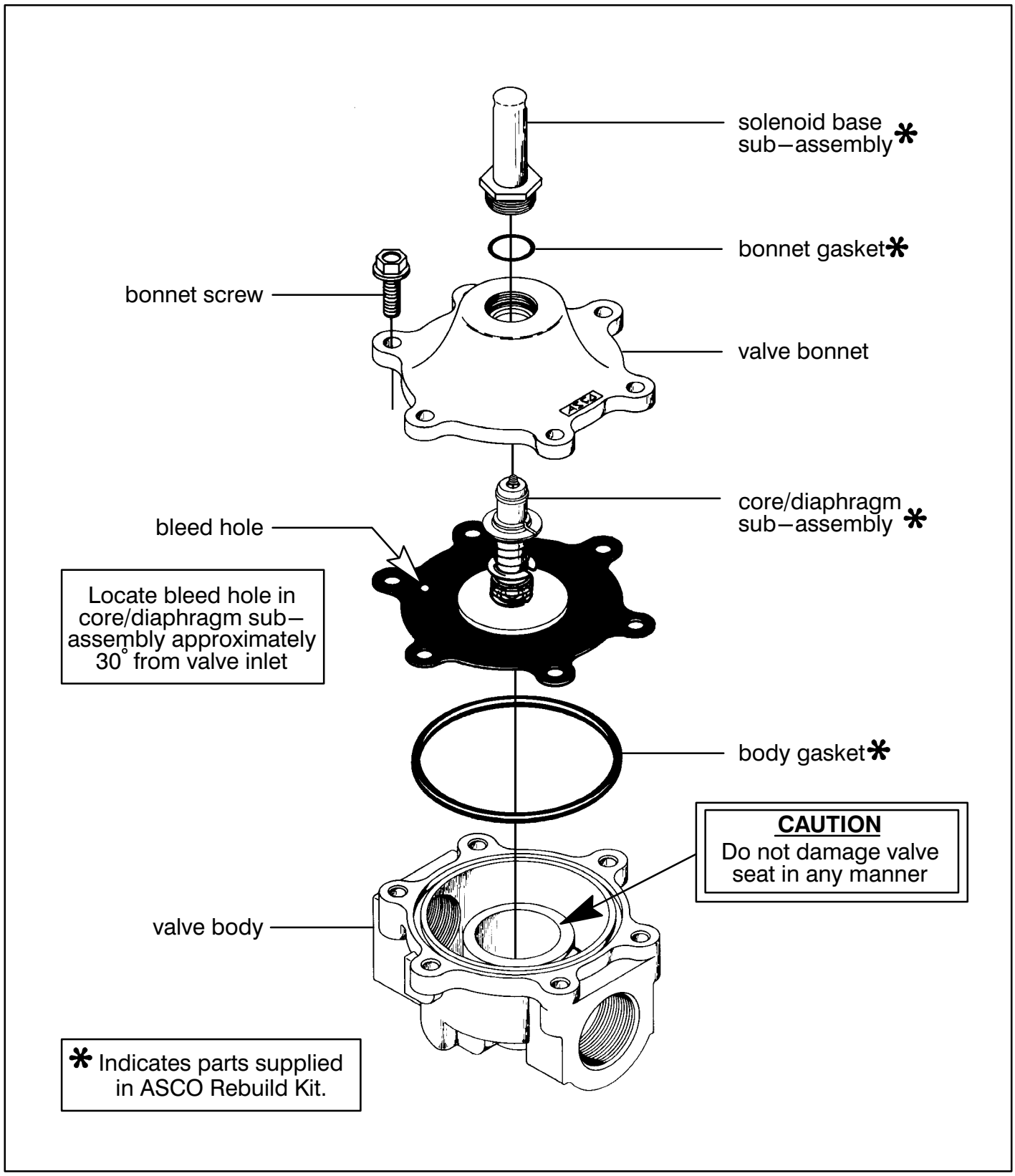

Figure 1. Series 8215 valves without solenoid, AC Construction.

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Torque Chart

Part Name	Torque Value	Torque Value in Newton–Meters
Solenoid Base Sub–Assembly	30 ± 5 ft–lbs	40,7 ± 6,8
Bonnet Screws	100 ± 10 in–lbs	11,3 ±1,1

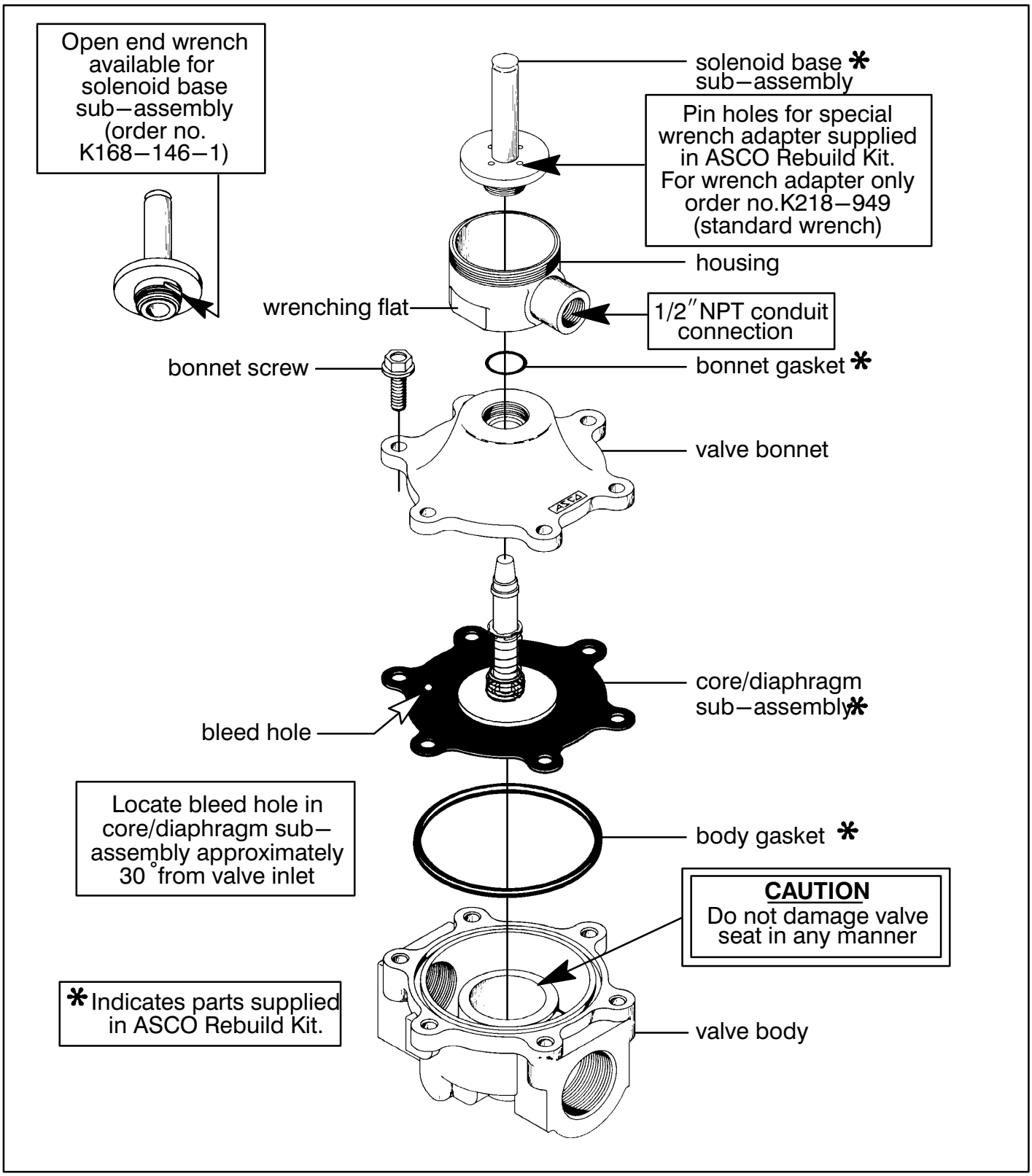

Figure 2. Series 8215 valves without solenoid, DC Construction.

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Installation & Maintenance Instructions

2–WAY DIRECT–ACTING SOLENOID VALVES
NORMALLY OPEN OR NORMALLY CLOSED OPERATION
BRASS OR STAINLESS STEEL CONSTRUCTION – 1/8″, 1/4″, OR 3/8″ NPT

SERIES
8262
8263

Form No.V5256R9

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Causes of Improper Operation, and Coil or Solenoid Replacement.

DESCRIPTION

Series 8262 and 8263 valves are 2–way direct–acting general service solenoid valves. Valves bodies are of rugged brass or stainless steel. Series 8262 or 8263 valves may be provided with a general purpose or explosionproof solenoid enclosure. Series 8262 and 8263 valves with suffix "P" in the catalog number are designed for dry inert gas and non–lubricated air service.

OPERATION

Normally Open: Valve is open when solenoid is de–energized; closed when is energized.

Normally Closed: Valve is closed when solenoid is de–energized; open when energized.

IMPORTANT: No minimum operating pressure required.

Manual Operation

Manual operator allows manual operation when desired or during an electrical power outage. Depending upon basic valve construction, three types of manual operators are available:

Push Type Manual Operator

To engage push type manual operator, push stem at base of valve body upward as far as possible. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, release stem. Manual operator will return to original position.

Screw Type Manual Operator

To engage screw type manual operator, rotate stem at base of the valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage, rotate stem counterclockwise until it hits a stop.

⚠ **CAUTION: For valve to operate electrically, manual operator stem must be fully rotated counterclockwise.**

Stem/Lever Type Manual Operator

To engage manual operator, turn stem/lever clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, turn stem/lever counterclockwise until it hits a stop.

⚠ **CAUTION: For valve to operate electrically, manual operator stem/lever must be fully rotated counterclockwise.**

Flow Metering Devices

Valves with suffix "M" in catalog number are provided with a metering device for flow control. Turn stem to right to reduce flow; left to increase flow.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Note: Inlet port will either be marked "I" or "IN". Outlet port will be marked "2" or "OUT".

Future Service Considerations.

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous,noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to charts below. Check catalog number, coil prefix, suffix, and watt rating on nameplate to determine the maximum temperatures.

Wattage	Catalog Number Coil Prefix	Coil Class	Max. Ambient Temp. °F	Max. Fluid Temp. °F
6, 10.5, 12.4	none, DA or S	A	77	180
6,10.5 12.4	DF, FT or SF	F	125	180
6,10.5, 12.4	HT	H	140	180
9,10.7	none, DP or SP	F	77	180
9.7	none, FT or HT	A, F or H	77	120
11.2	none, FT or HT	A, F or H	77	150
16.7	none, DP or SP	F	77	200
17.1	none, KP SP or SD	F	125	180
17.1	HB, KB SS or SV	H	140	180

Catalog Nos.8262B200 and 8262 C200 AC construction only and Catalog Nos.8262B214 and 8262 D200 AC and DC construction are limited to 140°F fluid temperature.

Valves with Suffix V or W that are designed for AC service and normally closed operation are for use with No. 2 and 4 fuel oil service. These valves have the same maximum temperatures per the above table except Suffix W valves are limited to a maximum fluid temperature of 140°F.

Listed below are valves with Suffix V in the catalog number that are acceptable for higher temperatures.

Catalog Number Coil Prefix	Max. Ambient Temp.°F	Max. Fluid Temp.°F
FT8262, HB8262 FT8263, HB8263 8262G, 8263G	125	250*
HT or HB 8262G HT or HB 8263G	140	250

*The only exception is the 8262G and 8263G series (Class F coil) at 50 Hertz rated 11.1 and 17.1 watts are limited to 210°F fluid temperature.

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub–assembly area.

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Valves with suffix "P" in the catalog number must be mounted with the solenoid vertical and upright.

Mounting

Refer to Figure 2 for mounting dimensions.

Piping

Connect piping or tubing to valve according to markings on valve body. Inlet port will either be marked "I" or "IN". Outlet port will be marked "2" or "OUT". Wipe the pipe threads clean of cutting oils. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

IMPORTANT: To protect the solenoid valve, install a strainer or filter suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601 and 8602 for strainers.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize valve, and vent fluid to a safe area before servicing the valve.

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct,sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the valve as free from dirt and foreign material as possible.
- While in service, the valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Causes of Improper Operation

- **Incorrect Pressure**: Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage**: Disassemble valve (see Maintenance) and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly

1. Disassemble valve using exploded views for identification of parts.
2. Remove solenoid, see separate instructions.
3. Unscrew solenoid base sub−assembly or valve bonnet with special wrench adapter supplied in ASCO Rebuild Kit. For wrench adapter only, order No. K218948. Remove core assembly, core spring, and solenoid base gasket from valve body. For normal maintenance on Series 8263 valves it is not necessary to remove valve seat. See Figure 1 for metering or manual operator constructions.
4. For normally open construction (Figure 3) remove end cap, or manual operator, (not shown) end cap gasket, disc holder spring, and disc holder assembly.
5. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Reassembly

1. Use exploded views for identification, orientation and placement of parts.
2. Lubricate all gaskets with DOW CORNING® 111 Compound lubricant or an equivalent high−grade silicone grease.
3. For normally open construction (Figure 3), install disc holder assembly, disc holder spring, end cap gasket and end cap or manual operator. For valves with 1/8″ NPT, torque end cap or manual operator to 90 ± 10 in−lbs [10,2 ± 1,1 Nm]. For all other valves torque end cap or manual operator to 175 ± 25 in−lbs [19,8 ± 2,8 Nm].
4. For Series 8263 apply a small amount of LOCTITE® PST® pipe sealant to threads of valve seat (if removed). Follow manufacturers instructions for application of pipe sealant. Then install valve seat and torque to 75 ± 10 in−lbs [8,5 ± 1,1 Nm].
5. Replace solenoid base gasket, core assembly with core spring and solenoid base sub−assembly or plugnut/core tube sub−assembly and valve bonnet. Note: For core assemblies with internal type core springs, install wide end of core spring in core assembly first, closed end of core spring protrudes from top of core assembly.
6. For 1/8″ NPT valve constructions, Torque valve bonnet to 90 ± 10 in−lbs [10,2 ± 1,1 Nm]. Torque solenoid base sub−assembly to 175 ± 25 in−lbs [19,8 ± 2,8 Nm].
7. Install solenoid, see separate solenoid instructions. Then make electrical hookup to solenoid.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

8. Restore line pressure and electrical power supply to valve.
9. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic *click* signifies the solenoid is operating.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits. When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

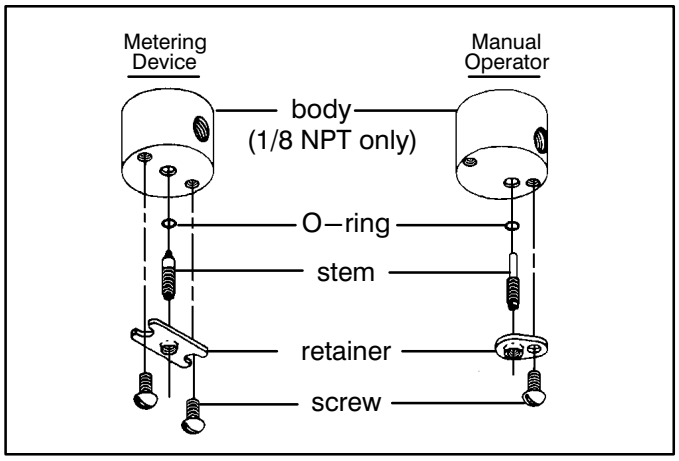

Figure 1. Metering and manual operator constructions.

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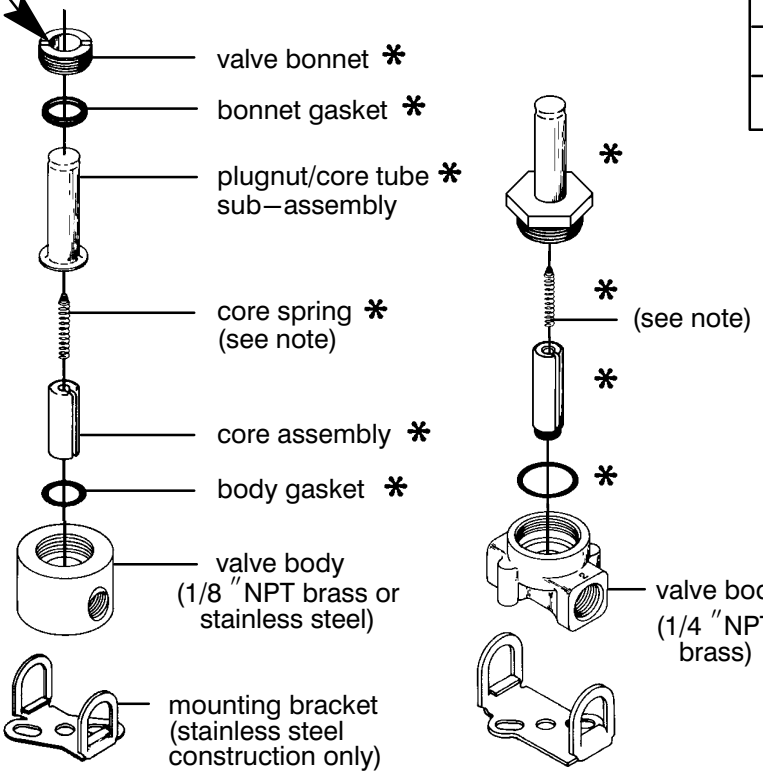
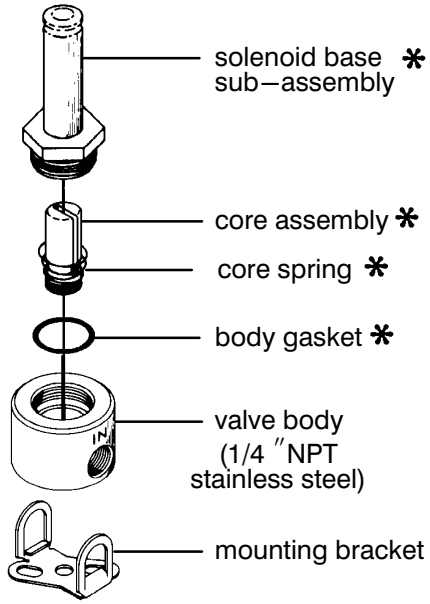
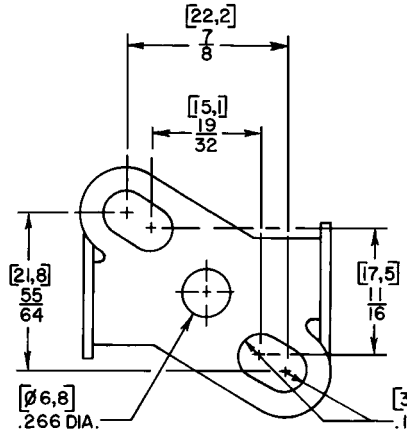
Torque Chart		
Part Name	Torque value Inch−Pounds	Torque value Newton−Meters
solenoid base sub−assembly	175±25	19,8±2,8
valve bonnet	90±10	10,2±1,1
valve seat	75±10	8,5±1,1

* Bonnet wrench supplied in ASCO Rebuild Kits. For bonnet wrench only order No. K218948.



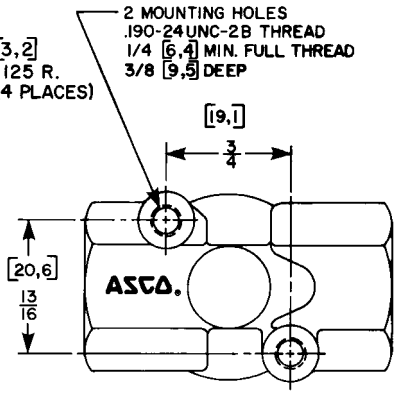


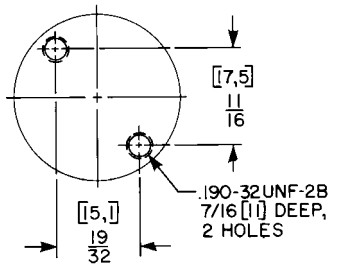
Series 8262



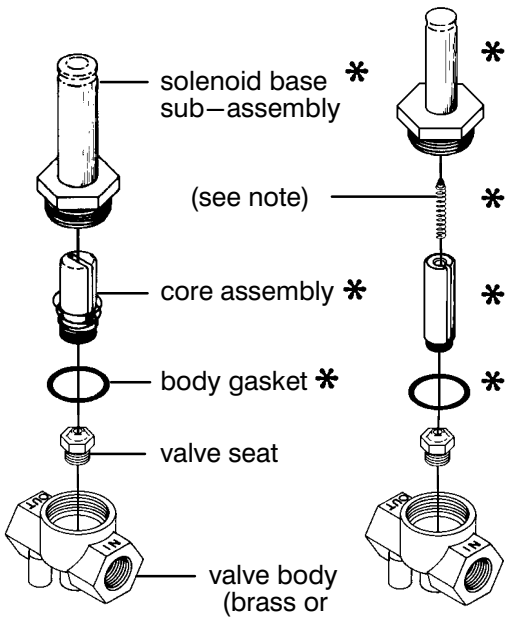
* Indicates Parts Supplied in ASCO Rebuild Kits.

[m m] INCHES





(1/8 ″ NPT brass)



Series 8263

Note:
Wide end of core spring in core first, closed end protrudes from top of core.

Figure 2. Series 8262 and 8263, normally closed construction.

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Disassembly and Reassembly of Stem /Lever Type Manual Operator (Refer to Figure 3)

NOTE: There are two stem/lever manual operator constructions. They are identified by the location of the core spring as ***internal*** or ***external*** spring construction.

1. Unscrew solenoid base sub−assembly from manual operator body.
2. Unscrew manual operator body from valve body. Then remove body gasket and stem retainer.
3. Slip stem/spacer sub−assembly with stem gasket from manual operator body. Remove core assembly with core spring from center of manual operator body.
4. All parts are now accessible for cleaning or replacement. Lubricate gaskets per ***Valve Reassembly*** step 2.
5. Position core assembly with core spring into base of manual operator body. Then install stem/spacer sub−assembly into manual operator body to engage with core assembly.
6. Reinstall stem retainer on body and stem/spacer sub−assembly.

IMPORTANT: The spacer on the stem/spacer sub−assembly must be *inside* of the stem retainer for *internal* spring construction and *outside* the stem retainer for *external* spring construction.

7. Replace body gasket and install manual operator assembly in valve body. Torque manual operator body to 175 ± 25 in−lbs [19,8 ± 2,8 Nm].
8. Replace solenoid base gasket and solenoid base sub−assembly. Torque solenoid base sub−assembly to 175 ± 25 in−lbs [19,8 ± 2,8 Nm].
9. Check manual operator for proper operation. Turn stem clockwise and counterclockwise; stem should turn freely without binding.

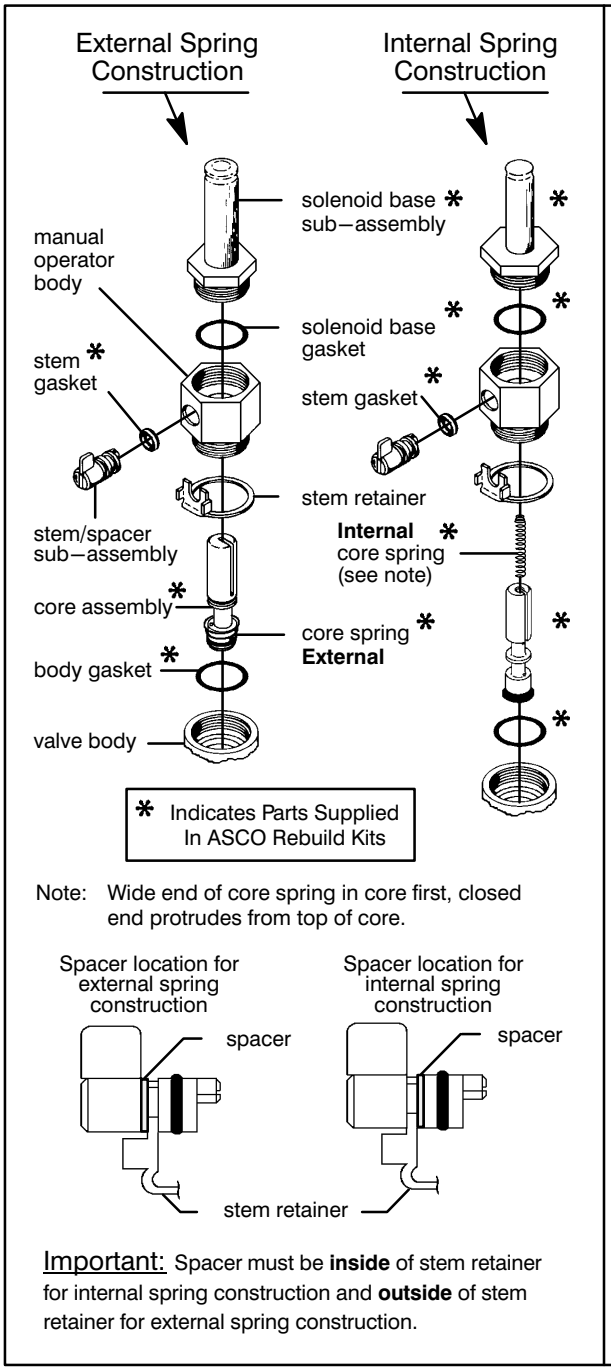

Figure 3. Stem/lever type manual operators

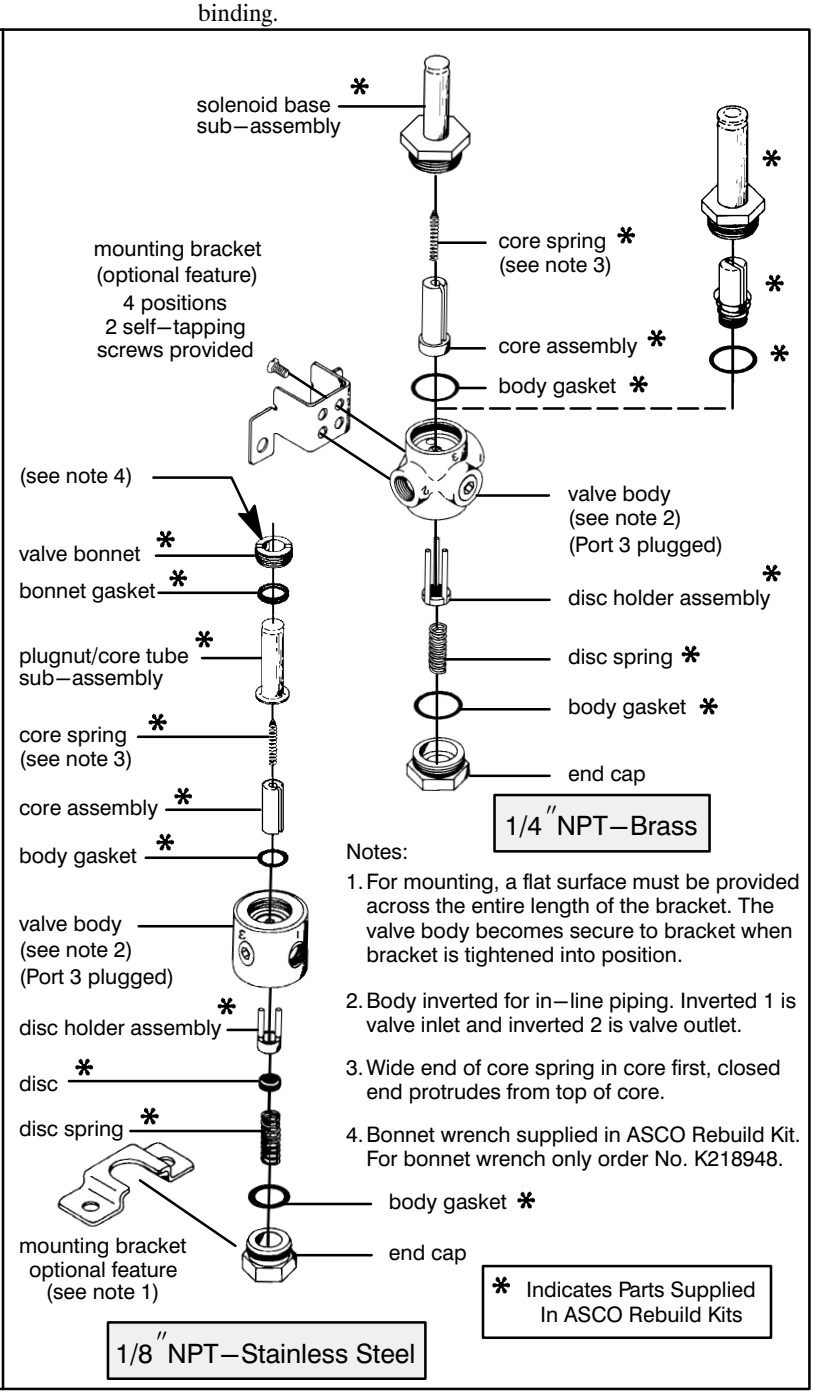

Figure 4. Series 8262, normally open construction.

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"Apollo" INTERNATIONAL

SUBMITTAL SHEET

94A Series

Full-Port **Brass Ball Valve**

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO Number:	
Representative:	
Wholesale Distributor:	

DESCRIPTION

The **Apollo International™** 94A forged brass ball valves combine reliable operation with maximum economy. Ideal for plumbing, HVAC and gas service applications. Valves include most pertinent agency approvals.

FEATURES

- Full-Port
- Blow-out Proof Stem Design
- Adjustable Stem Packing Nut
- Silicone Free

PERFORMANCE RATING

- Valve Design Rating: 600 CWP (400 CWP 2-1/2" to 4")
- Temperature Range 0°F - 400°F

APPROVALS

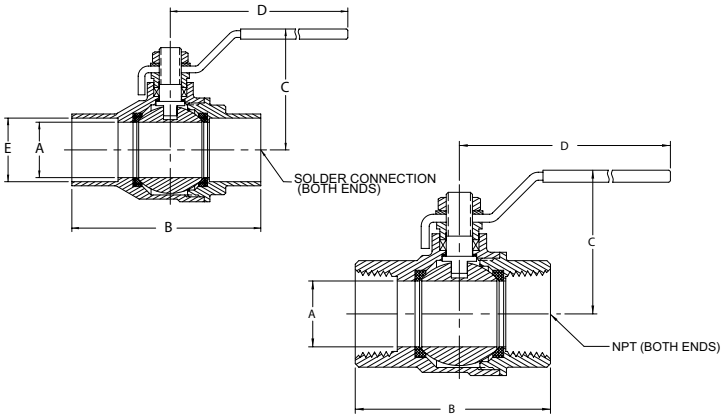
- **CSA:** ¼"-4" NPT per ANSI Z21.15/ CGA 9.1 (1/2 psi)/CGA 3.16 (125 psi)
  ¼"-4" NPT per ASME B16.44 (5 psi)
  ½"-2" NPT per ASME B16.33 (125 psi)
  2 ½"-4" NPT per ASME B16.38 (125 psi)
- **UL:** Guides YQNZ, YRBX, YRPV, and YSDT (NPT only)
- **FM:** ¼"-2" per FM1140 (<175 psi)
- **NSF:** ¼"-4" meets NSF/ANSI 61 – 8, 2009
- **MSS SP-110:** Ball Valves Threaded, Socket-Welding, Solder joint, Grooved and Flared Ends

STANDARD MATERIALS LIST

Part Name	Material
Body	Forged Brass (Cu >57%)
Retainer	Forged Brass (Cu >57%)
Ball	Brass, Cr plated
Stem	Brass, Cr plated
Seats	PTFE
Stem Packing	PTFE
Gland Nut	Brass
Friction Washer	PTFE
Handle	Steel w/corrosion resistant plating
Handle Cover	PVC
Handle Nut	Steel w/corrosion resistant plating

DIMENSIONS

Part Number	Size (in.)	Dimensions (in.)					Wt. (lbs.)
		A	B	C	D	E	
NPT							
94A10101	1/4"	0.395	1.746	1.840	3.543	–	0.33
94A10201	3/8"	0.407	1.756	1.840	3.543	–	0.30
94A10301	1/2"	0.583	2.047	1.921	3.543	–	0.44
94A10401	3/4"	0.748	2.362	2.087	3.780	–	0.66
94A10501	1"	0.945	2.756	2.559	4.528	–	1.10
94A10601	1-1/4"	1.260	3.307	2.953	4.528	–	1.57
94A10701	1-1/2"	1.575	3.661	3.346	5.512	–	2.40
94A10801	2"	1.969	4.181	3.681	5.512	–	3.37
94A10901	2-1/2"	2.520	5.378	4.764	8.661	–	7.60
94A10001	3"	2.953	6.039	5.079	8.661	–	9.36
94A10A01	4"	3.898	7.386	5.866	9.606	–	16.85
SWEAT							
94A20301	1/2"	0.583	2.047	1.839	3.543	0.630	0.38
94A20401	3/4"	0.748	2.748	1.996	3.780	0.878	0.64
94A20501	1"	0.945	3.228	2.441	4.528	1.130	0.99
94A20601	1-1/4"	1.260	3.819	2.854	4.528	1.378	1.40
94A20701	1-1/2"	1.575	4.425	3.169	5.512	1.630	2.17
94A20801	2"	1.969	5.315	3.449	5.512	2.130	2.97
94A20901	2-1/2"	2.520	6.283	4.764	8.661	2.630	6.36
94A20001	3"	2.953	7.150	5.079	8.661	3.130	8.32
94A20A01	4"	3.945	9.276	5.866	9.606	4.130	15.78



OPTIONAL HANDLE KITS

Size	Replacement Lever Handles	2-1/4" Stem Extension + Memory Stop
1/4" - 3/8"	W932400	78217101
1/2"	W932500	78217201
3/4"	W936000	78217301
1"	W932600	78217401
1-1/4"	W932700	78217501
1-1/2"	W932800	78217601
2"	W233200	78217601
2-1/2" - 3"	W932900	78217701
4"	W933000	78217801

Apollo Valves / **Conbraco Industries, Inc.**
701 Matthews Mint-Hill Road, Matthews, NC 28105 USA
www.**apollovalves**.com | (704) 841-6000

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3-pole contactors, for motor control and power switching

AC / DC Control supply				Type	AF09	AF12	AF16	AF26	AF30	AF38	AF40	AF52	AF65	AF80	AF96
IEC	AC-3	Rated operational power	220 - 230 - 240 V	kW	2.2	3	4	6.5	9	11	11	15	18.5	22	25
		θ ≤ 60 °C for AF09 ... AF370	380 - 400 V	kW	4	5.5	7.5	11	15	18.5	18.5	22	30	37	45
			415 V	kW	4	5.5	9	11	15	18.5	22	30	37	45	55
		θ ≤ 55 °C for AF400 ... AF2650	440 V	kW	4	5.5	9	15	18.5	22	22	30	37	45	55
			500 V	kW	5.5	7.5	9	15	18.5	22	22	30	37	45	55
			690 V	kW	5.5	7.5	9	15	18.5	22	22	30	37	45	55
			1000 V	kW	–	–	–	–	–	–	–	–	–	–	–
		Rated operational current	380 - 400 V	A	9	12	18	26	32	38	40	53	65	80	96
	AC-1	Rated operational current	θ ≤ 40 °C, 690 V	A	25	28	30	45	50	50	70	100	105	125	130
UL / CSA	1-phase motor rating		120 V	hp	0.75	1	1.5	2	2	2	3	3	5	7.5	7.5
			240 V	hp	1.5	2	3	3	5	5	7.5	10	15	15	20
	3-phase motor rating		200 - 208 V	hp	2	3	5	7.5	10	10	10	15	20	25	30
			220 - 240 V	hp	2	3	5	7.5	10	10	15	20	25	30	30
			440 - 480 V	hp	5	7.5	10	15	20	20	30	40	50	60	60
			550 - 600 V	hp	7.5	10	15	20	25	25	40	50	60	75	75
	General use rating		600 V	A	25	28	30	45	50	50	60	80	90	105	115
NEMA	NEMA Size				00	0	–	1	–	–	2	–	–	3	–

Main accessories

Auxiliary contact blocks	Front mounting	CA4-10 (1 x N.O.) CA4-01 (1 x N.C.)				
	Side mounting	CAL4-11 (1 x N.O. + 1 x N.C.)				
Timers	Electronic	TEF4-ON TEF4-OFF				
Interlocking units	Mechanical	VM4		VM96-4		
	Mechanical / Electrical	VEM4				
Connection sets	For reversing contactors	BER16-4	BER38-4	BER65-4	BER96-4	
Surge suppressors		Built-in surge protection				

Overload relays

Thermal relays	Class 10 (Class 10A for TF140, TA200DU)	TF42 (0.10...38 A)		TF65 (22...67 A)	TF96 (40...96 A)	
Electronic relays	Class 10E, 20E, 30E	EF19 (0.10...18.9 A)	EF19 (0.10...18.9 A) EF45 (9...45 A)	EF65 (25...70 A)	EF96 (36...100 A)	

Manual motor starters

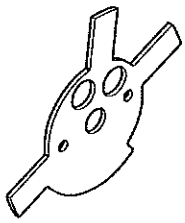
	Thermal / magnetic protection Class 10	MS116 (0.10...32 A) SCCR up to 30 kA		MS450 (28...50 A) SCCR up to 65 kA		
		MS132 (0.10...32 A) SCCR up to 65 kA			MS495 (45...100 A) SCCR up to 65 kA	
	Magnetic only types	MO132 (0.16...32 A) SCCR up to 65 kA		MO496 (32...100 A) SCCR up to 65 kA		
				MO450 (40...50 A) SCCR up to 65 kA	MO495 (63...100 A) SCCR up to 65 kA	
Accessories	For contactor mounting	BEA16-4	BEA38-4			

Mounting Instructions for Speed Sensor

AGG5.310 / AGG5.315

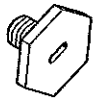
Scope of delivery

1 1 sensor disk

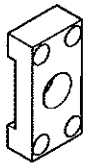


2 1 cup spring

3 1 fixing screw
M8 x 12 mm



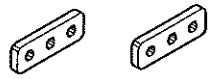
4 1 sensor base



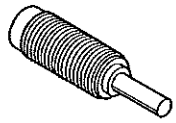
5 4 spring washers

6 4 cylinder head screws
M3 x 10 mm

7 2 threaded plates

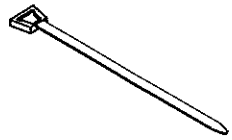


8 1 sensor



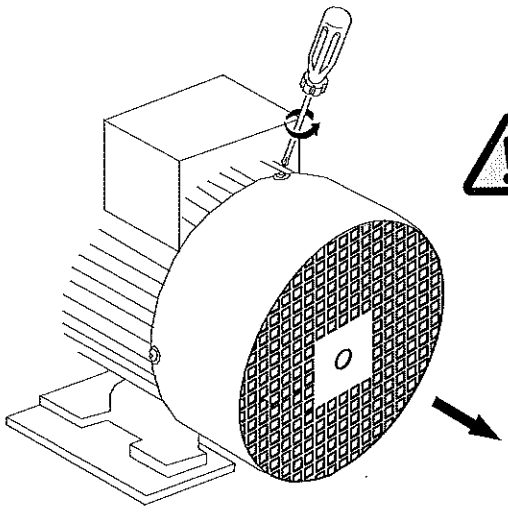
9 1 locknut

10 1 cable tie



These mounting instructions must be strictly followed.
Incorrect measurement of motor speed can lead to hazardous combustion conditions!
Check correct fit of sensor disk with fixing screw, sensor base and sensor once a year.
Readjust, if required.

1.

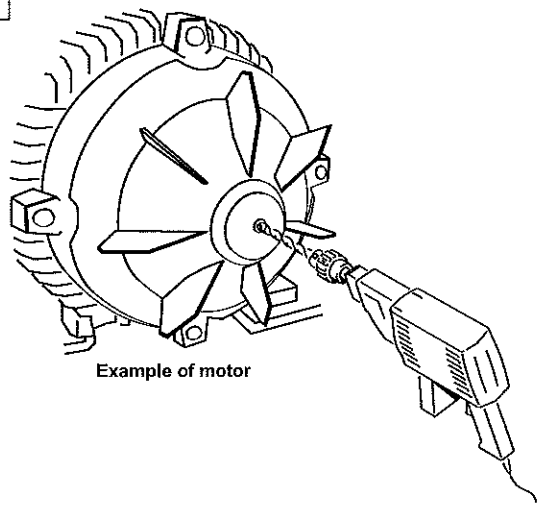


Example of motor

Before making any changes to the motor, contact your motor supplier with regard to warranty terms.

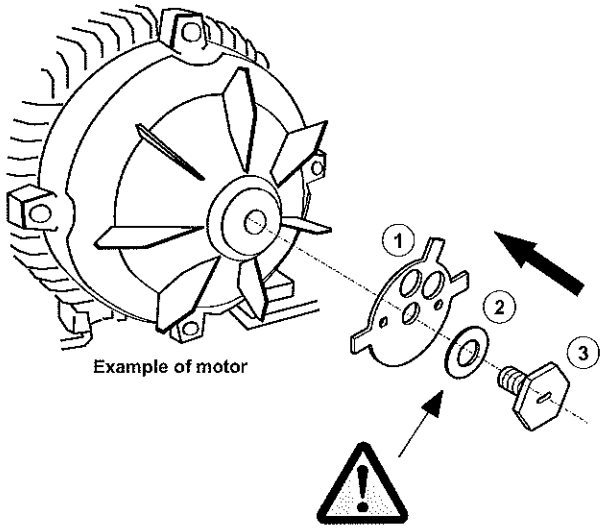
- **Remove protective cover from the motor.**
  Maximum thickness of mesh 2 mm

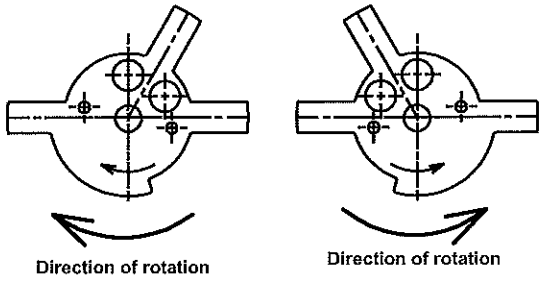
2.



- **Drill a central hole with a minimum depth of 18 mm into the motor´s drive shaft.**
  Core hole dia. 6.8 mm
- **Cut thread M8 x 15 mm.**
  Threaded hole must accept screw M8 x 12 mm

3.





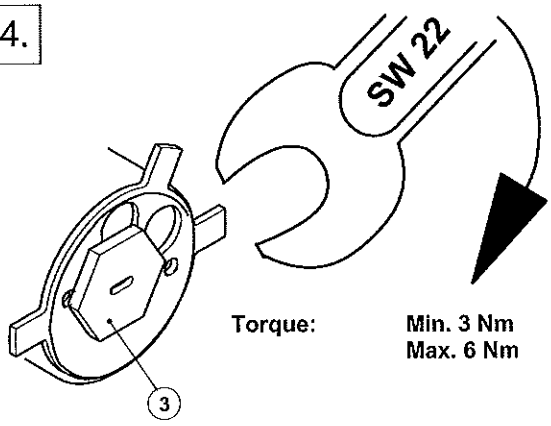
- **Fit sensor disk (1) while observing the motor´s direction of rotation (see illustrations above)**

  Small sensor disk (50 mm dia.) for drive shaft dia. 15...50 mm (set AGG5.310)

  Large sensor disk (70 mm dia.) for drive shaft dia. 51...70 mm (set AGG5.315 on request)

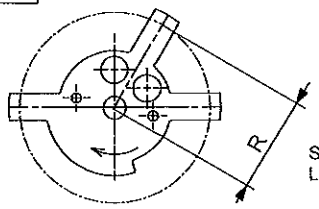
- **Fit sensor disk (1) and cup spring (2) (IMPORTANT) to the motor´s drive shaft using fixing screw (3)**

4.



- **Tighten fixing screw (3) with spanner SW 22 applying a torque of min. 3 Nm and max. 6 Nm**

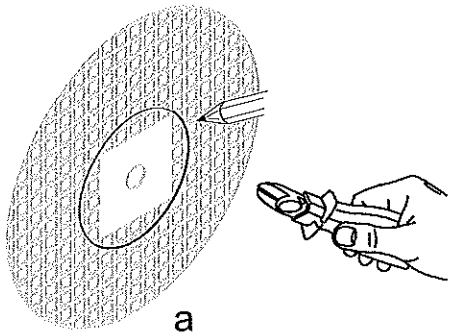
5.



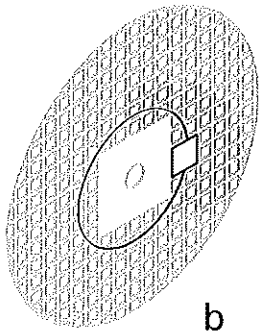
Small sensor disk: R = 41 mm
Large sensor disk: R = 51 mm

- **Use a pen and draw a central circle with a radius of 41 or 51 mm respectively on the mesh (see Fig. a)**
- **Use an edge cutter to cut a square hole into the mesh for fixing the sensor base (position similar to that shown in Fig. b).**

  Ensure that the position of the sensor base hole agrees with the position of one of the sensor disk fingers.

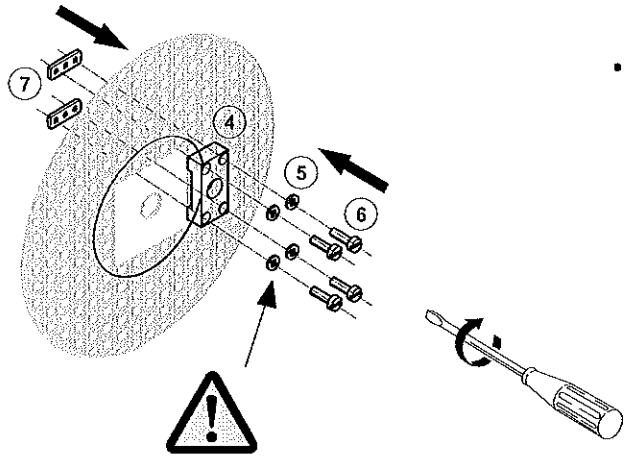


a



b

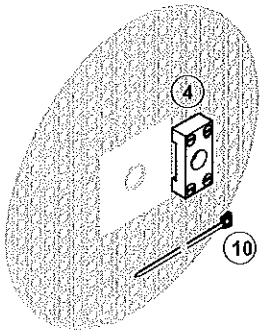
6.



- **Secure sensor base (4) with the 2 threaded plates (7) (rear of mesh) to the mesh using the 4 spring washers (5) (IMPORTANT) and the 4 screws M3 x 10 mm (6) (for correct position, refer to illustration).**

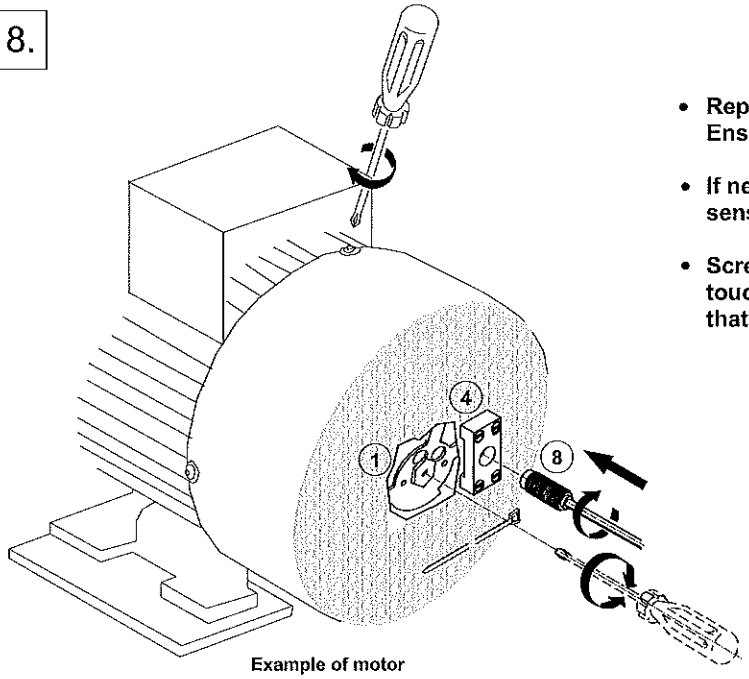
  The radius of the circle drawn should intersect with the center of the sensor base hole

7.



- **Introduce cable tie (10) below the center of sensor base (4) in the mesh (see illustration). Cable tie (10) will be required for securing the sensor´s cable**

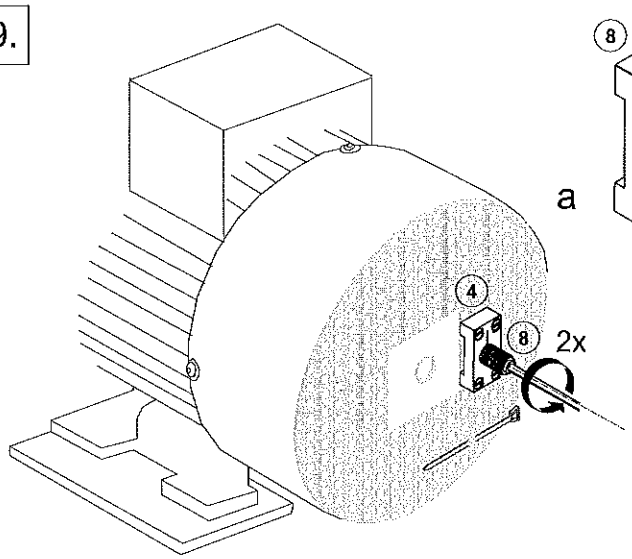
8.



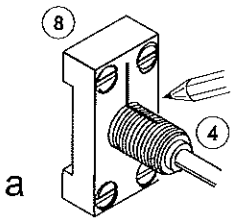
Example of motor

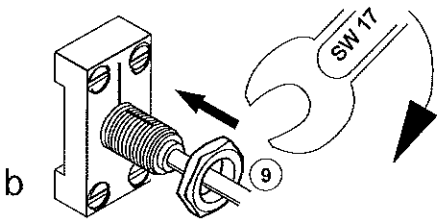
- Replace protective cover.
  Ensure that it is properly fitted
- If necessary, use a screwdriver to locate one of the sensor disk fingers beneath the sensor base hole
- Screw sensor (8) into sensor base (4) until sensor touches slightly the sensor disk finger (1) ensuring that sensor disk (1) and / or mesh will not be deformed

9.



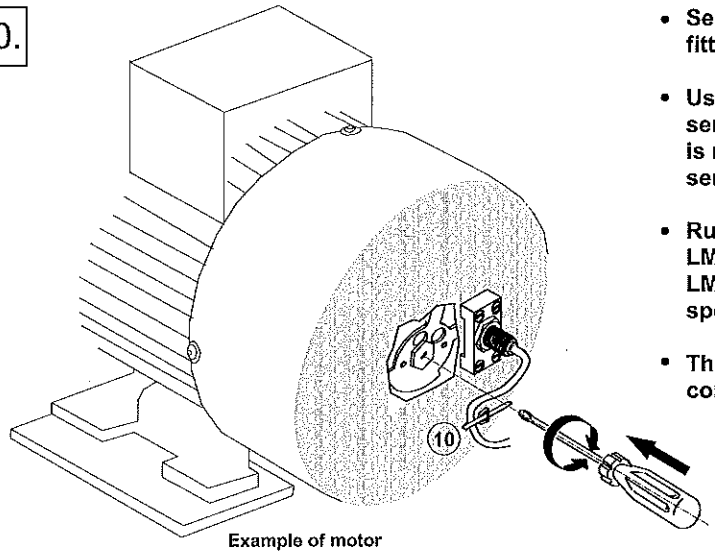
Example of motor





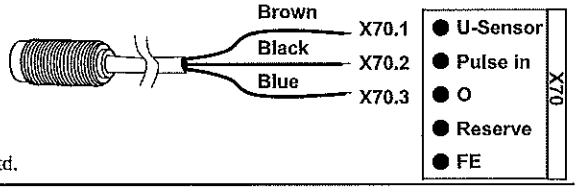
- Mark sensor (4) and sensor base (8) (see Fig. a) and undo by 2 mm (that is, 2 full revolutions, see illustration to the left)
- Distance between sensor and sensor disk:
  2 mm ± 0.1 mm
- Secure with locknut (9) (see Fig. b) (SW 17)

10.



Example of motor

- Secure sensor cable to the mesh using the previously fitted cable tie (10)
- Use a screwdriver to turn motor drive shaft with the sensor disk one full revolution to make certain that there is no mechanical contact between sensor disk and sensor
- Run sensor cable separately and connect it to the LMV5... (for details, refer to Basic Documentation LMV51..., P7550, Addendum 3: Variable speed drive (VSD) module)
- The plug requiered for the connection is contained in connector set AGG5.721



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11) With the ball in the closed position, thread the retainer into the body and torque to manufacturing specification to secure the body joint. *Tighten to the torque values shown in the table below.*

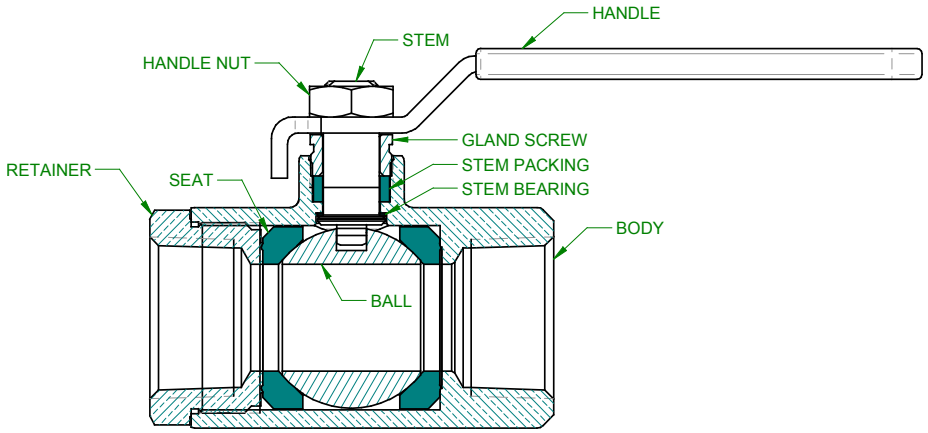
12) Cycle the valve to the open position and verify proper operation and alignment of handle and/or mechanism.

Note: Always test valve and system before putting the system into service.

Table 1: Torque Requirements

Valve Size	Gland Nut Torque (+ or – 10%) (ft-lb)	Retainer Torque (+ or – 10%) (ft-lb)
1/4" - 3/8"	12 - 18	13
1/2"	12 - 18	16
3/4"	20 - 25	42
1"	20 - 25	63
1-1/4"	61-100	130
1-1/2"	61-100	199
2"	61-100	282
2-1/2"	61-100	681
3"	61-100	905
4"	-	-

PARTS ILLUSTRATION



"Apollo" Valves

Made In The USA

A Division of Conbraco Industries, Inc. Matthews, NC Pageland, SC Conway, SC

2 PIECE THREADED STEEL BALL VALVES INSTALLATION, OPERATION, & MAINTENANCE GUIDE

INSTALLATION

Two piece threaded end Apollo Ball valves are bi-directional. They may be installed in vertical or horizontal pipe runs without regard to flow direction and without regard to stem orientation.

Note: Valves must be installed in piping systems that comply with the applicable portions of the ASME B31 standards. Special considerations must be taken with respect to pipe line expansions and contractions and the media expansion and contractions within the piping system.

Threaded End Valves

Pipe connections to be threaded into these valves should be accurately threaded, clean and free of foreign material or metal shavings. PTFE pipe tape is recommended for use as the pipe joint sealant. Two wrenches must be used when making up pipe joints to these valves. Apply one wrench on the valve end closest to the pipe joint being tightened and the other wrench to the pipe to prevent transmitting torque through the valve body joint. Typical pipe make-up is 1-1/2 turns after installing the pipe hand-tight.

OPERATION

The valve handle is marked showing proper rotation direction for “ON” and “OFF” positions. Rotation is clockwise for “OFF” (closed) and counterclockwise for “ON” (open).

MAINTENANCE

Regular Maintenance

Normal stem packing wear can be compensated for by tightening the packing gland screw. (Wrench part number H371400 is available to ease this operation.) Tighten the packing gland screw clockwise in 1/8 turn increments until observed leakage stops. Do not exceed the values shown in Table 1. If all of the adjustments to the packing gland screw have been made, remove the handle nut, handle and packing gland screw and add one or two replacements bearings on top of the old packing. Reinstall the handle and handle nut.

Caution: Do not disassemble valve while under pressure nor with entrapped hazardous fluids therein.

Valve Repair

Disassembly

1) Operate the valve fully opened to fully closed to assure there are no trapped fluids or pressure in the body cavity. Leave the valve in the closed position.
2) Remove the handle nut, handle and packing nut. Set aside for reuse.
3) Install pipe plugs in the body and retainer ports of NPT valves to prevent collapsing those areas.
4) Remove the retainer from the body. It may be necessary to heat the body joint above 450°F to breakdown the sealant used to secure the valve halves.
5) Remove the ball from the body cavity. Inspect the ball. If it is scarred, it is recommended that the whole valve be replaced, but replacement balls are available. Clean and set aside good balls for reuse.
6) Push the stem from the outside into the body cavity. Inspect the stem. If it is scarred or has damaged threads, replacements are available. Clean and set aside good stems for reuse.
7) Remove all seals and seats from the body and retainer then discard. Inspect the body and retainer for damage. If damaged, scrap the valve as replacements of these components are not offered.

Re-Assembly

1) Install stem bearing on to stem.
2) Fit stem into body from the retainer end and position the stem with the handle flats perpendicular to the flow axis.
3) Install stem packing over stem and fit into body recess.
4) Install packing gland screw into the threaded stem area.
5) Tighten the gland screw to manufacturing torque specifications: *Tightened to the torque values shown in Table 1.*
6) Install the handle and handle retaining hardware.
7) Apply suitable light lubricant to seat and fit into the seat pocket of the body.
8) Install the ball in the closed position.
9) Apply suitable light lubricant to seat and fit into the seat pocket of the retainer.
10) Apply an adequate amount of thread locking compound (Loctite® 609, 648 or 680) to the retainer threads so that it covers no less than two complete threads opposite of the retainer shoulder.

Note: Valves in oxygen service can only be sealed with oxygen compatible thread sealant.

Warning: (Required by California) This product contains a chemical known to the state of California to cause Cancer and Birth Defects or other Reproductive Harm.

489-100-A SERIES

Carbon Steel LP-Gas Ball Valve

Female NPT Thread, 1/4" to 1" 2000 CWP (psig), 1.25" to 2" 1500 CWP (psig), 2.5" to 3" 1000 CWP (psig) Cold Non-Shock.
250 psig LP-Gas. 150 psig Saturated Steam.
Vacuum Service to 29 in. Hg.
MSS SP-110 compliant.

UL LISTED

5 YEAR WARRANTY

FEATURES

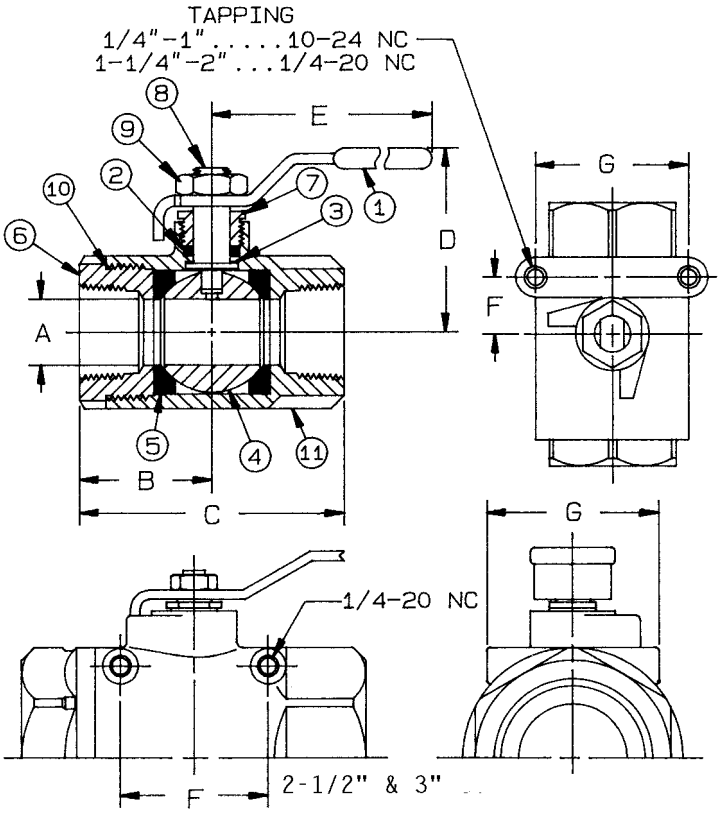
- UL Listed for LP-Gas, natural gas and flammable liquid to 250 psig
- Reinforced seats
- Mounting pad for easy actuator mounting
- Investment cast components
- Blow-out-proof stem design
- Adjustable packing gland
- Zinc phosphate corrosion protection

UL LISTINGS

- Guide YSDT: LP-Gas shut-off valve.
- Guide YRPV: Gas shut-off valve for use with natural and manufactured gases.
- Guide YRBX: Flammable liquid shutoff valve.
- Guide MHKZ: No. 6 oil at 250ºF.

VARIATIONS AVAILABLE:

489-140-01 Series with 316 SS Ball and Stem, UL Listed as noted above



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	Steel, zinc plated w/vinyl
2	Stem packing	RPTFE
3	Stem bearing	RPTFE
4	Ball	A108-CS Chrome Plated or ASTM A276 316 SS
5	Seat (2)	RPTFE
6	Retainer	A108-12L14 (1/4" to 1") A216-WCB (1.25" to 3")
7	Gland nut	A108-12L14
8	Stem	A108-12L14 or A276-316 SS
9	Lever nut	Steel, zinc plated
10	Body seal	PTFE (1.25" to 3")
11	Body	A216-WCB

FOR PRESSURE/TEMPERATURE RATINGS:
REFER TO PAGE M-14, GRAPH NO. 13 (1/4" TO 1")
REFER TO PAGE M-13, GRAPH NO. 11 (1.25" TO 2")

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	WT.
489-101-01A	1/4"	0.37	1.03	2.06	1.75	3.87	0.50	1.12	0.58
489-102-01A	3/8"	0.37	1.03	2.06	1.75	3.87	0.50	1.12	0.54
489-103-01A	1/2"	0.50	1.12	2.25	1.81	3.87	0.50	1.12	0.63
489-104-01A	3/4"	0.68	1.50	3.00	2.12	4.87	0.87	1.37	1.27
489-105-01A	1"	0.87	1.68	3.37	2.25	4.87	0.87	1.37	1.63
489-106-01	1.25"	1.00	2.00	4.00	2.62	5.50	0.93	1.50	3.06
489-107-01	1.5"	1.25	2.18	4.37	3.05	8.00	0.93	1.50	3.98
489-108-01	2"	1.50	2.75	5.50	3.24	8.00	0.93	1.50	5.99
489-109-01	2.5"	2.50	3.37	6.75	4.12	8.00	2.75	3.37	15.57
489-100-01	3"	2.50	3.37	6.75	4.12	8.00	2.75	3.37	16.79

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FLOW DATA

For Apollo® Ball Valves

The listed Cv "factors" are derived from actual flow testing, in the Apollo® Ball Valve Division, Conbraco Industries, Inc., Pageland, South Carolina. These tests were completed using standard "off the shelf" valves with no special preparation and utilizing standard schedule 40 pipe. It should be understood that these factors are for the valve only and also include the connection configuration. The flow testing is done utilizing water as a fluid media and is a direct statement of the gallons of water flowed per minute with a 1 psig pressure differential across the valve/connection unit. Line pressure is not a factor. Because the Cv is a factor, the formula can be used to estimate flow of most media for valve sizing.

FLOW OF LIQUID

$$Q = C_V \sqrt{\frac{\Delta P}{SpGr}}$$

$$\text{or } \Delta P = \frac{(Q)^2 (SpGr)}{(Cv)^2}$$

Where:

Q = flow in US gpm
ΔP = pressure drop (psig)
SpGr = specific gravity at flowing temperature
Cv = valve constant

FLOW OF GAS

$$Q = 1360\, C_V \sqrt{\frac{(\Delta P)(P_2)}{(SpGr)(T)}}$$

$$\text{or } \Delta P = \frac{5.4 \times 10^{-7} (SpGr)(T)(Q)^2}{(Cv)^2 (P_2)}$$

Where:

Q = flow in SCFH
ΔP = pressure drop (psig)
SpGr = specific gravity (based on air = 1.0)
P_2 = outlet pressure–psia (psig + 14.7)
T = (temp. °F + 460)
Cv = valve constant

CAUTION: The gas equation shown, is valid at very low pressure drop ratios. The gas equation is NOT valid when the ratio of pressure drop (ΔP) to inlet pressure (P1) exceeds 0.02.

NOTE: Only use the gas equation shown if (P1-P2)/P1 is less than 0.02.

Cv FACTORS FOR APOLLO VALVES

VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
70B-140 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
70-100/200 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	---
70-300/400 Series	--	--	15	30	43	48	84	108	--	--	--	--	--	--	--
70-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
70-800 Series	8.4	7.2	15	30	43	48	84	--	--	--	--	--	--	--	--
71-AR Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
71-100/200 Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
72-100/900 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
73A-100 Series	8.4	7.2	15	30	43	48	84	108	--	--	--	--	--	--	--
73-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
74-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
75-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76F-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FJ-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FK-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
76-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
76J-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76J-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76K-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76K-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
7K-100 Series	--	--	15	51	68	125	177	389	503	--	--	--	--	--	--
77-AR Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
77C-100/200 Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77D-140 Series	4.5	7.2	16	36	68	125	177	389	--	--	--	--	--	--	--

continued on next page

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FLOW DATA

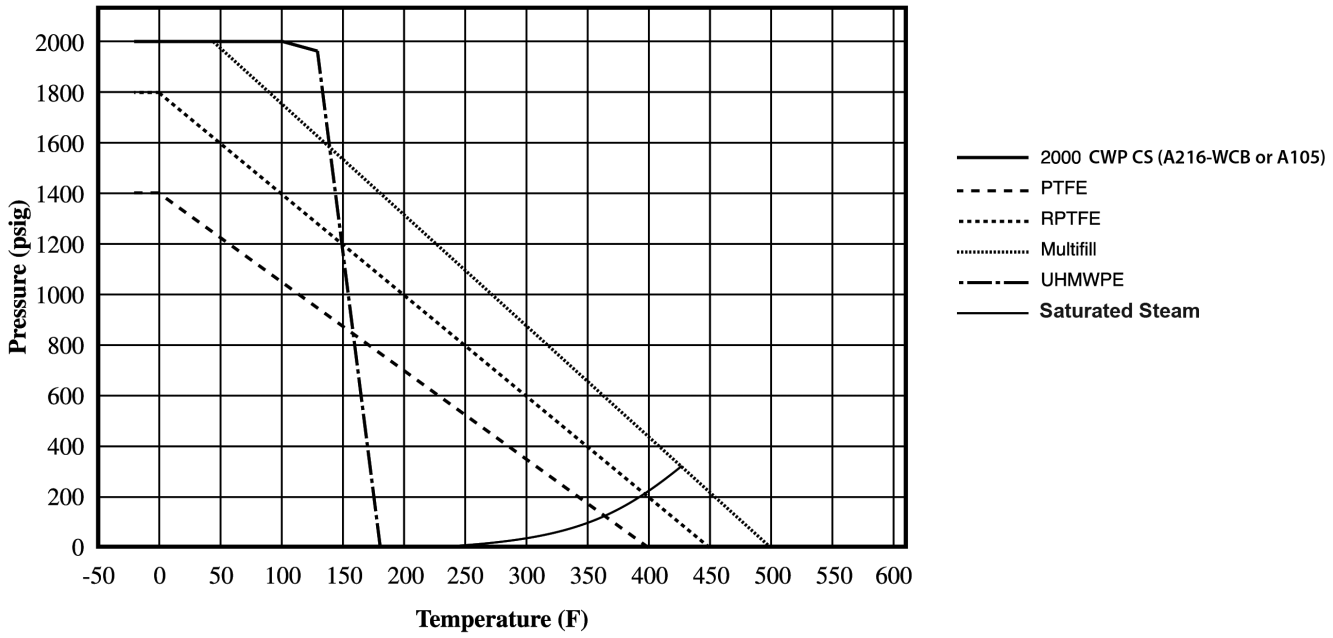
For Apollo® Ball Valves

Cv FACTORS FOR APOLLO VALVES (*continued from M-3)*

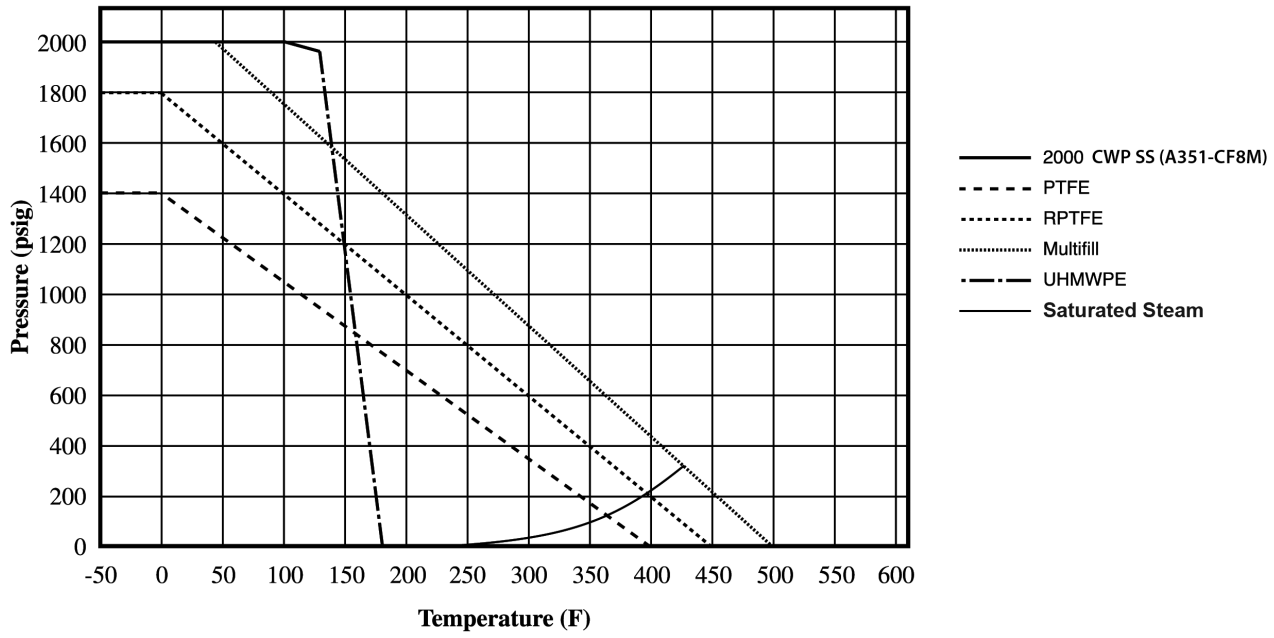
VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
77D-640 Series	--	--	--	11	24	35	--	--	--	--	--	--	--	--	--
77G-UL Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77W Series	--	--	16	36	68	125	177	389	--	--	--	--	--	--	--
77-100/200 Series	8.1	15	15	51	68	125	177	389	503	--	--	--	--	--	--
79 Series	8.5	8.5	9.8	32	44	66	148	218	440	390	--	--	--	--	--
80 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
82-100/200 Series	8.1	14	26	51	68	120	170	376	510	996	1893	--	--	--	--
83A/83B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
83R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
86A/86B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
86R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
87A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
87B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
87J-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87J-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
88B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
89-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
9A-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
90-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
92-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
93-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
94A-100/200 Series	6	7	19	34	50	104	268	309	629	1018	1622	--	--	--	--
96-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
399-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
489-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--

PRESSURE TEMPERATURE RATINGS

2000 CWP (CS) ASTM A216-WCB or A105 (GRAPH 13)

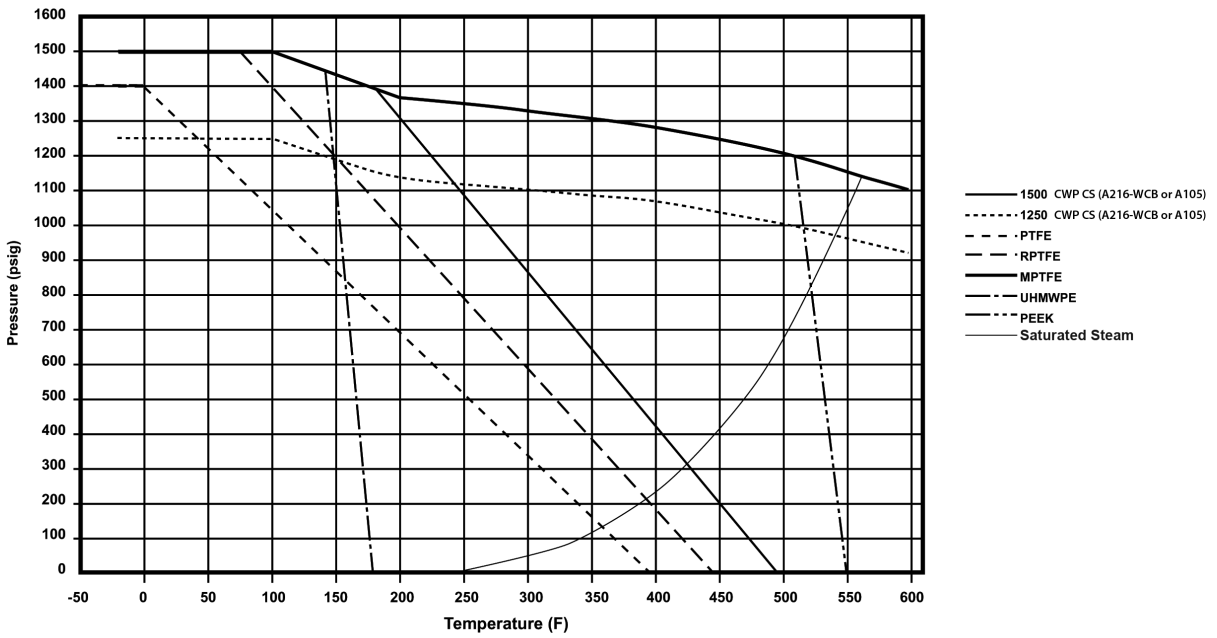


2000 CWP (SS) ASTM A351-CF8M (GRAPH 14)

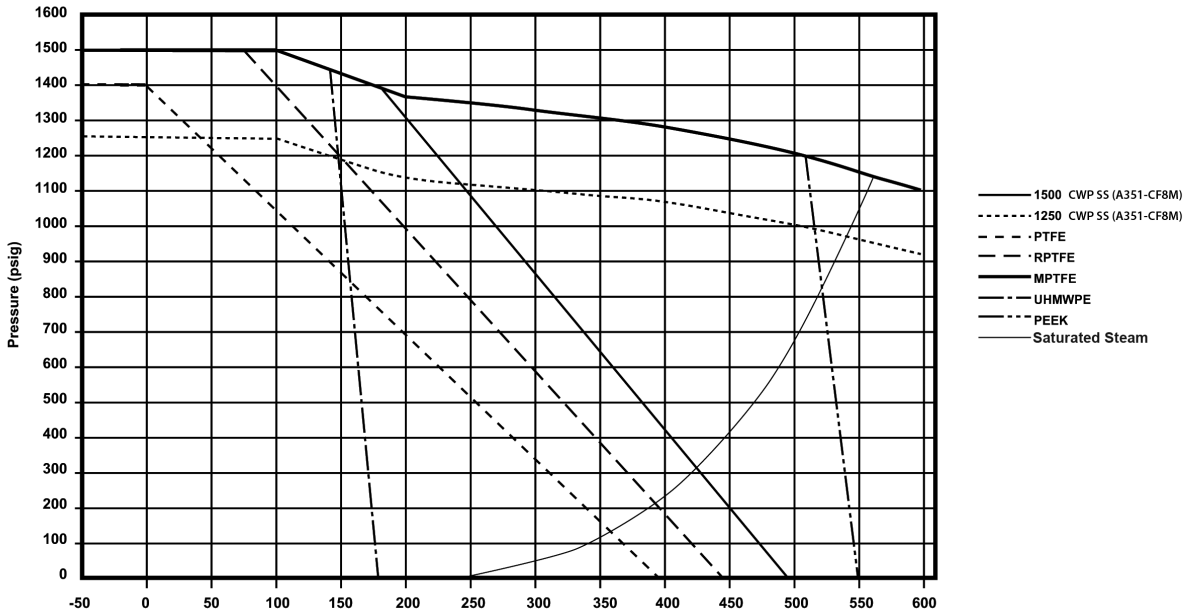


PRESSURE TEMPERATURE RATINGS

1500 CWP (CS) ASTM A216-WCB or ASTM A105 (GRAPH 11)



1500 CWP (SS) ASTM A351-CF8M (GRAPH 12)



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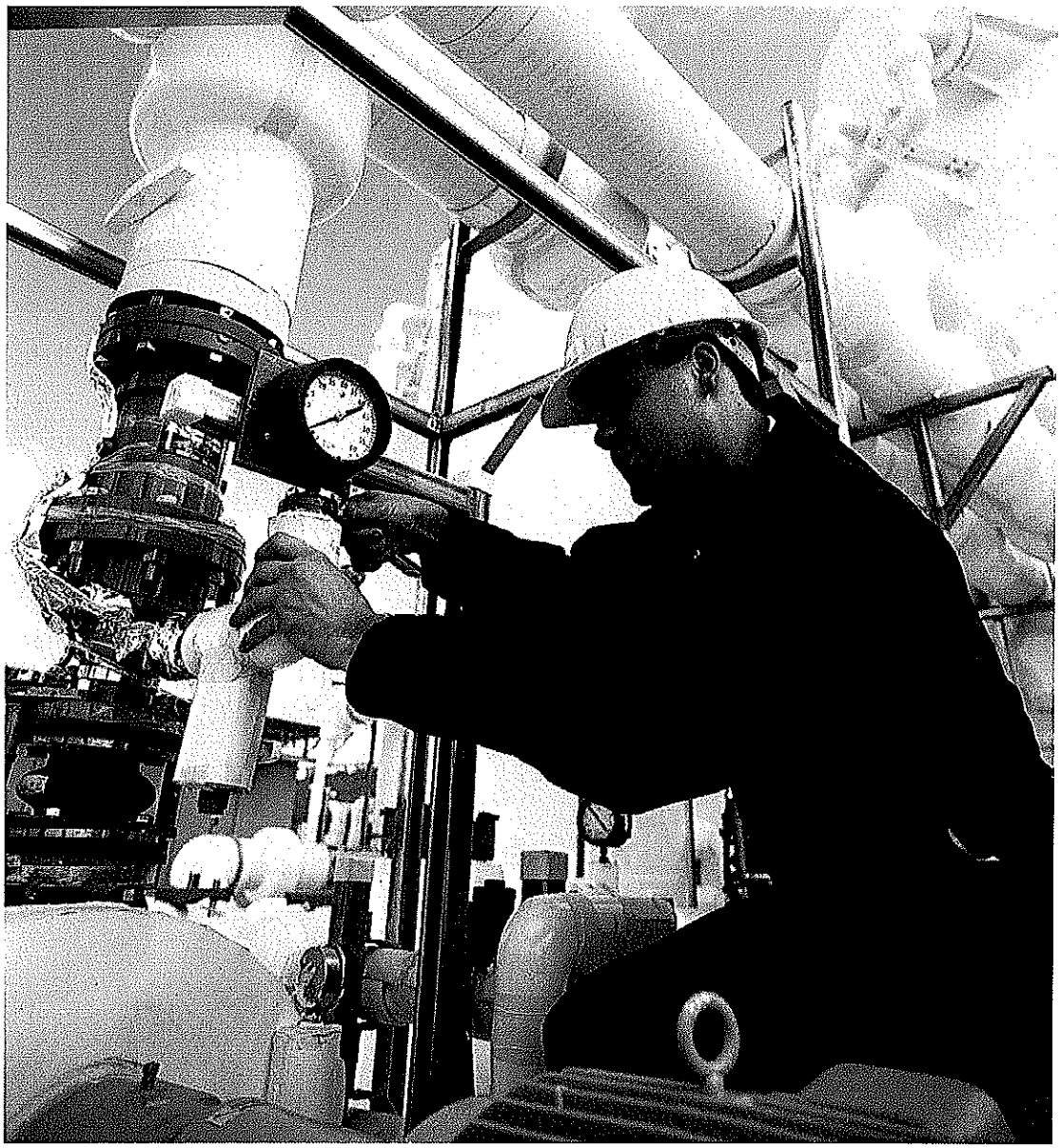
ASHCROFT®

PRESSURE GAUGE INSTALLATION, OPERATION AND MAINTENANCE



I&M008-10098-5/02 (250-1353-K) Rev. 01/12

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1.0 SELECTION & APPLICATION

Users should become familiar with ASME B40.100 (Gauges – Pressure Indicating Dial Type – Elastic Element) before specifying pressure measuring gauges. That document – containing valuable information regarding gauge construction, accuracy, safety, selection and testing – may be ordered from:

ASME International
Three Park Avenue
New York, N.Y. 10016-5990
800-843-2763 (US/Canada)
001-800-843-2763 (Mexico)
973-882-1170 outside North America
email: infocentral@asme.org
www.asme.org

WARNING: To prevent misapplication, pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. The information contained in this manual is offered as a guide in making the proper selection of a pressure gauge. Additional information is available from Ashcroft Inc.

The following is a highlight of some of the more important considerations:

1.1 Range – The range of the instrument should be approximately twice the maximum operating pressure. Too low a range may result in (a) low fatigue life of the elastic element due to high operating stress and (b) susceptibility to overpressure set due to pressure transients that exceed the normal operating pressure. Too high a range may yield insufficient resolution for the application.

1.2 Temperature – Refer to Section 2 of this manual for important information concerning temperature related limitations of pressure gauges, both dry and liquid filled.

1.3 Media – The material of the process sensing element must be compatible with the process media. Use of a diaphragm seal with the gauge is recommended for process media that (a) is corrosive to the process sensing element; (b) contain heavy particulates (slurries) or (c) are very viscous including those that harden at room temperature.

1.4 Oxidizing media – Gauges for direct use on oxidizing media should be specially cleaned. Gauges for oxygen service should be ordered to variation X6B and will carry the ASME required dial marking "USE NO OIL" in red letters. Gauges for direct use on other oxidizing media may be ordered to variation X6W. They will be cleaned but carry no dial marking. *PLUS!™* Performance gauges or Halocarbon filled gauge or diaphragm fill is required for use with oxidizing media; order variation XCF.

1.5 Pulsation/Vibration – Pressure pulsation can be dampened by several mechanisms; the patented *PLUS! Performance* gauge will handle the vast majority of applications. One exception to this is high frequency pulsation which is difficult to detect. The only indication may be an upscale zero shift due to movement wear. These applications should be addressed with a liquid filled gauge, or in extreme cases, a remotely mounted liquid filled gauge connected with a length of capillary line. The small diameter of the capillary provides excellent dampening, but can be plugged. The Ashcroft 1106 pulsation dampener and 1112 snubber are auxillary devices which dampen pulsation with less tendency to plug.

1.6 Gauge fills. – Once it has been determined that a liquid filled gauge is in order, the next step is selecting the type of fill. **Glycerin** satisfies most applications. While being the least expensive fill, its usable temperature range is 20/180°F. **Silicone** filled gauges have a broader service range: –40/250°F. Oxidizing media require the use of **Halocarbon,** with a service range of –40/250°F. Pointer motion will be slowed at the low end of the low end of these temperature ranges.

1.7 Mounting – Users should predetermine how the gauge will be mounted in service: stem (pipe), wall (surface) or panel (flush). Ashcroft wall or panel mounting kits should be ordered with the gauge. See Section 3.

2.0 TEMPERATURE

2.1 Ambient Temperature – To ensure long life and accuracy, pressure gauges should preferably be used at an ambient temperature between –20 and +150°F (–30 to +65°C). At very low temperatures, standard gauges may exhibit slow pointer response. Above 150°F, the accuracy will be affected by approximately 1.5% per 100°F. Other than discoloration of the dial and hardening of the gasketing and degradation of accuracy, non-liquid filled Type 1279 (phenolic case) and 1379 (aluminum case) Duragauge® gauge, with standard glass windows, can withstand continuous operating temperatures up to 250°F. Unigauge models 2½" and 3½" 1009 and 1008S liquid filled gauges can withstand 200°F but glycerin fill and the acrylic window of Duragauge® gauges will tend to yellow. Silicone fill will have much less tendency to yellow. Low pressure, liquid filled Types 1008 and 1009 gauges may have some downscale errors caused by liquid fill expansion. This can be alleviated by venting the gauge at the top plug (pullout the blue plug insert). To do this the gauge must be installed in the vertical position.

Although the gauge may be destroyed and calibration lost, gauges can withstand short times at the following temperatures: gauges with all welded pressure boundary joints, 750°F (400°C); gauges with silver brazed joints, 450°F (232°C) and gauges with soft soldered joints, 250°F (121°C). For expected long term service below –20°F (–30°C) Duragauge® and 4½" 1009 gauges should be hermetically sealed and specially lubricated; add "H" to the product code for hermetic sealing. Add variation XVY for special lubricant. Standard Duralife® gauges may be used to –50°F (–45°C) without modification.

2.2 Accuracy – Heat and cold affect accuracy of indication. A general rule of thumb for **dry gauges** is 0.5% of full scale change for every 40°F change from 75°F. Double that allowance for gauges with hermetically sealed or liquid filled cases, except for Duragauge® gauges where no extra allowance is required due to the elastomeric, compensating back. Above 250°F there may exist very significant errors in indication.

2.3 Steam service – In order to prevent live steam from entering the Bourdon tube, a siphon filled with water should be installed between the gauge and the process line. Siphons can be supplied with ratings up to 4,000 psi. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal should be used to isolate the gauge from the process steam. Siphons should also be used whenever condensing, hot vapors (not just steam) are present. Super heated steam should have enough piping or capillary line ahead of the siphon to maintain liquid water in the siphon loop.

2.4 Hot or very cold media – A five foot capillary line assembly will bring most hot or cold process media within the recommended gauge ambient temperature range. For media above

750°F (400°C) the customers should use their own small diameter piping to avoid possible corrosion of the stainless steel. The five foot capillary will protect the gauges used on the common cryogenic (less than –300°F (200°C) gases, liquid argon, nitrogen, and oxygen.) The capillary and gauge must be cleaned for oxygen service. The media must not be corrosive to stainless steel, and must not plug the small bore of the capillary.

2.5 Diaphragm seals – A diaphragm seal should be used to protect gauges from corrosive media, or media that will plug the instrument. Diaphragm seals are offered in a wide variety of designs and corrosion resistant materials to accommodate almost any application and most connections. Visit www.ashcroft.com for details.

2.6 Autoclaving – Sanitary gauges with clamp type connections are frequently steam sterilized in an autoclave. Gauges equipped with polysulfone windows will withstand more autoclave cycles than those equipped with polycarbonate windows. Gauges equipped with plain glass or laminated safety glass **should not be autoclaved.** Gauge cases should be vented to atmosphere (removing the rubber fill/safety plug if necessary) **before** autoclaving to prevent the plastic window from cracking or excessively distorting. If the gauge is liquid filled, the fill should be drained from the case and the front ring loosened before autoclaving.

3.0 INSTALLATION

3.1 Location – Whenever possible, gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

3.2 Gauge reuse – ASME B40.100 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

3.3 Tightening of gauge – Torque should never be applied to the gauge case. Instead, an open end or adjustable wrench should always be used on the wrench flats of the gauge socket to tighten the gauge into the fitting or pipe. NPT threads require the use of a suitable thread sealant, such as pipe dope or teflon tape, and must be tightened very securely to ensure a leak tight seal.

CAUTION: Torque applied to a diaphragm seal or its attached gauge, that tends to loosen one relative to the other, can cause loss of fill and subsequent inaccurate readings. Always apply torque **only** to the wrench flats on the lower seal housing when installing filled, diaphragm seal assemblies or removing same from process lines.

3.4 Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

3.5 Surface mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

3.6 Flush mounting – Also known as panel mounting. The applicable panel mounting cutout dimensions can be found at www.ashcroft.com

4.0 OPERATION

4.1 Frequency of inspection – This is quite subjective and depends upon the severity of the service and how critical the accuracy of the indicated pressure is. For example, a monthly inspection frequency may be in order for critical, severe service applications. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

4.2 In-service inspection – If the accuracy of the gauge cannot be checked in place, the user can at least look for (a) erratic or random pointer motion; (b) readings that are suspect – especially indications of pressure when the user believes the true pressure is 0 psig. Any gauge which is obviously not working or indicating erroneously, should be immediately valved-off or removed from service to avoid a possible pressure boundary failure.

4.3 When to check accuracy – Any suspicious behavior of the gauge pointer warrants that a full accuracy check be performed. Even if the gauge is not showing any symptoms of abnormal performance, the user may want to establish a frequency of bench type inspection.

4.4 When to recalibrate – This depends on the criticality of the application. If the accuracy of a 3-2-3% commercial type gauge is only 0.5% beyond specification, the user must decide whether it's worth the time and expense to bring the gauge back into specification. Conversely if the accuracy of a 0.25% test gauge is found to be 0.1% out of specification then the gauge should be recalibrated.

4.5 Other considerations – These include (a) bent or unattached pointers due to extreme pressure pulsation; (b) broken windows which should be replaced to keep dirt out of the internals; (c) leakage of gauge fill; (d) case damage – dents and/or cracks; (e) any signs of service media leakage through the gauge including its connection; (f) discoloration of gauge fill that impedes readability.

4.6 Spare parts – As a general rule it is recommended that the user maintain in inventory one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service.

5.0 GAUGE REPLACEMENT

It is recommended that the user stock one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service. With regard to gauges having a service history, consideration should be given to discarding rather than repairing them. Gauges in this category include the following:

a. Gauges that exhibit a span shift greater than 10%. It is possible the Bourdon tube has suffered thinning of its walls by corrosion.
b. Gauges that exhibit a zero shift greater than 25%. It is likely the Bourdon tube has seen significant overpressure leaving residual stresses that may be detrimental to the application.
c. Gauges which have accumulated over 1,000,000 pressure cycles with significant pointer excursion.
d. Gauges showing any signs of corrosion and/or leakage of the pressure system.
e. Gauges which have been exposed to high temperature or exhibit signs of having been exposed to high temperature – specifically 250°F or greater for soft soldered systems; 450°F or greater for brazed systems; and 750°F or greater for welded systems.

f. Gauges showing significant friction error and/or wear of the movement and linkage.

g. Gauges having damaged sockets, especially damaged threads.

h. Liquid filled gauges showing loss of case fill.

NOTE: ASME B40.100 does not recommend moving gauges from one application to another. This policy is prudent in that it encourages the user to procure a new gauge, properly tailored by specification, to each application that arises.

6.0 ACCURACY: PROCEDURES/DEFINITIONS

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and downscale, before and after lightly rapping the gauge to remove friction. **A pressure standard with accuracy at least four times greater than the accuracy of the gauge being tested is recommended.**

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leaktight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – ASME B40.100 recommends that **known** pressure (based on the reading from the pressure standard used) be applied to the gauge under test. Readings including any error from the nominal input pressure, are then taken from the gauge under test. The practice of aligning the pointer of the gauge under test with a dial graduation and then reading the error from the master gauge ("reverse reading") can result in inconsistent and misleading data and should NOT be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap. *"Rap"* means lightly tapping the gauge **before** reading to remove friction as described in ASME B40.100.

Referring to Figure 1, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is

FIG. 1

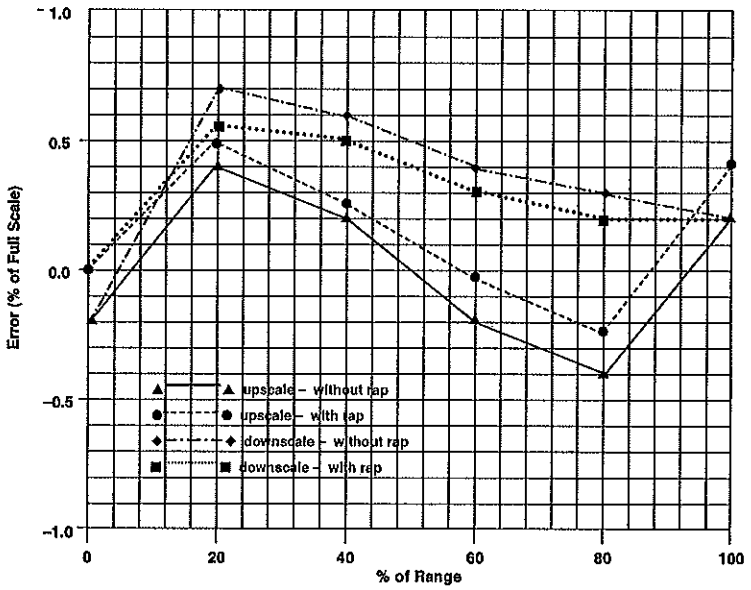
TYPICAL CALIBRATION CHART

INDICATED VALUE (PSI)

True Value – PSI	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.4	0	–.4	0
40	+.8	+1.0	+1.4	+1.1
80	+.4	+.5	+1.2	+1.0
120	–.4	–1.0	+.8	+.6
160	–.8	–.5	+.6	+.4
200	+.4	+.8	+.4	+.4

ERROR (% OF FULL SCALE)

True Value – % of Range	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.20	0	–.20	0
20	+.40	+.50	+.70	+.55
40	+.20	+.25	+.60	+.50
60	–.20	–.05	+.40	+.30
80	–.40	–.25	+.30	+.20
100	+.20	+.40	+.20	+.20



dropped or overpressured and the Bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer. Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 (Typical Calibration Chart) is not linear. The Ashcroft Duragauge® pressure gauge is equipped with a rotary movement feature which permits the user to minimize this class of error. Other Ashcroft gauge designs (e.g., 1009 Duralife®) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some Bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves. This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly tapping the gauge case at a check point. Possible causes of friction are burrs or foreign material in the movement gearing, "bound" linkages between the movement and the bourdon tube, or an improperly tensioned hairspring. If correcting these potential causes of friction does not eliminate excessive friction error, the movement should be replaced.

6.1 Calibration – Rotary Movement Gauges and Type 1259 Gauges – Inspect gauge for accuracy. Many times gauges are simply "off zero" and a simple pointer adjustment using the micrometer pointer is adequate. If inspection shows the gauge warrants recalibration to correct span and/or linearity errors, proceed as follows:

a. Remove ring, window and, if solid front case, the rear closure assembly.

b. Pressurize the gauge **once** to full scale and back to zero.

c. Refer to Figure 2 (Ashcroft System Assembly w/Rotary Gear Movement) for a view of a typical Ashcroft rotary system assembly with component parts identified. Refer to Figure 2A for link configuration of Type 1259 gauge.

FIG. 2 ASHCROFT SYSTEM ASSEMBLY W/ROTARY GEAR MOVEMENT

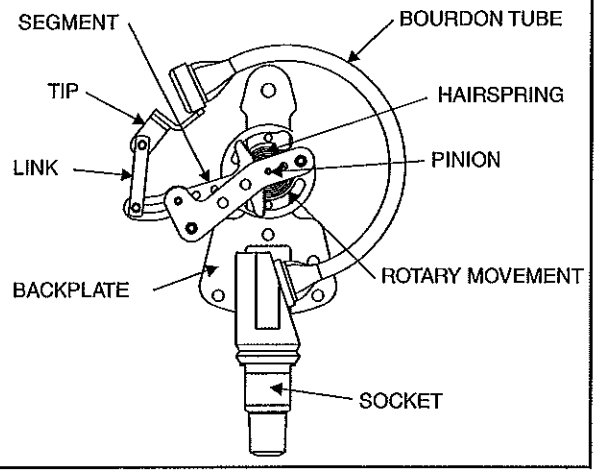
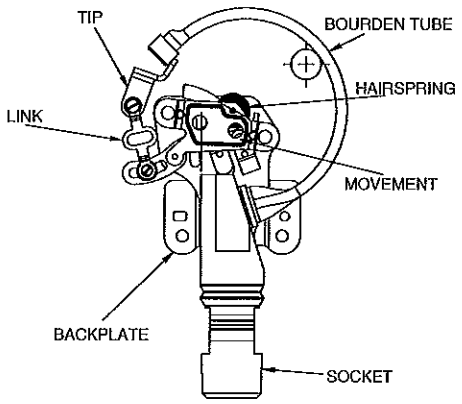


FIG. 2A ASHCROFT TYPE 1259 SYSTEM ASSEMBLY



d. Adjust the micrometer pointer so that it rests at the true zero position. For open front gauges the pointer and dial must also be disassembled and the pointer should then be lightly pressed onto the pinion at the 9:00 o'clock position.

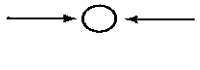
e. Apply full scale pressure and note the magnitude of the span error. With open front gauges, ideal span (270 degrees) will exist when at full scale pressure the pointer rests exactly at the 6:00 o'clock position.

f. If the span has shifted significantly (span error greater than 10%), the gauge should be replaced because there may be some partial corrosion inside the Bourdon tube which could lead to ultimate failure. If the span error exceeds 0.25%, loosen the lower link screw and move the lower end of the link toward the movement to increase span or away to decrease span. An adjustment of 0.004 inch will change the span by approximately 1%. This is a repetitive procedure which often requires more than one adjustment of the link position and the subsequent rechecking of the errors at zero and full scale pressure.

g. Apply midscale pressure and note error in reading. Even though the gauge is accurate at zero and full scale, it may be inaccurate at the midpoint. This is called linearity error. For corrections to linearity with the Type 1259 gauges refer to Figure 2B. For rotary movement gauges,

FIG. 2B LINEARITY ADJUSTMENT & LINK CONFIGURATION FOR ASHCROFT TYPE 1259

To increase pointer indication at mid-scale, use a pliers to open the link.



To decrease pointer indication at mid-scale, use a pliers to close the link.

note the following: if the error is positive, the movement should be rotated counter clockwise. Rotating the movement one degree will change this error by approximately 0.25%. Rotating the movement often affects span and it should be subsequently rechecked and readjusted if necessary according to step 6.1e and 6.1f.

h. While recalibrating the gauge, the friction error – difference in readings taken with and without rap – should be noted. This error should not exceed the basic accuracy

of the gauge. If the friction error is excessive, the movement should be replaced. One possible cause of excessive friction is improper adjustment of the hairspring. The hairspring torque,or tension, must be adequate without being excessive. The hairspring should also be level, unwind evenly (no turns rubbing) and it should never tangle.

NOTES:

1 For operation of test gauge external zero reset, refer to page 17.

2 For test gauge calibration procedure, refer to Figure 2 on page 18.

7.0 DIAPHRAGM SEALS

7.1 General – A diaphragm seal (isolator) is a device which is attached to the inlet connection of a pressure instrument to isolate its measuring element from the process media. The space between the diaphragm and the instrument's pressure sensing element is solidly filled with a suitable liquid. Displacement of the liquid fill in the pressure element, through movement of the diaphragm, transmits process pressure changes directly to a gauge, switch or any other pressure instrument. When diaphragm seals are used with pressure gauges, an additional 0.5% tolerance must be added to the gauge accuracy because of the diaphragm spring rate.

Used in a variety of process applications where corrosives, slurries or viscous fluids may be encountered, the diaphragm seal affords protection to the instrument where:

- The process fluid being measured would normally clog the pressure element.
- Pressure element materials capable of withstanding corrosive effects of certain fluids are not available.
- The process fluid might freeze due to changes in ambient temperature and damage the element.

7.2 Installation – Refer to bulletin OH-1 for information regarding (a) seal configurations; (b) filling fluids; (c) temperature range of filling fluids; (d) diaphragm material pressure and temperature limits; (e) bottom housing material pressure and temperature limits; (f) pressure rating of seal assembly; (g) accuracy/temperature errors of seal assembly; (h) diaphragm seal displacement. The volumetric displacement of the diaphragm must at least equal the volumetric displacement of the measuring element in the pressure instrument to which the seal is to be attached.

It is imperative that the pressure instrument/diaphragm seal assembly be **properly** filled prior to being placed in service. Ashcroft diaphragm seal assemblies should only be filled by a seal assembler certified by Ashcroft Inc. Refer to section 3.3 for a cautionary note about not applying torque on either the instrument or seal relative to the other.

7.3 Operation – All Ashcroft® diaphragm seals, with the exception of Type 310 mini-seals, are continuous duty. Should the pressure instrument fail, or be removed accidentally or deliberately, the diaphragm will seat against a matching surface preventing damage to the diaphragm or leakage of the process fluid.

7.4 Maintenance – Clamp type diaphragm seals – Types 100, 200 and 300 – allow for replacement of the diaphragm or diaphragm capsule, if that ever becomes necessary. The Type 200 top housing must also be replaced with the diaphragm. With all three types the clamping arrangement allows field disassembly to permit cleaning of the seal interior.

7.5 Failures – Diaphragm failures are generally caused by either corrosion, high temperatures or fill leakage. Process media build-up on the process side of the diaphragm can also require seal cleaning or replacement. Consult Customer Service, Stratford CT for advice on seal failures and/or replacement.

WARNING: All seal components should be selected considering process and ambient operating conditions to prevent misapplication. Improper application could result in failure, possible personal injury, property damage or death.

8.0 DAMPENING DEVICES

8.1 General – Some type of dampening device should be used whenever the pressure gauge may be exposed to repetitive pressure fluctuations that are fairly rapid, high in magnitude and especially when transitory pressure spikes exceeding the gauge range are present (as with starting and stopping action of valves and pumps). A restricted orifice of some kind is employed through which pressure fluctuations must pass before they reach the Bourdon tube. The dampener reduces the magnitude of the pressure pulse thus extending the life of the Bourdon tube and movement. This reduction of the pressure pulsation as "seen" by the pressure gauge is generally evidenced by a reduction in the pointer travel. If the orifice is very small the pointer may indicate the average service pressure, with little or no indication of the time varying component of the process pressure.

Commonly encountered media (e.g. – water and hydraulic oil) often carry impurities which can plug the orifice over time thus rendering the gauge inoperative until the dampener is cleaned or replaced.

Highly viscous media and media that tend to periodically harden (e.g., asphalt) require a diaphragm seal be fitted to the gauge. The seal contains an internal orifice which dampens the pressure fluctuation within the fill fluid.

8.2 Throttle Screws & Plugs – These accessories provide dampening for the least cost. They have the advantage of fitting completely within the gauge socket and come in three types: (a) a screwed-in type which permits easy removal for cleaning or replacement; (b) a pressed in, non-threaded design and (c) a pressed in, threaded design which provides a highly restrictive, helical flow path. Not all styles are available on all gauge types.

8.3 Ashcroft Pulsation Dampener – Type 1106 Ashcroft pulsation dampener is a moving pin type in which the restricted orifice is the clearance between the pin and any one of five preselected hole diameters. Unlike a simple throttle screw/plug, this device has a self-cleaning action in that the pin moves up and down under the influence of pressure fluctuations.

8.4 Ashcroft Pressure Snubber – The heart of the Type 1112 pressure snubber is a thick porous metal filter disc. The disc is available in four standard porosity grades.

8.5 Ashcroft Needle Valves – Type 7001 thru 7004 steel needle valves provide varying degrees of dampening. These devices, in the event of plugging, can easily be opened to allow the pressure fluid to clear away the obstruction.

8.6 Chemiquip® Pressure Limiting Valves – Model PLV-255, PLV-2550, PLV-5460, PLV-5500 and PLV-6430, available with and without built-in snubbers, automatically "shut off" at adjustable preset values of pressure to protect the gauge from damage to overpressure. They are especially useful on hydraulic systems wherein hydraulic transients (spikes) are common.

9.0 TEST EQUIPMENT & TOOL KITS

See our website www.ashcroft.com for more details

9.1 Pressure Instrument Testing Equipment

Type 1305D Deadweight Tester

Type 1327D Pressure Gauge Comparator

Type 1327CM "Precision" Gauge Comparator

9.2 Tools & Tool Kits For Recalibration of 4½" and Larger Gauges

Type 2505 universal carrying case for 1082 test gauge

Type 266A132-01 span wrench for 1082 test gauge

Type 1281 socket O-Ring kit for 1279/1379 lower connect

Type 1285 4½" ring wrench for 1279/1379 lower & back connect

Type 1286 6" ring wrench for 1379 lower & back connect

Type 3220 pointer puller (all gauges except 1009 Duralife®)

Type 3530 pinion back-up tool for 1009 Duralife®

Type 3220 Handjack set

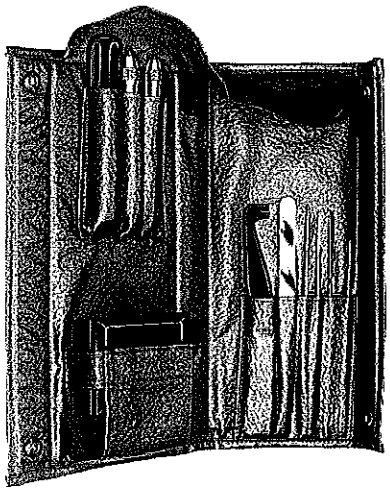
Type 1105 Tool Kit

9.3 Kits to Convert a Dry Gauge to a Liquid Filled or Weather Proof Case Gauge

Type 1280 conversion kit for 4½" lower connect 1279/1379

Type 1283 conversion kit for 4½" back connect 1279/1379

Type 1284 conversion kit for 6" lower & back connect



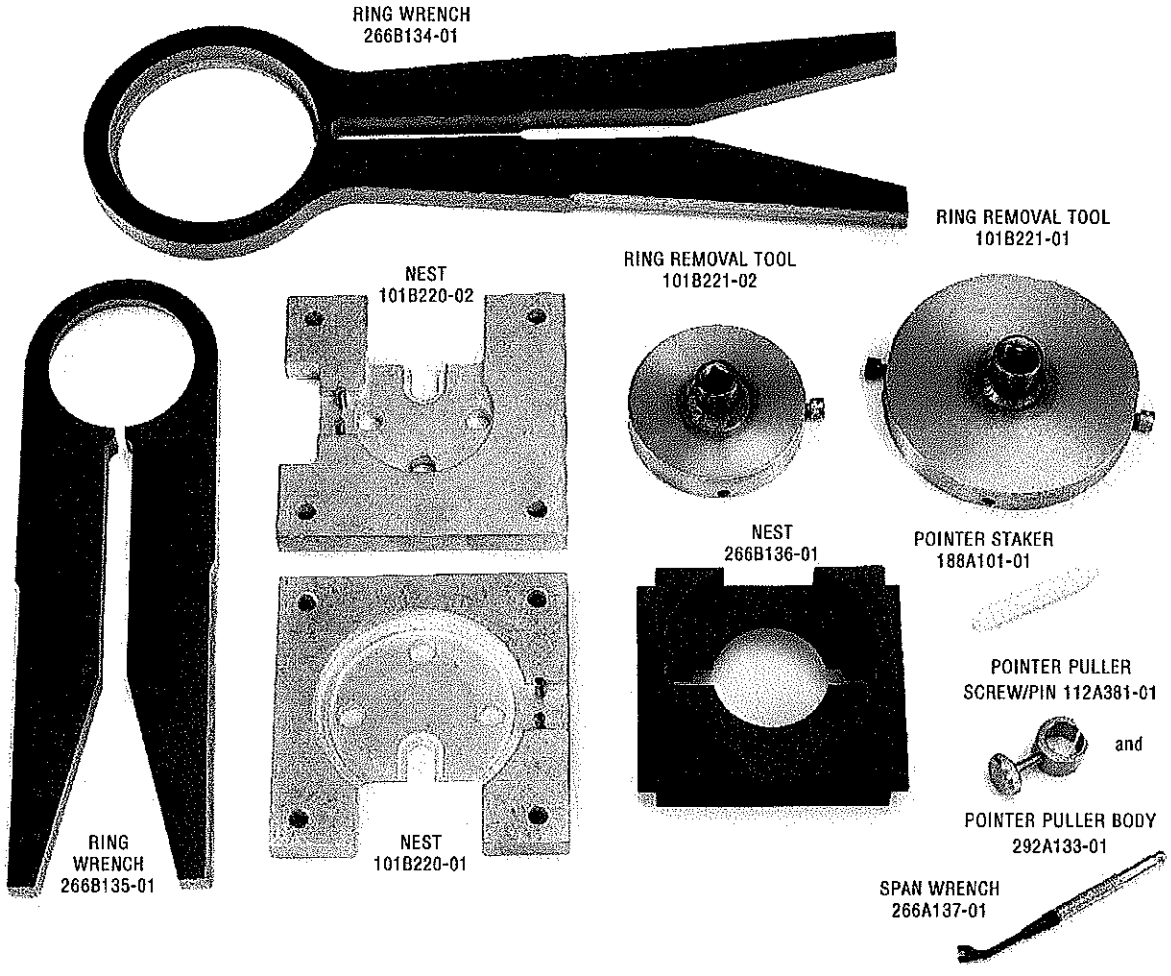
TYPE 1105
TOOL KIT

TYPE 3220
HAND JACK SET

9.4 2½ & 3½ 1009 Duralife® Gauge Tools

Description	Part No.
Pointer Puller Screw/Pin[2][3][4]	112A381-01
Pointer Puller Body[2][3][4]	292A133-01
Pointer Staker[2][4]	188A101-01
Span Wrench[2][5] (to adjust span)	266A137-01
Ring Wrench 3½"[1][5] (for ring removal) (35 1009)	266B134-01
Ring Wrench 2½"[1][5] (for ring removal) (25 1009)	266B135-01
Nest 2½" & 3½"[1][5] (to hold gauge for ring removal) (25/35 1009)	266B136-01
Ring Removal Tool[6] (25 1009)	101B221-02
Ring Removal Tool[6] (35 1009)	101B221-01
Nest 2½"[6] (to hold gauge for ring removal) (25 1009)	101B220-02
Nest 3½"[6] (to hold gauge for ring removal) (35 1009)	101B220-01
Type 1230 throttle plug insertion (¼ NPT) for 1009 Duralife®	1230
Type 1231 throttle plug insertion (¼ NPT) for 1009 Duralife® (body only)	1231
Tool to open orifice on push-in throttle plug	101A206-01

(1) Formerly 1206T Tool Kit.
(2) Formerly some parts in 1205T Tool Kit.
(3) Both parts must be purchased together.
(4) Previous and current design.
(5) Previous design only.
(6) Current design only.



ASHCROFT® Type 1188 Bellows Gauge Calibration Procedure

ASHCROFT®

CALIBRATION & TROUBLE CORRECTION DIAGRAM

RANGE SPAN ADJUSTMENT

RANGE TOO SHORT
Adjust slide "S" inward

RANGE TOO LONG
Adjust slide "S" outward

POINTER JUMPING

STICKY PARTS
Clean all bearings and gear teeth

LOOSE HAIRSPRING
Remove backlash by disengaging pinion & rotate to tighten

COUNTER BALANCE RUBBING
Bend if necessary to clear socket in travel

NOTE: After adjusting range span, set both movement stops. Set the underload stop so that the pointer will stop at zero. Set the overload stop so that the pointer will pass the maximum range approximately 5°.

After adjusting span re-zero pointer by removing from pinion and re-assembling at the proper dial mark.

SLUGGISH MOVEMENT

TIGHT HAIRSPRING
Loosen by disengaging pinion & rotate

NON LINEAR

NON LINEAR FIRST 3RD.

ADJ. ANGLE OF PULL BY INCREASING ANGLE "A"

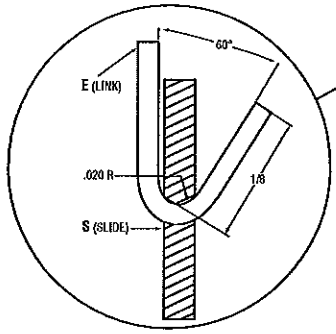
NON LINEAR LAST 3RD.

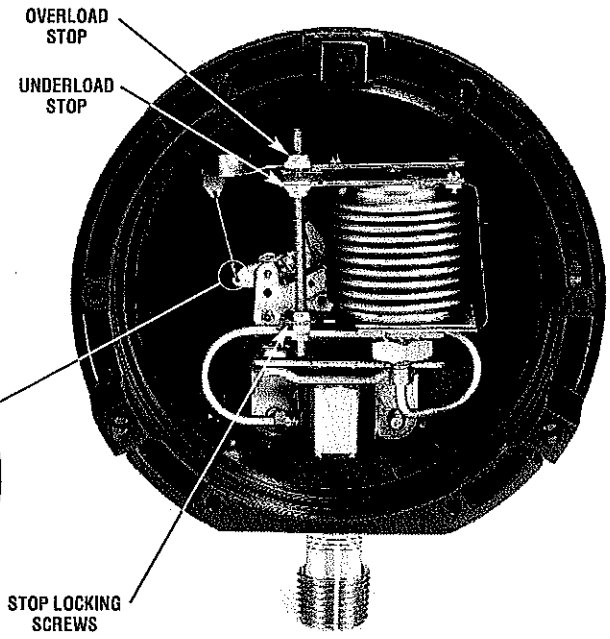
ADJ. ANGLE OF PULL BY DECREASING ANGLE "A"

NOTE: To increase or decrease angle "A," bend tip inward or outward as required. Doing this may run the movement segment off the pinion. This can be corrected by cutting off one end off the link "E" decreasing its length, or makin a new length from .032 dia. phos. bronze wire.
Caution: When reproducing link end, follow figure 44 very closely. this will prevent too much play, or, binding in operation.

REF: Replacing System Bellows
After assembling bellows to the gauge socket securely, subject system to 30 psi for five minutes, allowing bellows to travel approximately 1/8" against the overload stop. After this, heat treat system for 15 hours at 250°F, this procedure is necssary to prevent gauge drift.

SLIDE AND LINK (angle "A")
Enlarged view of slide and link





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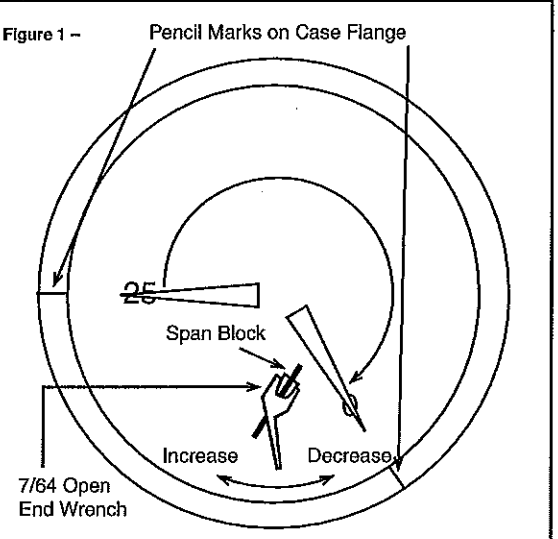
ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Vacuum Range

ASHCROFT®

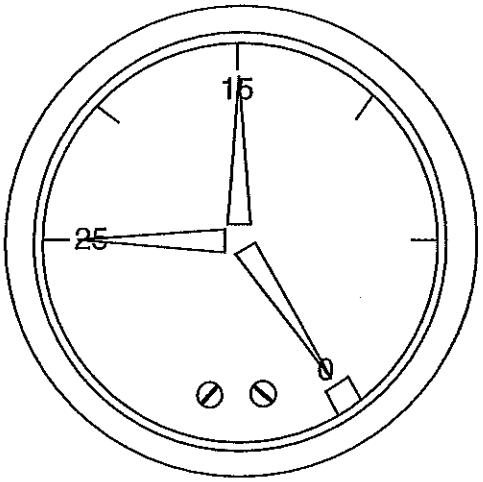
1. Remove ring, window and gasket pointer.
2. Using a pencil, refer to dial and mark the 0 and 25″ Hg positions on the case flange.
3. Remove dial.
4. Apply 25″ Hg vac.
5. Lightly press pointer onto pinion carefully aligning it with the 25″ Hg vac. mark on the flange.
6. Release vacuum fully.
7. Note agreement of pointer to zero mark on flange.
8. If span is high or low, turn span block as shown in Figure 1.

Figure 1 –



9. Repeat steps 4 through 8 until span is correct.
10. Remove pointer.
11. With 25″ Hg vac applied, reassemble dial, dial screws (finger tight) and point.
12. Apply 15″ Hg vac. and note accuracy of indication. If required, slide dial left or right to reduce error to 1% maximum.
13. Firmly tighten dial screws.
14. Firmly tap pointer onto pinion.
15. recheck accuracy at 15 and 25″ Hg vac. (Figure 2).
16. Reassemble window, gasket and ring.

Figure 2 –



Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½″ version and December 2008 for 3½″ version.
Back of gauge will have a date code sticker.

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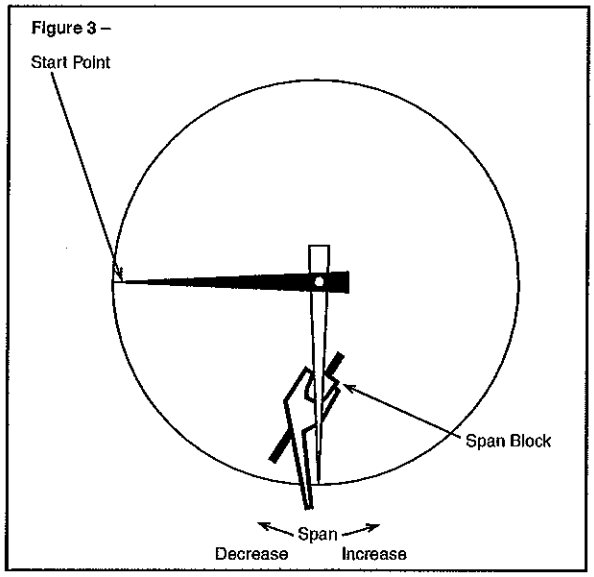
ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Pressure Range

Step 1. With the dial off, install pointer at 9 o'clock "lightly," Figure 3.

Figure 3 –

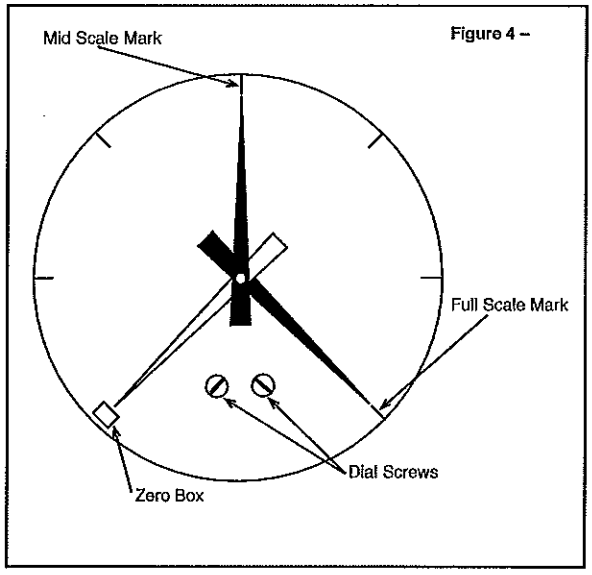


Step 2. Go to full scale pressure...rotate span block with tool until pointer rests at 6 o'clock.

Step 3. Go to zero pressure (9 o'clock)...if pointer has not moved away from start point, go to Step 4. If pointer has moved, repeat Step 1 until span is correct.

Step 4. Install dial with screws snug.

Figure 4 –



Step 5. Install pointer centered in zero box, Figure 4.

Step 6. Go to full scale pressure...check that pointer is within 1% of full scale mark. If not, remove pointer and dial and return to step 1, Figure 4.

Step 7. Go to mid-scale pressure...rotate dial until mid-scale mark is aligned with pointer, Figure 4.

Step 8. Tighten dials screws and stake on pointer.

Step 9. Check zero and full scale. Reassemble window, gasket and ring.

Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½" version and December 2008 for 3½" version.
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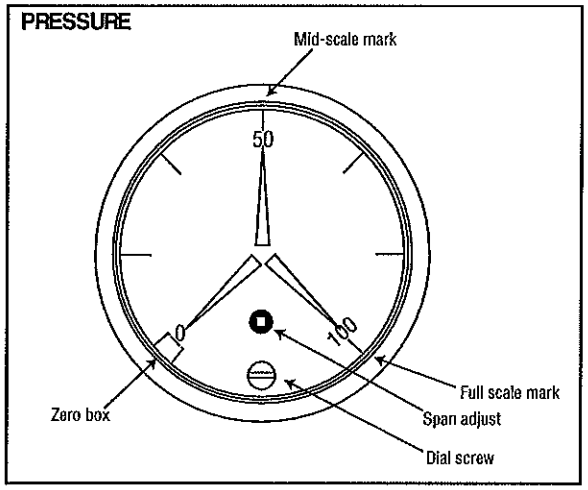
ASHCROFT® Current Type 1009 Duralife® Calibration Procedure – Pressure and Vacuum Range

Calibration – 1009 Duralife® Gauge –
Inspect gauge for accuracy. At times gauges are simply "off zero" and opening the ventable plug at the top of the gauge will relieve internal gauge pressure and correct the offset. If this is not adequate and inspection shows that the gauge warrants recalibration to correct zero, span and/or linearity errors, proceed as follows:

Remove ring, window, and gasket using Ashcroft Ring Removal Tools P/N 101B220-02 and 101B221-02 for 2½" gauges and 101B220-01 and 101B221-01 for 3½" gauges.

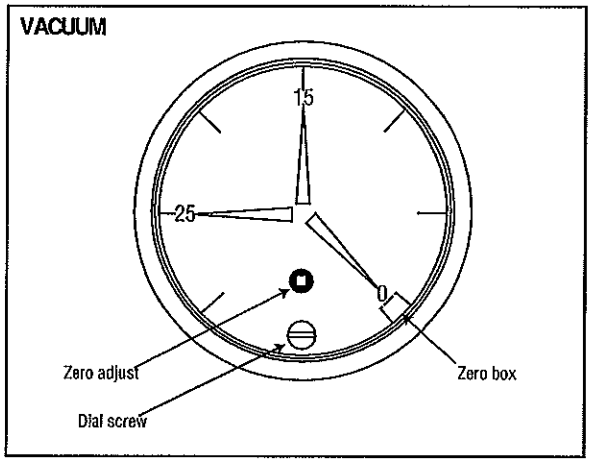


Positive Pressure Ranges –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.
2. Apply full scale pressure. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise increases span, counterclockwise decrease span.
3. Fully exhaust pressure and check that pointer still is still in the zero box. If not, repeat step 1 and 2
4. Once 0 and full scale are within tolerance, pressurize gauge to mid-scale.
5. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.
6. If an adjustment was made in step 5, recheck the gauge at zero and full scale, adjust accordingly until zero, mid and full scale points are in tolerance.

Vacuum Range –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.
2. Apply 25 inches Hg vacuum. If the error exceeds 1% adjust pointer with a slotted screwdriver until gauge is within tolerance.



3. Vent to 0 pressure and check pointer position in the zero box. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise rotation moves pointer clockwise, counterclockwise rotation moves the pointer counterclockwise.
4. Repeat step 1 and 2 until 0 and 25 inches of Hg are within gauge tolerance.
5. Apply 15 inches Hg vacuum. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.
6. If an adjustment was made in step 4, recheck the gauge at zero and 25 inches of Hg vacuum, adjust accordingly until zero, 15 and 25 inches Hg are in tolerance.
7. Continue below.

Re-assemble window and ring to gauge:

a. If plastic window is used, push window back into front of gauge, ensure the o-ring does not roll out of window groove (lubricate if necessary). Align the tabs of the window with the tabs of the case front. Once window is in place, install ring and tighten with tools referenced above and shown on page 10.

b If safety glass is used, reinstall window, gasket, and ring. Ensure that the gasket is seated properly under all four tabs of the ring and does not wrinkle when ring is tightened.

Note: Tighten ring: Apply 120-200inlb of torque. Rotate ring clockwise to tighten. Warning: over tightening of safety glass may induce cracking.

Notes: See page 10 for any tools required to calibrate.

For models produced after September 2008 for 2½" version and December 2008 for 3½" version.
Back of gauge will have a date code sticker.

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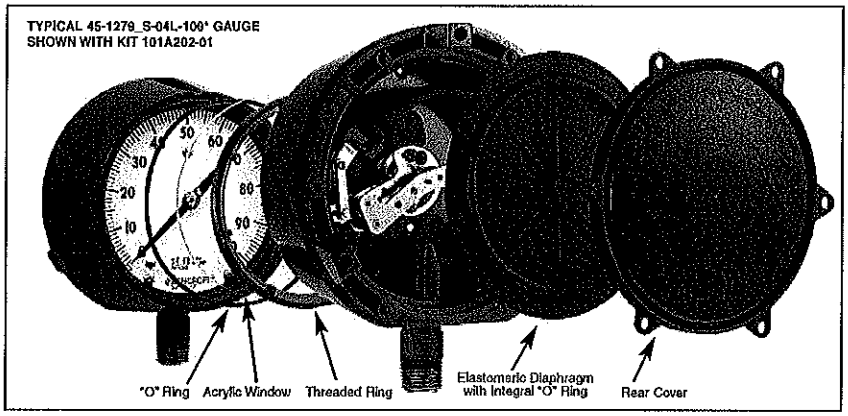
Type 1279 & 1379 Solid Front Duragauge® Pressure Gauge Liquid Fill Conversion Instructions

ASHCROFT®



	1279		1379		
	4½" LOWER	4½" BACK	4½" LOWER	4½" BACK	6" LOWER & BACK
KIT PART NO.	101A202-01	101A203-01	1280	1283	1284
	QUANTITY INCLUDED				
ACRYLIC WINDOW	1	1	1	1	1
FRONT O-RING	1	1	1	1	1
DIAPHRAGM[1]	1	1	1	1	2(1-LC:1-BC)
REAR COVER	1	1	1	1	2(1-LC:1-BC)
COVER SCREWS	4	4	-	-	-
THROTTLE SCREWS	2	2	2	2	2
GARTER SPRING	–	1	1	1	1
FILL IDENTIFICATION	1	1	1	1	1
THREADED RING	–	–	1	1	1

1. When Halocarbon fill is a requirement, rear case diaphragm bladder material is Viton instead of the standard Buna diaphragm bladder. Consult factory for part number.

	Ambient Temp. Limits		60 psi and Under Down Scale Zero Shift Required
	°F	°C	
Weatherproof	–50/150	–45/65	N/A
Hermetically Sealed	–10/125	–25/50	N/A
Glycerin Filled	0/150	30/65	.15 psi
Silicone Filled	–50/150	–45/65	.12 psi

1. Unscrew front threaded ring (turn CCW). Remove and discard glass window. For range spans 60 psi and under, shift pointer down scale by the amount shown in the table. With either the glass or plastic window, replace the O-ring with one furnished in the kit.
2. Remove protective paper from acrylic plastic window taking care not to scratch window. Assemble window in gauge.
3. Moisten face of threaded ring with silicone oil or silicone grease where ring bears up against window. Replace front threaded ring and tighten firmly hand tight. See instructions on reverse side for applying proper torque to ring to establish desired squeeze on O-ring seal. **(Fig. 4).**
   It is important to hold gauge **rigidly,** otherwise ring lugs may be damaged during removal or assembly process.
4. From rear of gauge, remove and discard these parts: rear cover and cover gaskets from case.
   Note: Disregard Step Nos. 5a and 5b if converting to hermetically sealed version. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.
5. **Filling Procedures:**
   a. **Manual Filling Procedure:** Place gauge face down on bench and **tip gauge** by blocking up front with a ⅜ inch block at the 12 o'clock dial position. Tipping of the gauge is necessary so fluid will flow into front cavity of the case. Pour in fill liquid to within about 1/16 inch of rear seal lip. When bubbles stop rising, front cavity is filled. Remove ⅜ inch block and pour in liquid until level is about 1/16 inch below rear sealing lip.
   Note: An alternative method of filling is to fill the front dial cavity, adding the front window, etc., as in Step No. 3. Then fill the rear of the gauge. This method eliminates the need to tip the gauge.
   b. **Vacuum Pump Fill Procedure:** (This procedure is recommended when filling a large number of gauges.) Place gauge face down and insert a ⅛ inch diameter tube, connected to a vacuum pump, through the 12 o'clock position hole in the rear, solid front portion of the case **(see Fig. 5).** Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16 inch BELOW the O-ring channel lip. Pre-measuring fill amount is not necessary with above methods. For reference, amount of fill is approximately 400 ml. or 14 fluid oz. (4½" GA.) and 455 ml. or 16 fluid oz. (6" GA.).
   c. **Note:** The liquid fill level should be ⅜" (±⅛) as measured from the inside of the ring at the 12:00 o'clock position.
6. On lower connection gauges, assemble rear seal diaphragm to case.
   For back connection gauges see instructions on reverse side. **(Fig. 2/4).**
7. **For 1279:**
   Assemble rear cover and six self tapping screws in a criss-cross pattern and torque to 12 in lbs. (±2 in lbs.)
   For 1379:
   - Thread rear ring and torque to 200 in lbs
   - Install stainless steel back cover using two screws. Torque screws to 14 in lbs. (±2 in lbs.)
8. Assemble throttle screw to threaded hole in socket.
   Note: If system is monel (socket wrench flat stamped "PHS" or "PH") use monel throttle screw.
9. Check appropriate box on fill identification label, and peel off label back, and attach fill label to gauge case.
10. If gauge is to be repackaged:
    a. Include enclosed instruction sheet inside carton.
    b. Change type number on carton label to:
       (1) Hermetically Sealed – 1279(*)SH.
       (2) Liquid Filled – 1279(*)SL.
       *Bourdon Tube System Code

Glycerin or silicone should not be used in applications involving Oxygen, Chlorine, Nitric Acid, Hydrogen Peroxide or other strong oxidizing agents, because of danger of spontaneous chemical reaction, ignition or explosion. Halocarbon should be specified. Products with this fill can be ordered from factory. The use of fluids other than those listed in the table above (for example, Hydrocarbon-based oils) may result in leakage caused by a reaction between the fluid and the elastomeric seals. Consult the factory before filling with any other fluid.

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Type 1279 & 1379 Solid Front Duragauge® Pressure Gauge Liquid Fill Conversion Instructions

ASHCROFT®

INSTRUCTIONS FOR USING CONE TOOL AND RING WRENCH

Garter Spring & Diaphragm Assembly (Back Connection Gauge Only)

A. Place cone tool over socket shank as shown.
B. Moisten lip of socket and outer O-ring surface with silicone oil or grease.
C. Place diaphragm with rib side facing upward over cone into case grove.
Diaphragm O-ring must be completely in socket-shank grove.
D. Place garter spring over cone as shown and slide onto diaphragm in socket grove
E. Assemble rear cover with screws per step 7.

Front Ring Assembly (All Gauges)

A. Assemble ring to case by hand to start.
B. Place ring on wrench as shown
C. Use ½" drive extension and torque ring to 200 in. lb

Alternate Method

A. Tighten ring snugly by hand
B. Mark case and ring.
C. Turn ring another 100 to 120 degrees (slightly less than ½ turn) using the ring wrench and ½" drive socket wrench or place the blunt end of a wooden or plastic dowel against a ring lug and tap with a hammer.

INSTRUCTIONS FOR LIQUID FILLING ASHCROFT® TYPE 1279 AND 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGES USING A VACUUM PUMP

A. Insert a length of ¼" diameter tubing through the 12 o'clock position hole in the rear, solid front portion of the case, as shown.
B. Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid.*
C. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16" below the o-ring channel lip, as shown.
D. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

*To prevent breakage, reduce vacuum to 15 in. Hg for plain glass and safety glass.

BACK CONNECTION ASSEMBLED GAUGE

Fig. 2

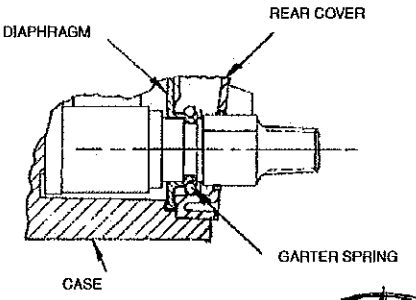


Fig. 3

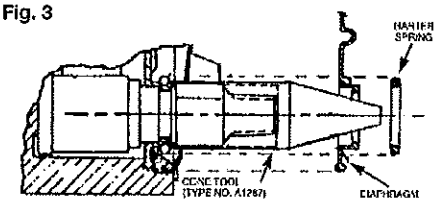


Fig. 4

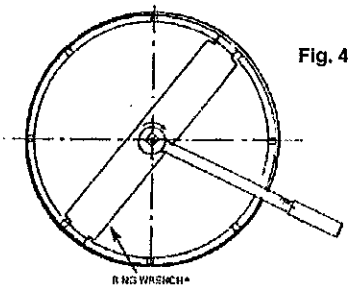
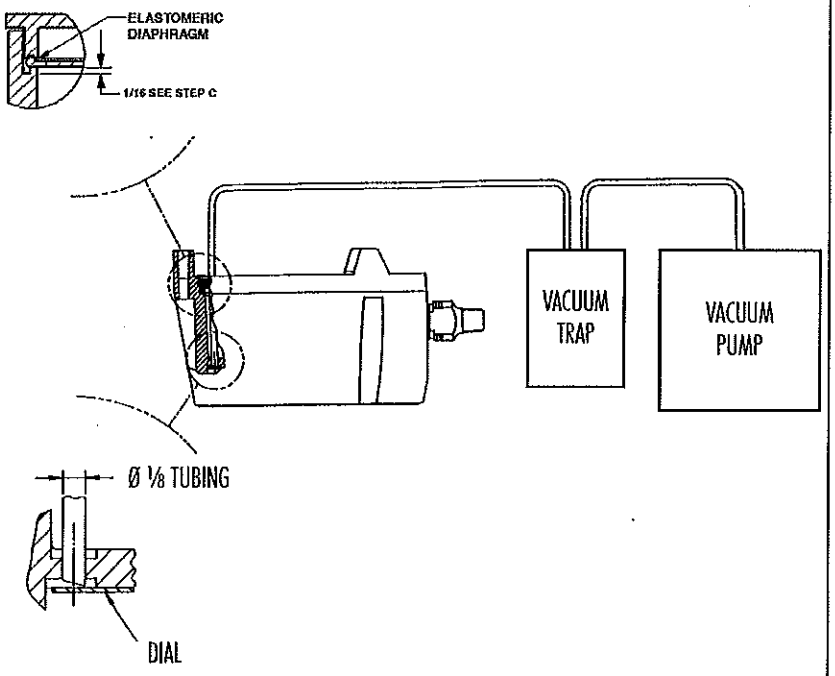


Fig. 5



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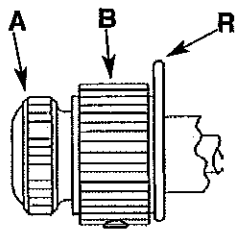
INSTRUCTIONS FOR USE OF EXTERNAL EASY ZERO™ ADJUST FEATURE*

Fig. 1



1. LOOSEN RING-LOCKING SCREW A.
2. OBTAIN REQUIRED ADJUSTMENT BY ROTATING KNOB B CLOCKWISE OR COUNTER-CLOCKWISE.
3. TIGHTEN SCREW A DOWN ON KNOB B.

*Applicable only for test gauge with hinged ring design.

ADDITIONAL CALIBRATION INSTRUCTIONS

1) "Standards shall have nominal errors no greater than ¼ of these permitted for the gauge being tested." *(Ref: ASME B40=100-1998)*
2) The instrument used as the calibration standard should have a maximum range no greater than 2x that of the gauge being tested. (i.e. Do not use a 400psi standard to test a 15psi gauge.)
3) "Known pressure shall be applied at each test point on increasing pressure (or vacuum) from one end to the other end of the scale. At each test point the gauge shall be . . .
lightly tapped, and then read . . ."
(*Ref: ASME B40.1 ¶ 6.2.4.1*)
4) To read gauge indication, move eye over red pointer tip at OD of printed dial until red reflection in mirror band is no longer visible, and then read the pointer position in reference to the dial.

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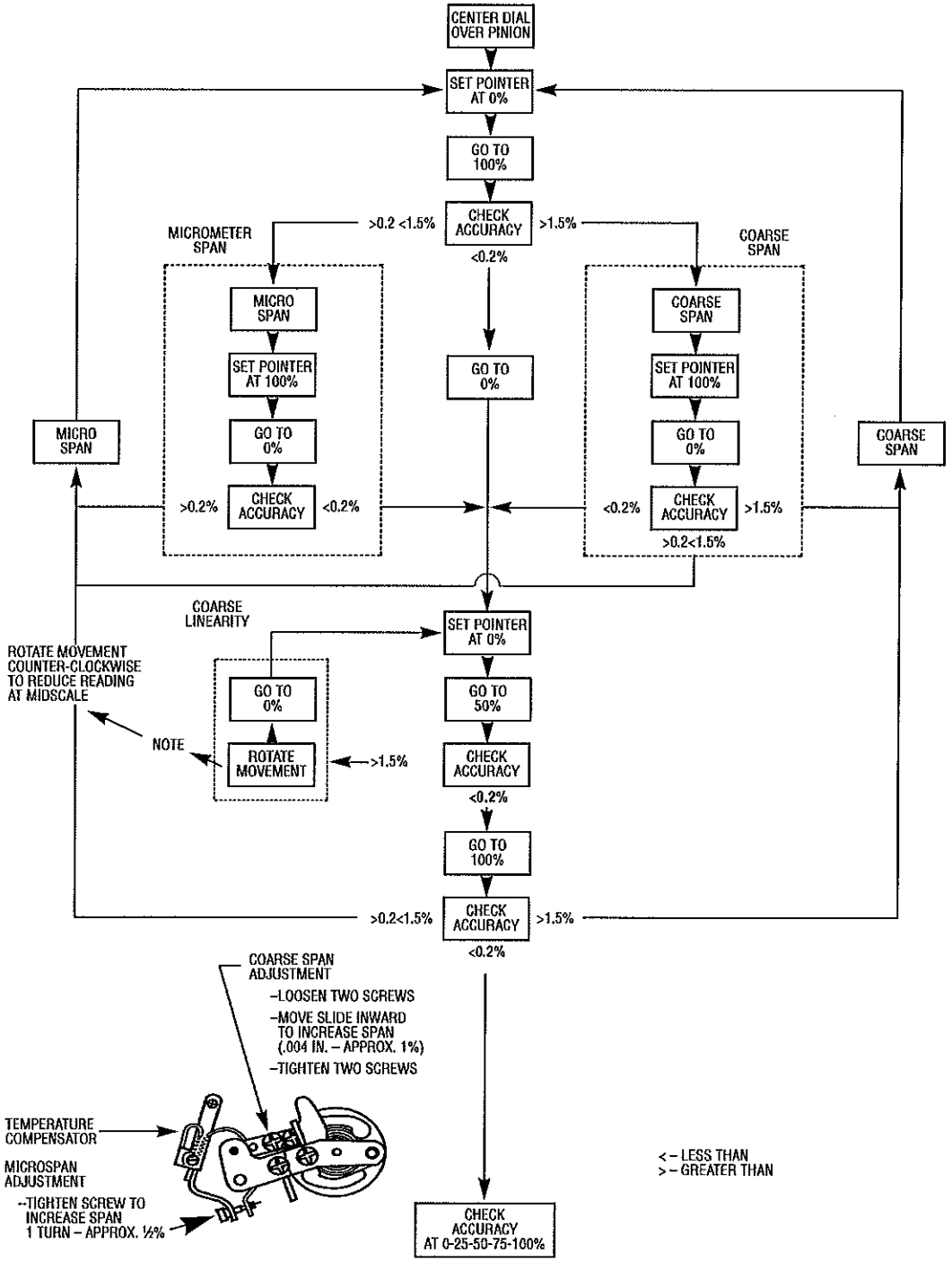
Installation and Maintenance Instructions for ASHCROFT® Type 1082 Test Gauge Calibration Procedure – Pressure Range

ASHCROFT®

Fig. 2

THIS TEST GAUGE IS PROVIDED WITH A MICROSPAN™ ADJUSTMENT TO SIMPLIFY CALIBRATION. THE FLOW CHART BELOW OUTLINES THE RECOMMENDED CALIBRATION PROCEDURE



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I&M008-10098-5/02 (250-1353-K) Rev. 01/12

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BLUE RIBBON CORP.

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LOW PRESSURE DIAPHRAGM GAUGES
MODEL BR501D

SPECIFICATIONS:

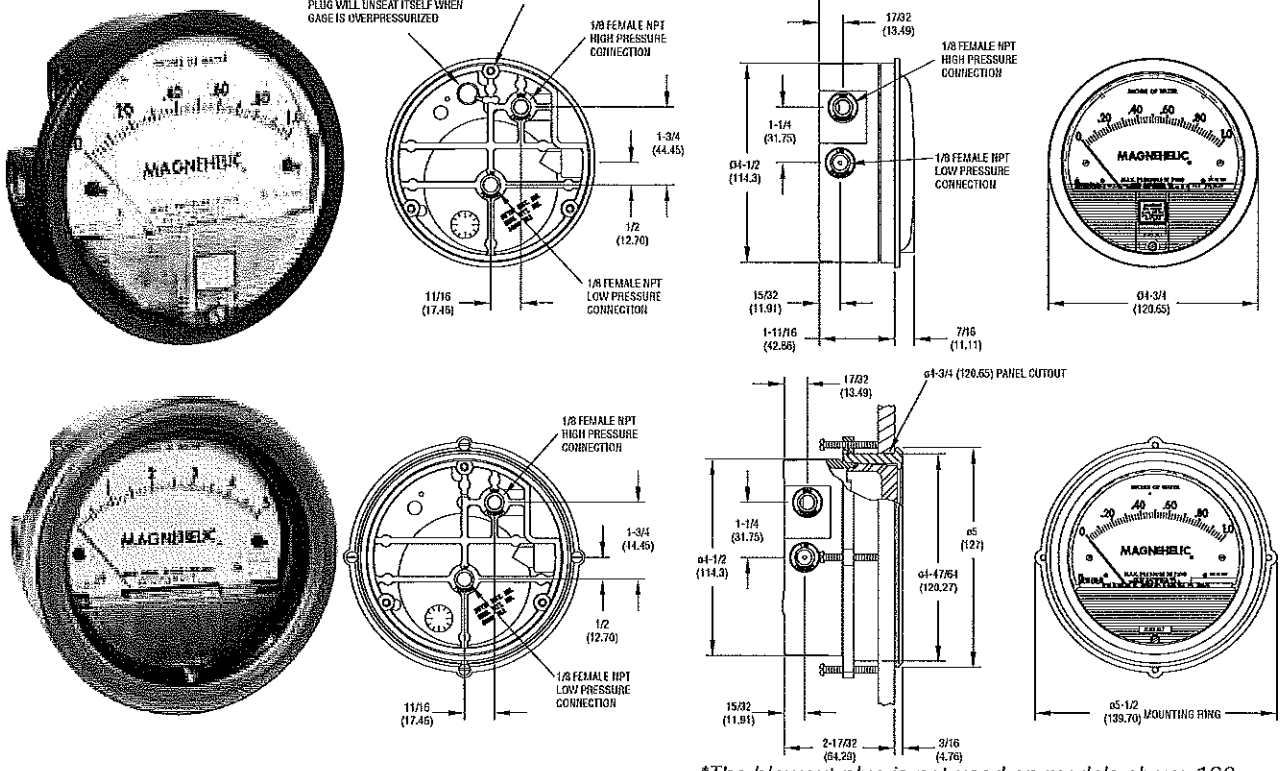
- Available Dial Size: 2½”
- Twist lock plastic lens
- Chrome Plated Case (Bottom Conn.)
- Black Steel Case (Back & PNL Mount)
- Brass Internals and Connection
- Dry, non-fillable
- Accuracy: ±1.5%
- Capsule type diaphragm to measure low pressures
- 1/4” (M)NPT bottom or back connection

AVAILABLE RANGES:
200-0”WC Vacuum (2” Minor Inc.)
160-0”WC Vacuum (2” Minor Inc.)
100-0”WC Vacuum (1” Minor Inc.)
60-0”WC Vacuum (1” Minor Inc.)
30-0”WC Vacuum (.5”WC Minor Inc.)
0-10”WC (.5”WC Minor Inc.)
0-15”WC (.2”WC Minor Inc.)
0-30”WC (.5”WC Minor Inc.)
20 oz./35”WC (5”WC Minor Inc.)
35 oz./60”WC (1”WC Minor Inc.)
0-60”WC (1”WC Minor Inc.)
0-100”WC (2”WC Minor Inc.)
0-160”WC (5”WC Minor Inc.)
0-200”WC (5”WC Minor Inc.)
0-3PSI (.05PSI Minor Inc.)
0-5PSI (.1PSI Minor Inc.)
0-10PSI (.2PSI Minor Inc.)

	LP1	LP2	LP3
A	2.60”	2.85”	2.85”
B	1.70”	1.60”	1.60”
C	.85”	.85”	.85”
D	3.45”	2.45”	2.45”
E	.55”	.55”	.55”
F	-	2.60”	2.60”

Blue Ribbon reserves the right to make product improvements and amendments to the product specifications stated throughout this brochure without prior notification. Please contact the factory on all critical dimensions and specifications for verification.

Magnehelic® Differential Pressure Gage



The Magnehelic® Differential Pressure Gage consists of two pressure-tight compartments separated by a molded flexible diaphragm.

The interior of the gage case serves as the "high" pressure compartment and a sealed chamber behind the diaphragm serves as the "low" pressure compartment.

Differences in pressure between the "high" and "low" sides of the diaphragm cause the diaphragm to assume a balanced position between the two pressures. The front support plate of the diaphragm is linked to a leaf spring which is anchored at one end. The spring provides calibrated resistance to the diaphragm motion. Motion of the spring is transmitted through an exclusive magnetic linkage to the pointer.

The Magnehelic® Differential Pressure Gage requires no maintenance. The only field adjustment required is occasional zero setting of the pointer which is done by opening the plastic vent valves and turning the adjustment of the gage.

STANDARD GAGE ACCESSORIES: Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters and three flush mounting adapters with screws.

MP AND HP GAGE ACCESSORIES: Mounting ring and snap ring retainer substituted for 3 adaptors, 1/4" compression fittings replace 1/8" pipe thread to rubber tubing adaptors.

**The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.*

SPECIFICATIONS

Service: Air and non-combustible, compatible gases. (Natural Gas option available.)
Wetted Materials: Consult factory.
Housing: Die cast aluminum case and bezel, with acrylic cover. (MP model has polycarbonate cover).
Accuracy: ±2% of full scale (±3% on - 0, -100 Pa, -125 Pa, 10MM and ±4% on -00, - 00N, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).
Pressure Limits: -20" Hg to 15 psig.† (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).
Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.
Temperature Limits: 20 to 140°F (-6.67 to 60°C). *Low temperature models available as special option.
Size: 4" (101.6 mm) diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.
Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options.
Note: May be used with hydrogen when ordering Buna-N diaphragm. Pressure must be less than 35 psi.

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MAGNEHELIC® INSTALLATION

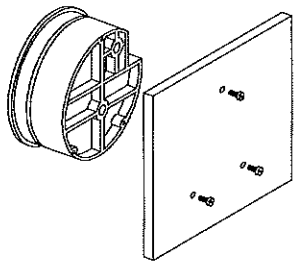
OVERPRESSURE PROTECTION: Standard Magnehelic® Differential Pressure Gages are rated for a maximum pressure of 15 psig and should not be used where that limit could be exceeded. Models employ a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (excludes MP and HP models). To provide a free path for pressure relief, there are four spacer pads which maintain .023" clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

INSTALLATION

Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F (60°C). Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

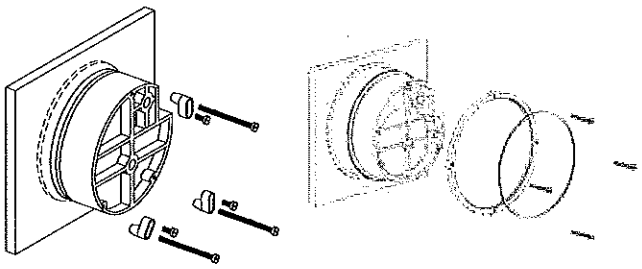
All standard Magnehelic® Differential Pressure Gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range models of 0.5" w.c. plus 0.25" w.c. and metric equivalents must be used in the vertical position only.

SURFACE MOUNTING



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

FLUSH MOUNTING



Provide a 4-9/16" dia. (116 mm) opening in panel. Provide a 4-3/4" dia. (120 mm) opening for MP and HP models. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place.

PIPE MOUNTING

To mount gage on 1-1/4" - 2" pipe, order optional A-610 pipe mounting kit.

TO ZERO GAGE AFTER INSTALLATION

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

OPERATION

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

A. For portable use of temporary installation use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with flexible rubber or vinyl tubing.

B. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended.

MAINTENANCE

MAINTENANCE

No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves should be used in permanent installations.

WARNING

Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended.

TROUBLE SHOOTING TIPS

Gage won't indicate or is sluggish.

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F (-7°C), order gage with low temperature, (LT) option.

Pointer stuck-gage can't be zeroed.

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. Metallic particles clinging to magnet and interfering with helix movement.
4. Cover zero adjust shaft broken or not properly engaged in adjusting screw.

ORDERING INSTRUCTIONS

The Series 2000 is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

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TW Series — 22mm NEMA Style Pushbuttons

TW NEMA Style Switches with snap-on contacts

Key features include:

- Corrosion resistant octagonal chrome plated locking bezel
- Snap-on 10A contact blocks
- Incandescent or LED illumination
- Slow make, double break, self cleaning contacts
- Modular construction for maximum flexibility
- NEMA 4X and IP65 watertight/oiltight panel
- Available assembled or as sub-components
- Large M3.5 screw terminals with captive sems plate

IDEC has your 22mm switching needs covered.

Button styles include flush, extended, mushroom, or square and all bodies are crafted from fracture-resistant nylon.

All illuminated units feature two lense styles, one that maximizes light dispersion, the other accommodates direct lens engraving.

Self cleaning contact mechanisms allow for a wide current rating, 5mA to 10A, which reduces the need for various contact materials.

When looking for a 22mm switch that is durable, easy to use, and versatile, then IDEC's TW series is your solution.

UL Listed
File No. E70646

TÜV Rheinland

CSA Approved
File No. LR21451

File No. DK95-01696

Specifications

Conforming to Standards	EN60947-1, EN60947-5-1, VDE0660-200, UL508, CSA C22-2 No.14
Approvals File No. E70646 File No. LR21451 Certificate No. 2030010305027380 TÜV Rheinland Registration No: J9551802 (E-Stops) Registration No: J9551803 (All other switches) Registration No: J9551804 (Pilot Lights)	**CSA:** pushbuttons and selector switches: A600 pilot lights and illuminated pushbuttons, direct supply pilot lights and illuminated pushbuttons with integral transformer (100/110, 115, 120, 200/220, 230, 240, 380, 400/440, 480V) **UL:** pushbuttons and selector switches: A600 pilot lights and illuminated pushbuttons, direct supply pilot lights and illuminated pushbuttons with integral transformer (100/110, 115, 120, 200/220, 230, 240, 380, 400/440, 480V) **TÜV:** pushbuttons and selector switches: A600=P600 (NO, NC)/Q600 (NO-EM, NC-LB) pilot lights and illuminated pushbuttons, direct supply pilot lights and illuminated pushbuttons with integral transformer (100/110, 115, 120, 200/220, 230, 240, 380, 400/440, 480V)
Operating Temperature	Operation: –25 to +50°C (without freezing), Storage: –40 to +80°C (without freezing)
Vibration Resistance	5 to 55Hz, 100m/sec^2 (10g) conforming to IEC6068-2-6
Shock Resistance	1000m/sec^2 (100g) conforming to IEC6068-2-7
Electric Shock Protection	Class 0 conforming to IEC60536
Degree of Protection **(conforming to IEC60529)** **(conforming to NEMA ICS6-110)**	IP65 from front of the panel; (IP54 for key switches) IP20 (Type HW-F contact block) NEMA 1, 2, 3, 3R, 3S, 4, 4X, 5, 12, 13 (NEMA 1, 2, 3R, 5, 12, 13 for key switches)
Mechanical Life	Momentary pushbuttons: 5,000,000 (900 operations per hour) All other switches: 500,000
Pollution Degree (conforming to IEC60947-1)	3 for switches not using a transformer, 2 for switches using a transformer
Rated Operational Characteristics	AC-15: A600 or Ue = 250V, Ie = 3A (NO, NC, NO-EM, NC-LB) DC-13: P600 or Ue = 125V, Ie = 1.1A (NO, NC) DC-13: Q600 or Ue = 125V, Ie = 0.9A (NO-EM, NC-LB)
Rated Insulation Voltage	600V
Rated Switching Over-Voltage	Less than 4kV, conforming to IEC60947-1
Rated Impulse Withstanding Voltage	4kV for contact circuit, 2.5kV for lamp circuit
Rated Thermal Current	10 Amp
Minimum Switching Capacity	5 mA at 3V AC/DC
Contact Operation	Slow break NC or slow make NO, self-cleaning
Recommended Terminal Torque	0.8 N m (7.1 in lb.)
External Short-Circuit Protection	10A 250V fuse conforming to IEC60269-1
Applicable Wire Size	Minimum 1 x 22 AWG, max. 2 x 14 AWG or 1 x 12 AWG
Contact Resistance	Initial contact resistance of 50mΩ or less
Contact Gap	4mm (NO and NC), 2mm (NO-EM and NC-LB)
Electrical Reliability	MTBF < 1 fault for 10 million operation cycles (3V DC, 5mA)
Lamp Ratings	Incandescent: 1 W LEDs: 6V: 17mA max, 12/24V: 11mA max, 120/240V: 10mA max
Horsepower Rating	1/4 HP @ 120V (single-phase, non-reversing motor); 1 HP @ 240V (3 phase, non-reversing motor)
Maximum Inrush Current	40 A (40 ms)
Contact Material	Silver

Contact Ratings

Pushbuttons **Illuminated Pushbuttons** **Selector Switches** **Illuminated Selector Switches** **Pushbutton Selectors**	Contact Block	Type HW-C/HW-F
	Rated Insulation Voltage	600V
	Rated Continuous Current	10A
	Contact Ratings by Utilization Category IEC 60947-5-1	AC-15 (A600) DC-13 (P600)

Characteristics

Contact Ratings by Utilization Category

Operational Voltage			24V	48V	50V	110V	220V	440V
Operational Current	AC50/60Hz	AC-12 Control of resistive loads and solid state loads	10A	—	10A	10A	6A	2A
		AC-15 Control of electromagnetic loads (> 72VA)	10A	—	7A	5A	3A	1A
	DC	DC-12 Control of resistive loads and solid state loads	8A	5A	—	2.2A	1.1A	—
		DC-13 Control of electromagnets	5A	2A	—	1.1A	0.6A	—

Non-Illuminated Pushbuttons (Assembled)

Assembled Pushbuttons

A B ( ) W 1 10 ( ) – B

Function

B: Momentary
O: Maintained
K: Key On/Off Lock

Bezel Shape

Blank: Octagonal
F: Full Shroud
G: Mushroom Shroud
Q: Square

Button Color

B: Black G: Green W: White
R: Red S: Blue Y: Yellow

Terminal Style

Blank: Standard
N: Fingersafe (IP20)

Contact Arrangement

10: 1NO 01: 1NC
20: 2NO 02: 2NC
11: 1NO-1NC 22: 2NO-2NC

Button Shape

1: Flush
2: Extended
3: Mushroom Head Ø 29mm
4: Mushroom Head Ø 40mm

Series Designation

W: TW Series

To be used for interpreting part numbers only, not for part number development.

Non-Illuminated Pushbuttons (Assembled) continued

Non-Illuminated Pushbuttons

Style		Contacts	Momentary Action	Maintained Action
Flush		1NO 1NC 1NO-1NC 2NO 2NC	ABW110-① ABW101-① ABW111-① ABW120-① ABW102-①	AOW110-① AOW101-① AOW111-① AOW120-① AOW102-①
Extended		1NO 1NC 1NO-1NC 2NO 2NC	ABW210-① ABW201-① ABW211-① ABW220-① ABW202-①	AOW210-① AOW201-① AOW211-① AOW220-① AOW202-①
Recessed		1NO 1NC 1NO-1NC 2NO 2NC	ABFW110-① ABFW101-① ABFW111-① ABFW120-① ABFW102-①	AOFW110-① AOFW101-① AOFW111-① AOFW120-① AOFW102-①
Extended with Full Shroud		1NO 1NC 1NO-1NC 2NO 2NC	ABFW210-① ABFW201-① ABFW211-① ABFW220-① ABFW202-①	AOFW210-① AOFW201-① AOFW211-① AOFW220-① AOFW202-①
Ø 29mm Mushroom Head		1NO 1NC 1NO-1NC 2NO 2NC	ABW310-① ABW301-① ABW311-① ABW320-① ABW302-①	AOW310-① AOW301-① AOW311-① AOW320-① AOW302-①
Ø 40mm Mushroom Head		1NO 1NC 1NO-1NC 2NO 2NC	ABW410-① ABW401-① ABW411-① ABW420-① ABW402-①	AOW410-① AOW401-① AOW411-① AOW420-① AOW402-①
Ø 40mm Mushroom Head with Full Shroud		1NO 1NC 1NO-1NC 2NO 2NC	ABGW410-① ABGW401-① ABGW411-① ABGW420-① ABGW402-①	AOGW410-① AOGW401-① AOGW411-① AOGW420-① AOGW402-①
Square Flush		1NO 1NC 1NO-1NC 2NO 2NC	ABQW110-① ABQW101-① ABQW111-① ABQW120-① ABQW102-①	AOQW110-① AOQW101-① AOQW111-① AOQW120-① AOQW102-①
Square Extended		1NO 1NC 1NO-1NC 2NO 2NC	ABQW210-① ABQW201-① ABQW211-① ABQW220-① ABQW202-①	AOQW210-① AOQW201-① AOQW211-① AOQW220-① AOQW202-①
Keylock Push On/Off		1NO 1NC 1NO-1NC 2NO 2NC	AKW210 AKW201 AKW211 AKW220 AKW202	–

① Button Color Codes

Color	Code
Black	B
Green	G
Red	R
Blue	S
Yellow	Y
White	W

1. In place of ①, specify the Button Color Code from table.
2. For sub-assembled part numbers, see next page.
3. For accessories, see page593.
4. For dimensions, see page 595.
5. Keyed switches are supplied with two keys. All units are keyed alike.

Non-Illuminated Pushbuttons (Sub-Assembled)

Contact Blocks	+	Operator	+	Button	=	Complete Part

Operators

Style	Part Number	
	Momentary	Maintained
Round Flush/Extended	ABW-100	AOW-100
Round with Full Shroud/ Recessed	ABFW-200	AOFW-200
Ø 40mm, Ø 29mm Mushroom Head	ABW-300	AOW-300
Ø 40mm Mushroom Head with Full Shroud	ABGW-400	AOGW-400
Square Flush/Extended	ABQW-100	AOQW-100
Keylock Push On/Off	—	AKW-200

Buttons

Style	Part Number
Round Flush	ABW1B-①
Round Extended	ABW2B-①
Ø 29mm Mushroom	ABW3B-①
Ø 40mm Mushroom	ABW4B-①
Square Flush	ABQW1B-①
Square Extended	ABQW2B-①

In place of ① specify the button color code from table

Contact Blocks

Style	Part Number	
	1NO	1NC
Standard Exposed Screw	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20), CE marked	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. Dummy blocks (no contacts) are used with an odd number of contact blocks.
2. Use of early and late break contacts creates a make before break function

① Button Color Codes

Color	Code
Black	B
Green	G
Red	R
Blue	S
Yellow	Y
White	W

E-Stops (Assembled)

Assembled E-Stops

A V (L) W 4 (B) (99) 11 (D) (N) – R – (24V)

Function

V: Pushlock Turn Reset
Y: Push-Pull
X: Pushlock Key Reset

Illumination

Blank: None
L: Illuminated

Series Designation

W: TW Series

Button/Lens Size

3: 29mm Mushroom
4: 40mm Mushroom

Lens Type
(illuminated units only)

Blank: Standard (ribbed)
B: Engravable (smooth with insert)

Illuminated Circuit
(illuminated unit only)

99: Full Voltage (lamp determines voltage)
126: 120V AC Step Down Transformer
246: 240V AC Step Down Transformer
486: 480V AC Step Down Transformer

Lamp Voltage
(full voltage illuminated units only)

6V: 6V AC/DC
12V: 12V AC/DC
24V: 24V AC/DC
120V: 120V AC (LED only)
240V: 240V AC (LED only)

Button/Lens Color

A: Amber R: Red W: White
G: Green S: Blue Y: Yellow
B: Black

Contact Terminal Style

Blank: Standard
N: Fingersafe (IP20)

Lamp Type
(illuminated units only)

Blank: Incandescent
D: LED

Contact Arrangement

10: 1NO 01: 1NC
20: 2NO 02: 2NC
11: 1NO/1NC 22: 2NO/2NC

To be used for interpreting part numbers only, not for part number development.

E-Stops (Assembled) continued

Non-Illuminated E-Stops

Style		Contacts	Part Number
Ø 40mm Pushlock Turn Reset*		1NO 1NC 1NO-1NC 2NO 2NC	AVW410-R* AVW401-R* AVW411-R* AVW420-R* AVW402-R*
Ø 29mm Pushlock Turn Reset*		1NO 1NC 1NO-1NC 2NO 2NC	AVW310-R* AVW301-R* AVW311-R* AVW320-R* AVW302-R*
Ø 40mm Push-Pull		1NO 1NC 1NO-1NC 2NO 2NC	AYW410-① AYW401-① AYW411-① AYW420-① AYW402-①
Ø 40mm Pushlock Key Reset *		1NO 1NC 1NO-1NC 2NO 2NC	AXW410- R* AXW401- R* AXW411- R* AXW420- R* AXW402- R*

1. *Available in Red only.
2. In place of ①, specify the Button Color Code from table.
3. For sub-assembled part numbers, see next page.
4. For accessories, see page 593.
5. For dimensions, see page 595.

Illuminated E-Stops

Style		Type	Contacts	Part Number
Ø 40mm Pushlock Turn Reset Type		Transformer	1NO-1NC 2NO 2NC	AVLW4 ④ 11⑤-R* AVLW4 ④ 20⑤-R* AVLW4 ④ 02⑤-R*
		Full Voltage	1NO-1NC 2NO 2NC	AVLW49911⑤-R*-③ AVLW49920⑤-R*-③ AVLW49902⑤-R*-③
Ø 29mm Pushlock Turn Reset		Transformer	1NO-1NC 2NO 2NC	AVLW3④11⑤-R* AVLW3④20⑤-R* AVLW3④02⑤-R*
		Full Voltage	1NO-1NC 2NO 2NC	AVLW39911⑤-R*-③ AVLW39920⑤-R*-③ AVLW39902⑤-R*-③
Ø 40mm Push-Pull		Transformer	1NO-1NC 2NO 2NC	AYLW4 ④ 11⑤-② AYLW4 ④ 20⑤-② AYLW4 ④ 02⑤-②
		Full Voltage	1NO-1NC 2NO 2NC	AYLW49911⑤-②-③ AYLW49920⑤-②-③ AYLW49902⑤-②-③

1. *Available in red only.
2. In place of ②, specify the Lens Color Code (see table above).
3. In place of ③, specify the Full Voltage Code (lamp voltage) (see table above).
4. In place of ④, specify the Transformer Voltage Code (see table above).
5. In place of ⑤, specify the Lamp Type Code from table above.
6. For sub-assembly part numbers, see next page.
7. For accessories, see page 593.
8. For dimensions, see page 595.

① Button Color Codes

Color	Code
Black	B
Green	G
Red	R
Blue	S
White	W
Yellow	Y

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W

③ Full Voltage Codes

Voltage	Code
6V AC/DC	6V
12V AC/DC	12V
24V AC/DC	24V
120V AC	120V (LED only)
240V AC	240V (LED only)

④ Transformer Voltage Codes

Voltage	Code
120VAC	126
240VAC	246
480VAC	486

Transformers step down to 6V.

⑤ Lamp Type Codes

Lamp	Code
Incandescent	Blank
LED	D

E-Stops (Sub-Assembled)

Transformer/ Adaptor*	+	Contacts	+	Lamp Holder	+	Operator	+	Lamp	+	Button or Lens	=	Complete Part

*Not applicable for full voltage units

Operators

Style	Part Number	
	Non-Illuminated	Illuminated
Ø 29/Ø 40mm Push-lock Turn Reset	AVW-300	AVLW3-0600
Ø 40mm Push-Pull	AYW-400	AYLW4-0600
Ø 40mm Pushlock Key Reset	AXW-300	—

Buttons

Style	Part Number
Ø 40mm Pushlock Turn Reset	AVW4B-R*
Ø 29mm Pushlock Turn Reset	AVW3B-R*
Ø 40mm Push-Pull	AYW4B-①
Ø 40mm Pushlock Key Reset	AXW4B-R*

1. *Available in Red only
2. In place of ①, specify the button color code from table.

Contact Blocks

Style	Voltage	Part Number
LED	6V AC/DC	LSTD-6②
	12V AC/DC	LSTD-1②
	24V AC/DC	LSTD-2②
	120V AC	LSTD-H2②
	240V AC	LSTD-M4②
Incandescent	6V AC/DC	IS-6
	12V AC/DC	IS-12
	24V AC/DC	IS-24

1. In place of ②, specify the LED color code.
2. The LED contains a current-limiting resistor and a protection diode.

① Button Color Codes

Color	Code
Black	B
Green	G
Red	R
Blue	S
White	W
Yellow	Y

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W

Illuminated E-Stops (Sub-Assembled) continued

Lenses

Style	Part Number	
	Standard	Engravable
Ø 29mm Head Pushlock Turn Reset	AVLW3LU-R*	AVLW3BLU-R*
Ø 40mm Head Pushlock Turn Reset	AVLW4LU-R*	AVLW4BLU-R*
Ø 40mm Head Push Pull	AYLW4LU-②	AYLW4BLU-②

1. In place of ②, specify the lens color code from table on previous page.
2. *Available only in red
3. Standard lenses have ribbed pattern, Engravable lenses are smooth and include an engravable insert.

Lamp Circuit Components

Style	Application	Part Number
Short Lamp Holder	**Used with** a Half-size Transformer and one contact block	TW-LH1
Long Lamp Holder	**Used with** Full-size Transformer and two contact blocks **Used with** Half-size Transformer and three contact blocks **Used with** Full Voltage Adaptor and two contact blocks	TW-LH2
Lead Holder	**Used with** TW-LH2 holder when using four contact blocks	HW-LH3

Transformers/Full Voltage Modules

Style	Description		Part Number
Full Size Transformer	Standard	120V AC	TW-T126B
		240V AC	TW-T246B
		480V AC	TW-T486B
	Fingersafe	120V AC	TW-F126B
		240V AC	TW-F246B
		480V AC	TW-F486B
Half Size Transformer	120V AC		TW-T126SB
	240V AC		TW-T246SB
Full voltage model (use with even number of contacts)	Standard		TW-DA1B
	Fingersafe		TW-DA1FB
Full voltage model (use with odd number of contacts)	Standard		HW-DA1B
	Fingersafe		HW-DA1FB

All Transformers step down to 6V (use 6V lamp).

Contact Blocks

Style	Part Number	
	1NO	1NC
Standard Exposed Screw	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20), CE marked	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. Dummy blocks (no contacts) are used with an odd number of contact blocks.
2. Use of early and late break contacts creates a make before break function

Pilot Lights (Assembled)

Assembled Pilot Lights

A P (Q) W 1 (B) (99) (D) – R – (24V)

Function

P: Pilot Light

Bezel Shape

Blank: Octagonal (round lenses)
Q: Square

Series Designation

W: TW Series

Lens Shape

1: Flat
2: Dome

Lens Type

Blank: Standard (ribbed)
B: Engravable (smooth with insert included)

Illumination Circuit

99: Full Voltage (lamp determines voltage)
126: 120V AC Step Down Transformer
246: 240V AC Step Down Transformer
486: 480V AC Step Down Transformer

Lamp Voltage
(Full Voltage Units Only)

6V: 6V AC/DC
12V: 12V AC/DC
24V: 24V AC/DC
120V: 120V AC (LED only)
240V: 240V AC (LED only)

Lens Color Code

A: Amber
G: Green
R: Red
S: Blue
W: White
Y: Yellow

Lamp Type

Blank: Incandescent
D: LED

1. Use only when interpreting part numbers. Do not use for developing part numbers.
2. All transformers step down to 6V.

Pilot Lights (Assembled) continued

Assembled Pilot Lights

Style		Type	Voltage	Part Number
Round Flat		Transformer	120VAC 240VAC 480VAC	APW1126④-② APW1246④-② APW1486④-②
		Full Voltage	—	APW199④-②-③
Dome		Transformer	120VAC 240VAC 480VAC	APW2126④-② APW2246④-② APW2486④-②
		Full Voltage	—	APW299④-②-③
Square Flat		Transformer	120VAC 240VAC 480VAC	APQW1B126④-② APQW1B246④-② APQW1B486④-②
		Full Voltage	—	APQW1B99④-②-③

1. In place of ②, specify the Lens Color Code from table below.
2. In place of ③, specify the Full Voltage Code from table below.
3. In place of ④, specify the Lamp Type Code from table below.
4. For accessories, see page 593.
5. For dimensions, see page 595.
6. For sub-assembly part numbers, see next page.
7. Yellow pilot light comes with white LED.

② Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W
Yellow	Y

③ Full Voltage Codes

Voltage	Code
6V AC/DC	6V
12V AC/DC	12V
24V AC/DC	24V
120V AC	120V (LED only)
240V AC	240V (LED only)

④ Lamp Type Codes

Lamp	Code
Incandescent	Blank
LED	D

Pilot Lights (Sub-Assembled)

Transformer	+	Operator	+	Lamp	+	Lens	=	Complete Part

* Transformer not required for full voltage units.

Operators

Style	Part Number
Round Dome/Flat	APW-199
Square	UPQW-199

Same operator is used for full voltage as for transformer completed units.

Lenses

Style	Part Number	
	Standard	Engravable
Dome	APW2LU-②	—
Round Flat	APW1LU-②	APW1BLU-②
Square Flat	—	APQW1BLU-②

1. In place of ②, specify the Lens Color Code from table.
2. Standard lenses have a ribbed lens to enhance light dispersion. Marking lenses are smooth and include an engravable insert.

Lamps

Style	Voltage	Part Number
LED	6V AC/DC	LSTD-6②
	12V AC/DC	LSTD-1②
	24V AC/DC	LSTD-2②
	120V AC	LSTD-H2②
	240V AC	LSTD-M4②
Incandescent	6V AC/DC	IS-6
	12V AC/DC	IS-12
	24V AC/DC	IS-24

1. In place of ②, specify the LED color code.
2. The LED contains a current-limiting resistor and a protection diode.
3. Yellow LED not available. Use white LED.

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W
Yellow	Y

If clear lens is desired, use white marking lens and remove engraving insert

Transformers

Style	Description		Part Number
	Standard	120V AC	TW-T126B
		240V AC	TW-T246B
		480V AC	TW-T486B
	Fingersafe	120V AC	TW-F126B
		240V AC	TW-F246B
		480V AC	TW-F486B

All Transformers step down to 6V (use 6V lamp).

Illuminated Pushbuttons (Assembled)

Assembled Illuminated Pushbuttons

A L (F) W 2 (B) 99 11 (D) (N) – R – (24V)

Function

L:Momentary Action
OL:Maintained Action

Bezel Shape

Blank: Octagonal (round lenses)
F: Full Shroud (round lenses)
Q: Square

Series Designation

W: TW series

Lens Shape/Size

2: Standard Extended (round or square)
3: 29mm Mushroom
4: 40mm Mushroom

Lens Type

Blank: Standard (ribbed)
B: Engravable (smooth with insert)

Illumination Circuit

99: Full Voltage (lamp determines voltage)
126: 120V AC Step Down Transformer
246: 240V AC Step Down Transformer
486: 480V AC Step Down Transformer

Lamp Voltage
(Full Voltage Units Only)

6V: 6V AC/DC
12V: 12V AC/DC
24V: 24V AC/DC
120V: 120V AC (LED only)
240V: 240V AC (LED only)

Lens Code

A: Amber
G: Green
R: Red
S: Blue
W: White
Y: Yellow

Contact Terminal Style

Blank: Standard
N: Fingersafe

Lamp Type

Blank: Incandescent Lamp
D: LED Lamp

Contact Arrangement

10: 1NO
20: 2NO
11: 1NO-1NC
01: 1NC
02: 2NC
22: 2NO-2NC

1. Use only when interpreting part numbers. Do not use for developing part numbers.
2. Transformers step down to 6V.

Illuminated Pushbuttons (Assembled)

Illuminated Pushbuttons

Style		Contacts	Part Number	
			Momentary	Maintained
Extended Lens	Transformer	1NO-1NC 2NO 2NC	ALW2 ④ 11⑤-② ALW2 ④ 20⑤-② ALW2 ④ 02⑤-②	AOLW2 ④ 11⑤-② AOLW2 ④ 20⑤-② AOLW2 ④ 02⑤-②
	Full Voltage	1NO-1NC 2NO 2NC	ALW29911⑤-②-③ ALW29920⑤-②-③ ALW29902⑤-②-③	AOLW29911⑤-②-③ AOLW29920⑤-②-③ AOLW29902⑤-②-③
Extended Lens with Full Shroud	Transformer	1NO-1NC 2NO 2NC	ALFW2 ④ 11⑤-② ALFW2 ④ 20⑤-② ALFW2 ④ 02⑤-②	AOLFW2 ④ 11⑤-② AOLFW2 ④ 20⑤-② AOLFW2 ④ 02⑤-②
	Full Voltage	1NO-1NC 2NO 2NC	ALFW29911⑤-②-③ ALFW29920⑤-②-③ ALFW29902⑤-②-③	AOLFW29911⑤-②-③ AOLFW29920⑤-②-③ AOLFW29902⑤-②-③
ø29mm Mushroom Lens	Transformer	1NO-1NC 2NO 2NC	ALW3 ④ 11⑤-② ALW3 ④ 20⑤-② ALW3 ④ 02⑤-②	AOLW3 ④11⑤-② AOLW3 ④20⑤-② AOLW3 ④ 02⑤-②
	Full Voltage	1NO-1NC 2NO 2NC	ALW39911⑤-②-③ ALW39920⑤-②-③ ALW39902⑤-②-③	AOLW39911⑤-②-③ AOLW39920⑤-②-③ AOLW39902⑤-②-③
ø40mm Mushroom Lens	Transformer	1NO-1NC 2NO 2NC	ALW4 ④ 11⑤-② ALW4 ④ 20⑤-② ALW4 ④ 02⑤-②	AOLW4 ④11⑤-② AOLW4 ④20⑤-② AOLW4 ④ 02⑤-②
	Full Voltage	1NO-1NC 2NO 2NC	ALW49911⑤-②-③ ALW49920⑤-②-③ ALW49902⑤-②-③	AOLW49911⑤-②-③ AOLW49920⑤-②-③ AOLW49902⑤-②-③
Square Extended	Transformer	1NO-1NC 2NO 2NC	ALQW2B ④11⑤-② ALQW2B ④20⑤-② ALQW2B ④02⑤-②	AOLQW2B ④11⑤-② AOLQW2B ④20⑤-② AOLQW2B ④02⑤-②
	Full Voltage	1NO-1NC 2NO 2NC	ALQW2B9911⑤-②-③ ALQW2B9920⑤-②-③ ALQW2B9902⑤-②-③	AOLQW2B9911⑤-②-③ AOLQW2B9920⑤-②-③ AOLQW2B9902⑤-②-③

1. In place of ②, specify the Lens Color Code (see table). Mushroom lenses not available in yellow.
2. In place of ③, specify the Full Voltage Code (lamp voltage) (see table).
3. In place of ④, specify the Transformer Voltage Code (see table).
4. In place of ⑤, specify the Lamp Type Code from table.
5. For sub-assembly part numbers, see next page.
6. For accessories, see page 593.
7. For dimensions, see page 595.
8. Light is independent of switch position.
9. Yellow pushbutton comes with white LED.

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W
Yellow	Y

1. Mushroom lenses not available in yellow.
2. Yellow pushbutton comes with white LED.

③ Full Voltage Codes

Voltage	Code
6V AC/DC	6V
12V AC/DC	12V
24V AC/DC	24V
120V AC	120V (LED only)
240V AC	240V (LED only)

④ Transformer Voltage Codes

Voltage	Code
120VAC	126
240VAC	246
480VAC	486

Transformers step down to 6V (use 6V lamp).

⑤ Lamp Type Codes

Lamp	Code
Incandescent	Blank
LED	D

Illuminated Pushbuttons (Sub-Assembled)

Transformer/ Adaptor*	+	Contacts	+	Lamp Holder	+	Operator	+	Lamp	+	Lens	=	Complete Part

*Not applicable for full voltage units

Operators

Style		Part Number	
		Momentary	Maintained
Extended		ALW-0600	AOLW-0600
Extended with Full Shroud		ALFW-0600	AOLFW-0600
ø29mm/ø40mm Mushroom		ALW3-0600	AOLW3-0600
Square/Extended		ALQW-2B0600	AOLQW-2B0600

Lenses

Style		Part Number	
		Standard	Engravable
Round Extended		ALW2LU-②	ALW2BLU-②
ø 29mm Mushroom Head*		ALW3LU-②	ALW3BLU-②
ø 40mm Mushroom Head*		ALW4LU-②	ALW4BLU-②
Square Extended		—	ALQW2BLU-②

1. In place of ②, specify the lens color code from table on the bottom right.
2. *Mushroom lens not available in yellow.
3. Standard lenses have ribbed pattern, Engravable lenses are smooth and include an engravable insert.

Lamps

Style	Voltage	Part Number
LED	6V AC/DC	LSTD-6②
	12V AC/DC	LSTD-1②
	24V AC/DC	LSTD-2②
	120V AC	LSTD-H2②
	240V AC	LSTD-M4②
Incandescent	6V AC/DC	IS-6
	12V AC/DC	IS-12
	24V AC/DC	IS-24

1. In place of ②, specify the LED color code.
2. The LED contains a current-limiting resistor and a protection diode.

Lamp Circuit Components

Style	Application	Part Number
Short Lamp Holder	**Used with** a Half-size Transformer and one contact block	TW-LH1
Long Lamp Holder	**Used with** Full-size Transformer and two contact blocks **Used with** Half-size Transformer and three contact blocks **Used with** Full Voltage Adaptor and two contact blocks	TW-LH2
Lead Holder	**Used with** TW-LH2 holder when using four contact blocks	HW-LH3

② LED/Lens Color Codes

Color	Code	Color	Code
Amber	A	Blue	S
Green	G	White	W
Red	R	Yellow	Y

Yellow LED not available. Use white LED.

Illuminated Pushbuttons (Sub-Assembled) continued

Contact Blocks

Style	Part Number	
	1NO	1NC
Standard Exposed Screw	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20), CE marked	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. Dummy blocks (no contacts) are used with an odd number of contact blocks.
2. Use of early and late break contacts creates a make before break function

Transformers/Full Voltage Modules

Style	Description		Part Number
Full Size Transformer	Standard	120V AC	TW-T126B
		240V AC	TW-T246B
		480V AC	TW-T486B
	Fingersafe	120V AC	TW-F126B
		240V AC	TW-F246B
		480V AC	TW-F486B
Half Size Transformer	120V AC		TW-T126SB
	240V AC		TW-T246SB
Full voltage model (use with even number of contacts)	Standard		TW-DA1B
	Fingersafe		TW-DA1FB
Full voltage model (use with odd number of contacts)	Standard		HW-DA1B
	Fingersafe		HW-DA1FB

All Transformers step down to 6V (use 6V lamp).

Non-Illuminated Selector Switches (Assembled)

Assembled Selector Switches

A S W 3 (1) (L) 20 (N) – 304

Function

S: Selector Switch

Series Designation

W: TW Series

Number of Positions

2: 2-Position
3: 3-Position
4: 4-Position
5: 5-Position

Spring Return Action

Blank: Maintained
1: Spring return from Right (2 or 3 position)
2: Spring return from Left (2 or 3 position)
3: 2-Way spring return from Left and Right (3 position only)

Circuit Number

(Standard circuits shown on following pages and 585.)

Contacts Terminal Style

Blank: standard
N: Fingersafe (IP20)

Contact Arrangement Code

10: 1NO	01: 1NC
20: 2NO	02: 2NC
40: 4NO	04: 4NC
11: 1NO-1NC	22: 2NO-2NC

Operator Style Code

Blank: Knob Operator
L: Lever Operator
K: Key Operator

1. Use only when interpreting part numbers. Do not use for developing part numbers.
2. Custom contact configurations available.
3. Custom key removable codes available.
4. Portions of part number inside ( ) are optional.

Non-Illuminated Selector Switches (Assembled) continued

2-Position Selector Switches

Style					Part Number		
Contact	Mounting	Operator Position L	Operator Position R		Maintained	Spring Return from Right	Spring Return from Left
		L	R		L R	L R	L R
1NO	1 2	0 0	X 0	Knob Lever Key	ASW210 ASW2L10 ASW2K10	ASW2110 ASW21L10 ASW21K10	ASW2210 ASW22L10 ASW22K10
1NC	1 2	X 0	0 0	Knob Lever Key	ASW201-116 ASW2L01-116 ASW2K01-116	ASW2101-116 ASW21L01-116 ASW21K01-116	ASW2201-116 ASW22L01-116 ASW22K01-116
1NO 1NC	1 2	X 0	0 X	Knob Lever Key	ASW211 ASW2L11 ASW2K11	ASW2111 ASW21L11 ASW21K11	ASW2211 ASW22L11 ASW22K11
2NO	1 2	0 0	X X	Knob Lever Key	ASW220 ASW2L20 ASW2K20	ASW2120 ASW21L20 ASW21K20	ASW2220 ASW22L20 ASW22K20
2NC	1 2	X X	0 0	Knob Lever Key	ASW202-104 ASW2L02-104 ASW2K02-104	ASW2102-104 ASW21L02-104 ASW21K02-104	ASW2202-104 ASW22L02-104 ASW22K02-104
2NO 2NC	1 2 3 4	0 X 0 X	X 0 X 0	Knob Lever Key	ASW222 ASW2L22 ASW2K22	ASW2122 ASW21L22 ASW21K22	ASW2222 ASW22L22 ASW22K22
2NO 2NC	1 2 3 4	0 0 X X	X X 0 0	Knob Lever Key	ASW222-111 ASW2L22-111 ASW2K22-111	ASW2122-111 ASW21L22-111 ASW21K22-111	ASW2222-111 ASW22L22-111 ASW22K22-111

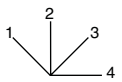
Non-Illuminated Selector Switches (Assembled) continued

3-Position Selector Switches

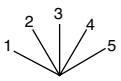
Style						Part Number			
Contact	Mounting	Operator Position L	Operator Position C	Operator Position R		Maintained	Spring Return from Right	Spring Return from Left	Spring Return Two-Way
2NO	1 2	X 0	0 0	0 X	Knob Lever Key	ASW320 ASW3L20 ASW3K20	ASW3120 ASW31L20 ASW31K20	ASW3220 ASW32L20 ASW32K20	ASW3320 ASW33L20 ASW33K20
2NC	1 2	0 X	X X	X 0	Knob Lever Key	ASW302 ASW3L02 ASW3K02	ASW3102 ASW31L02 ASW31K02	ASW3202 ASW32L02 ASW32K02	ASW3302 ASW33L02 ASW33K02
2NO 2NC	1 2 3 4	X 0 0 X	0 0 X X	0 X X 0	Knob Lever Key	ASW322 ASW3L22 ASW3K22	ASW3122 ASW31L22 ASW31K22	ASW3222 ASW32L22 ASW32K22	ASW3322 ASW33L22 ASW33K22
2NO 2NC	1 2 3 4	X X 0 0	0 X X 0	X 0 0 X	Knob Lever Key	ASW322-309 ASW3L22-309 ASW3K22-309	ASW3122-309 ASW31L22-309 ASW31K22-309	ASW3222-309 ASW32L22-309 ASW32K22-309	ASW3322-309 ASW33L22-309 ASW33K22-309
2NO 2NC	1 2 3 4	0 0 0 0	X 0 X 0	0 X 0 X	Knob Lever Key	ASW322-310 ASW3L22-310 ASW3K22-310	ASW3122-310 ASW31L22-310 ASW31K22-310	ASW3222-310 ASW32L22-310 ASW32K22-310	ASW3322-310 ASW33L22-310 ASW33K22-310
4NO	1 2 3 4	X 0 X 0	0 0 0 0	0 X 0 X	Knob Lever Key	ASW340 ASW3L40 ASW3K40	ASW3140 ASW31L40 ASW31K40	ASW3240 ASW32L40 ASW32K40	ASW3340 ASW33L40 ASW33K40
4NC	1 2 3 4	0 X 0 X	X X X X	X 0 X 0	Knob Lever Key	ASW304 ASW3L04 ASW3K04	ASW3104 ASW31L04 ASW31K04	ASW3204 ASW32L04 ASW32K04	ASW3304 ASW33L04 ASW33K04

1. The truth table indicates the operating position of contact block when the operator is switched to that position.
   X = On (closed contacts)
   0 = Off (open contacts)
   X——X = Overlapping Contacts: Remain on (closed contacts) when switch is moved between these two positions.
2. All knob and lever selector switches come in black. Other colors are available by ordering the knob or lever separately.
3. Every key selector switch uses an identical key. The key is removable in any maintained position.
4. Custom contact configurations are available, see page 585.

4-Position Selector Switch

Style							Maintained
Contact	Mounting	Operator Position 1	Operator Position 2	Operator Position 3	Operator Position 4		Part Number
							
2NO 2NC	1 2 3 4	X 0 0 0	0 X 0 0	0 0 X 0	0 0 0 X	Knob Lever	ASW422-411 ASW4L22-411

5-Position Selector Switch

Style								Maintained
Contact	Mounting	Operator Position 1	Operator Position 2	Operator Position 3	Operator Position 4	Operator Position 5		Part Number
								
2NO 2NC	1 2 3 4	X 0 0 0	0 X 0 0	0 0 0 0	0 0 X 0	0 0 0 X	Knob Lever	ASW522-501 ASW5L22-501

Non-illuminated Selector Switches (Sub-Assembled)

Contact Blocks	+	Operator	+	Knob or Lever*	+	Color Insert*	=	Complete Part†

1. *Not needed with key type switches.
2. †Knob type shown.

Operators

Style	Positions	Description	Part Number
Knob/Lever	2	Maintained	ASW200
		Spring return from right	ASW2100
		Spring return from left	ASW2200
	3	Maintained, Cam 1 Maintained, Cam 2 Maintained, Cam 3	ASW300-1 ASW300-2 ASW300-3
		Spring return from right, Cam 1 Spring return from right, Cam 2	ASW3100-1 ASW3100-2
		Spring return from left, Cam 1 Spring return from left, Cam 2	ASW3200-1 ASW3200-2
		Spring return from left/right, Cam 1 Spring return from left/right, Cam 2	ASW3300-1 ASW3300-2
	4	Maintained, Standard Cam Maintained, Cam 1	ASW400 ASW400-1
	5	Maintained, Standard cam Maintained, Cam 1	ASW500 ASW500-1
Key	2	Maintained	ASW2K00
		Spring return from right	ASW21K00
		Spring return from left	ASW22K00
	3	Maintained, Cam 1 Maintained, Cam 2 Maintained, Cam 3	ASW3K00-1 ASW3K00-2 ASW3K00-3
		Spring return from right, Cam 1 Spring return from right, Cam 2	ASW31K00-1 ASW31K00-2
		Spring return from left, Cam 1 Spring return from left, Cam 2	ASW32K00-1 ASW32K00-2
		Spring return from left/right, Cam 1 Spring return from left/right, Cam 2	ASW33K00-1 ASW33K00-2

1. Two keys are supplied with every key switch, all are keyed alike, and removable from any maintained position.
2. Locking rings are included with all operators. Order knobs, levers, and color inserts separately.
3. Different cams produce different contact actions. For details, see contact arrangement charts, page 585.
4. Key switch operator supplied with black sleeve.

① Handle/Insert Color Codes

Color	Code
Black*	B
Blue	S
Green	G
Red	R
Yellow	Y
White†	W

*Color inserts not available in black.
†Knob and lever not available in white.

Handles and Inserts

Style		Part Number
Knob		ASWHHY-①
Lever		ASWHHL-①
Color Insert		TW-HC1-①

Contact Blocks

Style	Part Number	
	1NO	1NC
Standard Exposed Screw	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20), CE marked	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. Push rod color code:
   Green = NO contact block
   Red = NC contact block.
2. Dummy blocks (no contacts) are used with an odd number of contact blocks.

Replacement Parts

Key Switch Black Sleeve	AKW2B-B

Illuminated Selector Switches (Assembled)

Assembled Illuminated Selector Switches

A SL W 2 (2) 99 11 (D) (N) – (103) – R – (24V)

Function

SL:Illuminated Selector Switch

Series Designation

W: TW series

Number of Positions

2: 2-Position
3: 3-Position

Spring Return Action

Blank: Maintained
1: Spring return from Right
2: Spring return from Left
3: Two-Way spring return from Left and Right

Illumination Circuit

99: Full Voltage (lamp determines voltage)
126: 120V AC Step Down Transformer
246: 240V AC Step Down Transformer
486: 480V AC Step Down Transformer

Lamp Voltage
(Full Voltage Units Only)

6V: 6V AC/DC
12V: 12V AC/DC
24V: 24V AC/DC
120V: 120V AC (LED only)
240V: 240V AC (LED only)

Lens Color Code

A: Amber
G: Green
R: Red
S: Blue
W: White
Y: Yellow

Contact Circuit Number

Standard circuits are listed on the following pages and 585.

Contact Terminal Style

Blank: Standard
N: Fingersafe

Lamp Type

Blank: Incandescent Lamp
D: LED Lamp

Contact Arrangement

10: 1NO	01: 1NC
20: 2NO	02: 2NC
40: 4NO	04: 4NC
11: 1NO-1NC	22: 2NO-2NC

1. Use only when interpreting part numbers. Do not use for developing part numbers.
2. All transformers step down to 6V (use 6V lamp).

Illuminated Selector Switches(Assembled) continued

Illuminated 2-Position Selector Switches

Style					Part Number		
Contact	Mounting	Operator Position L	Operator Position R	Lamp Circuit Type	Maintained	Spring Return from Right	Spring Return from Left
					L R	L R	L R
1NO 1NC	1 2	0 X	X 0	Transformer Full Voltage	ASLW2 ① 11④-② ASLW29911④-②-③	ASLW21 ① 11④-② ASLW219911④-②-③	ASLW22 ① 11④-② ASLW229911④-②-③
2NO	1 2	0 0	X X	Transformer Full Voltage	ASLW2 ① 20④-② ASLW29920④-②-③	ASLW21 ① 20④-② ASLW219920④-②-③	ASLW22 ① 20④-② ASLW229920④-②-③
2NC	1 2	X X	0 0	Transformer Full Voltage	ASLW2 ① 02④-104-② ASLW29902④-104-②-③	ASLW21 ① 02④-104-② ASLW219902④-104-②-③	ASLW22 ① 02④-104-② ASLW229902④-104-②-③
2NO 2NC	1 2 3 4	0 X 0 X	X 0 X 0	Transformer Full Voltage	ASLW2 ① 22④-② ASLW29922④-②-③	ASLW21 ① 22④-② ASLW219922④-②-③	ASLW22 ① 22④-② ASLW229922④-②-③

① Transformer Voltage Codes

Voltage	Code
120VAC	126
240VAC	246
480VAC	486

Transformers step down to 6V (use 6V lamp).

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W
Yellow	Y

Illuminated 3-Position Selector Switches, Maintained and Spring Return from Right

Style						Part Number			
Contact	Mounting	Operator Position L	Operator Position C	Operator Position R	Lamp Circuit Type	Maintained	Spring Return From Right	Spring Return from Left	Spring Return Two-Way
						L C R	L C R	L C R	L C R
2NO	1 2	X 0	0 0	0 X	Transformer Full Voltage	ASLW3 ① 20④-② ASLW39920④-②-③	ASLW31 ① 20④-② ASLW319920④-②-③	ASLW32 ① 20④-② ASLW329920④-②-③	ASLW33 ① 20④-② ASLW339920④-②-③
2NC	1 2	0 X	X X	X 0	Transformer Full Voltage	ASLW3 ① 02④-② ASLW39902④-②-③	ASLW31 ① 02④-② ASLW319902④-②-③	ASLW32 ① 02④-② ASLW329902④-②-③	ASLW33 ① 02④-② ASLW339902④-②-③
2NO 2NC	1 2 3 4	X 0 0 X	0 0 X X	0 X X 0	Transformer Full Voltage	ASLW3 ① 22④-② ASLW39922④-②-③	ASLW31 ① 22④-② ASLW319922④-②-③	ASLW32 ① 22④-② ASLW329922④-②-③	ASLW33 ① 22④-② ASLW339922④-②-③
2NO 2NC	1 2 3 4	X X 0 0	0 X X 0	X 0 0 X	Transformer Full Voltage	ASLW3 ① 22④-309-② ASLW39922④-309-②-③	ASLW31 ① 22④-309-② ASLW319922④-309-②-③	ASLW32 ① 22④-309-② ASLW329922④-309-②-③	ASLW33 ① 22④-309-② ASLW339922④-309-②-③
2NO 2NC	1 2 3 4	0 0 0 0	X 0 X 0	0 X 0 X	Transformer Full Voltage	ASLW3 ① 22④-310-② ASLW39922④-310-②-③	ASLW31 ① 22④-310-② ASLW319922④-310-②-③	ASLW32 ① 22④-310- ② ASLW329922④-310- ② -③	ASLW33 ① 22④-310-② ASLW339922④-310-②-③
4NO	1 2 3 4	X 0 X 0	0 0 0 0	0 X 0 X	Transformer Full Voltage	ASLW3 ① 40④-② ASLW39940④-②-③	ASLW31 ① 40④-② ASLW319940④-②-③	ASLW32 ① 40④-② ASLW329940④-②-③	ASLW33 ① 40④-② ASLW339940④-②-③
4NC	1 2 3 4	0 X 0 X	X X X X	X 0 X 0	Transformer Full Voltage	ASLW3 ① 04④-② ASLW39904④-②-③	ASLW31 ① 04④-② ASLW319904④-②-③	ASLW32 ① 04④-② ASLW329904④-②-③	ASLW33 ① 04④-② ASLW339904④-②-③

1. In place of ①, specify the Transformer Voltage Code.
2. In place of ②, specify the Lens/LED Color Code.
3. In place of ③, specify the Full Voltage Code.
4. In place of ④ specify Lamp Type Code
5. For custom contact configurations, see page 585.
6. Light is independent of switch position.
7. Yellow selector switch comes with white LED.

③ Full Voltage Codes

Voltage	Code
6V AC/DC	6V
12V AC/DC	12V
24V AC/DC	24V
120V AC	120V (LED only)
240V AC	240V (LED only)

④ Lamp Type Codes

Lamp	Code
Incandescent	Blank
LED	D

Illuminated Selector Switches (Sub-Assembled)

Transformer*	+	Contact Block	+	Operator	+	Lamp/Lead Holder†	+	Lamp	+	Lens	=	Complete Part

*Full voltage units use a full voltage adaptor (TW-DA1B) instead of a transformer.
†Lamp holder is not included with operators, order separately.
Lead holder is used when using 3 or more contact blocks. Order separately.

Operators

Style	Positions	Description	Part Number
	2	Maintained	ASLW200
		Spring return from right	ASLW2100
		Spring return from left	ASLW2200
	3	Maintained, cam 1 Maintained, cam 2 Maintained, cam 3	ASLW300-1
			ASLW300-2
			ASLW300-3
		Spring return from right, cam 1 Spring return from right, cam 2	ASLW3100-1
			ASLW3100-2
		Spring return from left, cam 1 Spring return from left, cam 2	ASLW3200-1
			ASLW3200-2
		Spring return from left/right, cam 1 Spring return from left/right, cam 2	ASLW3300-1
			ASLW3300-2

Different cams produce different contact action. For details, see Contact Arrangements on page 585.

Lenses (Knobs)

Description		Part Number
Knob		ASLWLU-②

In place of ②, specify the lens color code from table.

Lamps

Style	Voltage	Part Number
LED	6V AC/DC	LSTD-6②
	12V AC/DC	LSTD-1②
	24V AC/DC	LSTD-2②
	120V AC	LSTD-H2②
	240V AC	LSTD-M4②
Incandescent	6V AC/DC	IS-6
	12V AC/DC	IS-12
	24V AC/DC	IS-24

1. In place of ②, specify the LED color code.
2. The LED contains a current-limiting resistor and a protection diode.

② LED/Lens Color Codes

Color	Code
Amber	A
Green	G
Red	R
Blue	S
White	W
Yellow	Y

Yellow LED not available. Use white LED

Illuminated Selector Switches (Sub-Assembled) continued

Contact Blocks

Style	Part Number	
	1NO	1NC
Standard Exposed Screw	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20), CE marked	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. Dummy blocks (no contacts) are used with an odd number of contact blocks.
2. Use of early and late break contacts creates a make before break function

Lamp Circuit Components

Style	Application	Part Number
Short Lamp Holder	**Used with** a Half-size Transformer and one contact block	TW-LH1
Long Lamp Holder	**Used with** Full-size Transformer and two contact blocks **Used with** Half-size Transformer and three contact blocks **Used with** Full Voltage Adaptor and two contact blocks	TW-LH2
Lead Holder	**Used with** TW-LH2 holder when using four contact blocks	HW-LH3

Transformers/Full Voltage Modules

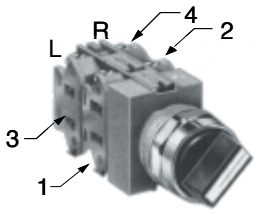
Style	Description		Part Number
Full Size Transformer	Standard	120V AC	TW-T126B
		240V AC	TW-T246B
		480V AC	TW-T486B
	Fingersafe	120V AC	TW-F126B
		240V AC	TW-F246B
		480V AC	TW-F486B
Half Size Transformer	120V AC		TW-T126SB
	240V AC		TW-T246SB
Full voltage model (use with even number of contacts)	Standard		TW-DA1B
	Fingersafe		TW-DA1FB
Full voltage model (use with odd number of contacts)	Standard		HW-DA1B
	Fingersafe		HW-DA1FB

All Transformers step down to 6V (use 6V lamp).

Contact Arrangement Charts

How to Read Contact Arrangement Charts

To determine contact block mounting position, first make sure the selector switch is oriented as shown on the right



Contact Arrangement
Type and quantity of switch contacts

Circuit Number
* N/D = No designation required

Contact Block Mounting Position
Position or mounting contact blocks on operator

Operator Position
Truth table indicates the operating position of contact block when operator is switched to that position.

Contact Block Part Number
Part number to use when ordering sub-assembly contact blocks, as required for use with corresponding mounting position

Contact Arrangement Chart: 2-Position Selector Switches

Style		Mounting Position	Operator Position		Contact Block Part Number	Description	Operator Part Number		
Contact	Circuit Number		L	R			Maintained	Spring Ret. from Rt.	Spring Ret. from Lt.
			↖	↗			L ↘ R	L ↗ R	L ↙ R
1NO	N/D	1	O	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	O	TW-DB				
1NC	116	1	X	O	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	O	TW-DB				
1NO 1NC	N/D	1	O	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	O	HW-C01				
	103	1	X	O	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	X	HW-C10				
1NO-EM 1NC-LB	600	1	O	X	HW-C10R	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	O	HW-C01R				
	601	1	X	O	HW-C01R	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	X	HW-C10R				
2NO	N/D	1	O	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	X	HW-C10				
2NC	104	1	X	O	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	O	HW-C01				
2NO 2NC	N/D	1	O	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	O	HW-C01				
		3	O	X	HW-C10				
		4	X	O	HW-C01				
	111	1	O	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	O	X	HW-C10				
		3	X	O	HW-C01				
		4	X	O	HW-C01				

1. NO-EM, NC-LB = Early Make, Late Break.
   N/D = No circuit number designation required in assembled selector switch part number.
2. X = On (closed contacts) O = Off (Open contacts)

Contact Arrangement Chart: 3-Position Selector Switches

Style		Mounting Position	Operator Position			Contact Block Part Number	Description	Operator Part Number			
Contact	Circuit Number		L	C	R			Maintained	Spring Return from Right	Spring Return from Left	Two-Way
1NO 1NC	202	1	X	0	0	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	X—X		0	HW-C01					
	203	1	0	X—X		HW-C01	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	0	0	X	HW-C10					
	302	1	X	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	X—X		0	HW-C01					
	303	1	0	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	0	0	X	HW-C10					
2NO	N/D	1	X	0	0	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	0	0	X	HW-C10					
	301	1	X	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	0	0	X	HW-C10					
2NC	304	1	0	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	X—X		0	HW-C01					
	N/D	1	0	X—X		HW-C01	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	X—X		0	HW-C01					
2NO 2NC	N/D	1	X	0	0	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	0	0	X	HW-C10					
		3	0	X—X		HW-C01					
		4	X—X		0	HW-C01					
	210	1	0	X	X	HW-C01	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	0	0—X		HW-C10					
		3	0	X—X		HW-C01					
		4	0	0	X	HW-C10					
	308	1	X	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	X—X		0	HW-C01					
		3	X	0	X	HW-C10					
		4	X—X		0	HW-C01					
	309	1	X	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	X—X		0	HW-C01					
		3	0	X	0	HW-C01					
		4	0	0	X	HW-C10					
	310	1	0	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	0	0	X	HW-C10					
		3	0	X	0	HW-C01					
		4	0	0	X	HW-C10					

1. Each operator sub-assembly is available as a "-1" and a "-2" for 3-position selector switches. The internal cam of a "-1" is different from that of a "-2". This results in designated combinations of open and closed contacts in the various operator positions.
2. N/D = No circuit number designation required in assembled part number.
3. X = On (closed contacts) O = Off (open contacts). X X Overlapping contacts remain on (closed) when switch is moved between these two positions.

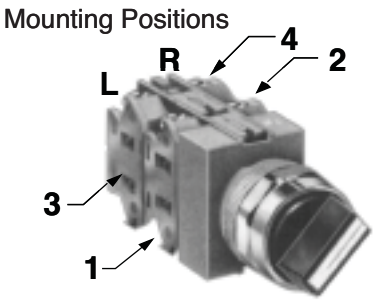
Contact Arrangement Chart: 3-Position Selector Switches

Style		Mounting Position	Operator Position			Contact Block Part Number	Description	Operator Part Number			
Contact	Circuit Number		L	C	R			Maintained	Spring Return from Right	Spring Return from Left	Two-Way
4NO	N/D	1	X	0	0	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	0	0	X	HW-C10					
		3	X	0	0	HW-C10					
		4	0	0	X	HW-C10					
	305	1	X	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	0	0	X	HW-C10					
		3	X	0	X	HW-C10					
		4	0	0	X	HW-C10					
4NC	N/D	1	0	X—X		HW-C01	Knob/Lever Key Illuminated Knob	ASW300-1 ASW3K00-1 ASLW300-1	ASW3100-1 ASW31K00-1 ASLW3100-1	ASW3200-1 ASW32K00-1 ASLW3200-1	ASW3300-1 ASW33K00-1 ASLW3300-1
		2	X—X		0	HW-C01					
		3	0	X—X		HW-C01					
		4	X—X		0	HW-C01					
	314	1	0	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW300-2 ASW3K00-2 ASLW300-2	ASW3100-2 ASW31K00-2 ASLW3100-2	ASW3200-2 ASW32K00-2 ASLW3200-2	ASW3300-2 ASW33K00-2 ASLW3300-2
		2	X—X		0	HW-C01					
		3	0	X	0	HW-C01					
		4	X—X		0	HW-C01					

1. Each operator sub-assembly is available as a "-1" and a "-2" for 3-position selector switches. The internal cam of a "-1" is different from that of a "-2". This results in designated combinations of open and closed contacts in the various operator positions.
2. N/D = No circuit number designation required in assembled part number.
3. X = On (closed contacts) O = Off (open contacts). X X Overlapping contacts remain on (closed) when switch is moved between these two positions.

Custom Selector Switch Building Guide

To build a custom selector switch, follow these steps.



Step 1

How many positions of the switch are needed?

# of positions (2, 3, 4, 5) ☐

Step 2

How many contacts should there be?

# of isolated contacts (maximum 6) ☐

Step 3

Fill in the Truth Table

(X = closed, 0 = open)

		Knob Position				
		1	2	3	4	5
Contacts	1					
	2					
	3					
	4					
	5					
	6					

Step 4

If building a 2 position selector, skip this step. (2 position selectors have only one cam)

If building a 3, 4, or 5 position selector, determine appropriate cam as follows:

- Look at Row 1 from above table and locate an identical row in the operator truth tables (See next page).
- Repeat for all rows. The user must find one operator that contains all rows from above table.
- Record the operator cam version.

Step 5

Build by placing appropriate contact in appropriate mounting position for each desired row on operator cam truth table. “L” and “R” refer to mounting on left or right side of operator as viewed from the front of the panel.

Step 6

Develop an assembly part number (if necessary) as follows: follow standard numbering nomenclature for selector switches (see pages 577 or 581. In place of the “Circuit Number” indicate the cam number and contact arrangement as such ASW322-3-OELCSS, where “3” is the cam number, and contact arrangement “OELCXX” calls out individual contact mounting locations in order (see diagram above). O=NO, C=NC, E=NO-EM, L=NC-LB, X= no contact. Part number must designate all 6 possible mounting locations.

Caution: Before putting any custom selector switch into use, the user should use an ohmmeter to test for desired performance.
1. For Operator Truth Tables, see next page.

Operator Truth Tables

Use the following tables to build custom selector switches.

2 Position Selector Switches

	Contact	Mounting Position	Operator Position	
			Left	Right
ASW200 ASLW200 ASW2K00	HW-C10 (NO)	L	0	X
		R	0	X
	HW-C01 (NC)	L	X	0
		R	X	0
	HW-C10R (NO-EM)	L	0	X
		R	0	X
	HW-C01R (NC-LB)	L	X	0
		R	X	0

3 Position Selector Switches

	Contact	Mounting Position	Operator Position		
			Left	Center	Right
ASW300-1 ASW3K00-1 ASLW300-1	HW-C10 (NO)	L	X	0	0
		R	0	0	X
	HW-C01 (NC)	L	0	X	X
		R	X	X	0
	HW-C10R (NO-EM)	L	X	0	0
		R	0	0	X
	HW-C01R (NC-LB)	L	0	X	X
		R	X	X	0

	Contact	Mounting Position	Operator Position		
			Left	Center	Right
ASW300-2 ASW3K00-2 ASLW300-2	HW-C10 (NO)	L	X	0	X
		R	0	0	X
	HW-C01 (NC)	L	0	X	0
		R	X	X	0
	HW-C10R (NO-EM)	L	X	0	X
		R	0	0	X
	HW-C01R (NC-LB)	L	0	X	0
		R	X	X	0

	Contact	Mounting Position	Operator Position		
			Left	Center	Right
ASW300-3 ASW3K00-3 ASLW300-3	HW-C10 (NO)	L	X	0	0
		R	0	0	X
	HW-C01 (NC)	L	0	X	0
		R	0	X	0
	HW-C10R (NO-EM)	L	X	0	X
		R	X	0	X
	HW-C01R (NC-LB)	L	0	X	X
		R	X	X	0

4 Position Selector Switches

	Contact	Mounting Position	Operator Position			
			1	2	3	4
ASW400	HW-C10 (NO)	L	X	0	0	0
		R	0	X	0	0
	HW-C01 (NC)	L	0	X	X	X
		R	X	0	X	X
	HW-C10R (NO-EM)	L	X	0	0	0
		R	0	X	0	0
	HW-C01R (NC-LB)	L	0	X	X	X
		R	X	0	X	X

	Contact	Mounting Position	Operator Position			
			1	2	3	4
ASW400-1	HW-C10 (NO)	L	X	0	0	0
		R	0	0	0	X
	HW-C01 (NC)	L	0	0	X	0
		R	0	X	0	0
	HW-C10R (NO-EM)	L	X	X	0	X
		R	X	0	X	X
	HW-C01R (NC-LB)	L	0	X	X	X
		R	X	X	X	0

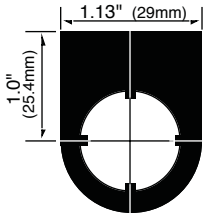
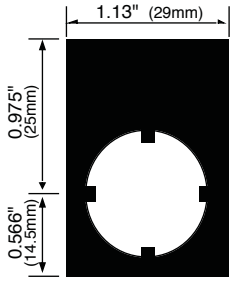
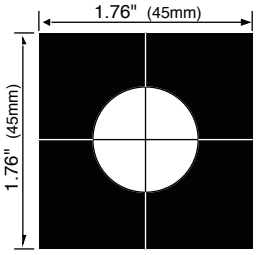
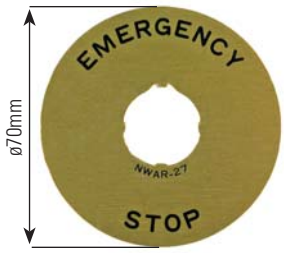
5 Position Selector Switches

	Contact	Mounting Position	Operator Position				
			1	2	3	4	5
ASW500	HW-C10 (NO)	L	X	0	0	0	0
		R	0	X	0	0	0
	HW-C01 (NC)	L	0	0	X	X	X
		R	0	0	0	X	X
	HW-C10R (NO-EM)	L	X	0	0	0	0
		R	0	X	0	0	0
	HW-C01R (NC-LB)	L	0	X	X	X	X
		R	X	0	X	X	X

	Contact	Mounting Position	Operator Position				
			1	2	3	4	5
ASW500-1	HW-C10 (NO)	L	X	0	0	0	0
		R	0	0	0	0	X
	HW-C01 (NC)	L	0	0	0	X	0
		R	0	X	0	0	0
	HW-C10R (NO-EM)	L	X	X	X	0	X
		R	X	0	X	X	X
	HW-C01R (NC-LB)	L	0	X	X	X	X
		R	X	X	X	X	0

Nameplates — TW Series

Faceplates

	NWAL	NWAQL	NWAS	EMERGENCY STOP
				
	Part Number			
Nameplate (blank)	NWAL-OB (black) NWAL-OR (red)	NWAQL-OB (black) NWAQL-OR (red)	NWAS-OB	NWAR-O
Nameplate (engraved)	NWAL-①	NWAQL-①	NWAS-①	NWAR-27†

1. In place of ①, insert either the Standard Legend Code from table below or custom engraving delimited by " ".
2. Standard engravings are available at no charge.
3 NWAR-27 comes marked "Emergency Stop" as shown in drawing.

Standard Legend Codes

Pushbuttons				Pushbuttons/Selector Switches				Selector Switches	
Legend	**Code**	**Legend**	**Code**	**Legend**	**Code**	**Legend**	**Code**	**Legend**	**Code**
AUTO	101	OPEN	116	AUTO-MAN	201	REV-FOR	216	AUTO-MAN-OFF	301
CLOSE	102	OUT	117	CLOSE-OPEN	202	RUN-JOG	217	AUTO-OFF-MAN	302
DOWN	103	RAISE	118	DOWN-UP	203	RUN-SAFE	218	CLOSE-OFF-OPEN	303
EMERG.STOP	104	RESET	119	FAST-SLOW	204	SAFE-RUN	219	DOWN-OFF-SLOW	304
FAST	105	REVERSE	120	FOR-REV	205	SLOW-FAST	220	FAST-OFF-SLOW	305
FORWARD	106	RUN	121	HAND-AUTO	206	START-STOP	221	FOR-OFF-REV	306
HAND	107	SLOW	122	HIGH-LOW	207	STOP-START	222	LEFT-OFF-RIGHT	307
HIGH	108	START	123	JOG-RUN	208	UP-DOWN	223	LOWER-OFF-RAISE	308
IN	109	STOP	124	LEFT-RIGHT	209			OFF-MAN-AUTO	309
INCH	110	STOP	125	LOWER-RAISE	210			OFF-SLOW-FAST	310
JOG	111	TEST	126	MAN-AUTO	211			OFF-1-2	311
LOW	112	UP	127	OFF-ON	212			OPEN-OFF-CLOSE	312
LOWER	113	I (Int'l On)	150	ON-OFF	213			SLOW-OFF-FAST	313
OFF	114	O (Int'l Off)	151	OPEN-CLOSE	214			SUMMER-OFF-WINTER	314
ON	115	EMO	152	RAISE-LOWER	215			UP-OFF-DOWN	315
								1-OFF-2	316
								HAND-OFF-AUTO	317

1. To order engraved nameplates, add legend code to nameplate part number.
Character height based on the number of characters and size of nameplate. Standard character size is 3/16".
2. Nameplates with standard legends are the same list price as blank nameplates.

Nameplate Order Form on next page.

Custom Engraved Nameplates Order Form — TW Series

Copy this order form and use it to specify Letter Height, Custom Engravings, Location of Engraving on Nameplate, and Quantity Desired.
To ensure engraving accuracy, fax it to your IDEC representative. or Distributor.

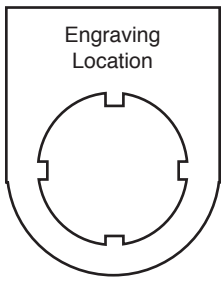
Your Company Name: _____ IDEC Rep/Distributor Contact: _____

Your Name: _____ PO number (if known): _____

Telephone: _____ IDEC Rep/Distributor Phone: _____

Fax & Email: _____ IDEC Rep/Distributor Fax & Email: _____

NWAL



Step 1.
Choose Letter Size - 7/64" or 1/8".

Check the box for the letter size you want. Then write your lettering in box below checkboxes. Note: 1/8" size letters cannot exceed 9 characters.

Step 2.
Specify Quantity.

Enter the number of nameplates desired in the box on the right.

Qty

7/64" Letter Size ☐ 11 characters max (for 7/64" size letters)

1/8" Letter Size ☐ 9 characters max (for 1/8" size letters)

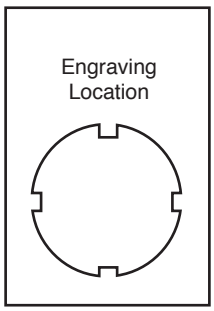
1 2 3 4 5 6 7 8 9 10 11

Sample Letter Sizes

7/64" Letters: A B C D

1/8" Letters: A B C D

NWAQL



Step 1.
Choose Letter Size - 7/64" or 1/8".

Check the box for the letter size you want. Then write your lettering in box below checkboxes. Note: 1/8" size letters cannot exceed 9 characters.

Step 2.
Specify Quantity.

Enter the number of nameplates desired in the box on the right.

Qty

7/64" Letter Size ☐ 11 characters max (for 7/64" size letters)

1/8" Letter Size ☐ 9 characters max (for 1/8" size letters)

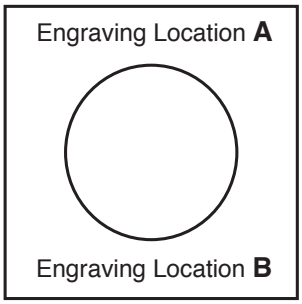
1 2 3 4 5 6 7 8 9 10 11

Sample Letter Sizes

7/64" Letters: A B C D

1/8" Letters: A B C D

NWAS



Step 1.
Choose Letter Size - 1/8" or 3/32".

Check the box for the letter size you want. Then write your lettering in box below checkboxes. Note: 1/8" size letters cannot exceed 14 characters.

3/32" Letter Size ☐ 20 characters max (for 3/32" size letters)

1/8" Letter Size ☐ 14 characters max (for 1/8" size letters)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Step 2.
Specify Quantity.

Enter the number of nameplates desired in the box on the right.

Qty

Step 3.
Specify Location.

Enter the location of engraving (A or B), in the box on the right.

Location

Sample Letter Sizes

3/32" Letters: A B C D

1/8" Letters: A B C D

Switch Engraving Order Form – TW Series

Copy this order form and use it to specify Letter Height, Maximum Number of Lines and Text to be engraved.

To insure engraving accuracy, fax it to your IDEC representative or Distributor.

Your Company: _____ Telephone: _____

Name: _____ Fax: _____

Address: _____ Email: _____

PO: _____ Part Number to be Engraved: _____

Please check one of the boxes below to indicate your choice of engraving options:

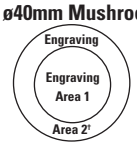
Square Switch

	# of Lines	Letter Height	Max. Characters Per Line
☐	1	5/32	6
☐		1/8	6
☐	2	5/32	6
☐		1/8	5
☐	3	1/8	6
☐	4	3/32	5

Round Switch

	# of Lines	Letter Height	Max. Characters Per Line
☐	1	5/32	5
☐		1/8	6
☐	2	5/32	5
☐		1/8	6
☐	3	1/8	5
☐	4	3/32	5

ø29mm, ø40mm Mushroom Head



		# of Lines	Letter Height	Max. Characters Per Line
☐	Engraving Area 1	1	5/32	5
☐			1/8	5
☐	Engraving Area 2	1	5/32	7
☐			1/8	7

1. Above mentioned specifications hold true for standard size pushbuttons (round and square).
2. †Engraving Area 2 can be engraved for 40mm mushroom Head non-Illuminated push button only.
3. Engraving is done on the button itself for non-Illuminated push buttons and on marking plate for illuminated push buttons and pilot lights.
4. Please enter text exactly how you want it engraved, take care to emphasize capital or small letters.

Enter text to be engraved:

Line 1: _____

Line 2: _____

Line 3: _____

Line 4: _____

Sample Letter Sizes

1/8 Letters: OPEN

5/32 Letters: OPEN

For IDEC Internal Use Only:

Work Order #: _____

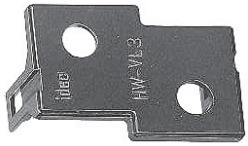
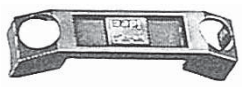
Accessories

TW Series Accessories

Appearance		Description/Usage		Part Number
Lamp Removal Tool		Rubber tool used to install or remove LED's and incandescent lamps		OR-55
Contact Block Remover		Used to remove contact blocks, transformers, lenses, and adaptors. Can also be used to determine panel thickness adjustment.		TW-KC1
Nut Locking Wrench		Used in OR-14 locking wrench to tighten locking nuts inside square bezel		TW-KQ2
Metal Bezel		Chrome plated bezels tighten onto operator (replacement for damaged bezels)	Standard octagonal units (chrome-pl.)	AW-R8
			Full shroud octagonal units (chrome-pl.)	AW-RF8
			Full shroud mushroom head units Ø 40mm	AW-G4
Plastic Bezel		Black plastic bezels for square buttons (replacement for damaged bezels)	Round flush units (black plastic)	AW-RP1B
			Round extended units (black plastic)	AW-FP1B
			Square units (black plastic)	AW-Q1B
			Square units with full shroud (black plastic)	AW-QF1B
Boot/Cover		Used to cover and protect pushbuttons	Waterproof lens cover for square pilot lights	APW00LN
			Waterproof lens cover for square illuminated buttons	APW00L
			Clear boot for round flush units	OC-31
			Clear boot for round extended units	OC-32
			*In place of asterisk, specify **Rubber Boot** color: **B** (black), **G** (green), **R** (red), **Y** (yellow) - (nitril rubber)	OCW-11*
Anti-Rotation Ring		Ring to prevent operator base from rotating in the mounting hole. Used when nameplate is not used		OGL-31
Mounting Hole Plug		Black rubber plug fills unused mounting holes in panel.		OB-31
Metallic Mounting Hole Plug		For plugging unused mounting holes in the panel. Tighten the attached locking ring to a torque of 12 kfg-cm maximum Degree of protection: IP66		LW9Z-BM
Replacement Keys		Pair of keys (#0)		TW-SK
Replacement Black Sleeve for Keyswitch				AKW2B-B
Metal Button Guard		Used on flush buttons to prevent inadvertent actuation		OLW-C

Appearance		Description/Usage		Part Number
Terminal Tab Adaptor		Quick- connect terminals	#250 (17/64" x 3/64") single tab	TW-FA1
Lock-out Adaptor		Used to provide lock-out protection for pushbuttons and knob selector switches: • Up to Ø 40mm mushroom head size (Padlock not included.)		HW9Z-KL1
TW to TWTD Adaptor		Used to mount TW series control unit (except square units) Ø 7/8" (22mm) into a Ø 1-13/64" (30mm) panel cut-out.		TWN-A1R8
Replacement Marking Plates		White plastic engraving plate for use on all illuminated units (included in each lens). May be used to capture printed mylar insert (not supplied by IDEC) under lens face.	Round Pushbutton (Ø14mm)	ALW2B
			Round Pilot Light (Ø 14mm)	APW2B
			Mushroom Pushbutton (Ø 14mm)	ALW3B
			Square Pilot Light (q 21mm)	APQW1B
			Square Pushbutton (q 21mm)	ALQW2B

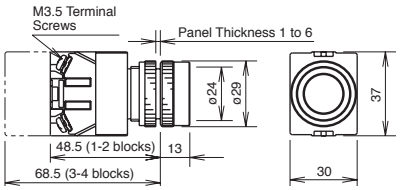
Fingersafe Covers for TW Series

Appearance	Description	Used with	Part Number
	Fingersafe terminal cover, adds 6mm to overall depth	APW and UPQW full voltage pilot lights	APS-PVL
	Fingersafe terminal cover, adds 3.5mm to overall depth. One required for each contact, only for rear-most terminals	Non-illuminated pushbuttons and selectors	HW-VL2
	Fingersafe terminal cover, adds 3mm to overall depth	APW and UPQW transformer pilot lights, and illuminated pushbuttons and illuminated selectors	HW-VL3
	Fingersafe terminal cover for contacts.	Full voltage illuminated pushbuttons and selectors	HW-VL4
	Fingersafe terminal cover for full voltage adaptor, adds 3 mm to depth	Full voltage illuminated pushbuttons and selectors	HW-VL5
	Fingersafe terminal cover for half size transformer adaptor, adds 3 mm to depth	Illuminated pushbuttons and selectors	HW-VL6

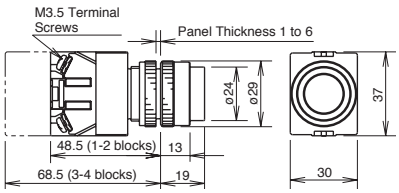
Dimensions

Pushbuttons

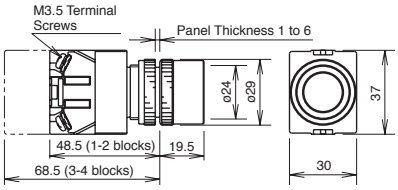
Flush



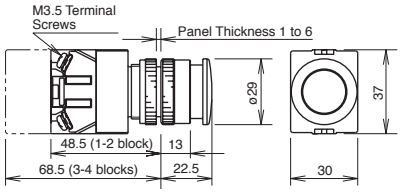
Extended



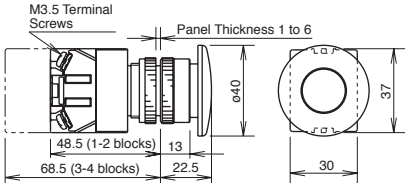
Extended with Full Shroud



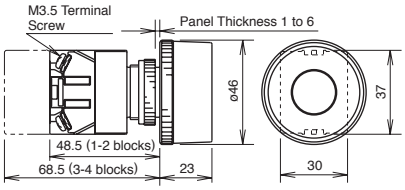
29mm Mushroom



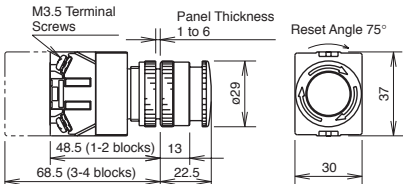
40mm Mushroom



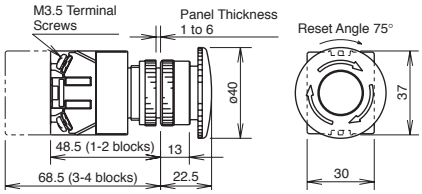
Mushroom with Full Shroud



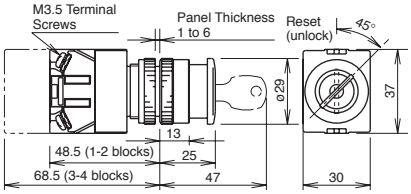
29mm Push-Lock-Turn-Reset



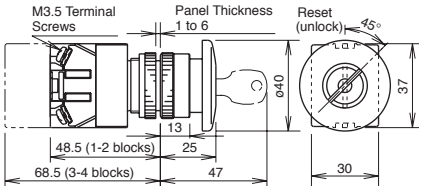
40mm Push-Lock-Turn-Reset



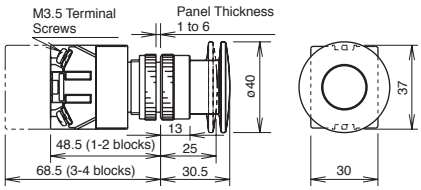
Keylock Push On/Off



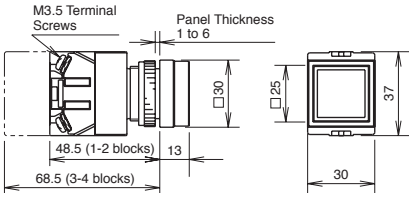
40mm Pushlock Key reset



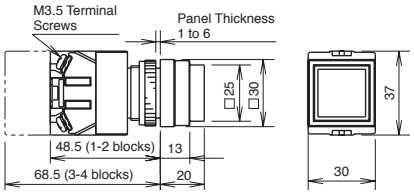
40mm Push-Pull



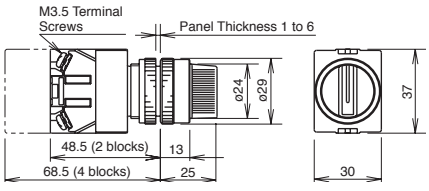
Square Flush

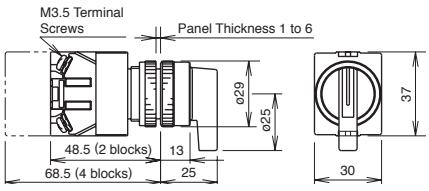


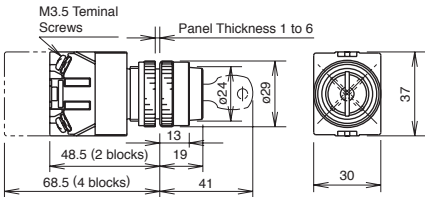
Square Extended



Selector Switches



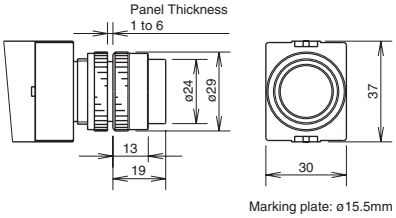




Dimensions continued

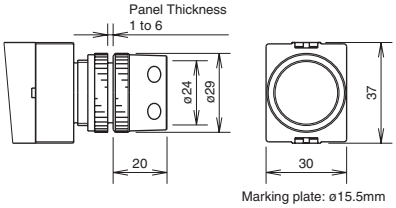
Illuminated Pushbuttons

Extended



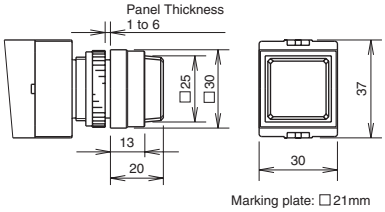
Marking plate: ø15.5mm

Extended with Full Shroud



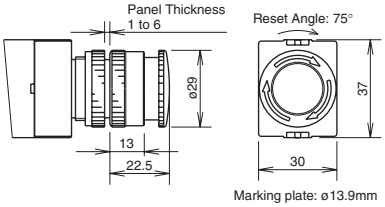
Marking plate: ø15.5mm

Square Extended



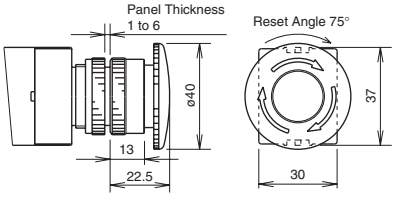
Marking plate: □21mm

29mm Push-Turn-Reset



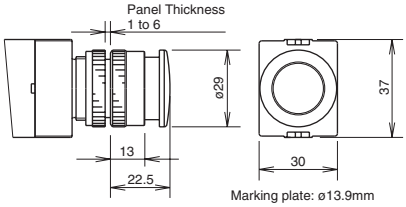
Marking plate: ø13.9mm

40mm Push-Turn-Reset



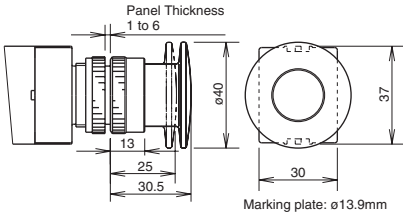
Marking plate: ø13.9mm

Mushroom



Marking plate: ø13.9mm

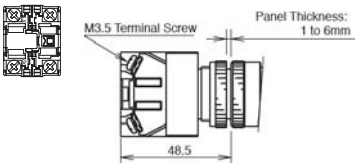
Push-Pull



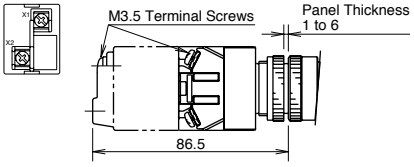
Marking plate: ø13.9mm

Illuminated Selector Switches

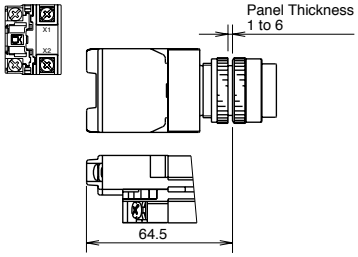
1 Contact Block with Full Voltage Adaptor



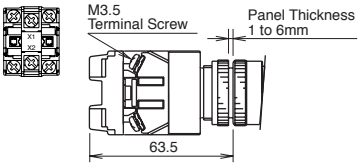
Transformer (2 blocks)



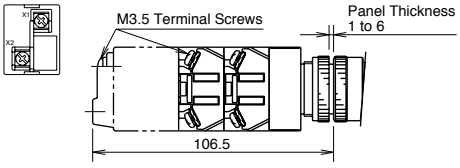
1 Contact Block with Half Size Transformer



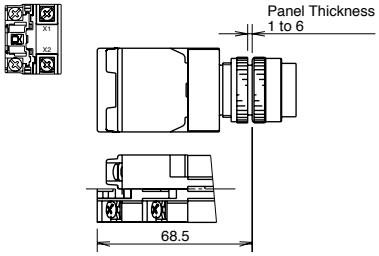
2 Contact Blocks with Full Voltage Adaptor



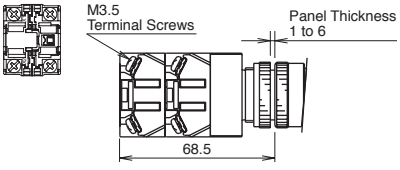
Transformer (4 blocks)



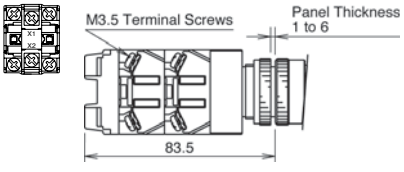
2 Contact Blocks with Half Size Transformer



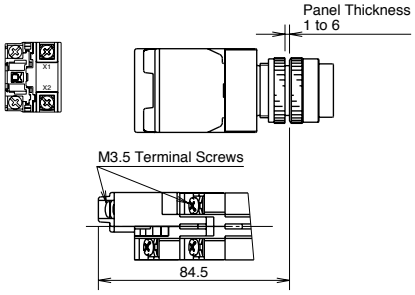
3 Contact Blocks with Full Voltage Adaptor



4 Contact Blocks with Full Voltage Adaptor



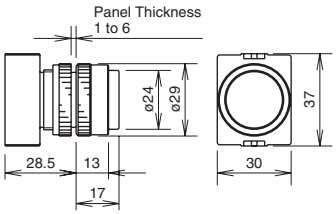
3 Contact Blocks with Half Size Transformer



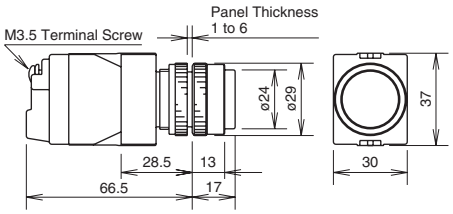
Dimensions continued

Pilot Lights

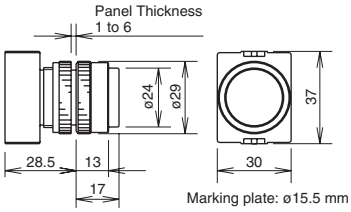
Round Flush APW1 Full Voltage



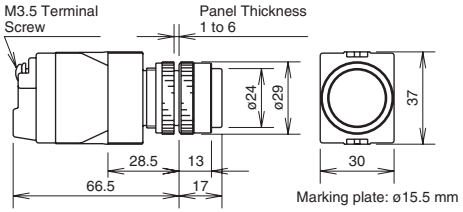
Round Flush APW1 Transformer



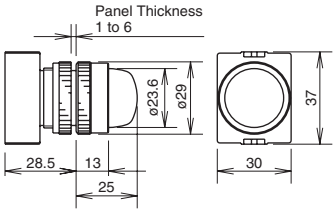
Round Flush Marking Type APW1B Full Voltage



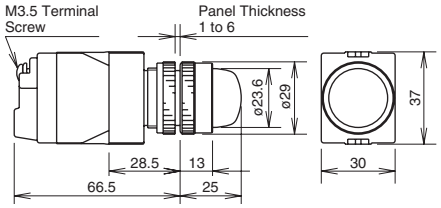
Round Flush Marking Type APW1B Transformer



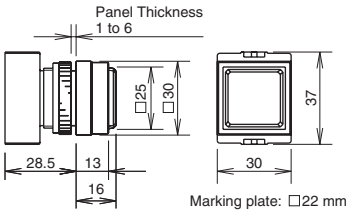
Dome APW2 Full Voltage



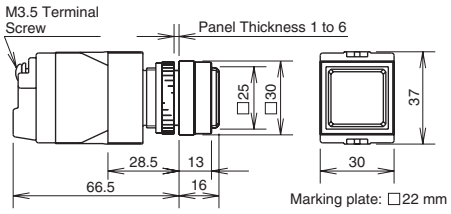
Dome APW2 Transformer



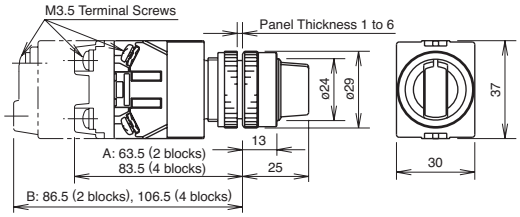
Square Flush Marking Type APQW1B Full Voltage



Square Flush Marking Type APQW1B Transformer

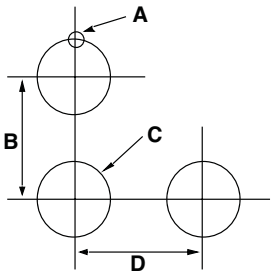


IlluminatedSelector Switches



Dimensions continued

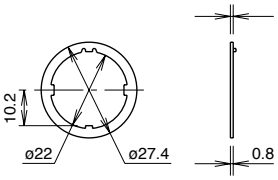
Panel Cut-Out

Diagram	Part	Dimension			
		A	B	C	D
	Pushbuttons	Ø 0.137" (3.5mm)	1.95" (50mm); 1.76" (45mm) minimum	Ø 0.878" (22.3mm)	1.17" (30mm) Std. Octagonal > 1.56" (40mm) Large Mushroom
	Pilot Light				
	Illuminated Pushbuttons				
	Selector Switches				1.17" (30mm) *See note.
	Illuminated Selector Switches				

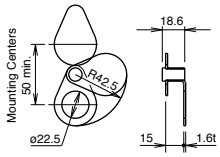
1.The Ø 0.137" (Ø 3.5mm) recess is necessary when either the nameplate or anti-rotation ring is used.
2. *>1.404" (36mm) for 2- or 3-position.
>1.95" (50mm) for 4- or 5-position.

Accessory Dimensions

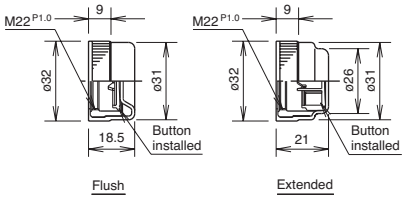
OGL-31
Anti-Rotation Ring



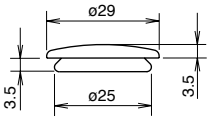
OLW-C
Metal Button Guard



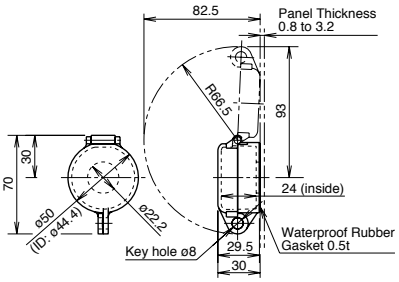
OCW-11
Pushbutton Rubber Boot



OB-31
Mounting Hole Rubber Plug



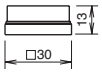
HW9Z-KL1
Lock-out Adaptor



AW-RP1B
Round Plastic Bezel

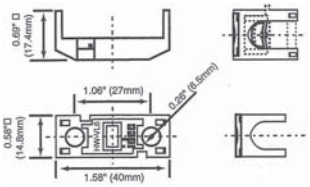
AW-FP1B
Round Plastic w/Full Shroud

AW-QF1B
Square Full Shroud

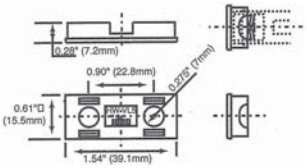


Finger-Safe Cover Dimensions

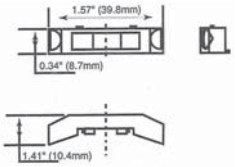
HW-VL6



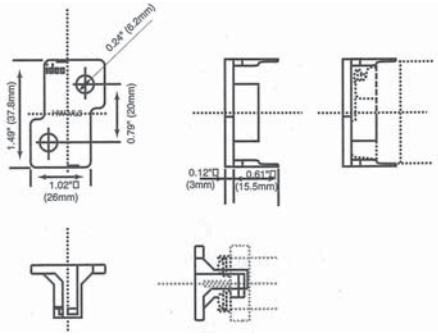
HW-VL5



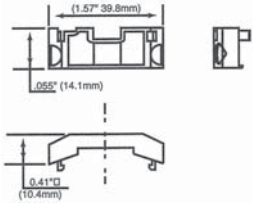
HW-VL4



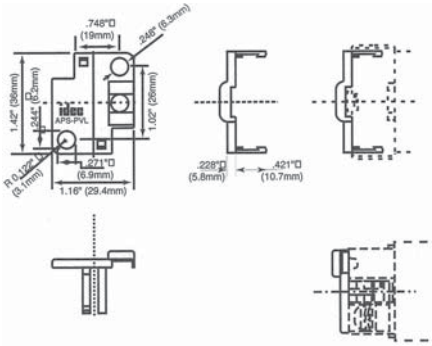
HW-VL3



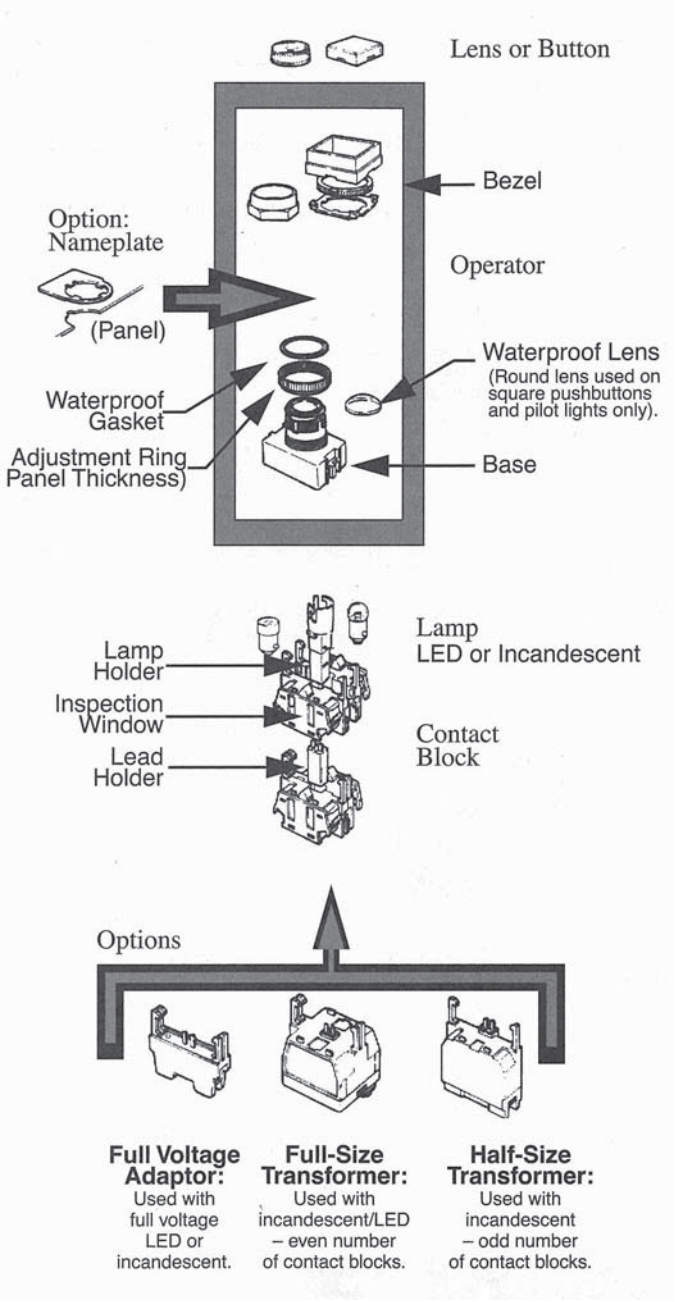
HW-VL2



APS-PVL



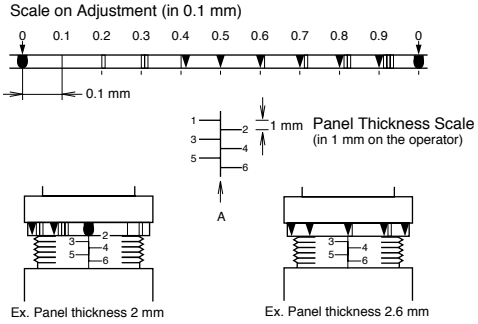
Component Construction and General Instructions — TW Series



Instructions for Switches and Pilot Devices

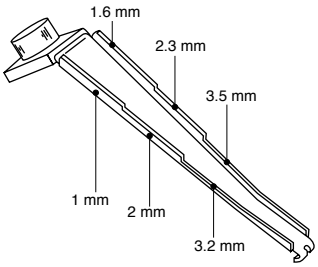
TW Series: Adjustment for Panel Thickness

The panel thickness ring provides adjustment from 0.04" to 0.24" (1 to 6mm) in 0.004" (0.1mm) increments. Rotate the ring until the markings around the periphery are aligned for the desired thickness, as shown below.

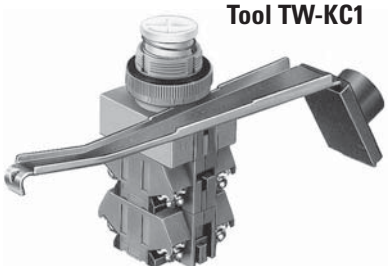


Note: When a nameplate or an anti-rotation ring is used, add 0.03" (0.8mm) to the panel thickness dimension.

An adjustment for panel thicknesses shown below can be made quickly by using the contact block remover tool.



Tool TW-KC1



Instructions continued

Pilot Lights and Pushbuttons

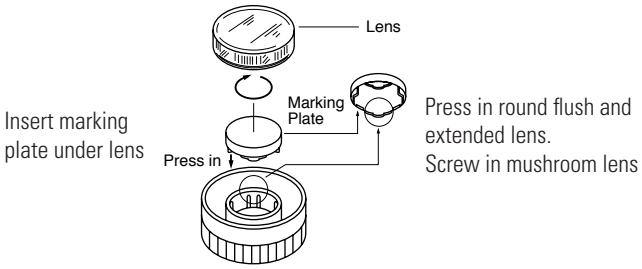
IMPORTANT: Install the body of the TW control unit with the panel thickness scale facing up.

Octagonal and Round Bezels

Octagonal and round bezels screw into the operator. Use a locking ring wrench (optional) for secure tightening and easy removal. Round flush and extended buttons snap onto the operator base. Mushroom buttons screw onto the operator base.

Every round lens can be used with or without legend markings. Engraving can be done on a white translucent plate which is placed in the lens, or clear mylar can be printed and placed in the lens.

Round Marking Unit

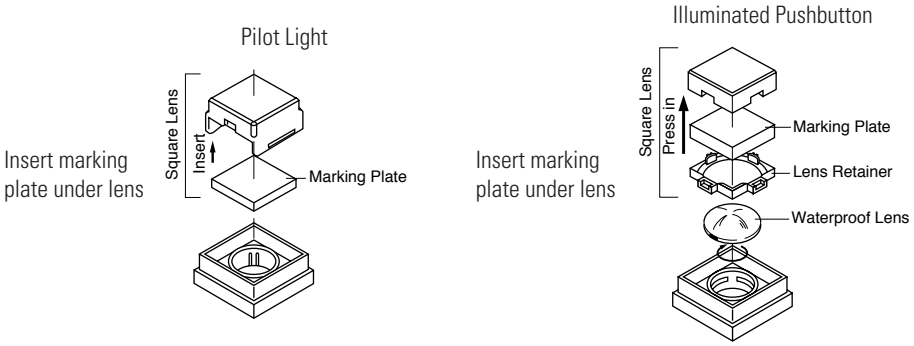


Square Bezels

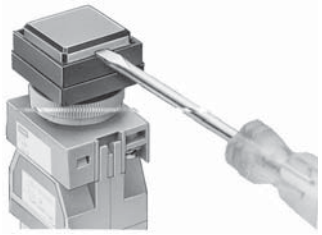
Square bezels are installed in a 3-step procedure. First install the base plate from the front. Then install the lock nut using the nut locking wrench (optional). Finally, install the square bezel, which snap-fits onto the base plate. Square buttons also snap onto the operator base.

Every square lens can be used with or without legend markings. Engraving can be done on a white translucent plate which is placed in the lens, or clear mylar can be printed and placed in the lens. Square units include a round waterproof lens which screws into the operator. The square outer lens snaps on.

Square Marking Units



To remove square lens from operator, place a screwdriver under the indentation on the side of the lens. To remove the marking plate, place a screwdriver under the indentation and lift out the plate. The lens retainer can be removed by pressing a 3/16" screwdriver into one of the recesses.



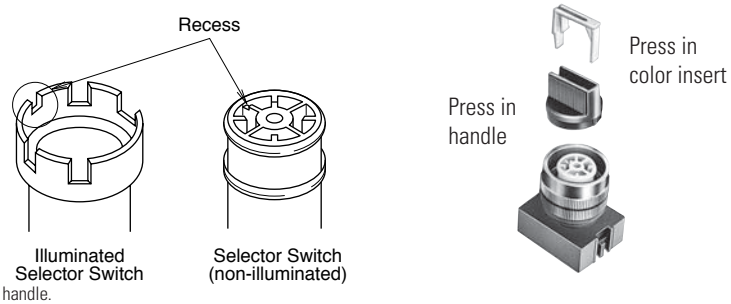
Marking Plate Engraving Area

Shape	Engraving Area	Used With	Part Number
Round	Ø 0.55" (14mm)	Illuminated pushbuttons	ALW2B
	Ø 0.55" (14mm)	Pilot lights	APW2B
Mushroom	Ø 0.55" (14mm)	Illuminated mushroom	ALW3B
Square	❑ 0.83" (21mm)	Square pilot lights	APQW1B
Square	❑ 0.83" (21mm)	Square illuminated pushbuttons	ALQW2B

Instructions continued

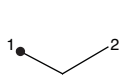
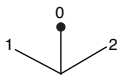
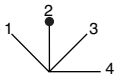
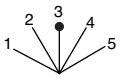
Selector Switches

The operator shaft of each unit has a recess to identify in which direction to install the handle. Align the handle with the recess. Press color insert (TW-HC1) into the handle and then press handle into the operator, as shown below.

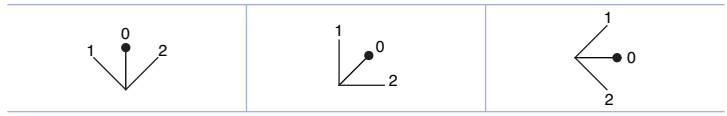


Remove color insert before pulling out the handle.

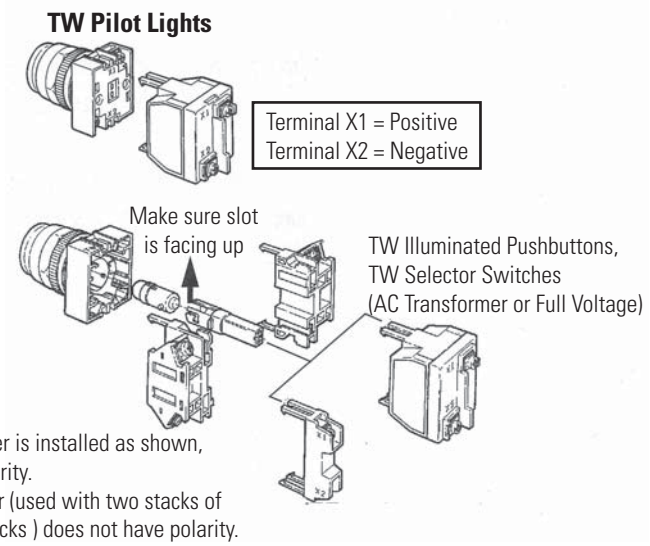
Standard Operating Positions

2-Postion, 90°	3-Postion, 45°	4-Postion, 45°	5-Postion, 30°
			

Positions: Non-Illuminated 3-Position Operators

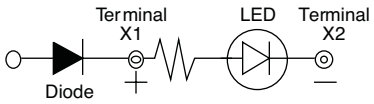


Installation



Installation of LED Illuminated Units

AC transformers are recommended for use in areas subjected to inductive noise. When using full voltage types, install a protection diode as shown below. (Diode with DC power supply to protect against surges and noise.)

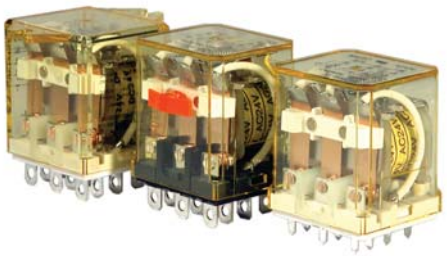


Make sure that LED illuminated units are installed with correct polarity, as indicated at the terminals.

RH Series Compact Power Relays

SPDT through 4PDT, 10A contacts
Compact power type relays

The RH series are miniature power relays with a large capacity. The RH relays feature 10A contact capacity as large as the RR series but in a miniature package. The compact size saves space.



Part Number Selection

Contact	Model	Part Number: Blade Terminal	Part Number: PCB Terminal	Coil Voltage Code (Standard Stock in bold)
SPDT	Basic	RH1B-U	RH1V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH1B-UL	—	
	With Check Button	RH1B-UC	—	
	With Indicator and Check Button	RH1B-ULC	—	
	Top Bracket Mounting	RH1B-UT	—	
	With Diode (DC coil only)	RH1B-UD	RH1V2-UD	DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH1B-ULD	—	**DC12V**, **DC24V**, DC48V, DC110V
DPDT	Basic	RH2B-U	RH2V2-U	AC6V, AC12V, **AC24V**, **AC110-120V**, **AC220-240V** DC6V, **DC12V**, **DC24V**, DC48V, DC100-110V
	With Indicator	RH2B-UL	RH2V2-UL	
	With Check Button	RH2B-UC	—	
	With Indicator and Check Button	RH2B-ULC	—	
	Top Bracket Mounting	RH2B-UT	—	
	With Diode (DC coil only)	RH2B-UD	RH2V2-UD	DC6V, **DC12V**, **DC24V**, DC48V, DC100-110V
	With Indicator and Diode (DC coil only)	RH2B-ULD	—	
3PDT	Basic	RH3B-U	RH3V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH3B-UL	RH3V2-UL	
	With Check Button	RH3B-UC	—	
	With Indicator and Check Button	RH3B-ULC	—	
	Top Bracket Mounting	RH3B-UT	—	
	With Diode (DC coil only)	RH3B-D*	RH3V2-D*	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH3B-LD*	—	
4PDT	Basic	RH4B-U	RH4V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH4B-UL	RH4V2-UL	
	With Check Button	RH4B-UC	—	
	With Indicator and Check Button	RH4B-ULC	—	
	Top Bracket Mounting	RH4B-UT	—	
	With Diode (DC coil only)	RH4B-UD	RH4V2-UD	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH4B-LD*	—	

1. *Carries no UL recognition mark.
2. PCB terminal relays are designed to mount directly to a circuit board without any socket.

Ordering Information
When ordering, specify the Part No. and coil voltage code:
(example) **RH3B-U** **AC120V**
Part No. — Coil Voltage Code

Sockets (for Blade Terminal Models)

Relays	Standard DIN Rail Mount [1]	Finger-safe DIN Rail Mount [1]	Through Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C	SH4B-51	SH4B-62

1. DIN Rail mount socket comes with two horseshoe clips. Do not use unless you plan to insert pullover wire spring. Replacement horseshoe clip part number is Y778-011.

Hold Down Springs & Clips

Appearance	Description	Relay	For DIN Mount Socket	For Through Panel & PCB Mount Socket	Min Order Qty
	Pullover Wire Spring	RH1B	SY2S-02F1 [2]	SY4S-51F1	10
		RH2B	SY4S-02F1 [2]		
		RH3B	SH3B-05F1 [2]		
		RH4B	SH4B-02F1 [2]		
	Leaf Spring (side latch)	RH1B, RH2B, RH3B, RH4B	SFA-202 [3]	SFA-302 [3]	20
	Leaf Spring (top latch)	RH1B, RH2B, RH3B, RH4B	SFA-101 [3]	SFA-301 [3]	

2. Must use horseshoe clip when mounting in DIN mount socket. Replacement horseshoe clip part number is Y778-011.
3. Two required per relay.

AC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C								Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	AC 50Hz				AC 60Hz										
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
6	170	240	330	387	150	200	280	330	330	9.4	6.4	5.4	110%	80% maximum	30% minimum
12	86	121	165	196	75	100	140	165	165	39.3	25.3	21.2			
24	42	60.5	81	98	37	50	70	83	83	153	103	84.5			
110	9.6	—	18.1	21.6	8.4	—	15.5	18.2	18.2	—	2,200	1,800			
110-120	—	9.4-10.8	—	—	—	8.0-9.2	—	—	—	—	—	—			
120	8.6	—	16.4	19.5	7.5	—	14.2	16.5	16.5	—	10,800	7,360			
220	4.7	—	8.8	10.7	4.1	—	7.7	9.1	9.1	—	10,800	7,360			
220-240	—	4.7-5.4	—	—	—	4.0-4.6	—		—	18,820	—	—			
240	4.9	—	8.2	9.8	4.3	—	7.1	8.3	8.3	—	12,100	9,120			

DC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C				Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
6	128	150	240	250	47	40	25	24	110%	80% maximum	10% minimum
12	64	75	120	125	188	160	100	96			
24	32	36.9	60	62	750	650	400	388			
48	18	18.5	30	31	2,660	2,600	1,600	1,550			
100-110	—	8.2-9.0	—	—	—	12,250	—	—			
110	8	—	12.8	15	13,800	—	8,600	7,340			

Standard coil voltages are in **BOLD**.

Contact Ratings

Maximum Contact Capacity						
Model	Continuous Current	Allowable Contact Power		Rated Load		
		Resistive Load	Inductive Load	Voltage (V)	Res. Load	Ind. Load
SPDT	10A	1540VA 300W	990VA 210W	110 AC	10A	7A
				220 AC	7A	4.5A
				30 DC	10A	7A
DPDT 3PDT 4PDT	10A	1650VA 300W	1100VA 225W	110 AC	10A	7.5A
				220 AC	7.5A	5A
				30 DC	10A	7.5A

Note: Inductive load for the rated load — cos ø = 0.3, L/R = 7 ms

TÜV Ratings

Voltage	RH1	RH2	RH3	RH4
240V AC	10A	10A	7.5A	7.5A
30V DC	10A	10A	10A	10A

AC: cos ø = 1.0, DC: L/R = 0 ms

UL Ratings

Voltage	Resistive			General Use			Horse Power Rating		
	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4
240V AC	10A	7.5A	7.5A	7A	6.5A	5A	1/3 HP	1/3 HP	—
120V AC	—	10A	10A	—	7.5A	7.5A	1/6 HP	1/6 HP	—
30V DC	10A	10A	—	7A	—	—	—	—	—
28V DC	—	—	10A	—	—	—	—	—	—

CSA Ratings

Voltage	Resistive				General Use				Horse Power Rating
	RH1	RH2	RH3	RH4	RH1	RH2	RH3	RH4	RH1, 2, 3
240V AC	10A	10A	—	7.5A	7A	7A	7A	5A	1/3 HP
120V AC	10A	10A	10A	10A	7.5A	7.5A	—	7.5A	1/6 HP
30V DC	10A	10A	10A	10A	7A	7.5A	—	—	—

Socket Specifications

	Sockets	Terminal	Electrical Rating	Wire Size	Torque
DIN Rail Mount Sockets	SH1B-05	(Coil) M3 screws (contact) M3.5 screws with captive wire clamp	250V, 10A	Maximum up to 2–#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05 SH3B-05 SH4B-05	M3.5 screws with captive wire clamp	300V, 10A	Maximum up to 2–#12AWG	9 - 11.5 in•lbs
Finger-safe DIN Rail Mount	SH1B-05C	(coil) M3 screws (contact) M3.5 screws with captive wire clamp, fingersafe	250V, 10A	Maximum up to 2–#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05C SH3B-05C SH4B-05C	M3.5 screws with captive wire clamp, fingersafe	300V, 10A	Maximum up to 2–#12AWG	9 - 11.5 in•lbs
Through Panel Mount Socket	SH1B-51 SH2B-51 SH3B-51 SH4B-51	Solder	300V, 10A	—	—
PCB Mount Socket	SH1B-62	PCB mount	250V, 10A	—	—
	SH2B-62 SH3B-62 SH4B-62	PCB mount	300V, 10A	—	—

Accessories

Description	Appearance	Use with	Part No.	Remarks
Aluminum DIN Rail (1 meter length)		All DIN rail sockets	BNDN1000	IDEC offers a low-profile DIN rail (BNDN1000). The BNDN1000 is designed to accommodate DIN mount sockets. Made of durable extruded aluminum, the BNDN1000 measures 0.413 (10.5mm) in height and 1.37 (35mm) in width (DIN standard). Standard length is 39" (1,000mm).
DIN Rail End Stop		DIN rail	BNL5	9.1 mm wide.
Replacement Hold-Down Spring Anchor		DIN mount sockets and hold down springs.	Y778-011	For use on DIN rail mount socket when using pullover wire hold down spring. 2 pieces included with each socket.

Specifications

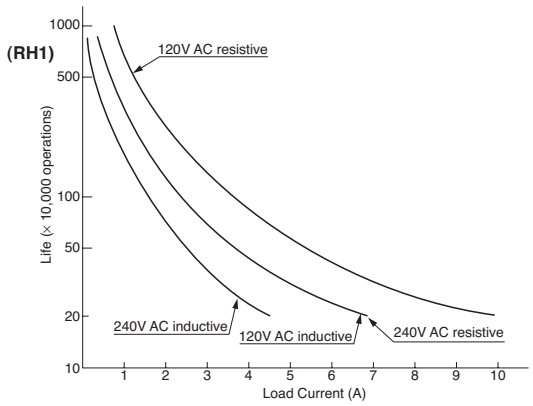
Contact Material		Silver cadmium oxide
Contact Resistance [1]		50mΩ maximum
Minimum Applicable Load		24V DC, 30 mA; 5V DC, 100 mA (reference value)
Operate Time [2]	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Release Time [2]	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Power Consumption (approx.)	SPDT	AC: 1.1VA (50Hz), 1VA (60Hz) DC: 0.8W
	DPDT	AC: 1.4VA (50Hz), 1.2VA (60Hz) DC: 0.9W
	3PDT	AC: 2VA (50Hz), 1.7VA (60Hz) DC: 1.5W
	4PDT	AC: 2.5VA (50Hz), 2VA (60Hz) DC: 1.5W
Insulation Resistance		100MΩ minimum (500V DC megger)
Dielectric Strength [3]	SPDT	Between live and dead parts: 2,000V AC, 1 minute Between contact and coil: 2,000V AC, 1 minute Between contacts of the same pole: 1,000V AC, 1 minute
	DPDT 3PDT 4PDT	Between live and dead parts: 2,000V AC, 1 minute Between contact and coil: 2,000V AC, 1 minute Between contacts of different poles: 2,000V AC, 1 minute Between contacts of the same pole: 1,000V AC, 1 minute
Operating Frequency		Electrical: 1,800 operations/hour maximum Mechanical: 18,000 operations/hour maximum
Vibration Resistance		Damage limits: 10 to 55Hz, amplitude 0.5 mm Operating extremes: 10 to 55Hz, amplitude 0.5 mm
Shock Resistance		Damage limits: 1,000m/s² (100G) Operating extremes: 200m/s² (20G - SPDT, DPDT) 100m/s² (10G - 3PDT, 4PDT)
Mechanical Life		50,000,000 operations minimum
Electrical Life	DPDT	500,000 operations minimum (120V AC, 10A)
	SPDT 3PDT 4PDT	200,000 operations minimum (120V AC, 10A)
Operating Temperature [4]	SPDT	–25 to +50°C (no freezing)
	DPDT 3PDT 4PDT	–25 to +40°C (no freezing)
Operating Humidity		45 to 85% RH (no condensation)
Weight (approx.)		SPDT: 24g, DPDT: 37g, 3PDT: 50g, 4PDT: 74g

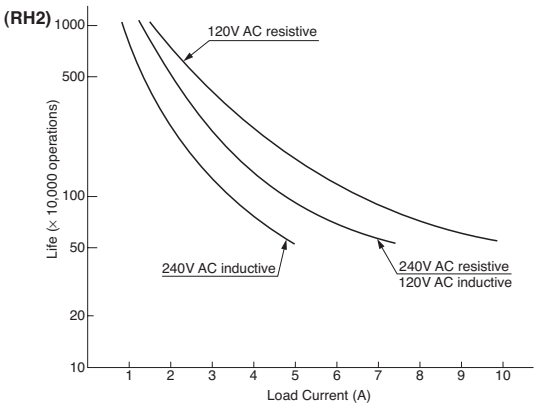
Note: Above values are initial values.
1. Measured using 5V DC, 1A voltage drop method
2. Measured at the rated voltage (at 20°C), excluding contact bouncing
   Release time of relays with diode: 40 ms maximum
3. Relays with indicator or diode: 1000V AC, 1 minute
4. For use under different temperature conditions, refer to Continuous Load Current vs. Operating Temperature Curve. The operating temperature range of relays with indicator or diode is –25 to +40°C.

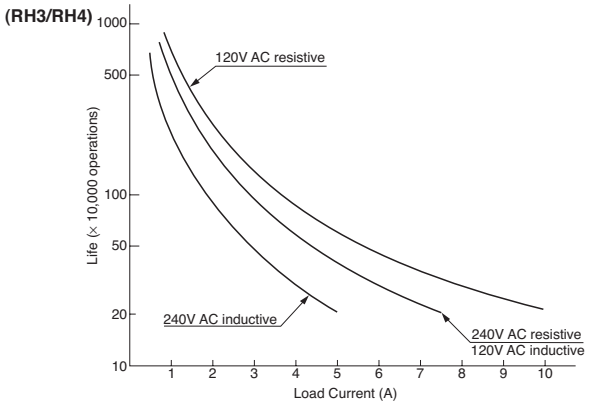
Characteristics (Reference Data)

Electrical Life Curves

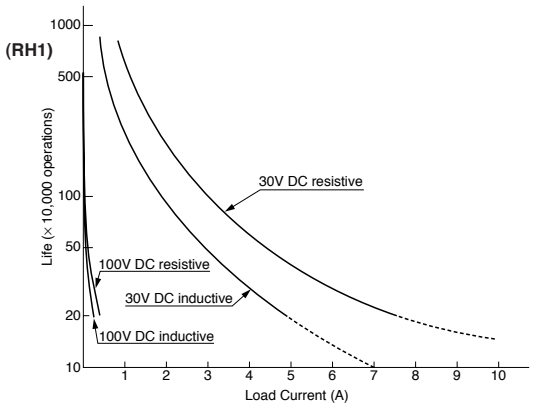
AC Load

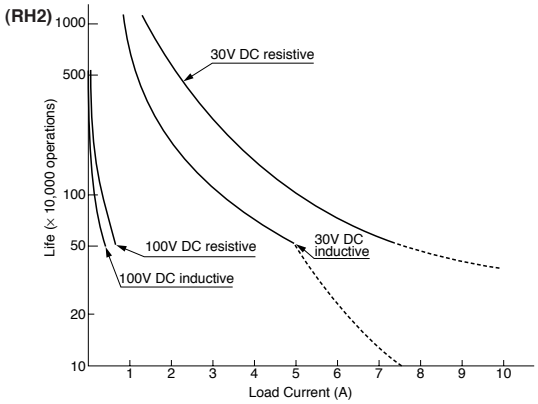


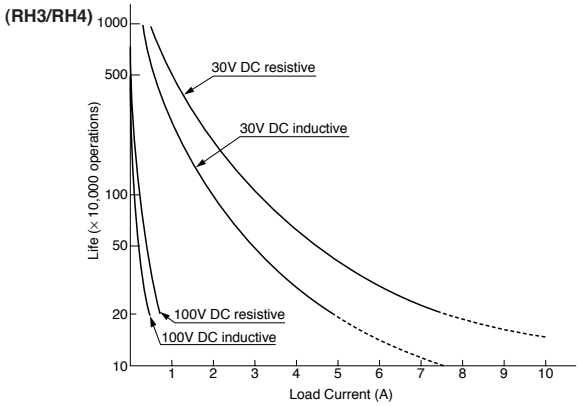




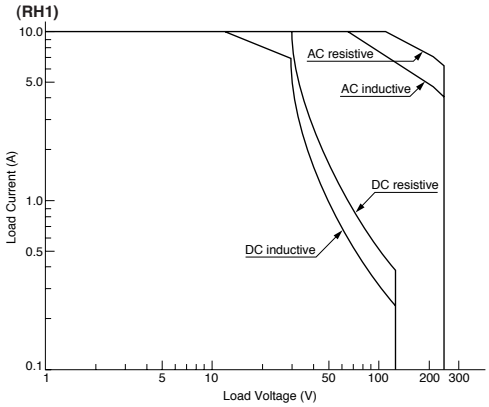
DC Load

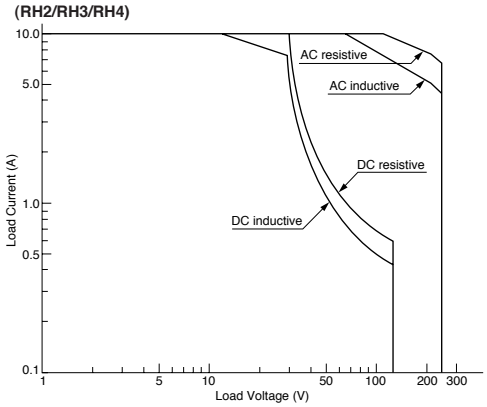






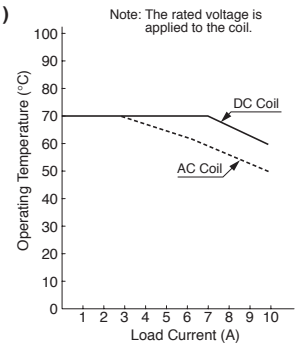
Maximum Switching Capacity



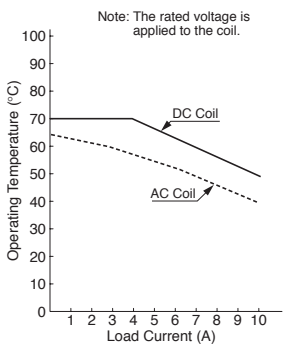


Continuous Load Current vs. Operating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)

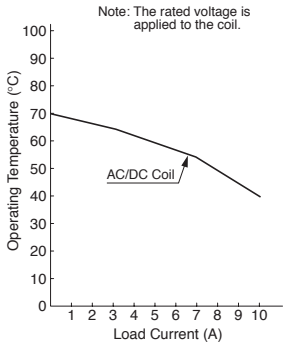
(RH1)



(RH2)

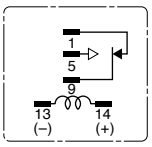
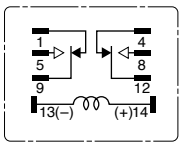
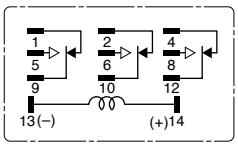
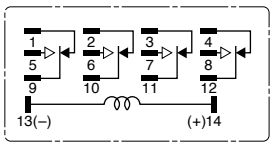
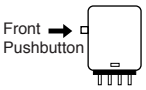


(RH3/RH4)

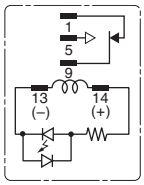
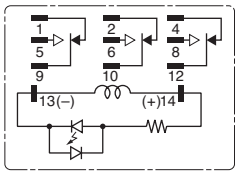
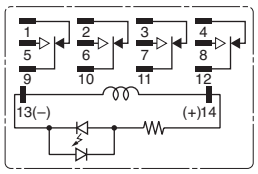
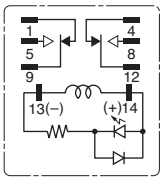
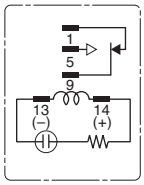
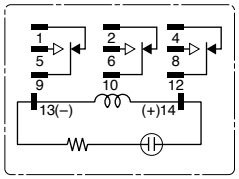
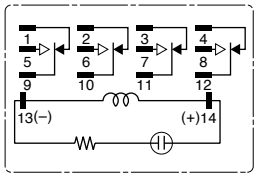
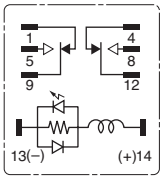


Internal Connection (View from Bottom)

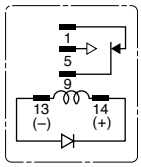
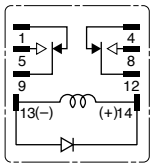
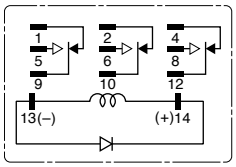
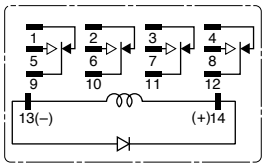
Basic Type

SPDT	DPDT	3PDT	4PDT	With Check Button
				 Contacts can be operated by pressing the check button.

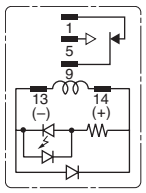
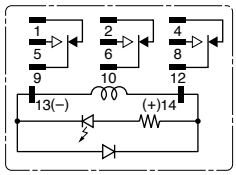
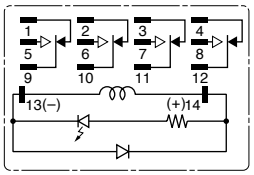
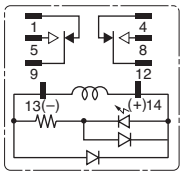
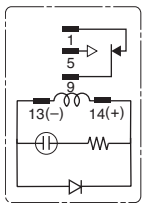
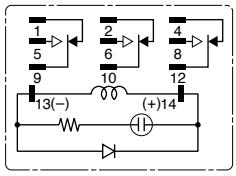
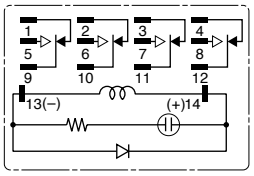
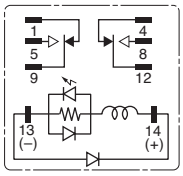
With Indicator (-L type)

	SPDT	3PDT	4PDT		DPDT	
Below 100V AC/DC				Below 24V AC/DC		When the relay is energized, the indicator goes on. • Relay coils less than 100V DC do not contain a protection diode (except DPDT). • Relay coils below 100V use LED indicator, coils above 100V use neon lamp indicator.
100V AC/DC and over				24V AC/DC and over		

With Diode (-D type)

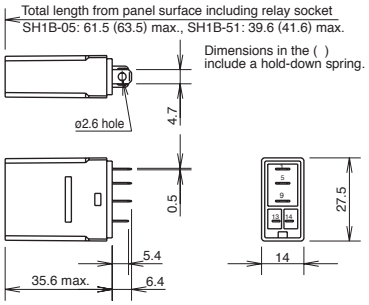
SPDT	DPDT	3PDT	4PDT	
				Contains a diode to absorb the back emf generated when the coil is de-energized. The release time is slightly longer. Available for DC coil only. • Diode Characteristics Reverse withstand voltage: 1,000V Forward current: 1A

With Indicator LED & Diode (-LD type)

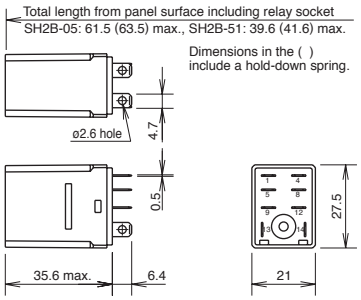
	SPDT	3PDT	4PDT		DPDT	
Below 100V DC				Below 24V AC/DC		Contains an LED indicator and a surge absorber, and has the same height as the basic type.
100V DC and over				24V AC/DC and over		

Dimensions (mm)

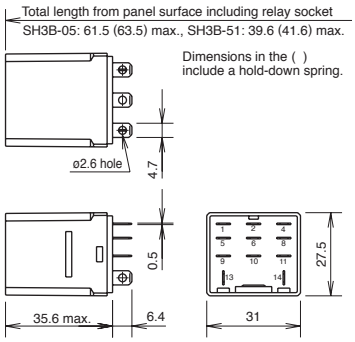
RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD



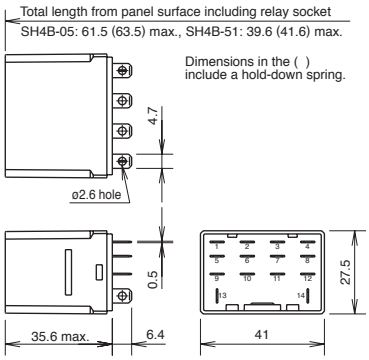
RH2B-U/RH2B-UL/RH2B-UD/RH2B-ULD



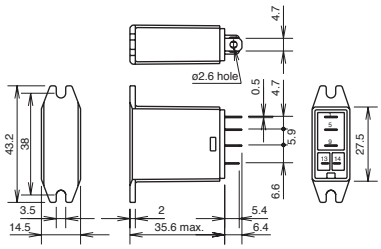
RH3B-U/RH3B-UL/RH3B-D/RH3B-LD



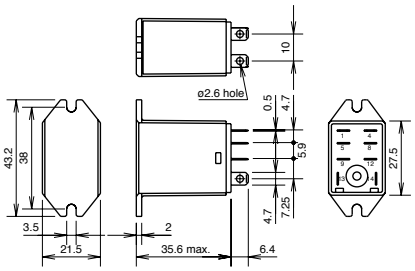
RH4B-U/RH4B-UL/RH4B-UD/RH4B-LD



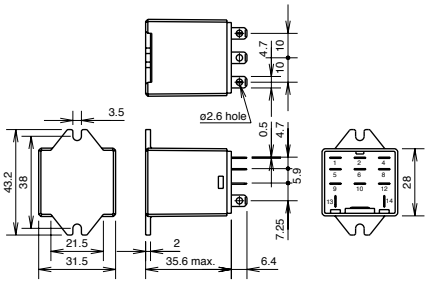
RH1B-UT



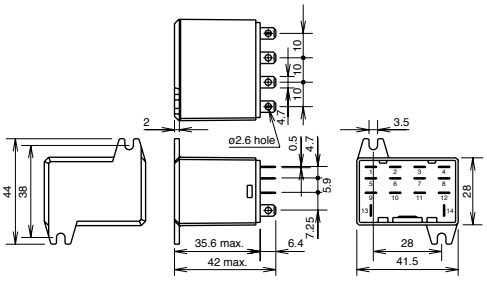
RH2B-UT



RH3B-UT

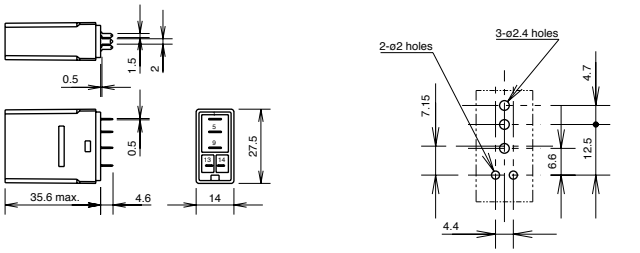


RH4B-UT

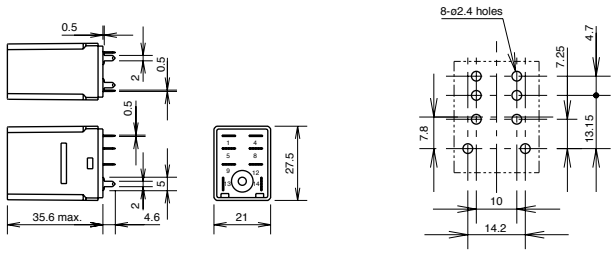


Dimensions con't (mm)

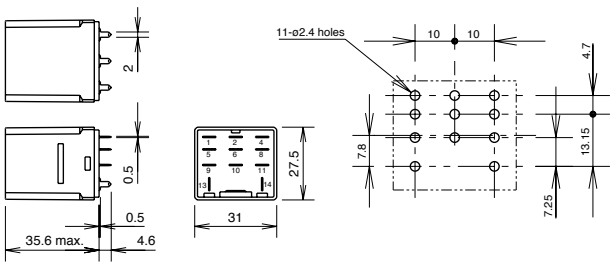
RH1V2-U/RH1V2-UD



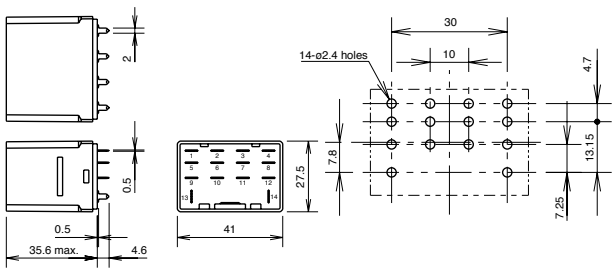
RH2V2-U/RH2V2-UL/RH2V2-UD



RH3V2-U/RH3V2-UL/RH3V2-D

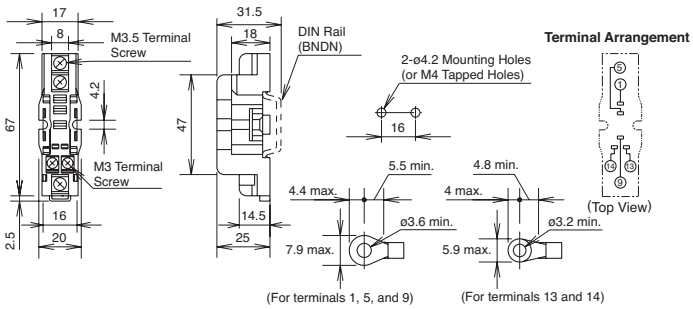


RH4V2-U/RH4V2-UL/RH4V2-UD

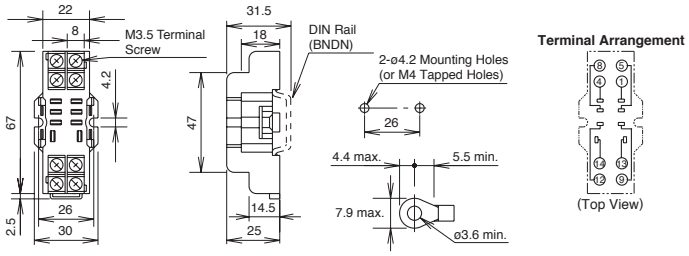


Standard DIN Rail Mount Sockets

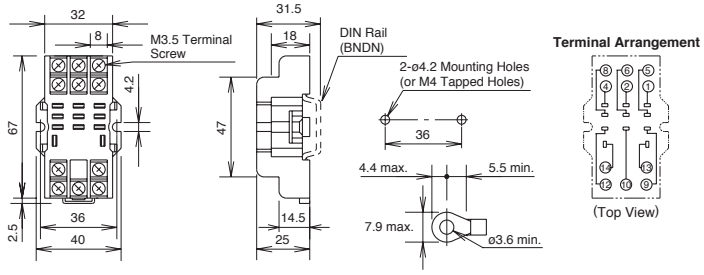
SH1B-05



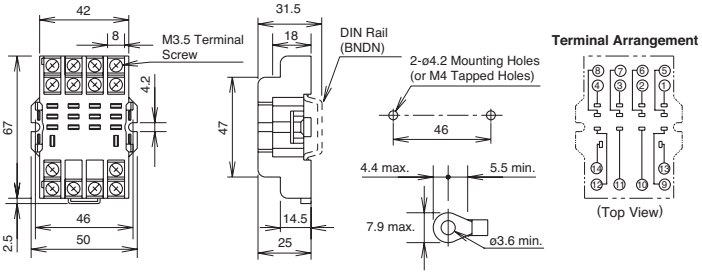
SH2B-05



SH3B-05



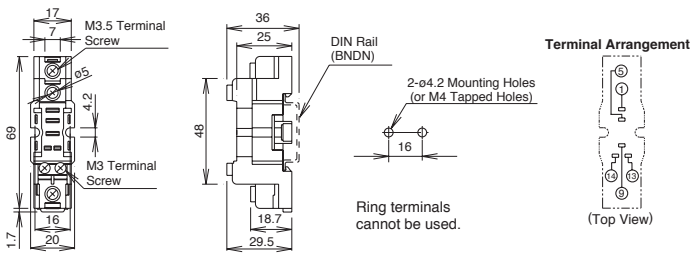
SH4B-05



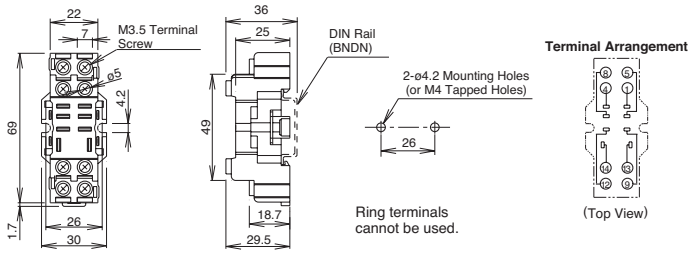
Dimensions con't (mm)

Finger-safe DIN Rail Mount Sockets

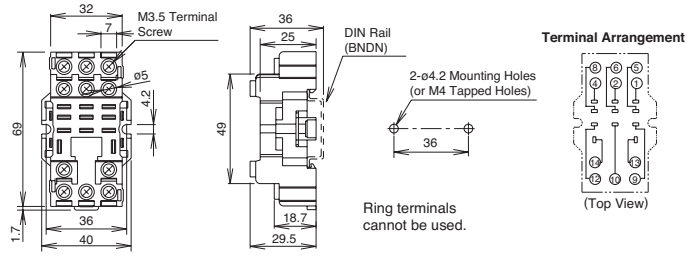
SH1B-05C



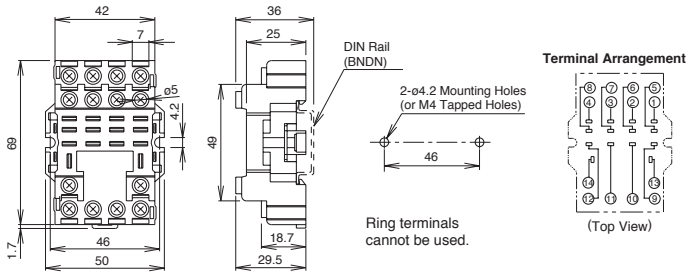
SH2B-05C



SH3B-05C

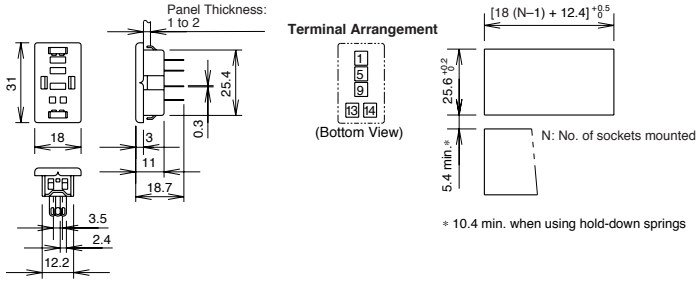


SH4B-05C

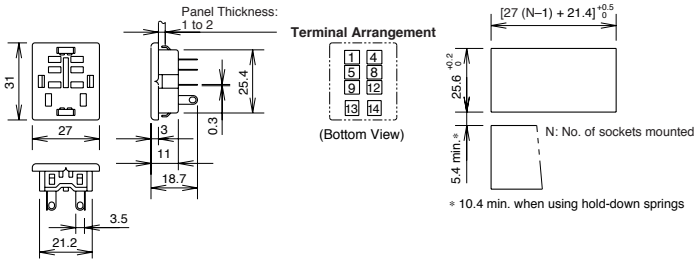


Through Panel Mount Socket

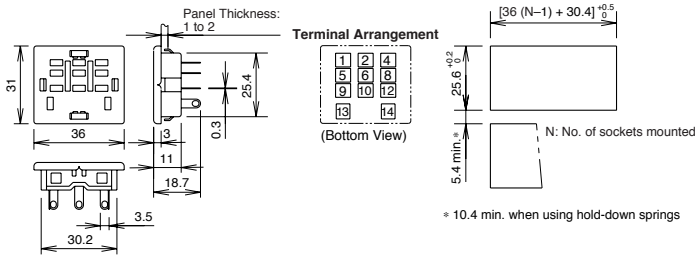
SH1B-51



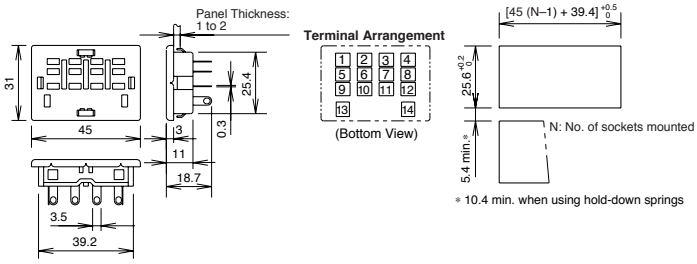
SH2B-51



SH3B-51



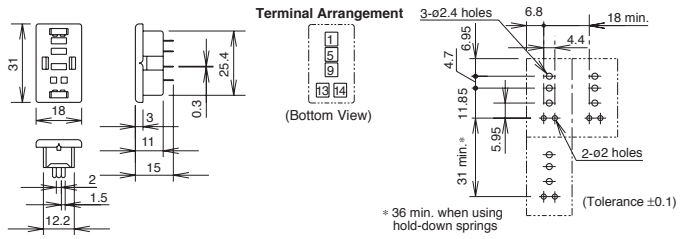
SH4B-51



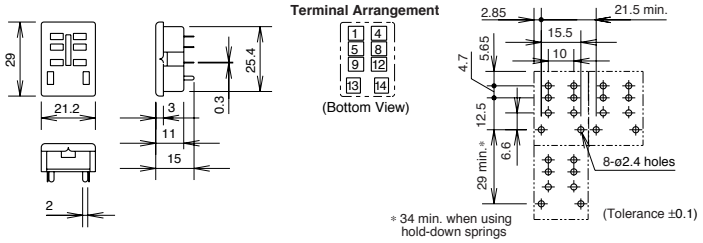
Dimensions con't (mm)

PCB Mount Sockets

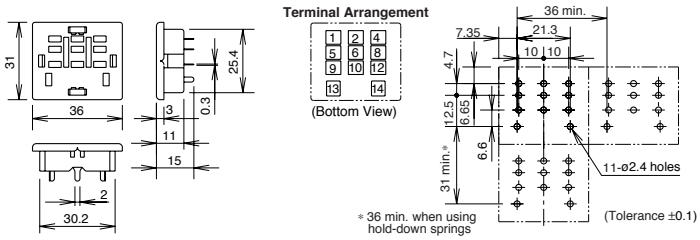
SH1B-62



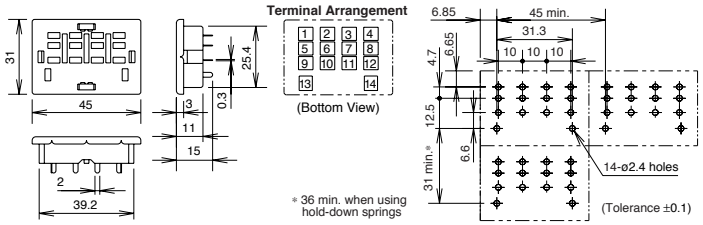
SH2B-62



SH3B-62



SH4B-62

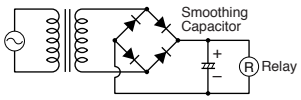


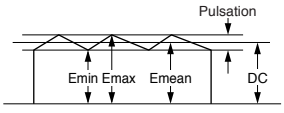
Operating Instructions

Driving Circuit for Relays

1. To ensure correct relay operation, apply rated voltage to the relay coil.

2. Input voltage for the DC coil:
   A complete DC voltage is best for the coil power to make sure of stable relay operation. When using a power supply containing a ripple voltage, suppress the ripple factor within 5%. When power is supplied through a rectification circuit, the relay operating characteristics, such as pickup voltage and dropout voltage, depend on the ripple factor. Connect a smoothing capacitor for better operating characteristics as shown below.



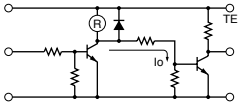


$$\text{Ripple Factor (\%)} \quad \frac{\text{Emax} - \text{Emin}}{\text{Emean}} \times 100\%$$

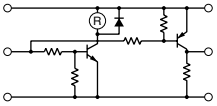
Emax = Maximum of pulsating current
Emin = Minimum of pulsating current
Emean = DC mean value

3. Leakage current while relay is off:
   When driving an element at the same time as the relay operation, special consideration is needed for the circuit design. As shown in the incorrect circuit below, leakage current (Io) flows through the relay coil while the relay is off. Leakage current causes coil release failure or adversely affects the vibration resistance and shock resistance. Design a circuit as shown in the correct example.

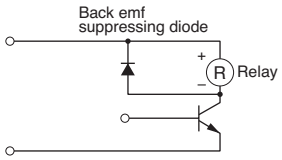
Incorrect



Correct



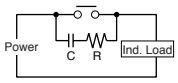
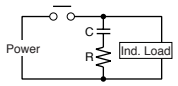
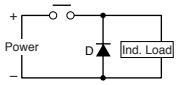
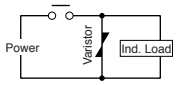
4. Surge suppression for transistor driving circuits:
   When the relay coil is turned off, a high-voltage pulse is generated, causing a transistor to deteriorate and sometimes to break. Be sure to connect a diode to suppress the back electromotive force. Then, the coil release time becomes slightly longer. To shorten the coil release time, connect a Zener diode between the collector and emitter of the transistor. Select a Zener diode with a Zener voltage slightly higher than the power voltage.



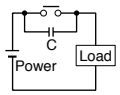
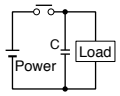
Protection for Relay Contacts

1. The contact ratings show maximum values. Make sure that these values are not exceeded. When an inrush current flows through the load, the contact may become welded. If this is the case, connect a contact protection circuit, such as a current limiting resistor.

2. Contact protection circuit:
   When switching an inductive load, arcing causes carbides to form on the contacts, resulting in increased contact resistance. In consideration of contact reliability, contact life, and noise suppression, use of a surge absorbing circuit is recommended. Note that the release time of the load becomes slightly longer. Check the operation using the actual load. Incorrect use of a contact protection circuit will adversely affect switching characteristics. Four typical examples of contact protection circuits are shown in the following table:

RC		This protection circuit can be used when the load impedance is smaller than the RC impedance in an AC load power circuit. • R: Resistor of approximately the same resistance value as the load • C:0.1 to 1 µF
		This protection circuit can be used for both AC and DC load power circuits. R: Resistor of approximately the same resistance value as the load C: 0.1 to 1 µF
Diode		This protection circuit can be used for DC load power circuits. Use a diode with the following ratings. Reverse withstand voltage: Power voltage of the load circuit x 10 Forward current: More than the load current
Varistor		This protection circuit can be used for both AC and DC load power circuits. For a best result, when using a power voltage of 24 to 48V AC/DC, connect a varistor across the load. When using a power voltage of 100 to 240V AC/DC, connect a varistor across the contacts.

3. Do not use a contact protection circuit as shown below:

	This protection circuit is very effective in arc suppression when opening the contacts. But, the capacitor is charged while the contacts are opened. When the contacts are closed, the capacitor is discharged through the contacts, increasing the possibility of contact welding.
	This protection circuit is very effective in arc suppression when opening the contacts. But, when the contacts are closed, a current flows to charge the capacitor, causing contact welding.

Generally, switching a DC inductive load is more difficult than switching a DC resistive load. Using an appropriate arc suppressor, however, will improve the switching characteristics of a DC inductive load.

Soldering

1. When soldering the relay terminals, use a soldering iron of 30 to 60W, and quickly complete soldering (within approximately 3 seconds).

2. Use a non-corrosive rosin flux.

Operating Instructions con't

Other Precautions

1. General notice:
   To maintain the initial characteristics, do not drop or shock the relay.

   The relay cover cannot be removed from the base during normal operation. To maintain the initial characteristics, do not remove the relay cover.

   Use the relay in environments free from condensation, dust, sulfur dioxide (SO_2), and hydrogen sulfide (H_2S).

   Make sure that the coil voltage does not exceed applicable coil voltage range.

2. UL and CSA ratings may differ from product rated values determined by IDEC.
3. Do not use relays in the vicinity of strong magnetic field, as this may affect relay operation.

Safety Precautions

- Turn off the power to the relay before starting installation, removal, wiring, maintenance, and inspection of the relays. Failure to turn power off may cause electrical shock or fire hazard.
- Observe specifications and rated values, otherwise electrical shock or fire hazard may be caused.
- Use wires of the proper size to meet voltage and current requirements. Tighten the terminal screws on the relay socket to the proper tightening torque.
- Surge absorbing elements on AC relays with RC or DC relays with diode are provided to absorb the back electromotive force generated by the coil. When the relay is subject to an excessive external surge voltage, the surge absorbing element may be damaged. Add another surge absorbing provision to the relay to prevent damage.

Precautions for the RU Relays

- Before operating the latching lever of the RU relay, turn off the power to the RU relay. After checking the circuit, return the latching lever to the original position.
- Do not use the latching lever as a switch. The durability of the latching lever is a minimum of 100 operations.
- When using DC loads on 4PDT relays, apply a positive voltage to terminals of neighboring poles and a negative voltage to the other terminals of neighboring poles to prevent the possibility of short circuits.
- DC relays with a diode have a polarity in the coil terminals. Apply the DC voltage to the correct terminals.

Non-Illuminated Pushbuttons (Assembled) con't

Part Numbers: Non-illuminated Pushbuttons

Style		Contacts	Momentary Action	Maintained Action
Flush		1NO 1NC 1NO-1NC 2NO 2NC	ABW110-① ABW101-① ABW111-① ABW120-① ABW102-①	AOW110-① AOW101-① AOW111-① AOW120-① AOW102-①
Extended		1NO 1NC 1NO-1NC 2NO 2NC	ABW210-① ABW201-① ABW211-① ABW220-① ABW202-①	AOW210-① AOW201-① AOW211-① AOW220-① AOW202-①
Recessed		1NO 1NC 1NO-1NC 2NO 2NC	ABFW110-① ABFW101-① ABFW111-① ABFW120-① ABFW102-①	AOFW110-① AOFW101-① AOFW111-① AOFW120-① AOFW102-①
Extended with Full Shroud		1NO 1NC 1NO-1NC 2NO 2NC	ABFW210-① ABFW201-① ABFW211-① ABFW220-① ABFW202-①	AOFW210-① AOFW201-① AOFW211-① AOFW220-① AOFW202-①
Ø 29mm Mushroom Head		1NO 1NC 1NO-1NC 2NO 2NC	ABW310-① ABW301-① ABW311-① ABW320-① ABW302-①	AOW310-① AOW301-① AOW311-① AOW320-① AOW302-①
Ø 40mm Mushroom Head		1NO 1NC 1NO-1NC 2NO 2NC	ABW410-① ABW401-① ABW411-① ABW420-① ABW402-①	AOW410-① AOW401-① AOW411-① AOW420-① AOW402-①
Ø 40mm Mushroom Head with Full Shroud		1NO 1NC 1NO-1NC 2NO 2NC	ABGW410-① ABGW401-① ABGW411-① ABGW420-① ABGW402-①	AOGW410-① AOGW401-① AOGW411-① AOGW420-① AOGW402-①
Square Flush		1NO 1NC 1NO-1NC 2NO 2NC	ABQW110-① ABQW101-① ABQW111-① ABQW120-① ABQW102-①	AOQW110-① AOQW101-① AOQW111-① AOQW120-① AOQW102-①
Square Extended		1NO 1NC 1NO-1NC 2NO 2NC	ABQW210-① ABQW201-① ABQW211-① ABQW220-① ABQW202-①	AOQW210-① AOQW201-① AOQW211-① AOQW220-① AOQW202-①
Keylock Push On/Off		1NO 1NC 1NO-1NC 2NO 2NC	AKW210 AKW201 AKW211 AKW220 AKW202	–

① Button Color Code

Color	Code
Black	B
Green	G
Red	R
Blue	S
White	W
Yellow	Y

1. *In place of ①, specify the Button Color Code from table.*
2. *For sub-assembled part numbers, see page A-125.*
3. *For accessories, see page A-150.*
4. *For dimensions, see page A-152.*
5. *Keyed switches are supplied with two keys. All units are keyed alike. For custom keys, contact IDEC.*

Non-Illuminated Selector Switches (Assembled) con't

Part Numbers: 2–Position Selector Switches

Style					Part Number	Part Number	Part Number
Contact	Mounting	Operator Position L	Operator Position R		Maintained L R	Spring Return from Right L R	Spring Return from Left L R
1NO	1 2	0 0	X 0	Knob Lever Key	ASW210 ASW2**L**10 ASW2**K**10	ASW2110 ASW21**L**10 ASW21**K**10	ASW2210 ASW22**L**10 ASW22**K**10
1NC	1 2	X 0	0 0	Knob Lever Key	ASW201-116 ASW2**L**01-116 ASW2**K**01-116	ASW2101-116 ASW21**L**01-116 ASW21**K**01-116	ASW2201-116 ASW22**L**01-116 ASW22**K**01-116
1NO 1NC	1 2	X 0	0 X	Knob Lever Key	ASW211 ASW2**L**11 ASW2**K**11	ASW2111 ASW21**L**11 ASW21**K**11	ASW2211 ASW22**L**11 ASW22**K**11
2NO	1 2	0 0	X X	Knob Lever Key	ASW220 ASW2**L**20 ASW2**K**20	ASW2120 ASW21**L**20 ASW21**K**20	ASW2220 ASW22**L**20 ASW22**K**20
2NC	1 2	X X	0 0	Knob Lever Key	ASW202-104 ASW2**L**02-104 ASW2**K**02-104	ASW2102-104 ASW21**L**02-104 ASW21**K**02-104	ASW2202-104 ASW22**L**02-104 ASW22**K**02-104
2NO 2NC	1 2 3 4	0 X 0 X	X 0 X 0	Knob Lever Key	ASW222 ASW2**L**22 ASW2**K**22	ASW2122 ASW21**L**22 ASW21**K**22	ASW2222 ASW22**L**22 ASW22**K**22
2NO 2NC	1 2 3 4	0 0 X X	X X 0 0	Knob Lever Key	ASW222-111 ASW2**L**22-111 ASW2**K**22-111	ASW2122-111 ASW21**L**22-111 ASW21**K**22-111	ASW2222-111 ASW22**L**22-111 ASW22**K**22-111

Part Numbers: 3–Position Selector Switches

Style						Part Number	Part Number	Part Number	Part Number
Contact	Mounting	Operator Position L	Operator Position C	Operator Position R		Maintained C L R	Spring Return from Right C L R	Spring Return from Left C L R	Spring Return Two-Way C L R
2NO	1 2	X 0	0 0	0 X	Knob Lever Key	ASW320 ASW3**L**20 ASW3**K**20	ASW3120 ASW31**L**20 ASW31**K**20	ASW3220 ASW32**L**20 ASW32**K**20	ASW3320 ASW33**L**20 ASW33**K**20
2NC	1 2	0 X	X X	X 0	Knob Lever Key	ASW302 ASW3**L**02 ASW3**K**02	ASW3102 ASW31**L**02 ASW31**K**02	ASW3202 ASW32**L**02 ASW32**K**02	ASW3302 ASW33**L**02 ASW33**K**02
2NO 2NC	1 2 3 4	X 0 0 X	0 0 X X	0 X X 0	Knob Lever Key	ASW322 ASW3**L**22 ASW3**K**22	ASW3122 ASW31**L**22 ASW31**K**22	ASW3222 ASW32**L**22 ASW32**K**22	ASW3322 ASW33**L**22 ASW33**K**22
2NO 2NC	1 2 3 4	X X 0 0	0 X X 0	X 0 0 X	Knob Lever Key	ASW322-309 ASW3**L**22-309 ASW3**K**22-309	ASW3122-309 ASW31**L**22-309 ASW31**K**22-309	ASW3222-309 ASW32**L**22-309 ASW32**K**22-309	ASW3322-309 ASW33**L**22-309 ASW33**K**22-309
2NO 2NC	1 2 3 4	0 0 0 0	X 0 X 0	0 X 0 X	Knob Lever Key	ASW322-310 ASW3**L**22-310 ASW3**K**22-310	ASW3122-310 ASW31**L**22-310 ASW31**K**22-310	ASW3222-310 ASW32**L**22-310 ASW32**K**22-310	ASW3322-310 ASW33**L**22-310 ASW33**K**22-310
4NO	1 2 3 4	X 0 X 0	0 0 0 0	0 X 0 X	Knob Lever Key	ASW340 ASW3**L**40 ASW3**K**40	ASW3140 ASW31**L**40 ASW31**K**40	ASW3240 ASW32**L**40 ASW32**K**40	ASW3340 ASW33**L**40 ASW33**K**40
4NC	1 2 3 4	0 X 0 X	X X X X	X 0 X 0	Knob Lever Key	ASW304 ASW3**L**04 ASW3**K**04	ASW3104 ASW31**L**04 ASW31**K**04	ASW3204 ASW32**L**04 ASW32**K**04	ASW3304 ASW33**L**04 ASW33**K**04

1. *The truth table indicates the operating position of contact block when the operator is switched to that position.*
   X = On (closed contacts)
   O = Off (open contacts)
   ~~X—X~~ = Overlapping Contacts: Remain on (closed contacts) when switch is moved between these two positions.
2. *All knob and lever selector switches come in black. Other colors are available by ordering the knob or lever separately.*
3. *Every key selector switch uses an identical key. The key is removable in any maintained position. If a different configuration is required, contact an IDEC representative for more information.*
4. *Custom contact configurations are available, see page A-144 or contact IDEC for details.*

Non-Illuminated Selector Switches (Sub-Assembled)

Contact Blocks	+	Operator	+	Knob or Lever *	+	Color Insert *	=	Complete Part †

1. * Not needed with key type switches.
2. † Knob type shown.

Part Numbers: Operators

Style	Positions	Description	Part Number
Knob/Lever	2	Maintained	ASW200
		Spring return from right	ASW2100
		Spring return from left	ASW2200
	3	Maintained, Cam 1 Maintained, Cam 2 Maintained, Cam 3	ASW300-1 ASW300-2 ASW300-3
		Spring return from right, Cam 1 Spring return from right, Cam 2	ASW3100-1 ASW3100-2
		Spring return from left, Cam 1 Spring return from left, Cam 2	ASW3200-1 ASW3200-2
		Spring return from left/right, Cam 1 Spring return from left/right, Cam 2	ASW3300-1 ASW3300-2
	4	Maintained, Standard Cam Maintained, Cam 1	ASW400 ASW400-1
	5	Maintained, Standard cam Maintained, Cam 1	ASW500 ASW500-1
Key	2	Maintained	ASW2K00
		Spring return from right	ASW21K00
		Spring return from left	ASW22K00
	3	Maintained, Cam 1 Maintained, Cam 2 Maintained, Cam 3	ASW3K00-1 ASW3K00-2 ASW3K00-3
		Spring return from right, Cam 1 Spring return from right, Cam 2	ASW31K00-1 ASW31K00-2
		Spring return from left, Cam 1 Spring return from left, Cam 2	ASW32K00-1 ASW32K00-2
		Spring return from left/right, Cam 1 Spring return from left/right, Cam 2	ASW33K00-1 ASW33K00-2

1. *Two keys are supplied with every switch, all are keyed alike, and removable from any maintained position. For other configurations, consult your IDEC representative.*
2. *Locking rings are included with all operators. Order knobs, levers, and color inserts separately.*
3. *Different cams produce different contact actions. For details, see contact arrangement charts, page A-144.*

① Handle/Insert Color Code

Color	Code
Black*	B
Blue	S
Green	G
Red	R
Yellow	Y
White†	W

* Color inserts not available in black.
† Knob and lever not available in white.

Part Numbers: Handles and Inserts

Style	Part Number
Knob	ASWHHY-①
Lever	ASWHHL-①
Color Insert	TW-HC1-①

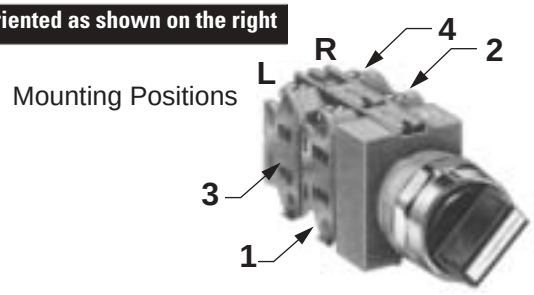
Part Numbers: Contact Blocks

Style	Part Number	
	1NO	1NC
Standard	HW-C10 HW-C10R (early make)	HW-C01 HW-C01R (late break)
Fingersafe (IP20)	HW-F10 HW-F10R (early make)	HW-F01 HW-F01R (late break)
Dummy Block	TW-DB	

1. *Push rod color code:Green = NO contact block Red = NC contact block.*
2. *Dummy blocks (no contacts) are used with an odd number of contact blocks.*

How to Read Contact Arrangement Charts

To determine contact block mounting position, first make sure the selector switch is oriented as shown on the right



Contact Arrangement
Type and quantity of switch contacts

Circuit Number
* N/D = No designation required

Contact Block Mounting Position
Position or mounting contact blocks on operator

Operator Position
Truth table indicates the operating position of contact block when operator is switched to that position.

Contact Block Part Number
Part number to use when ordering sub-assembly contact blocks, as required for use with corresponding mounting position

Contact Arrangement Chart: 2-Position Selector Switches

Style		Mounting Position	Operator Position		Contact Block Part Number	Description	Operator Part Number		
Contact	Circuit Number		L	R			Maintained	Spring Ret. from Rt.	Spring Ret. from Lt.
			L↖	R↗			L∨R	L∧R	L∨R
1NO	N/D	1	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	0	TW-DB				
1NC	116	1	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	0	TW-DB				
1NO 1NC	N/D	1	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	0	HW-C01				
	103	1	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	X	HW-C10				
1NO-EM 1NC-LB	600	1	0	X	HW-C10R	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	0	HW-C01R				
	601	1	X	0	HW-C01R	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	X	HW-C10R				
2NO	N/D	1	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	X	HW-C10				
2NC	104	1	X	0	HW-C01	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	0	HW-C01				
2NO 2NC	N/D	1	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	X	0	HW-C01				
		3	0	X	HW-C10				
		4	X	0	HW-C01				
	111	1	0	X	HW-C10	Knob/Lever Key Illuminated Knob	ASW200 ASW2K00 ASLW200	ASW2100 ASW21K00 ASLW2100	ASW2200 ASW22K00 ASLW2200
		2	0	X	HW-C10				
		3	X	0	HW-C01				
		4	X	0	HW-C01				

1. NO-EM, NC-LB = Early Make, Late Break.
N/D = No circuit number designation required in assembled selector switch part number.
2. X = On (closed contacts) O = Off (Open contacts)

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Installation Information

Model — JD-2

Model - JD-2

Air Flow Interlocking Safety Switches

Specifications

Ranges

BLUE .07" to 1.7" W.C.
(2 mm to 43 mm W.C.)

GREY 0.1" to 4" W.C.
(3 mm to 102 mm W.C.)

PURPLE 0.1" to 10" W.C.
(3 mm to 250 mm W.C.)

RED 0.1" to 24" W.C.
(3 mm to 600 mm W.C.)

ORANGE 5" to 35" W.C.
(125 mm to 875 mm W.C.)

Maximum Operating Pressure: 35" Water Column

Maximum Pressure Surge: 3 PSIG

Maximum Ambient Operating Temperature:
+140° F (+60° C)

Minimum Ambient Operating Temperature:
-20°F (-93° C)

Please read this instruction sheet carefully to assure correct installation. This equipment must be installed only by a licensed electrician who is experienced with combustion safeguard control systems and understands the functions of an interlocking switch such as gas pressure switches. Prior to being put into operation in conjunction with the combustion safeguard systems, all switches should be tested for proper range setting and proper wiring. Check piping connections and switch housing for leaks with a soap bubble test. All exhaust fans and blowers should be inspected and checked for proper rotation prior to starting up. If you have any problems or questions, phone, fax, email or write to the manufacturer, Antunes Controls.

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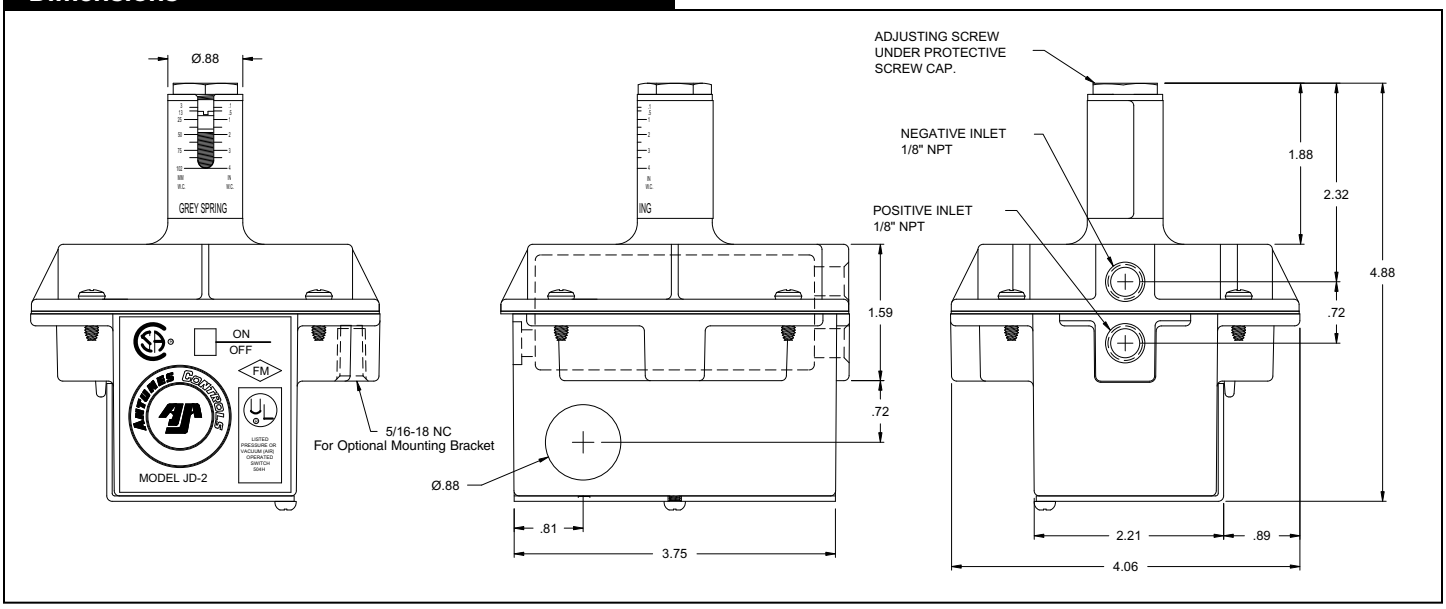
MODEL - JD-2

Dimensions



Installation

You are installing one of the finest switches of its type on the market. Design of this switch is based on the same principles of sensitivity, accuracy and dependability that have made Antunes Controls Air Flow Switches so successful. These switches are fully approved. They are UL listed and recognized for the U.S. and Canada, and approved by Factory Mutual (FM).

The switch is adjustable within its range, as shown on the range scale located on top of the unit.

The Model JD-2 is sturdy, compact and cost effective. All components are well made. The switch is neat in appearance with a die cast aluminum electrical housing. In every way you will be pleased with the ease of installation and the reliability of your Antunes Controls JD-2 Switch.

Electrical

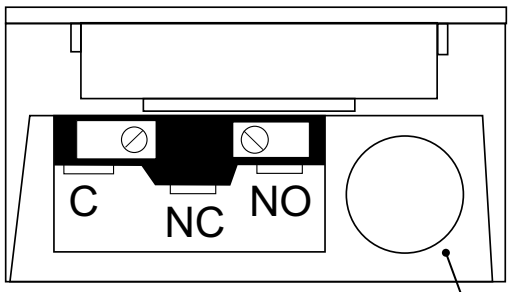
Ratings – All Models

10A, 1/8 HP, 125 VAC

5A, 1/4 HP, 250 VAC

Pilot Duty – 125 VA, 125 – 250 VAC

Field wiring by others must be rated at 90°C for industrial use.



Hole for 7/8" Conduit Connection

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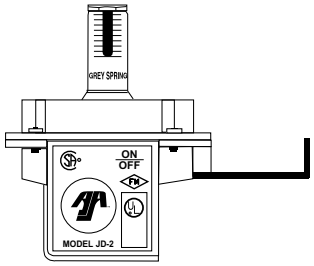
MODEL - JD-2

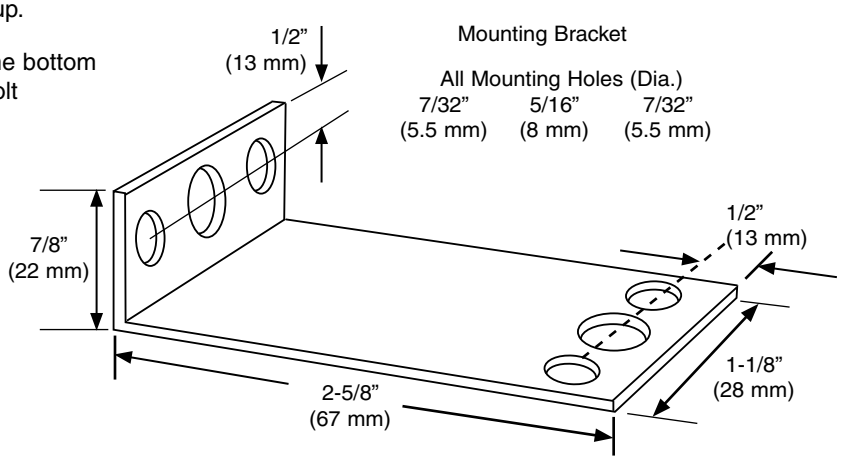
Mounting

The Model JD-2 is always mounted with the stem up.

An optional mounting bracket can be fastened to the bottom section of the switch housing with 5/16-18 x 1/2" bolt (supplied with bracket).



Mounting Bracket

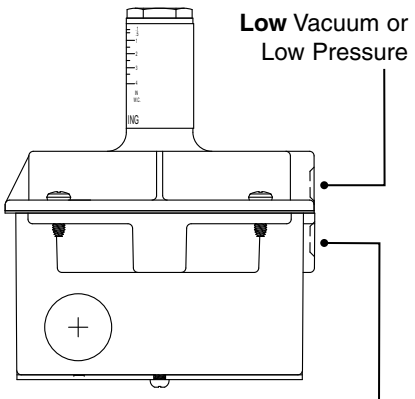


Air Connections

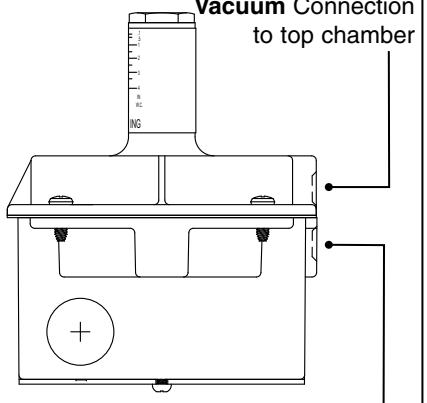
Tubing: Recommended as minimum: 1/4" copper or aluminum tubing or 1/8" pipe. All tubing and pipe must be clean and free from oil, dirt, and chips. If piping run is over five feet long, use larger size tubing or pipe, and reduce size at switch connection.

Air Supply: The switch is equipped with two 1/8" NPT connection ports. **Connect air supply as shown below.** When used for vacuum or pressure applications, Model JD-2 must always be vented as shown. No venting is required for differential application.

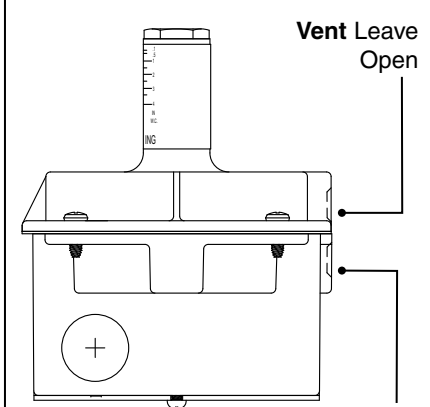
Differential



Vacuum Only



Pressure Only



Terminal Connections

Indicator Position	Terminal	Indicator Position	Terminal
Off	C and NO open C and NC closed	ON	C and NO closed C and NC open

Limitation of Liability

It is understood and agreed that seller's liability whether in contract, in tort, under any warranty, in negligence or otherwise shall not exceed the return of the amount of the purchase price paid by purchaser and under no circumstances shall seller be liable for special, indirect or consequential damages. The price stated for the equipment is a consideration in limiting seller's liability. No action, regardless of form, arising out of the transactions may be brought by purchaser more than one year after the cause of action has accrued.

Warranty

1. Antunes Controls products are guaranteed to be free from mechanical and electrical defects for a period of one year from date of shipment under normal use and service provided installation is made in accordance with manufacturers' recommendations.
2. Parts deemed defective shall be repaired or replaced at manufacturers option and at manufacturers expense but shall not include foreign or federal excise taxes, state or municipal sale or use taxes, all such taxes not limited to the foregoing being responsibility of the purchaser.
3. No charge for travel and/or mileage will be allowed to purchaser.
4. Antunes Controls reserves the right to make changes in design or make any improvements on any products. The right is always reserved to modify our equipment because of new technology, underwriter's requirements and/or government regulations.
5. The following are not covered under warranty:
   a. Failure from neglect, abuse, careless handling and mis-application of unit.
   b. Failure to observe guidelines for installation or improper voltage hook-up.
   c. Failure caused by improper maintenance. (See maintenance guidelines found in operation instructions.)
   d. Unless specifically allowed by Antunes Controls, no other charges may be included under warranty.

Antunes Controls
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www.ajantunes.com

Lubrication Instructions For Ball Bearing Motors

Lubrication
This motor is supplied with pre-lubrication ball bearings. No lubrication required before start up.

Relubrication Intervals
The following intervals are suggested as a guide:

SUGGESTED RELUBRICATION INTERVALS		
HOURS OF SERVICE PER YEAR	H.P. RANGE	RELUBE INTERVAL
5,000	Sub Fractional to 7 1/2 10 to 40 50-200	5 Years 3 Years 1 Year
Continuous Normal Applications	Sub Fractional to 7 1/2 10 to 40 50 to 200	2 Years 1 Year 9 Months
Season Service Motor Idle 6 Months or More	All	1 Year (Beginning of Season)
Continuous High Ambients Dirty or Moist Locations High Vibrations Where Shaft End is Hot (Pumps-Fans)	Sub Fractional to 40 50 to 200	6 Months 3 Months

Lubrication

Use high quality ball bearing lubricant. Use consistency of lubricant suitable for class of insulation stamped on nameplate as follows:

LUBRICATION CONSISTENCY				
INSULATION CLASS	CONSISTENCY	TYPE	TYPICAL LUBRICATION	FRAME TYPE
B & F F & H	Medium	Polyurea	Shell Dolium R and/or Chevron SR1 2	Sub Fractional to 447T All

Procedure

If motor is equipped with Alemite fitting, clean tip of fitting and apply grease gun. Use 1 to 2 full strokes on motors in NEMA 215T frame and smaller. Use 2 to 3 strokes on NEMA 254T thru NEMA 365 T frame. Use 3 to 4 strokes on NEMA 404T frames and larger. On motors having drain plugs, remove drain plug and operate motor for 20 minutes before replacing drain plug.

On motors equipped with slotted head grease screw, remove screw and apply grease tube to hole. Insert 2 to 3 inch length of grease string into each hole on motors in NEMA 215T frame and smaller. Insert 3 to 5 inch length on larger motors. For motors having drain plug and operate motor for 20 minutes before replacing drain plug.

CAUTION: Keep lubricant clean. Lubricate motors at standstill. remove and replace drain plugs at standstill. Do not mix petroleum lubricant and silicone lubricant in motor bearings.

LEESON®

ELECTRIC MOTORS, GEARMOTORS AND DRIVES

LEESON ELECTRIC
GRAFTON, WISCONSIN 53024-0241 U.S.A.
TEL (262)377-8810 FAX (262)377-9025 www.leeson.com

A Subsidiary of Regal-Beloit Corporation

Installation Maintenance Instructions
AC Induction Motors

Installation

After unpacking, check for damage. Be sure that shaft rotates freely. Before making electrical power connections, check for proper grounding of motor and application. All electrical contacts and connections must be properly insulated and enclosed. Couplings, belts, chains or other mounted devices must be in proper alignment, balance and secure to insure safe motor operation.

Electrical Wiring

Prior to connecting to the power line, check nameplate for proper voltage and rotation connection. This motor should be installed in compliance with the National Electrical Code and any other applicable codes. Voltage at motor not to exceed + or -10% of nameplate. Authorized person should make all electrical connections.

Mounting

This motor should be securely mounted to the application. Sufficient ventilation area should be provided to insure proper operation.

RECOMMENDED COPPER WIRE & TRANSFORMER SIZE

SINGLE PHASE MOTORS - 230 VOLTS

H.P.	TRANSFORMER KVA	DISTANCE - MOTOR TO TRANSF. IN FT.				
		100	150	200	300	500
1 1/2	3	10	8	8	6	4
2	3	10	8	8	6	4
3	5	8	8	6	4	2
5	7 1/2	6	4	4	2	0
7 1/2	10	6	4	3	1	0

THREE PHASE MOTORS - 230 & 460 VOLTS

H.P.	VOLTS	TRANSFORMER KVA	DISTANCE - MOTOR TO TRANSF. IN FT.				
			100	150	200	300	500
1 1/2	230	3	12	12	12	12	10
1 1/2	460	3	12	12	12	12	12
2	230	3	12	12	12	10	8
2	460	3	12	12	12	12	12
3	230	5	12	10	10	8	6
3	460	5	12	12	12	12	10
5	230	7	10	8	8	6	4
5	460	1/2	12	12	12	10	8
7 1/2	230	7 1/2	8	6	6	4	2
7 1/2	460	10	12	12	12	10	8
10	230	10	6	4	4	4	1
10	460	15	12	12	12	10	8
15	230	15	4	4	4	2	0
15	460	20	12	10	10	8	6
20	230	20	4	2	2	1	000
20	460		10	8	8	6	4
25	230		2	2	2	0	000
25	460	Consult	8	8	6	6	4
30	230	Local	2	1	1	00	0000
30	460	Power	8	6	6	4	2
40	230	Company	1	0	00	0000	300
40	460		6	6	4	2	0
50	230		1	0	00	0000	300
50	460		4	4	2	2	0
60	230		1	00	000	250	500
60	460		4	2	2	0	00
75	230		0	000	0000	300	500
75	460		4	2	0	00	000

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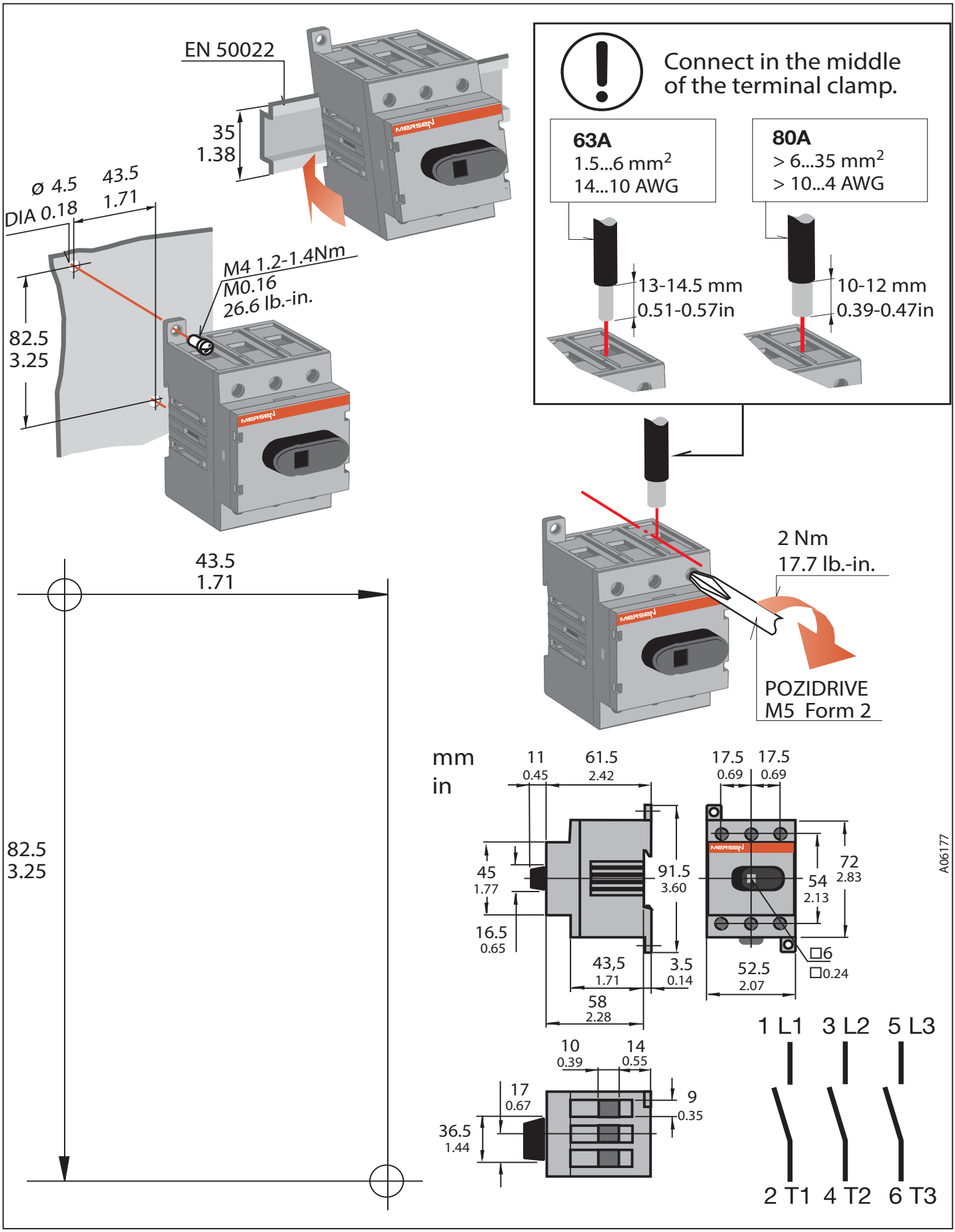
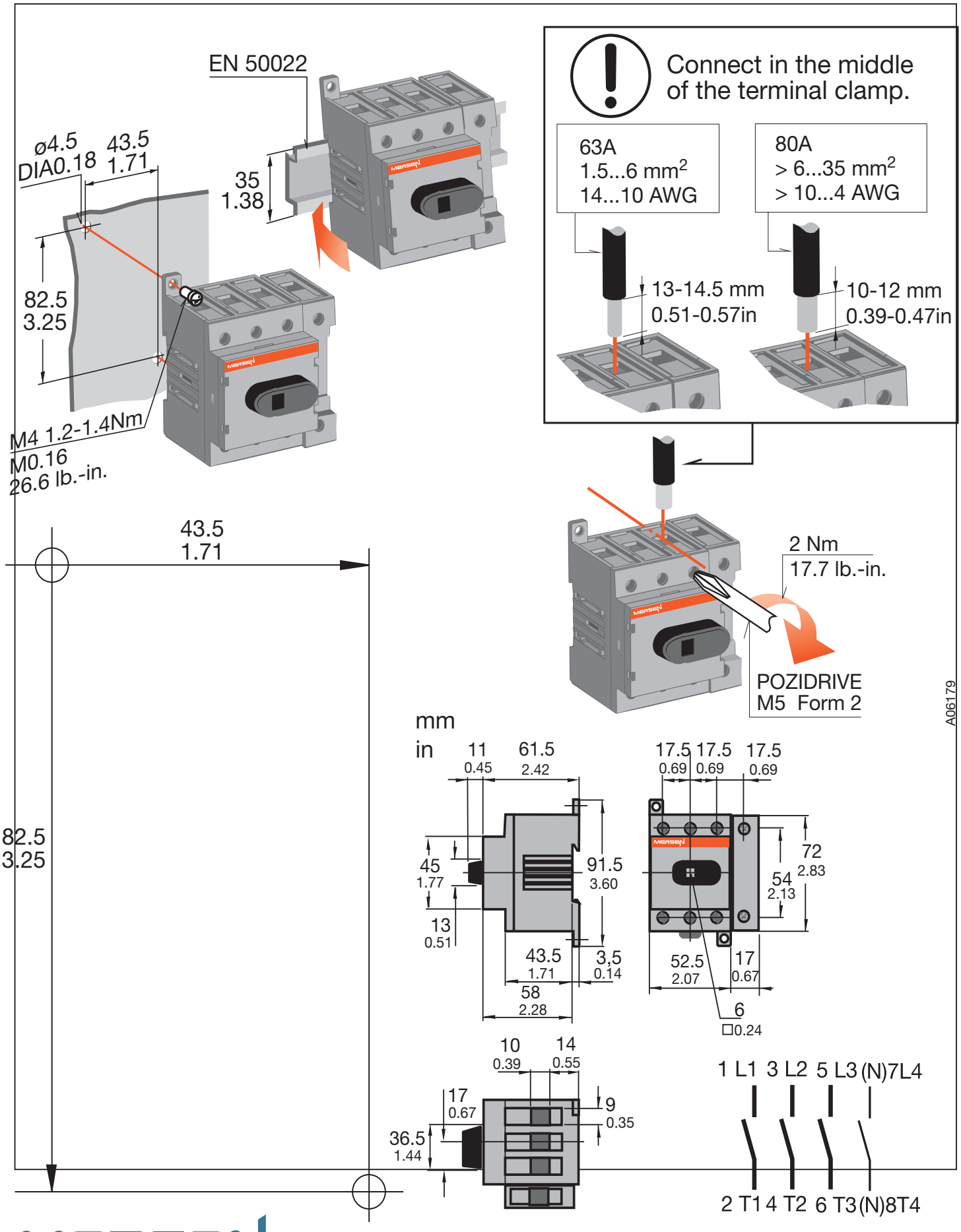
M633, M803 Non-Fused

Document no. 34M63-80NF-A



M633, M803 Non-Fused



MERSEN

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Edison Power Distribution Blocks

Short-Circuit Current Rated Power Distribution Blocks

We offer distinctly different styles of short-circuit current rated Power Distribution Blocks and Terminal Blocks to match different application needs. The different features are:

1) Enclosed style or Open style
2) UL1953 Listed power distribution blocks or UL1059 Recognized terminal blocks, that have different minimum spacing requirements.

The table below can assist in the selection of the correct series for your application requirements.

Why are these important?

Assembly short-circuit current ratings (SCCRs) are now required in the 2005 NEC® and UL508A Listed industrial control panels.

Marking the SCCR on:

Industrial Control Panels (NEC® 409.110)
Industrial Machinery Electrical Panels (NEC® 670.3(A))
HVAC equipment (NEC® 440.4(B)

The above sections are now required by the National Electrical Code. Power Distribution Blocks or Terminal Blocks not marked with an SCCR are typically one of the weakest links and may limit an assembly to no more than 10 kA SCCR per Table SB4.1 UL508A. The EPDB series and HPB series Power Distribution Blocks have increased spacing required where used in feeder circuits in equipment listed to UL508A. The PB series UL1059 Terminal Blocks must be evaluated for proper spacing. Also, for building wiring systems, the EPDB series and HPB series power distribution blocks can be used to meet the 2005 NEC® requirements in section 376.56(B) for power distribution blocks in wireways.

Edison Power Distribution Blocks Selection Guide*

Series	UL	† Enclosed	High SCCR**	Spacing*** 1" Air 2" Surface	Industrial Control Panels UL 508A Branch Circuit	Industrial Control Panels UL 508A Feeder Circuit	HVAC UL 1995	Wireways NEC® 376.56(B) (Requires UL 1953)
EPDB	UL 1953 Listed Power Distribution Blocks	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HPB	UL 1953 Listed Power Distribution Blocks	No****	Yes	Yes	Yes	Yes	Yes	Yes (with optional cover)
PB	UL 1059 Recognized Terminal Blocks	No****	Yes	No*****	Yes	No*****	Yes	No

† IP-20 finger-safe under specific conditions.

**Refer to specific UL standards and NEC sections for a complete application guide.*

***When protected by proper fuse class with maximum ampere rating specified or smaller. This does not apply to PB40, PB51 and PB71 series.*

****See Minimum Space Requirements for Equipment table below.*

*****Optional covers are available. They are not IP-20 rated, but do provide additional protection against direct contact with Live Parts.*

******Exception: Yes, if single pole units installed with proper spacings.*

Minimum Space Requirements for Equipment

UL Standard	Spacing Between Live Parts of Opposite Polarity		Spacing Between Live Parts and Grounded Parts or Enclosures, Through Air and Over Surface @ 600V
	Through Air @ 600V	Over Surface @ 600V	
508A Feeder Circuits, Table 10.2	1"	2"	1"
508A Branch Circuits, Table 10.1	3/8"	1/2"	1/2"
UL 1995 HVAC	3/8"	1/2"	1/2"

Note: Refer to specific UL standards for complete spacing details.

PB Series Edison Open-Style Terminal Blocks

Open-style terminal blocks for cable termination

Edison Open-style terminal blocks are a convenient way to manage your power distribution needs. They are engineered to maintain an SCCR rating of 200kA with copper conductors and an SCCR of 10 kA for aluminum conductors, making these distribution blocks the ideal solution to today's power circuit wiring needs.

Features

- Used in UL508A panels for branch circuit applications
- Standard aluminum box connectors accommodate copper wire. PB401x, PB512x and PB712x series accommodate copper or aluminum wire.
- Tin-plated aluminum connectors suitable for copper conductors
- Available safety covers for greater protection (purchase separately)
- Suitable for both factory and field wiring

Ratings

- Ampere ratings up to 760 Amps
- 600 VAC or VDC
- Short Circuit Current Rating (SCCR) 200kA with proper fusing
- Flammability: UL 94V0

Agency Approvals

- UL 1059 recognized - File E221592 Guide XCFR2
- CSA Certified: Class 6228-01, File 700489
- CE

Open Type Power Distribution Blocks Selection Table

Series	Part Number	Amps	Description	SCCR Rtg	Pcs/Pkg	Wt.	Price
PB Series	PB1011	175 max	1 pole distribution block, 1 in/1 out	200 kA	1	2.8 oz.	<--->
	PB1012	175 max	2 pole distribution block, 1 in/1 out	200 kA	1	4.6 oz.	<--->
	PB1013	175 max	3 pole distribution block, 1 in/1 out	200 kA	1	6.8 oz.	<--->
	PB1041	175 max	1 pole distribution block, 1 in/4 out	200 kA	1	3.1 oz.	<--->
	PB1042	175 max	2 pole distribution block, 1 in/4 out	200 kA	1	5.2 oz.	<--->
	PB1043	175 max	3 pole distribution block, 1 in/4 out	200 kA	1	7.3 oz.	<--->
	PB3061	310 max	1 pole distribution block, 1 in/6 out	200 kA	1	10.9 oz.	<--->
	PB3062	310 max	2 pole distribution block, 1 in/6 out	200 kA	1	19.1 oz.	<--->
	PB3063	310 max	3 pole distribution block, 1 in/6 out	200 kA	1	25.5 oz.	<--->
	PB3121	310 max	1 pole distribution block, 1 in/12 out	200 kA	1	12.7 oz.	<--->
	PB3122	310 max	2 pole distribution block, 1 in/12 out	200 kA	1	21.6 oz.	<--->
	PB3123	310 max	3 pole distribution block, 1 in/12 out	200 kA	1	31.1 oz.	<--->
	PB4011	380 max	1 pole distribution block, 1 in/stud	10 kA	1	11.9 oz.	<--->
	PB4012	380 max	2 pole distribution block, 1 in/stud	10 kA	1	20.7 oz.	<--->
	PB4013	380 max	3 pole distribution block, 1 in/stud	10 kA	1	29.1 oz.	<--->
	PB5121	570 max	1 pole distribution block, 2 in/12 out	10 kA	1	13.8 oz.	<--->
	PB5122	570 max	2 pole distribution block, 2 in/12 out	10 kA	1	24.4 oz.	<--->
	PB5123	570 max	3 pole distribution block, 2 in/12 out	10 kA	1	34.7 oz.	<--->
	PB7121	760 max	1 pole distribution block, 2 in/12 out	10 kA	1	17.0 oz	<--->
	PB7123	760 max	3 pole distribution block, 2 in/12 out	10 kA	1	44.0 oz.	<--->

Safety Covers for Open Power Distribution Blocks Selection Table

Part Number	Description	Pcs/Pkg	Wt.	Price
PBC21	Power distribution block cover for all 175A open style 1-pole blocks	1	0.3 oz.	<--->
PBC22	Power distribution block cover for all 175A open style 2-pole blocks	1	0.4 oz.	<--->
PBC23	Power distribution block cover for all 175A open style 3-pole blocks	1	0.5 oz.	<--->
PBC31	Power distribution block cover for all 310A, 380A, and 570A open style 1-pole blocks	1	0.9 oz.	<--->
PBC32	Power distribution block cover for all 310A, 380A, and 570A open style 2-pole blocks	1	1.3 oz.	<--->
PBC33	Power distribution block cover for all 310A, 380A, and 570A open style 3-pole blocks	1	1.6 oz.	<--->
PBC71	Power distribution block cover for all 760A open style 1-pole and 3-pole blocks. 1 pole block requires 1 cover. 3-pole block requires 3 covers	1	0.9 oz.	<--->

Open Style Power Distribution Block General Specifications

Wire type	75°C* Copper
Voltage	600 VAC or VDC maximum
Mounting	Surface mount

**Note: Amp Rating based on NEC table 310.16 for 75°C copper wire.*

PB Series Edison Open-Style Terminal Blocks Specifications

UL Series Wire and Torque Range Specifications								
Part Number	Line				Load			
	CU Wire Range	Torque Lb-in (Nm)	Trim Length in (mm)	Hex Key	CU Wire Range	Torque Lb-in (Nm)	Trim Length in (mm)	Hex Key, Slot, Stud
PB1011	2/0 to 8 AWG, 70 to 10 mm^2	110 [12.4]	0.70 [17.8]	3/16"	2/0 to 8 AWG , 70 to 10 mm^2	110 [12.4]	0.70 [17.8]	3/16" Hex
PB1012								
PB1013								
PB1041	2/0 to 8 AWG, 70 to 10 mm^2	120 [13.6]	0.670 [17.0]	3/16"	4 to 6 AWG, 25 to 16 mm^2	35 (4.0)	0.470 [11.9] top row, 0.780 [19.8] bottom row	Slot
PB1042					8 AWG, 10 mm^2	25 (2.8)		
PB1043					10 to 14 AWG, 6 to 2.5 mm^2	20 (2.3)		
PB3061	350 kcmil to 4 AWG,185 to 25 mm^2	275 [31.1]	0.90 [22.9]	5/16"	4 to 6 AWG, 25 to 16 mm^2	35 (4.0)	1.00 [25.4] top row 0.45 [11.43] bottom row	Slot
PB3062					8 AWG, 10 mm^2	25 (2.8)		
PB3063					10 to 12 AWG, 6 to 4 mm^2	20 (2.3)		
PB3121	350 kcmil to 4 AWG 185 to 25 mm^2	275 [31.1]	0.90 [22.9]	5/16"	4 to 6 AWG, 25 to 16 mm^2	35 (4.0)	0.450 [11.4] top row, 0.630 [16.0] middle row, 0.920 [23.4] bottom row	Slot
PB3122					8 AWG, 10 mm^2	25 (2.8)		
PB3123					10 to 14 AWG, 6 to 2.5 mm^2	20 (2.3)		

Short-Circuit Current Rating Data												
			Line	Load	Configuration	Conductors		Maximum Fuse Class and Amp**				
Part Number	Number of Poles	Capacity*	Wire Range	Wire Range	Openings per Pole	Line AWG or kcmil	Load AWG or kcmil	Class J (JDL)	Class T (A3T/ A6T)	Class RK1 (LENRK/ LESRK)	Class RK5 (ECNR/ ECSR)	SCCR
PB1011	1	175A	2/0 to 8 AWG 70 to 10 mm^2	2/0 to 8 AWG 70 to 10 mm^2	1/1	2/0 to 8	2/0 to 8	200	200	200	60	200 kA
PB1012	2											
PB1013	3											
PB1041	1	175A	2/0 to 8 AWG 70 to 10 mm^2	4 to 14 AWG 25 to 2.5 mm^2	1/4	2/0 to 8	4 to 12	200	200	200	60	200 kA
PB1042	2						4 to 14	175	175	100	60	100 kA
PB1043	3							200	200	100	60	50 kA
PB3061	1	310A	350 kcmil to 4 AWG 185 to 25 mm^2	4 to 12 AWG 25 to 4 mm^2	1/6	350 to 4	4 to 8	400	400	200	100	200 kA
PB3062	2							400	400	400	100	100 kA
PB3063	3						4 to 12	175	175	100	60	100 kA
PB3121	1	310A	350 kcmil to 4 AWG 185 to 25 mm^2	4 to 14 AWG 25 to 2.5 mm^2	1/12	350 to 4	4 to 8	400	400	200	100	200 kA
PB3122	2						4 to 14	175	175	100	60	100 kA
PB3123	3							175	175	100	60	100 kA
PB4011	1	380A	500 kcmil to 6 AWG 240 to 16 mm^2	One 3/8" - 16 x 1 stud	One 3/8" - 16 x 1 stud	500	One 3/8" - 16 x 1 stud	***	***	***	***	10 kA
PB4012	2					500 to 6		***	***	***	***	
PB4013	3							***	***	***	***	
PB5121	1	570A	300 kcmil to 4 AWG 150 to 25 mm^2	4 AWG to 14 AWG 25 to 2.5 mm^2	2/12	300	4 to 14	***	***	***	***	10 kA
PB5122	2							***	***	***	***	
PB5123	3					300 to 4	4 to 14	***	***	***	***	
PB7121	1	760A	500 kcmil to 6 AWG 240 to 16 mm^2	4 AWG to 14 AWG 25 to 2.5 mm^2	2/12	500 to 6	4 to 14	***	***	***	***	10 kA
PB7123	3							***	***	***	***	

*Amp ratings are based on NEC® Table 310.16 for 75°C copper wire and UL508A Table 28.1

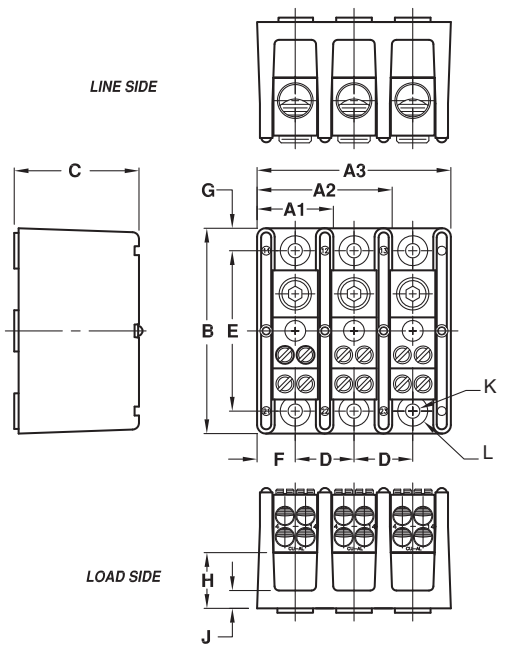
**Class G 60A or less or Class CC 30A or less fuses are suitable for all SCCRs in this table.

***Not High SCCR rated. Refer to UL508A Table SB4.1.

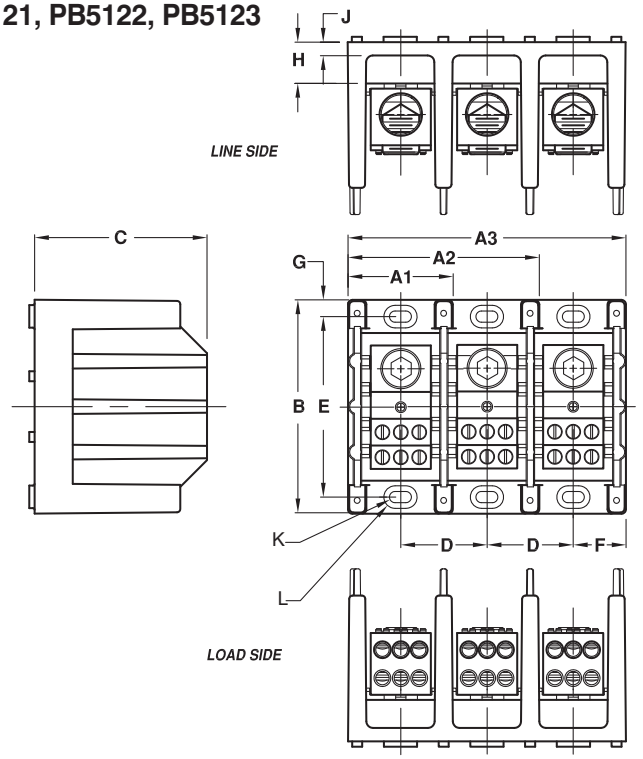
PB Series Edison Open-Style Terminal Blocks Dimensions

Edison Open-Style Power Distribution Blocks Dimensions (in[mm])													
Part Number	Width			Length	Height								
	A1	A2	A3	B	C	D	E	F	G	H	J	K	L
PB1011 PB1012 PB1013 PB1041 PB1042 PB1043	1.06 [26.92]	1.88 [47.75]	2.60 [66.04]	2.85 [72.39]	1.75 [44.45]	0.81 [20.57]	2.25 [57.15]	0.53 [13.46]	0.31 [7.87]	0.84 [21.34]	0.31 [7.87]	0.20 [5.08]	0.42 [10.67]
PB3061 PB3062 PB3063 PB3121 PB3122 PB3123 PB4011 PB4012 PB4013 PB5121 PB5122 PB5123	1.96 [49.78]	3.58 [90.93]	5.20 [132.08]	4.0 [101.60]	3.32 [84.33]	1.62 [41.15]	3.37 [85.60]	0.985 [25.02]	0.310 [7.87]	0.780 [19.81]	0.250 [6.35]	Slot 0.20 [5.08] (w) x 0.41 [10.41] (l)	Slot 0.42 [10.67] (w) x 0.62 [15.75] (l)

PB1011, PB1012, PB1013
PB1041, PB1042, PB1043



PB3061, PB3062, PB3063
PB3121, PB3122, PB3123
PB4011, PB4012, PB4013
PB5121, PB5122, PB5123

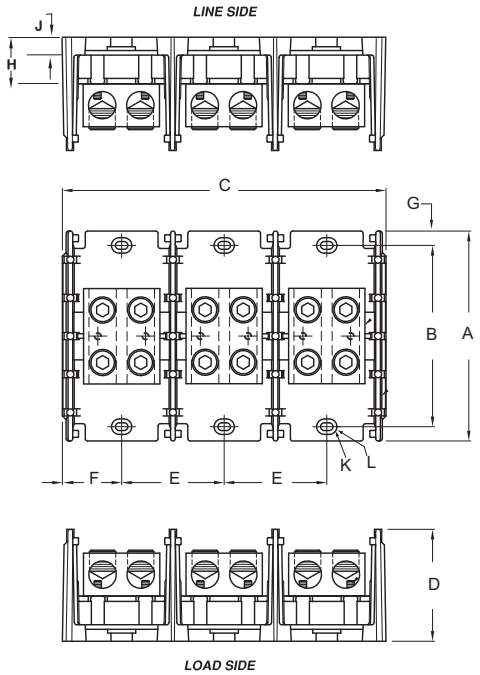


Part Number	Minimum Enclosure Size in[mm]*
PB1011, PB1012, PB1013	16 x 16 x 6.75 [406.4 x 406.4 x 171.45]
PB1041, PB1042, PB1043	16 x 16 x 6.75 [406.4 x 406.4 x 171.45]
PB3061, PB3062, PB3063	24 x 20 x 6.75 [609.6 x 508 x 171.45]
PB3121, PB3122, PB3123	24 x 20 x 6.75 [609.6 x 508 x 171.45]
PB4011, PB4012, PB4013	N/A
PB5121, PB5122, PB5123	N/A
PB7121, PB7123	N/A
*Note: Terminal block SCCR determined based on testing in minimum-size enclosure	

PB Series Edison Open-Style Terminal Blocks Dimensions

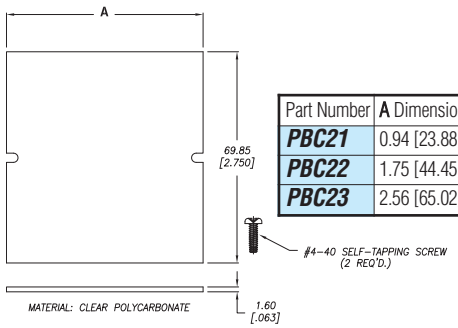
Edison Open-Style Power Distribution Blocks Dimensions (in [mm])													
Part Number	Width	Length	Height										
	A	B	C1	C2	C3	D	E	F	G	H	J	K	L
PB7121 PB7123	5.5 [139.7]	4.75 [120.7]	3.10 [78.74]	5.79 [147.1]	8.48 [215.39]	2.93 [74.42]	2.69 [68.33]	1.55 [39.37]	0.38 [9.65]	1.19 [30.23]	0.44 [11.18]	Slot: 0.20 [5.08] (w) X 0.33 [8.38](l)	Slot: 0.41 [10.41](w) X 0.53 [13.46](l)

PB7121, PB7123



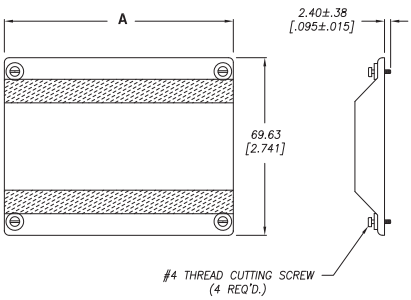
Covers

Optional Cover for PB1011, PB1012, PB1013 PB1041, PB1042, PB1043



Part Number	A Dimension in[mm]
PBC21	0.94 [23.88]
PBC22	1.75 [44.45]
PBC23	2.56 [65.02]

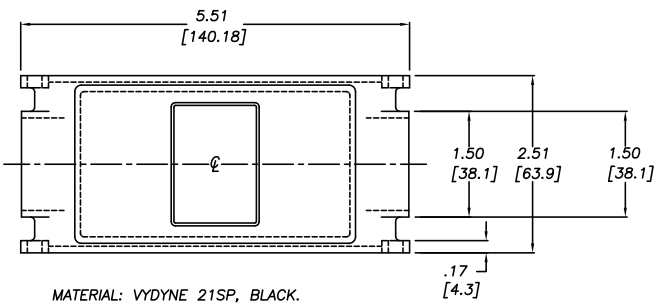
Optional Cover for PB3061, PB3062, PB3063 PB3121, PB3122, PB3123 PB4011, PB4012, PB4013 PB5121, PB5122, 5123



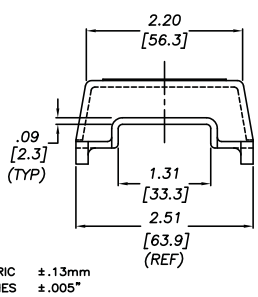
Part Number	A Dimension in[mm]
PBC31	2.10 [53.34]
PBC32	3.72 [94.49]
PBC33	5.34 [135.64]

Optional Cover for PB7121 and PB7123

Part Number
PBC71



Note: Dimensions are in inches [milimeters]



Edison Open-Style Power Distribution Blocks Quick Reference

Edison Open-Style Power Distribution Blocks Quick Reference						
Openings per pole	***Type***	***175 amps***	***310 amps***	***380 amps***	***570 amps***	***760 amps***
1 in 1 out	Recognized Open UL1059	PB101x	N/A	N/A	N/A	N/A
	Open UL1953 Listed	HPB101-x	HPB101-x	N/A	N/A	N/A
	Finger Safe UL1953 Listed	EPDB101	EPDB301	N/A	N/A	N/A
1 in 1 stud out	Recognized Open UL1059	N/A	N/A	PB401x	N/A	N/A
	Open UL1953 Listed	HPB10S-x	N/A	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	N/A	N/A	N/A
2 in 2 out	Recognized Open UL1059	N/A	N/A	N/A	N/A	N/A
	Open UL1953 Listed	N/A	N/A	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	N/A	N/A	EPDB702
1 in 4 out	Recognized Open UL1059	PB104x	N/A	N/A	N/A	N/A
	Open UL1953 Listed	HPB104-x	HPB104-x	N/A	N/A	N/A
	Finger Safe UL1953 Listed	EPDB104	N/A	N/A	N/A	N/A
1 in 6 out	Recognized Open UL1059	N/A	PB306x	N/A	N/A	N/A
	Open UL1953 Listed	HPB106-x	HPB306-x	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	EPDB306	N/A	N/A
1 in 9 out	Recognized Open UL1059	N/A	N/A	N/A	N/A	N/A
	Open UL1953 Listed	N/A	HPB309-x	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	N/A	N/A	N/A
1 in 12 out	Recognized Open UL1059	N/A	PB312x	N/A	N/A	N/A
	Open UL1953 Listed	N/A	HPB312-x	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	N/A	N/A	N/A
2 in 12 out	Recognized Open UL1059	N/A	N/A	N/A	PB512x	PB712x
	Open UL1953 Listed	N/A	N/A	N/A	N/A	N/A
	Finger Safe UL1953 Listed	N/A	N/A	N/A	EPDB512	N/A

SIEMENS

Technical Specification Sheet
Document No. 149-919
April 14, 2006

Immersion Well Temperature Sensors

Description

The Immersion Well Temperature Sensors monitor and transmit changes in temperature to the building control system. Specific devices within the range are compatible with whatever North American manufactured building automation system you may be installing. They thread into a well in a pipe and sense the medium temperature in the pipe. All sensors incorporate precision temperature sensing elements to accurately and reliably measure temperature.

Features

- Variety of sensing elements
- Suitable for hot or chilled medium
- Responsive to temperature change
- Accurate and reliable indication of temperature
- Familiar installation requires no special tools

Figure 1. Immersion Well Temperature Sensor.

Specifications

Temperature Range	Controller dependent
Output Signals	Changing resistance
Sensing Element Type	NTC Thermistor, Pt RTD, or Ni RTD
Accuracy	
NTC Thermistors, mid-range	±1.0°F (±0.5°C)
Pt RTD and Ni RTD, mid-range	±0.75°F (±0.4°C)
Installation	
Wiring	2-conductor: 18 to 22 AWG twisted pair (per code requirements)
Calibration Adjustments	NTC: None required RTD: Adjust for increased temperature offset (a constant) as required, related to added resistance of the field wiring
Threads into Immersion Well	1/2-inch – 14 NPSME
Conduit Pipe Threads	1/2-inch – 14 NPSMI
Housing Material	Cast zinc

Compatibility Table

Automation System	Element Type
AET	10K Type III
Alerton	10K Type II or 3K
American Auto-Matrix	10K Type III
Anderson Cornelius	2.252K
Andover	10K Type III
ASI	3K
ATS	3K
Automated Logic	10K Type II
Carrier	10K Type III
Circon	10K Type III
Delta Controls	10K Type III
Distech Energie	10K Type II
Honeywell	20K or 1K Platinum (385)
Invensys	10K Type III or 1K Platinum (385)
JCI	1K Nickel (JCI) or 10K Type II
KMC	10K Type III or 10K Type II
Reliable Controls	10K Type III
Richards Zeta	10K Type III
Schneider General	3K
Solidyne	10K Type II
T&A	1.8K
TAC/CSI	10K Type II
Trane	10K Type II or 1K Platinum (385)
Triangle Microsystems	10K Type II
Walker	3K
York	10K Type III

Accessories Ordering Information

Description		Part Number
Immer -sion Wells	2.5 in. (64 mm)	AQE2000.005
	4 in. (100 mm)	AQE2000.010
	6 in. (153 mm)	AQE2000.015
Immersion Well Repair Kit	PT 1000 Ohm (385)	AQE2012
	Ni 1K Ohm, Siemens	AQE2020
	Ni 1000 Ohm, JCI	AQE2021
	NTC 10K Ohm Type II	AQE2030
	NTC 10K Ohm Type III	AQE2032
	NTC 2.252K Ohm	AQE2033
	NTC 3K Ohm	AQE2034
	NTC 20K Ohm Type II	AQE2036
	NTC 1.8K Ohm	AQE2037

Repair kits have components to fill any of the three Immersion Wells offered.

Duct Averaging Temperature Sensor Product Numbers

Product Number	Sensing Element
QAE2037.XXX	1.8K Ω NTC
QAE2033.XXX	2.252K Ω NTC
QAE2034.XXX	3.0K Ω NTC
QAE2030.XXX	10K Ω NTC Type II
QAE2032.XXX	10K Ω NTC Type III
QAE2036.XXX	20K Ω NTC Type II
QAE2012.XXX	1K Ω Pt (385α)
QAE2020.XXX	1K Ω Ni Siemens
QAE2021.XXX	1K Ω Ni JCI
XXX	**Insertion Length in Inches (mm)**
.005	2.5 (63.5)
.010	4 (101.6)
.015	6 (152.4)

Product Ordering Information

UNIVERSAL SENSOR PROGRAM			Q A E 2 0 x x . x x x
TYPE	SENSOR	Q	
MEASURING UNIT	TEMPERATURE	A	
APPLICATION/LOCATION	IMMERSION	E	
SENSOR CATEGORY	STANDARD	2	
HOUSING TYPE			
	2" x 4" ELECTRICAL BOX HOUSING	0	
TEMP OUTPUT SIGNAL			
	PLATINUM 1000 OHM	1	
	NICKEL 1000 OHM	2	
	NEGATIVE TEMP COEFFICIENT (NTC)	3	
TEMP OUTPUT INFORMATION			
FOR PLATINUM:	PT 1000 (385 ALPHA)	2	
FOR NICKEL:	NI 1000 (Siemens)	0	
	NI 1000 (JCI)	1	
FOR NTC OUTPUT:	10K OHM TYPE II	0	
	10K OHM TYPE III	2	
	2,252 OHM	3	
	3K OHM	4	
	20K OHM	6	
	1.8K OHM	7	
SEPARATOR		.	
LENGTH DESCRIPTION (NOMINAL)			
	2.5 in. (64 mm)	005	
	4 in. (100 mm)	010	
	6 in. (153 mm)	015	

Part Number Example:
QAE2032.010=Pipe Temperature Sensor, Immersion Type, NTC, 10K Type III Sensing Element, 4-inch Probe.

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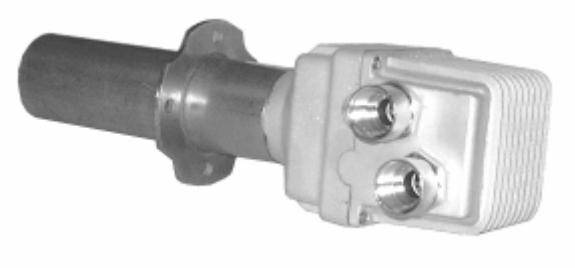


QGO20.000D17

QGO20.000D27

Oxygen Sensor QGO20.000...

The QGO20... is an oxygen sensor designed for acquiring the residual oxygen content of flue gases in heat generation plant burning natural gas or light fuel oil. Together with the control unit, the QGO20... monitors and controls the combustion process.

The QGO20... and this Data Sheet are intended for use by OEMs which integrate the oxygen sensor in their products.

Use

When used in connection with burner controls type LMV52… for residual oxygen control, the efficiency of combustion will be improved and oxygen emissions minimized.

The QGO20... is suited for use on all types of heat generation plant burning natural gas or light fuel oil with flue gas temperatures up to 300 °C at the point of measurement.

Warning notes

To avoid injury to persons, damage to property or the environment, the following warning notes should be observed!

Do not open, interfere with or modify the oxygen sensor!

- All activities (mounting, installation and service work) must be performed by qualified staff
- Before performing any wiring changes in the connection area of the QGO20..., completely isolate the sensor from the mains supply (all-polar disconnection). Make certain that the sensor cannot be inadvertently switched on and check this by making an appropriate voltage test
- Ensure protection against electric shock hazard by providing adequate protection for the sensor's connection terminals
- During operation, the sensor's connecting head must stay closed and all 3 screws must be properly tightened
- Ensure that wiring is in an orderly state. Keep cables away from extremely hot plant equipment or sensor parts
- Ensure that the QGO20... does not get into contact with explosive or inflammable gases
- There is a risk of burning since the measuring cell operates at a temperature of 700 °C and certain sensor parts can become very hot (> 60 °C)
- To prevent injury caused by the hot immersion tube, remove the QGO20... from the AGO20... only after the equipment has cooled down
- Fall or shock can adversely affect the safety functions and lead to dangerous conditions. Such sensors must not be put into operation, even if the measuring cell does not exhibit any damage
- Always keep the sensor's flue gas inlet and outlet free from dirt
- Before cleaning the flue gas inlet and outlet, allow the QGO20... to cool down for at least 1 hour. If compressed air is used (only permitted after the sensor has completely cooled down) the maximum permissible pressure is 0.5 bar. If this is not observed, the sensor can be damaged in a way that inadmissibly high CO concentrations in the flue gases can occur
- Ensure that air cannot enter the space between burner and measuring parts. In particular, the mounting flange must be completely gas-tight
- Always fit the sensor such that the connecting section (head plus flange) is free so that air can freely circulate. Otherwise, there is a risk of false measurements, which can lead to dangerous conditions
- The environment must be free from chemicals such as vapors from solvents

Engineering notes

- If the burner is shut down for no more than 2 weeks, maintain power supply to the QGO20... and the associated control unit (LMV52... with PLL52...)
- To ensure a good response, always use the QGO20... together with the AGO20...
- The flue gas temperature at the QGO20… must not exceed 300 °C since higher temperatures can damage the sensor
- Use the QGO20... only in connection with natural gas and light fuel oil since other types of fuel can damage the sensor due to the aggressive substances contained in them

Installation and mounting notes

- Ensure that the relevant national safety regulations are complied with
- To facilitate mounting, the QGO20... and AGO20... carry markings (refer to Mounting Instructions M7842)
- The flue gas flow passing the measuring cell must be homogeneous, with no or only very little turbulence. When mounted near air dampers or pipe bends, false measurements can occur
- The exchange of fresh air with reference air via the slots near the sensor's connecting section must be ensured and must not be covered (by insulation or similar)
- The sensor should not be exposed to aggressive gases (NOx, etc.). This applies to both the gas and air side since aggressive gases can drastically shorten the sensor's life
- Disturbances can distort the measurements (this can lead to dangerous conditions in connection with O2 trim control):
  – If flueways are not tight, false air can join the flue gases. In that case, the oxygen content acquired by the sensor is above the real content
  – When flue gas velocities are low, the sensor will respond more slowly since the flue gases need more time to pass the measuring cell. In that case, it is recommended to mount the sensor in an inclined position
  – The further the sensor is mounted from the flame, the longer the dead time

Note

For details on mounting, refer to Mounting Instructions M7842.

Electrical connection of the sensor

It is important to achieve practically disturbance- and loss-free signal transmission:

- Never run the sensor cable together with other cables; use a separate cable
- Observe the permissible length of the sensor cables and the relevant specification (refer to «Technical data»)

Commissioning notes

- Prior to commissioning, check to ensure that wiring is in an orderly state
- To prevent the collection of condensate inside the QGO20…, do not put the burner into operation before the sensor's heating up phase is completed
- To prevent false measurements, observe a heating up time of at least 2 hours when commissioning the plant, otherwise at least 1 hour

Note

For details on commissioning the QGO20..., refer to Basic Documentation P7842.

Standards and certificates

ISO 9001: 2000
Cert. 00739

ISO 14001: 2004
Cert. 38233

Only QGO20.000D17

Only in connection with LMV52... with PLL52...

Conformity to EEC directives

- Electromagnetic compatibility EMC (immunity)	89 / 336 EEC
- Directive for gas-fired appliances	90 / 936 / EEC

Service notes

- Each time a sensor has been replaced, check wiring to ensure it is in an orderly state
- Always keep the sensor's flue gas inlet and outlet free from dirt
- On each service visit, check to ensure that the flange is completely tight and replace gasket if necessary
- Before cleaning, allow the QGO20... to cool down for at least 1 hour
- Check the AGO20… flue gas collector at regular intervals and clean if necessary
- After cleaning and heating up, check oxygen measurement and control in the burner's entire working range

Note

For details on servicing the QGO20..., refer to Basic Documentation P7842.

Disposal notes

The oxygen sensor contains electrical and electronic components and must not be disposed of together with household waste.
Local and currently valid legislation must be observed.

Mechanical design

The **QGO20...** consists of
- immersion tube with mounting flange made of stainless steel, and
- connecting head made of die-cast aluminium

The **immersion tube** contains and protects
- the measuring cell
- the cell heating element, and
- is resistant to aggressive substances contained in the flue gases of combustion plant burning natural gas or light fuel oil

The sensor's **connecting head** houses a printed circuit board with the connection terminals. The cable enters through replaceable Pg11 cable glands. The cable glands can be left with the cable, thus facilitating installation and service work.

The AGO20... **flue gas collector** is one of the accessory items used with the QGO20...
- which is welded into the stack where the measurement shall be made, also serving as a
- mounting flange and
- flue gas guidance

Ordering

Oxygen sensor (including flange gasket)

- AC 230 V	**QGO20.000D27**
- AC 120 V	**QGO20.000D17**

Control unit for measurement and control

- Refer to Basic Documentation P7550	**LMV52...** with **PLL52...**

Flue gas collectors

- For stack diameters up to 400 mm	**AGO20.001A**
- For stack diameters above 400 mm	**AGO20.002A**

Flange gasket for service **5 769 2021 0**

Technical data

QGO20...	Mains voltage for heating the measuring cell	
	- QGO20.000D27	AC 230 V ±15 %
	- QGO20.000D17	AC 120 V ±15 % (only with LMV52... with PLL52...)
	Mains frequency	50...60 Hz ±6 %
	Power consumption	max. 90 W, typically 35 W (controlled)
	Perm. mounting position	refer to Mounting Instructions M7842
	Degree of protection	IP 40 (to be ensured through mounting)
	Weight	approx. 0.9 kg
	Signal lines	
	- Shielded 6-core cable	twisted pairs
	- Shielding connected to terminal «GND» of the LMV52...	
	- Wire dia.	min. 0.25 mm² (e.g. LifYCY6x2x0.2/22 or LifYCY6x2x0.2)
	Measuring principle	zirconium dioxide measuring cell as an oxygen ion conductor
	Perm. flue gas velocity (only with the AGO20...)	1...10 m / s
	Perm. types of fuel	light fuel oil «EL», or natural gas «H»
	Measuring range	0.2...20.9 % O_2
	Perm. cable length	max. 100 m
	Power supply lines (mains cable)	
	- Wire dia.	min. 1 mm² (e.g. NYM 3x1.5)
	Required operating temperature of measuring cell	700 °C ±50 °C

Environmental conditions	**Storage**	DIN EN 60 721-3-1
	Climatic conditions	class 1K3
	Mechanical conditions	class 1M2
	Temperature range	-20...+60 °C
	Humidity	< 95 % r.h.
	Transport	DIN EN 60 721-3-2
	Climatic conditions	class 2K2
	Mechanical conditions	class 2M2
	Temperature range	-25...+70 °C
	Humidity	< 95 % r.h.
	Operation	DIN EN 60 721-3-3
	Climatic conditions	class 3K5
	Mechanical conditions	class 3M2
	Temperature range	
	- Flange	max. 250 °C
	- Connecting head	max. 70 °C
	- Flue gas	≤ 300 °C
	Humidity	< 95 % r.h.

⚠ **Condensation, formation of ice and ingress of water are not permitted!**

AGO20...	Tube	DN50, steel X5 CrNi 18 9
	Tube length	
	- For the AGO20.001A	180 mm
	- For the AGO20.002A	260 mm
	Flange	DN50, steel X5 CrNi 18 9

Function

The difference of oxygen concentrations in the gas to be measured and the reference gas at the measuring cell generates a voltage, which is used as a signal for the control unit. The measuring cell is made of zirconium dioxide (ZrO_2). As ZrO_2 becomes oxygen ion-conductive at high temperatures, the difference between the O_2 concentrations inside and outside the measuring cell generates an electrical voltage.
This so-called Nernst voltage «VN», is acquired by porous platinum electrodes located on the inner and outer sides of the measuring cell. A heating element keeps the measuring cell at a constant working temperature of 700 °C. The flue gas enters the gas guidance chamber from the bottom of the immersion tube and passes the space between the outside of the measuring cell and the gas guidance in 1 to 2 seconds, then leaving laterally through the immersion tube. The inside of the measuring cell, which is hermetically sealed against the ingress of flue gases, communicates with the outside air which is used as the reference gas when making measurements (20.9 % O_2).

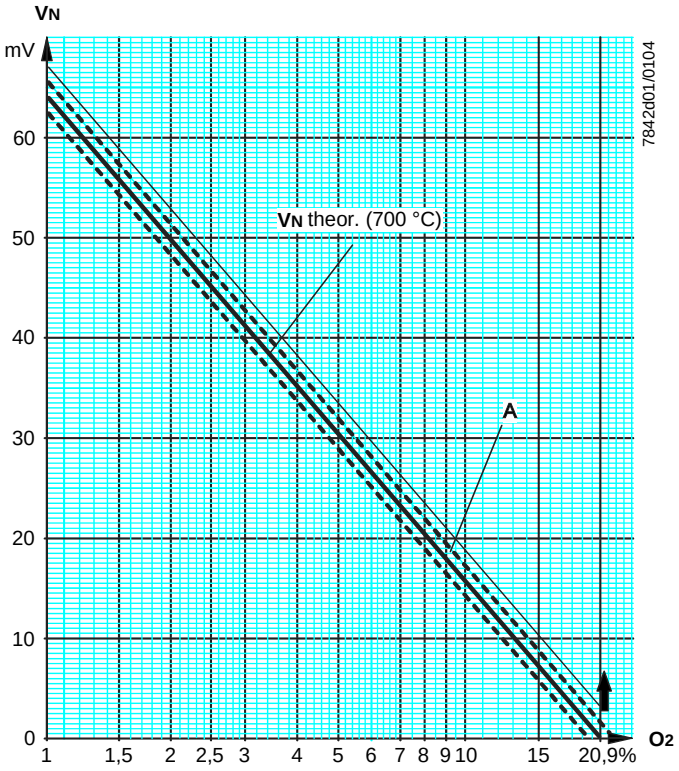
The Nernst voltage «VN» is a function of the oxygen content differential and the temperature of the measuring cell as expressed by the following formula:

$$V_N = \frac{R \times T}{4 \times F} \ln \frac{O_{2\text{-Ref.}}}{O_2} = (mV)$$

$$\text{when} = \frac{R}{4 \times F} = 21.5 \ \frac{\mu V}{K} \ \text{or}$$

$$\frac{R \times T}{4 \times F} = 20.9 \text{ mV for T} = 700 \text{ °C} = 973 \text{ K}$$

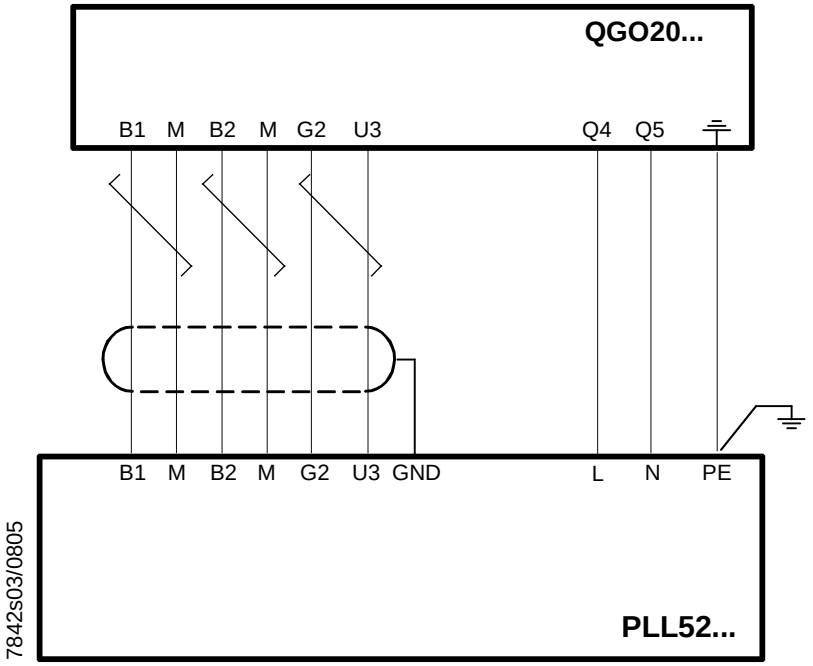
According to the above formula, the Nernst voltage at an oxygen concentration of 1 % in the flue gas is 64 mV.



Legend

A	Tolerance range	(O_2)	Oxygen content (vol. %) of flue gas
F	Faraday constant (96486 Clb)	R	Gas constant (8.3 J / K)
(O_2)Ref	Oxygen content (vol. %) inside the measuring cell (reference gas)	T	Absolute temperature of measuring cell (973 K)
		VN	Nernst voltage

Connection diagram



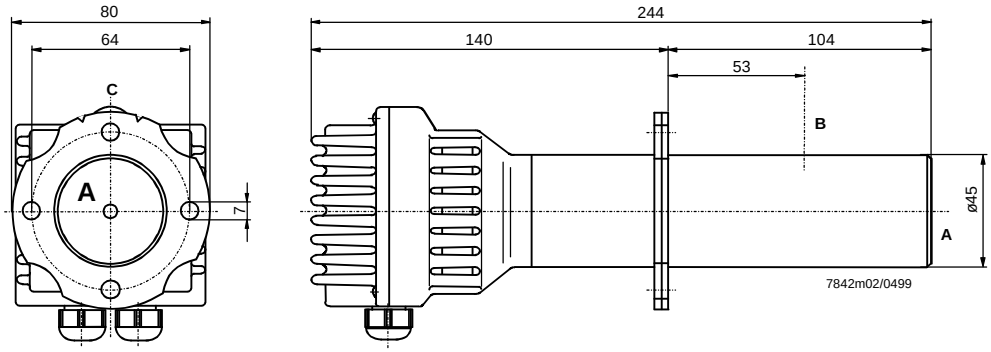
Legend

B1	(+)	Signal of oxygen measuring cell
B2	(+)	Thermocouple voltage
G2	(-)	Power supply temperature compensation element
GND		Electrical ground for shielding
L		Live conductor
M	(-)	Electrical ground for «B1» and «B2»
M	(-)	
N		Neutral conductor
Q4		Sensor heating element with mains connection
Q5		Sensor heating element with mains connection
U3	(+)	Signal of temperature compensation element
⏚		Protective earth (PE)

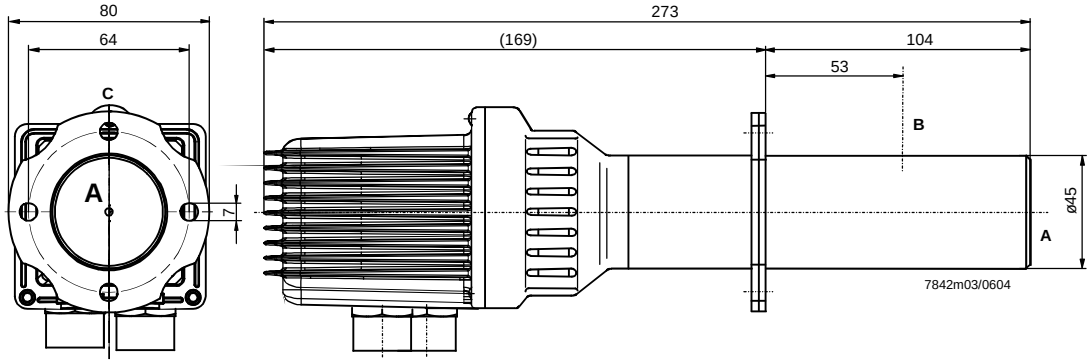
Dimensions

Dimensions in mm

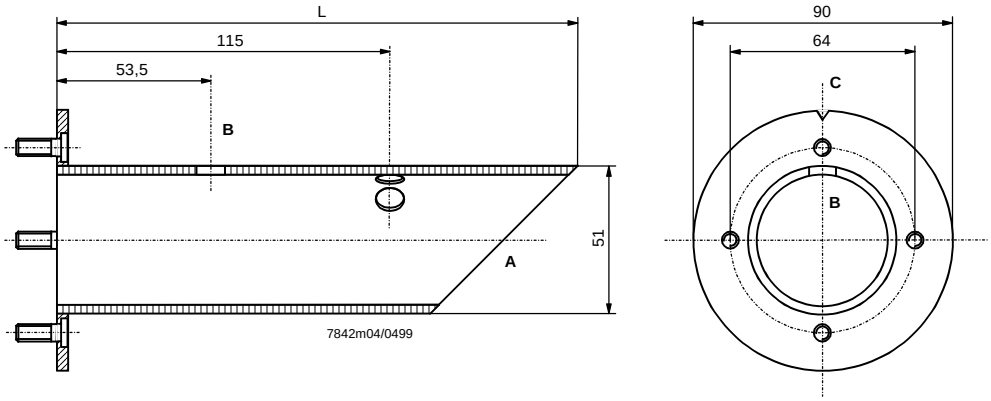
QGO20.000D27



QGO20.000D17



AGO20...



Legend

A Flue gas inlet
B Flue gas outlet
C Notch on the flange marking the flue gas outlet side
L 180 mm for the AGO20.001A
260 mm for the AGO20.002A

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SIEMENS

7719

Infrared Flame Detectors QRI...

Infrared flame detectors for use with Siemens burner controls, for the supervision of gas, oil and other flames that emit infrared light.
The QRI... are suited for burners of any capacity, either in continuous or intermittent operation.

The QRI... and this Data Sheet are intended for use by OEMs which integrate the flame detectors in their products.

Use, features

Key features of the QRI... flame detectors:
- Detector with infrared-sensitive flame detecting element
- Integrated flame signal amplifier
- Designed for frontal and lateral (90°) illumination
- Suited for use with burner controls type LMV5...
- Secured to the burner with flange and clamp

The spectral sensitivity of the QRI... is a maximum of about 2 µm covering infrared radiation emitted by gas, oil, and coal flames as well as other sources of infrared light.
Owing to electronic self-supervision of the flame signal, the QRI... can be used in connection with suitable burner controls designed for burners in continuous or intermittent operation.
The sensitivity of the QRI... is such that it must be fitted behind the burner's baffle plate.

Warning notes

To avoid injury to persons, damage to property or the environment, the following warning notes must be observed!

Do not open, interfere with or modify the flame detector!

- All activities (mounting, installation and service work etc.) must be performed by qualified staff
- Before making any wiring changes in the connection area, completely isolate the plant from mains supply (all-polar disconnection). Ensure that the plant cannot be inadvertently switched on again and that it is indeed dead. If not observed, there is a risk of electric shock hazard
- Ensure protection against electric shock hazard by providing adequate protection for the burner control's connection terminals
- Each time work has been carried out (mounting, installation, service work, etc.), check to ensure that wiring is in an orderly state and that the correct terminals of the LMV5... are used and make the safety checks as described in «Commissioning notes»
- Make certain that none of the 3 connecting wires of the QRI... is connected to terminal X10-02/3 (mains voltage **L**)! Risk of damage to QRI... and LMV5...!
- Use an AC voltmeter (Ri = 10 MΩ) to ensure that there is no voltage across the reference line (blue wire = **N** of the LMV5...) and the burner housing (**PE**)
- Due to its mounting location behind the baffle plate, the flame detector has high signal sensitivity and, therefore, identifies small variations in infrared radiation as a flame. For this reason, make certain that so-called heat streaks after loss of flame (emitted for example by after-glowing combustion chamber lining) will not reach the detector as these would simulate a flame. Air turbulence or similar may modulate infrared radiation emitted by hot boiler or burner components in a way that a flame will be simulated. Likewise, moving parts in the detector's viewing range can cause infrared radiation from the boiler (or a viewing tube) to be modulated, thereby possibly generating sporadic detector signals. Strong burner or detector vibrations can also produce variations in radiation. For this reason, the burner or boiler manufacturer must make certain that such modulated radiation cannot reach the flame detector. For example, loose cables (moving up and down in the fan's airstream) are not permitted within the detector's viewing range
- Consider carefully the use of infrared flame supervision if several burners use the same combustion chamber. In general, this type of flame supervision is not suited for the specific supervision of individual burners
- Check to ensure that the burner will initiate lockout when – while the burner is running – the flame detector is removed from its fixing on the burner and – without moving it – is exposed to room lighting
- Fall or shock can adversely affect the safety functions. Such units must not be put into operation even if they do not exhibit any damage

Mounting notes

- Ensure that the relevant national safety regulations are complied with
- Secure the flame detector to the burner with the clamp and flange provided. With the clamp's fixing screw loosened, the detector can be correctly adjusted toward the flame. This adjustment can be checked by watching the intensity of the flame signal on the AZL5... display and operating unit of the LMV5... burner control, or with the help of the measuring circuit (refer to «Detector signal measurement»)
- Ensure that the connection between the metal surface of the flange and the burner's earthed housing is electrically conductive

Installation notes

- Locate the detector such that, if possible, only the flickering peripheral range of the flame will be detected. The view at hot boiler walls or other hot boiler or burner components must be restricted as much as possible. This can be attained by clearly confined viewing conditions behind narrow baffle plates. If this is not possible, a viewing tube should be used to restrict the viewing range to a smaller area of the flame. Length, diameter and alignment of the viewing tube must be determined through testing, depending on the size of burner and boiler

  The viewing range should be reduced to such an extent that:
  a) the minimum detector output signal required is attained over the burner's entire output range (for details, refer to the Basic Documentation of the LMV5... (P7550)
  b) after loss of flame, the valve's operating voltage is switched off by the burner control as required by the standards (refer to «Commissioning notes»).

Electrical connection of the flame detectors

It is important to achieve practically disturbance- and loss-free signal transmission:

- Never run the detector cable together will other cables
  - Line capacitance reduces the magnitude of the flame signal
  - Use a separate cable
- Observe the permissible length of the detector cables (refer to «Technical data»)
- Always run the ignition cable separate while observing the greatest possible distance to other cables (min. 3 cm)
- Test the flame detector on all applications. When used in connection with the LMV5..., the test is to be made with a test routine (for details, refer to the Basic Documentation P7550)
- Make certain that the detector's cable does not get into contact with hot burner or boiler surfaces

Commissioning notes

- When commissioning the plant or when doing maintenance work, make the following safety checks:

	Safety check	Anticipated response
a)	Burner startup with flame detector darkened	Lockout at the end of «TSA»
b)	Burner startup with flame detector exposed to extraneous light (e.g. light from an incandescent lamp interrupted at about 20 Hz)	Lockout at the end of the prepurge time
c)	Simulation of flame failure during operation. For that purpose, darken the flame detector during operation and maintain this state	Lockout or restart, depending on the burner control's configuration
d)	Check the safety time in operation in the event of loss of flame; for that purpose, disconnect manually the fuel valves from power and check the time the burner control requires from this manual disconnection until the valves' power supply is turned off	Burner control disconnects power supply to the valves within the period of time allowed for the relevant plant

- Make a loss-of-flame test with the AZL5... of the LMV5... burner control

Standards and certificates

Only in connection with the burner control

CE

Conformity to EEC directives

- Electromagnetic compatibility EMC (immunity)	2004/108EC
- Directive for gas appliances	90/396EEC
- Low-voltage directive	2006/95EC

ISO 9001: 2000
Cert. 00739

ISO 14001: 2004
Cert. 38233

For use in the U.S. / Canada, the flame detectors carry the marks.

Service notes

- To clean the detector's lens, use a soft, clean cloth (free from oil and solvents)

Disposal notes

The flame detector contains electrical and electronic components and must not be disposed of together with domestic waste.
Local and currently valid legislation must be observed.

Mechanical design

The QRI... has an impact-proof housing made of black plastic. The lens is fitted in a dust-tight position.
The QRI... can be secured to the burner within its adjusting range, using the clamp and the flange provided.
The 3-core connecting cable is ready connected to the QRI... and features cable strain relief.
Depending on the type of burner construction, there are flame detectors for frontal or lateral illumination available.

Type summary

Type reference	Illumination	Cable length «L»	Cable end	Accessories
QRI2A2.B180B	Frontal	180 cm	Stripped	---
QRI2B2.B180B	Lateral	180 cm	Stripped	---
QRI2B2.B180B1	Lateral	180 cm	Stripped	Flange and clamp

When ordering, please give the complete type reference according to «Type summary».

Accessories

Flange, with radius **4 241 8855 0**

Flange, straight **4 241 8898 0**

Clamp **4 199 8806 0**

Mounting kit **AGG2.110**
For frontal illumination, including heat insulator with ¾“ 14-NPSM thread

Adapter, protective sleeve Pg9 / ½“ 14-NPSM thread **AGG2.120**

Technical data

General detector data	Operating voltage	
	- Operation	DC 14 V ±5 %
	- Test	DC 21 V ±5 %
	Signal voltage	DC 0...5 V
	Length of connecting cable	Max. 180 cm
	Degree of protection	IP54
	Power consumption	< 0.5 W
	Length of auxiliary detector cable	Max. 100 m
	Safety class	II
	Vibrations to IEC 6068-2-6	max. 1 g / 10...500 Hz
	Weight incl. cable 180 cm	approx. 0.175 kg
	Mounting position	optional
Environmental conditions	**Storage**	DIN EN 60 721-3-1
	Climatic conditions	class 1K3
	Mechanical conditions	class 1M2
	Temperature range	-20...+60 °C
	Humidity	< 95 % r.h.
	Transport	DIN EN 60 721-3-2
	Climatic conditions	class 2K2
	Mechanical conditions	class 2M2
	Temperature range	-20...+60 °C
	Humidity	< 95 % r.h.
	Operation	DIN EN 60721-3-3
	Climatic conditions	class 3K5
	Mechanical conditions	class 3M2
	Temperature range	-20...+60 °C short-time (max. 1 min) up to 75 °C
	Humidity	< 95 % r.h.

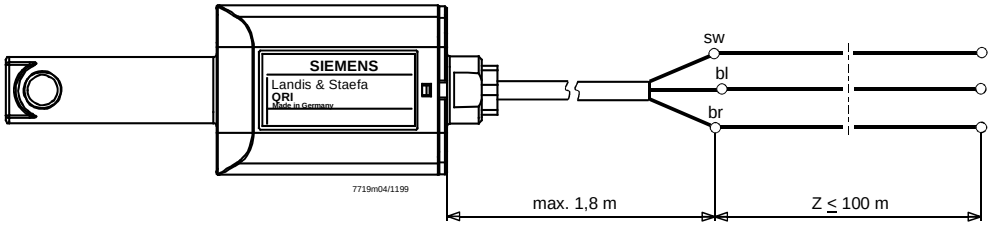
⚠ **Condensation, formation of ice and ingress of water are not permitted!**

Function

With this type of flame supervision, the changes in infrared radiation are used to generate the flame signal. The flame-detecting element is an infrared-sensitive photoresistor whose spectral sensitivity covers the range of approximately 1...3 µm. The detector does not respond to constant radiation or radiation with mains frequency harmonics (e.g. 50 Hz or multiples thereof). The suppression of these radiation frequencies is made electronically, directly dependent on the current mains frequency at which the relevant burner control (e.g. LMV5...) is operated. As a result, filtering takes place within a very narrow band, which means that the signal generated by the flame can almost completely be utilized since the frequency and the rate of change of infrared radiation constantly change. Hence, the detector's ability to capture the flame's radiation behind the burner's baffle plate is extremely high. As a result of the high level of sensitivity, constant or mains frequency-harmonic extraneous light sources remain undetected only if the detector itself is not moved. Due to its short-wave spectrum, the ignition spark will not be detected. The detector's analog output signal (0... approx. +5 V) is a measure of the changes of the flame's radiation intensity.

Maximum detector cable length

If the connecting cable length of 180 cm is not sufficient, the burner manufacturer can extend it up to a maximum of 100 m (also refer to «Installation notes»).



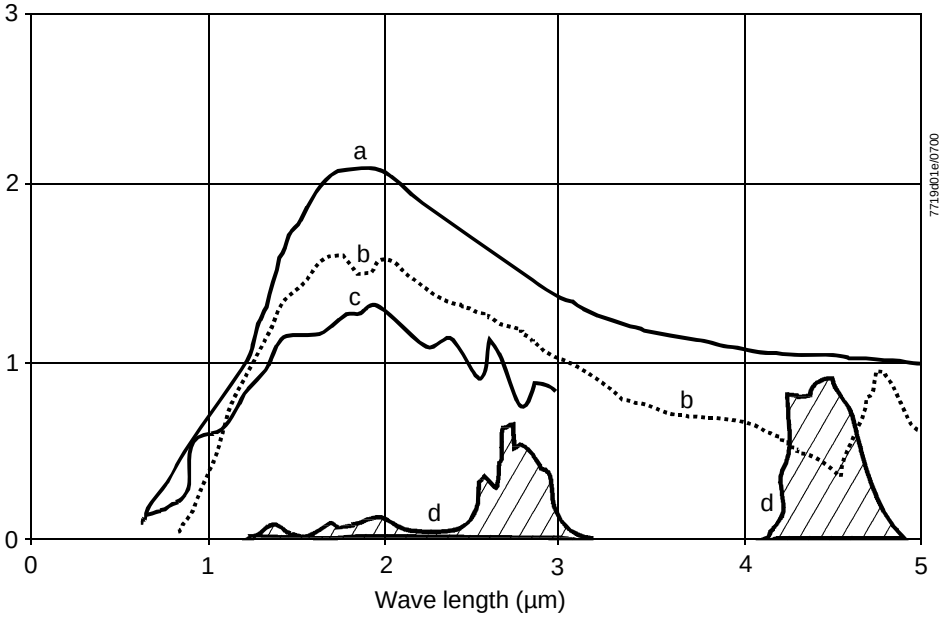
Legend

bl	Blue wire = reference line	sw	Black wire = signal line
br	Brown wire = power line	Z	Extension cable

Spectral curves

Flames

Relative intensity of radiation

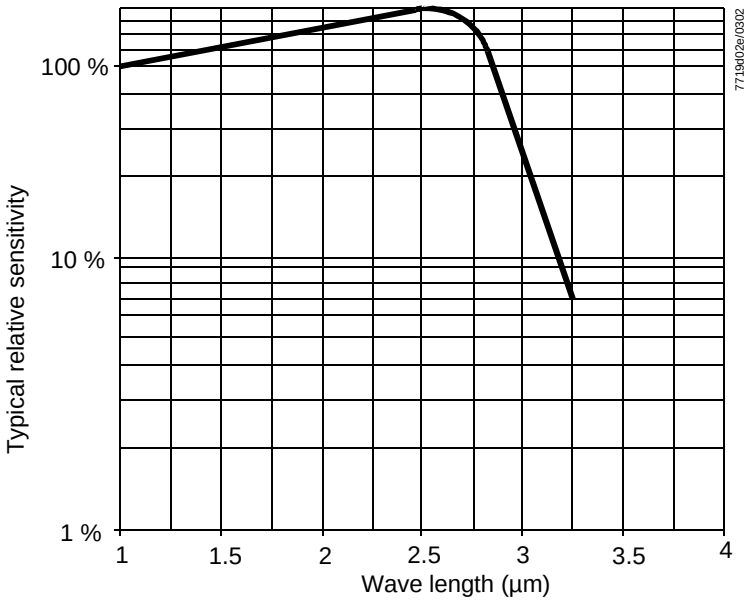


Spectral emission of radiation of luminous and nonluminous flames at 1,500 K (extract from VDI Report no. 423, 1981).

Legend

a Black body radiation
b Pulverized coal flame
c Oil flame
d Gas flame

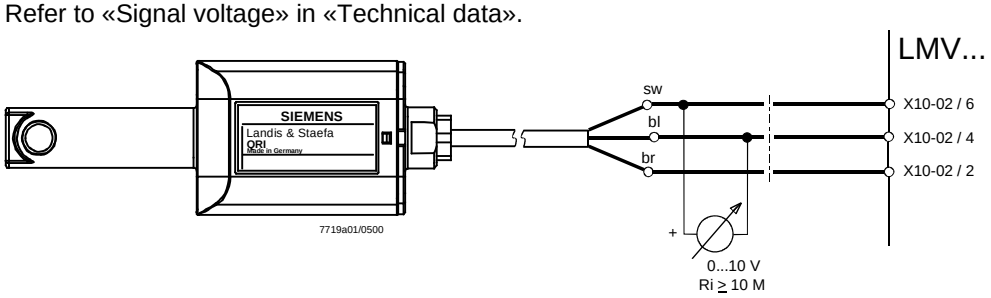
Sensitivity of flame detector



Measuring circuit and connection examples

Measurement of the detector current

Refer to «Signal voltage» in «Technical data».

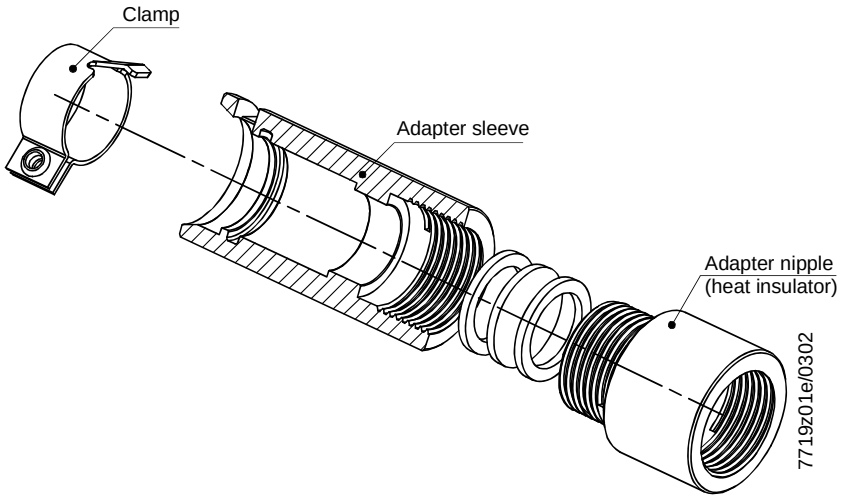


Measurement of the detector's signal with a Voltmeter is not normally required since the flame signal's intensity is shown on the AZL5... display and operating unit.

Drawing of disposition

AGG2.110

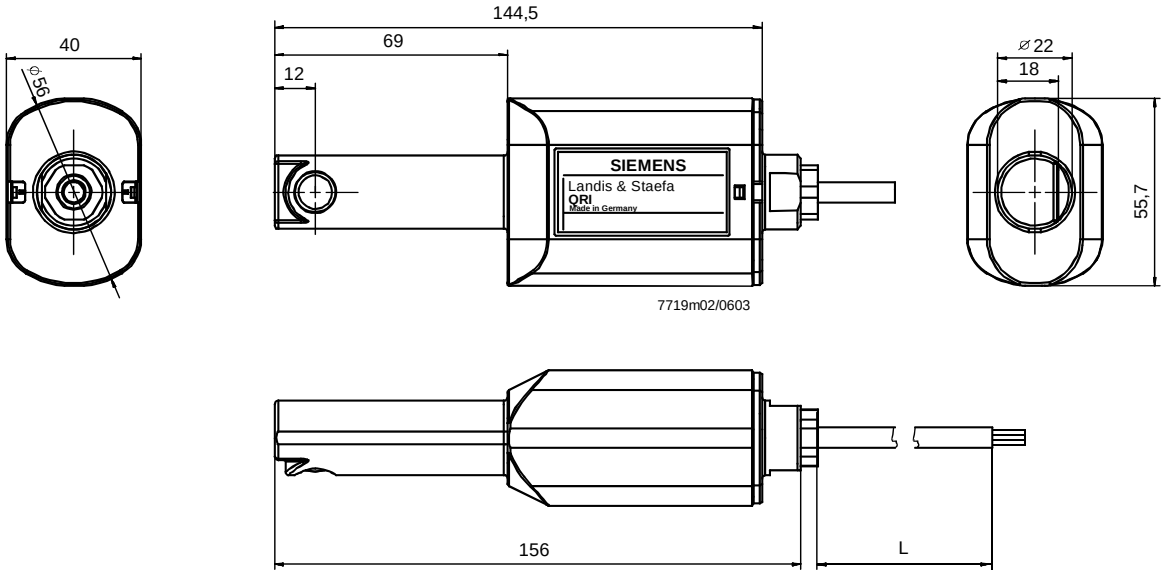
Mounting kit is supplied completely assembled.



Dimensions

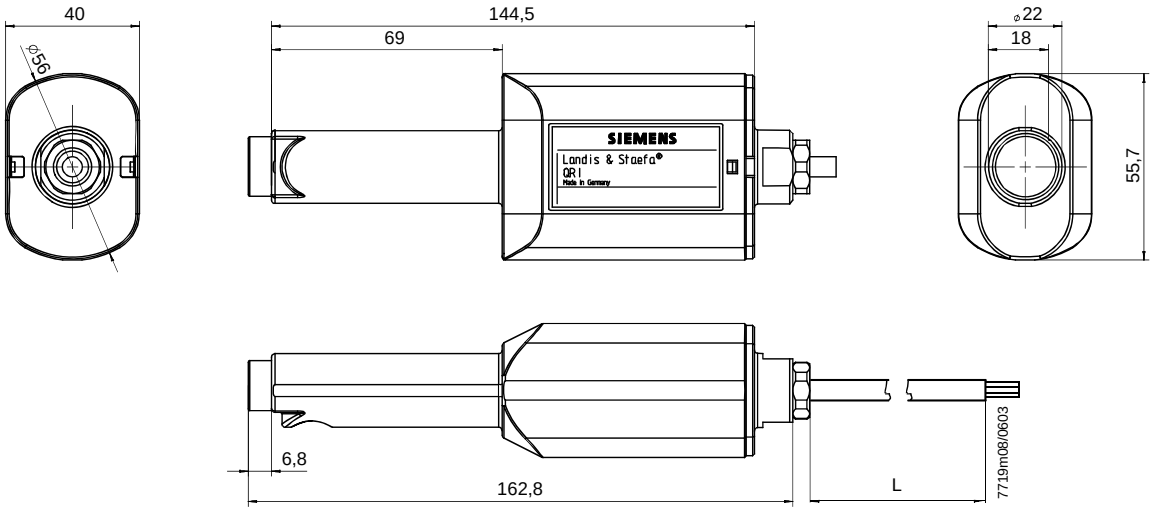
Dimensions in mm

QRI2B...
for lateral illumination



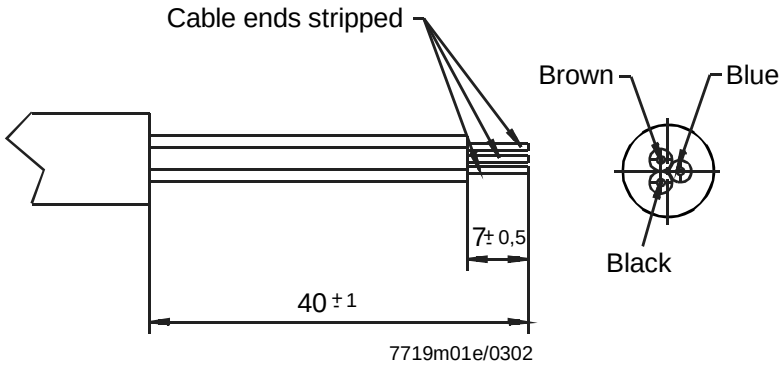
Legend L Available cable length (refer to «Type summary»)

QRI2A...
for frontal illumination



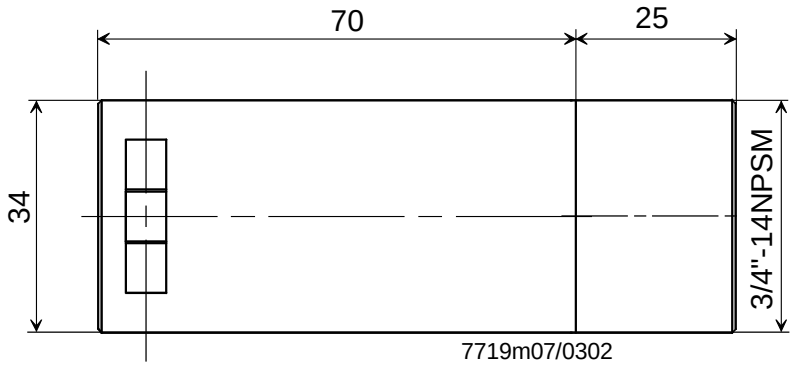
Dimensions (cont'd)

Connecting cable

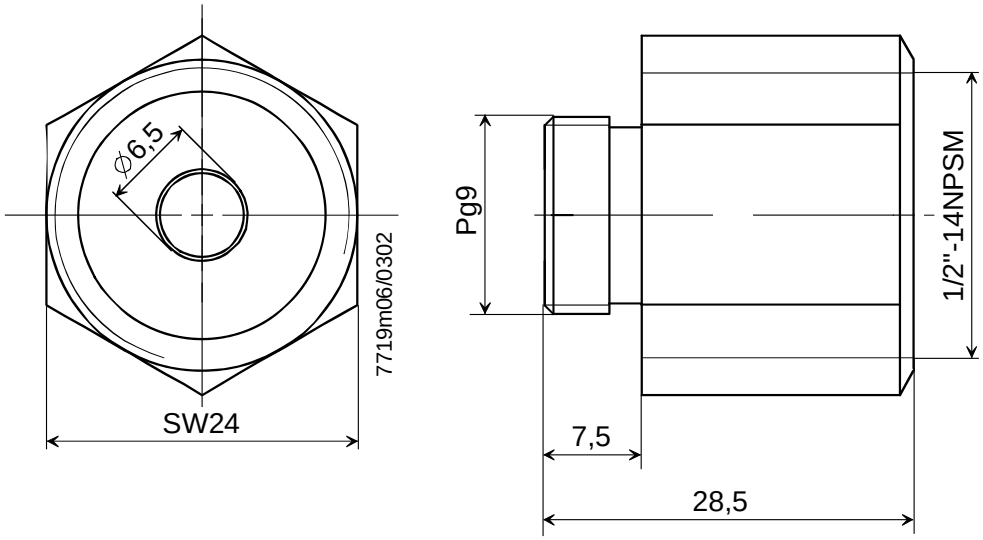


For AGG2.110 mounting kit

Adapter nipple and adapter sleeve

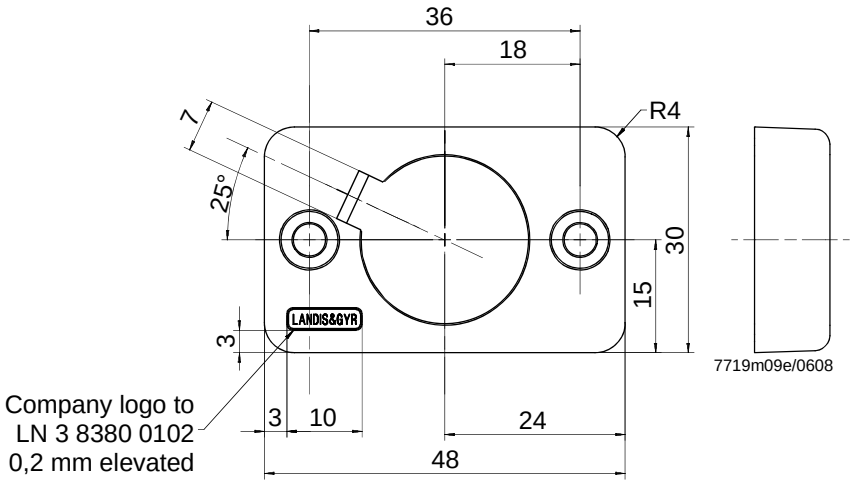


AGG2.120

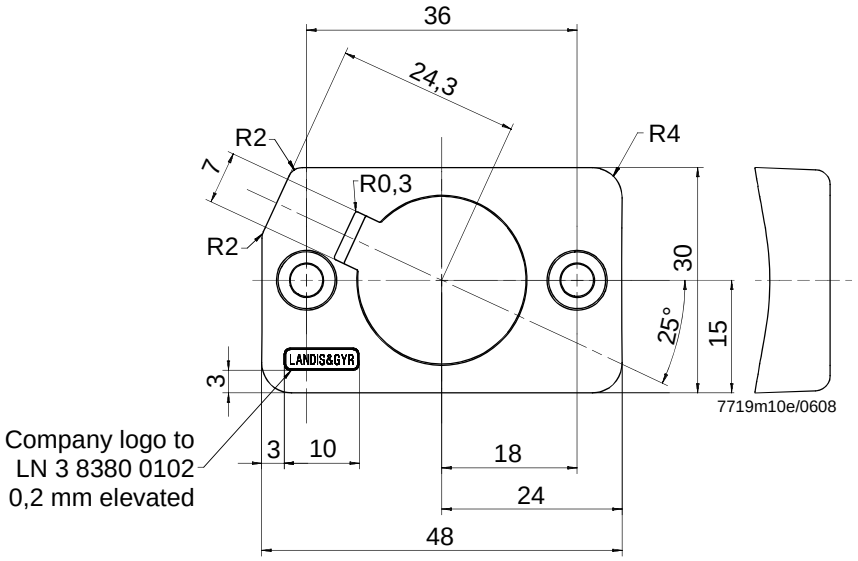


Dimensions (cont'd)

4 241 8898 0



4 241 88550



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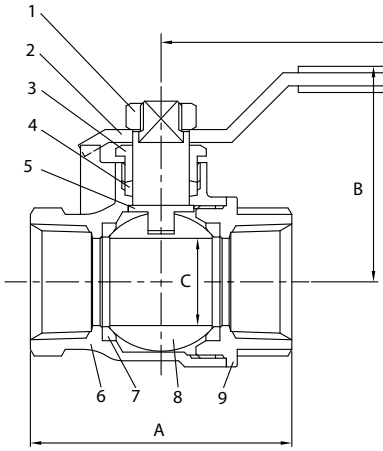
SMITH-COOPER® INTERNATIONAL

Series 01728170

Brass Ball Valve, Threaded

- 600 lb. WOG, 150 lb. WSP
- Full port
- Forged brass body
- Blow-out proof stem
- Chrome plated ball
- UL Listed (1/4" – 2") Threaded
- FM Approved, (1/2" – 2")
- CSA Approved under z21.15a for 1/2 psiG (1/2" – 2") – Threaded
- CSA Approved under 3-88 for 5 psig (1/2" – 2") – Threaded
- Approved under ANSI/ASM B16.33 spec for gas piping to 125 psig (1/2" – 2")
- Meets Fed Spec WW-V-35, Type II, Class A, Style 3 (1/2" – 2")
- Conforms to MSS-SP110
- Certified to NSF/ANSI 61.8
- ISO 9001:2008 manufacturer



No.	Part	Material
1	Nut	Forged Steel ASTM - AISI-1010 (1/8"- 2") - ASTM A-283 (2-1/2"- 4")
2	Handle	Forged Steel ASTM-A-283-D
3	Packing Nut	Brass ASTM B-16, C36000 (1/8"- 2") - ASTM B-124, C37700 (2-1/2"- 4")
4	Stem Packing	PTFE
5	Stem	Brass ASTM B-16, C36000 (1/8"- 2") - ASTM B-124, C37700 (2-1/2"- 4")
6	Body	Forged Brass ASTM B-124 C37700, (1/8"- 1 1/2") - Cast Brass ASTM B-584 C85700, (2" - 4")
7	Ball Seat	PTFE
8	Ball	Chrome Plated, Brass ASTM B-16, C36000, (1/8"- 1/2") Chrome Plated, Forged Brass ASTM B-124, C37700 (3/4"- 4")
9	Body End Cap	Forged Brass ASTM B-124, C37700

Size IN	Part Number	Weight LB	A IN	B IN	C IN	D IN	Cv
1/8	01728170A	0.34	1.81	1.37	0.37	3.23	6.5
1/4	01728170C	0.34	1.81	1.37	0.37	3.23	6.5
3/8	01728170E	0.34	1.81	1.37	0.37	3.23	6.5
1/2	01728170G	0.42	2.12	1.45	0.50	3.23	10.0
3/4	01728170I	0.83	2.41	1.78	0.75	3.94	26.0
1	01728170K	1.25	2.96	2.29	0.98	4.72	48.0
1-1/4	01728170L	2.05	3.28	2.44	1.24	4.72	70.0
1-1/2	01728170M	2.80	3.62	3.0	1.50	7.09	105.0
2	01728170N	4.72	4.21	3.30	1.98	7.09	200.0
2-1/2	01728170P	7.89	5.15	3.85	2.48	7.87	380
3	01728170Q	11.7	5.90	4.17	2.95	7.87	550
4	01728170T	16.0	7.38	6.00	3.85	10.5	1050

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SIEMENS

7814

ISO 9001

Actuators

SQM45...
SQM48...

for air dampers and control valves of oil and gas burners

Electromotoric actuators

- **Torques:** **– SQM45... up to 3 Nm**
  – SQM48... up to 20 Nm
  – SQM48.6... up to 35 Nm
- **Running times: [1)] – SQM45... 10 ... 120 s**
  – SQM48... 30 ... 120 s
  – SQM48.6... 60 ... 120 s
  [1)] Depending on the basic unit (LMV...)
- **Versions: – Choice of drive shafts (refer to «Type summary»)**

The SQM45... / SQM48... and this Data Sheet are intended for use by OEMs which integrate the actuators in their products!

Use

The actuators of the SQM45... / SQM48... range are used to drive gas dampers, air dampers, oil control valves and other ancillary equipment.
When used in connection with burner controls or electronic fuel / air ratio control, the associated controlling elements are controlled depending on burner output.

Warning notes

To avoid injury to persons, damage to property or the environment, the following warning notes should be observed!

Do not open, interfere with or modify the actuators!

- Ensure protection against electric shock hazard by providing adequate protection for the connection terminals
- Check to ensure that wiring is in an orderly state and that the wires are firmly connected

Mounting notes

- Ensure that the relevant national safety regulations are complied with
- The connection between actuator drive shaft and controlling element must be **rigid** with **no mechanical play**

Positive connection

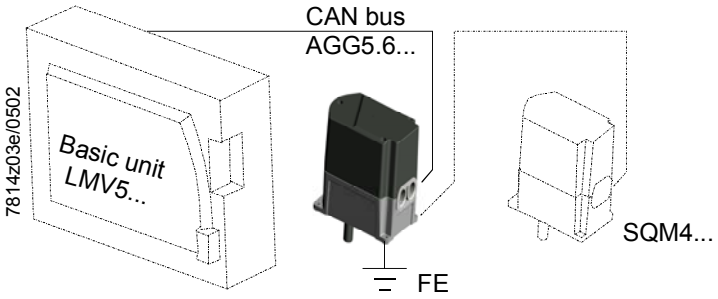
Possible connection with drive shaft or hub:
- Groove with Woodruff key
- Drive shaft with flat edge and matching counterpiece

To avoid inadmissible loads on bearings caused by rigid hubs, it is recommended to use compensating clutches with no mechanical play (e.g. metal bellows clutches).

Cable and cable shielding

Only the specified cable may be used (refer to Basic Documentation P7550). The cable's shielding must be connected to the printed circuit board using the tab provided.

Ensure that the actuator's housing is connected to functional earth (FE) of the system.
If necessary, remove isolating layers of paint from the fixing points on the burner's casing or run separate earth wires.
For detailed information, refer to «Installation Inctructions for the LMV5x system» J7550.1.



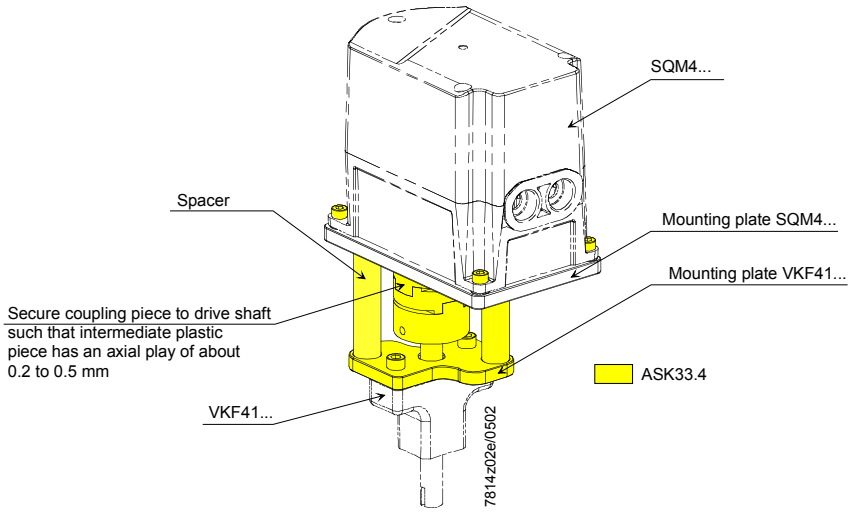
Working range of actuator

The working range is given on the type field and must be observed when mounting the actuator. To ensure the actuator is accurately located on the burner, a positioning pin of 6 mm diameter must be fitted on the mounting surface.

IP 54

To ensure **degree of protection IP 54,** suitable Pg glands must be fitted in the actuator's Pg11 openings.
The Pg glands used must feature cable strain relief.
To ensure degree of protection IP 54 during the actuator's entire service life, the bearing of the drive shaft must be located such that it will not be directly exposed to water or dust.

Mounting example



Installation notes

- Installation work must be carried out by qualified staff
- Always run the high-voltage ignition cables separate from the unit and other cables while observing the greatest possible distance
- To ensure protection against electric shock hazard, make certain that the AC 230 V section of the SQM4... is strictly segregated from the functional low-voltage section
- The holding torque is reduced when the actuator's power supply is switched off

Housing cover

⚠

The housing cover may only be removed for short periods of time for wiring or when making the addressing. It must be made certain that dust or dirt will not get inside the actuator while such work is carried out.

ESD

⚠

The actuator contains a printed circuit board with ESD-sensitive components.
The top side of the board carries a cover which affords protection against direct contact. This protective cover may **not** be removed! The underside side of the board may not be touched.

Addressing

Addressing (assignment of functions) defines whether the SQM4... shall operate as a

- fuel actuator
- air damper actuator, or
- auxiliary actuator,

and is made with the display and operating unit AZL... and the addressing button on the actuator, which is located under the housing cover (refer to Basic Documentation P7550).
The correct assignment of actuator functions can be checked with the help of flashing LEDs.

Cable length
Topology

For the maximum permissible cable length, refer to the Basic Documentation.
Cabling must be strictly serial (**no branching permitted!**).

Commissioning notes

- Commissioning work must be carried out by qualified staff

Standards

Conformity to EEC directives

- Electromagnetic compatibility EMC (immunity)	89 / 336 EEC
- Low-voltage directive	73 / 23 EEC

Service notes

- Maintenance work must be carried out by qualified staff
- Each time an actuator has been replaced, check to ensure that wiring is in an orderly state and that the wires are firmly connected

Replacement

When replacing an actuator, the following points must be checked and, if necessary, corrected:

- Addressing (assignment of functions)
- Bus termination
- Adjustment of the curvepoints of electronic fuel / air ratio control (e.g. with the LMV51...)

Disposal notes

The actuator contains electrical and electronic components and may not be disposed of together with household waste.
Local and currently valid legislation must be observed.

Mechanical design

Housing

The housing is made of die-cast aluminium.
The cover is made of impact-proof and heat-resistant plastic.

Color of cover: Black

Actuator

Stepper motor

Adjustment of switching points / position indication

In connection with the basic unit (e.g. LMV51...): Via the display and operating unit AZL5X (refer to Basic Documentation P7550).

Electrical connections

RAST3.5 terminals (supplied together with the AGG5.720 / AGG5.721).

Geartrain

SQM45...: Spur gears made of plastic with small backlash and permanent lubrication.
SQM48...: Spur gears made of steel with small backlash and permanent lubrication.

Drive shaft

Made of black-finished steel, ready fitted to the front of the geartrain (SQM48... uses a drive shaft made of hardened steel).

Mounting and fixing

The front of the geartrain is used as the mounting surface. The actuator has 4 fixing holes and 1 elongated hole for the positioning pin.
Alternatively, the actuator can be secured from the side of the controlling element with 3 self-tapping screws.

Type summary

Actuators SQM4...

Type reference	Drive shaft 1)	Running time (min.) for 90°	Nominal torque (max.)	Holding torque 2) (max.)	Radial bearing force (max.)
	no.	s	Nm	Nm	N
SQM45.291A9	1	10	3 3)	1.5	190
SQM45.295A9	5	10	3 3)	1.5	190
SQM48.497A9	7	30	20 4)	20	420
SQM48.697A9	7	60	35 4)	35	800

Legend

1) Refer to «Dimensions»
2) With operating voltage applied
3) Under nominal conditions. Under extreme conditions (below –15 °C ambient temperature), the available torque is about 15 % lower
4) Under nominal conditions. Under extreme conditions (above +50 °C ambient temperature), the torque is about 15 % lower

Ordering

When ordering, please give type references of actuator and accessories according to «Type summary».

In addition to the actuator, the following item is to be ordered **separately** and is also supplied as a separate item:

- Shielded cable
- Special terminals RAST3.5 as part of the AGG5.720 / AGG5.721 set

Accessories

Accessories must be ordered as separate items.

Adapter for gas valves VKF41...C **ASK33.4**

Connecting cables **AGG5.6...**
- **Only the specified cables may be used!**
- Refer to Basic Documentation P7550

Technical data

Actuator	Operating voltage	AC 2 x 12 V via bus cable from the basic unit or via a separate transformer
	Safety class	extra low-voltage with safe isolation from mains voltage
	Power consumption	
	- SQM45...	9...15 VA
	- SQM48...	26...34 VA
	On time	50 %, max. 3 min. continuously
	Angular adjustment	max. 90°
	Mounting position	optional
	Degree of protection	to EN 60 529, IP 54, provided adequate cable entries are used
	Cable entry	SQM45... / SQM48...: insertable threaded cable glands for 2 x Pg11
	Electrical connections	RAST3.5 terminals (for details, refer to the basic unit)
	Ferrules	matching the dia. of the stranded wire
	Direction of rotation	can be selected on the basic unit
	Torques and holding torques	refer to «Type summary»
	Reproducibility (typically in the show-room condition)	± 0.2° (when used with the basic unit LMV51...)
	Running times	refer to «Type summary» (can be selected on the basic unit)
	Load changes with continuous heavy loads	
	- SQM45... / SQM48.497	typically 500,000
	- SQM48.697	typically 300,000
	Weight	
	- SQM45...	approx. 1 kg
	- SQM48...	approx. 1.6 kg
	Direction of rotation (when facing the shaft)	
	- Standard	counterclockwise
	- Reverse	clockwise
Environment conditions	**Transport**	DIN EN 60 721-3-2
	Climatic conditions	class 2K2
	Mechanical conditions	class 2M2
	Temperature range	-20...+70 °C
	Humidity	< 95 % r.h.
	Operation	DIN EN 60 721-3-3
	Climatic conditions	class 3K5
	Mechanical conditions	class 3M2
	Temperature range	-20...+60 °C
	Humidity	< 95 % r.h.

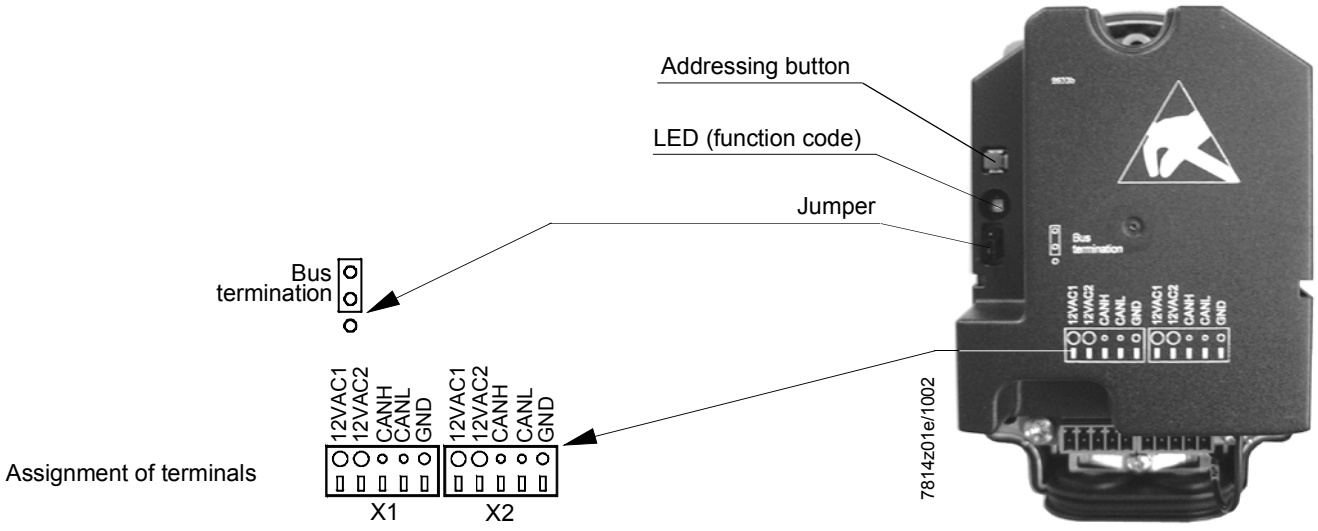
⚠ **Condensation, formation of ice and ingress of water are not permitted!**

Function

The SQM45... / SQM48... are of robust design and have a geartrain with only small backlash.
Control and position feedback take place via a bus system (CAN).
The bus cable is also used for powering the actuators.
The actuators are driven by stepper motors and can be positioned with a resolution of 0.1°.
The characteristics and settings (running time, direction of rotation, limit positions) of the SQM4... are determined by the controlling basic unit (e.g. LMV5...; for details, refer to the Basic Documentation of the LMV...).
The running times of the associated controlling elements are varied by the basic unit depending on the burner's control phase (e.g. startup phase: short running time; operation: long running time).

Terminating resistor

At the end of the serial bus cabling, a terminating resistor must be fitted.
For that purpose, a jumper must be set to BUS TERMINATION on the last actuator of the bus cable, which will activate the resistor.
On all the other actuators, that jumper must be set to the other position (deactivated).



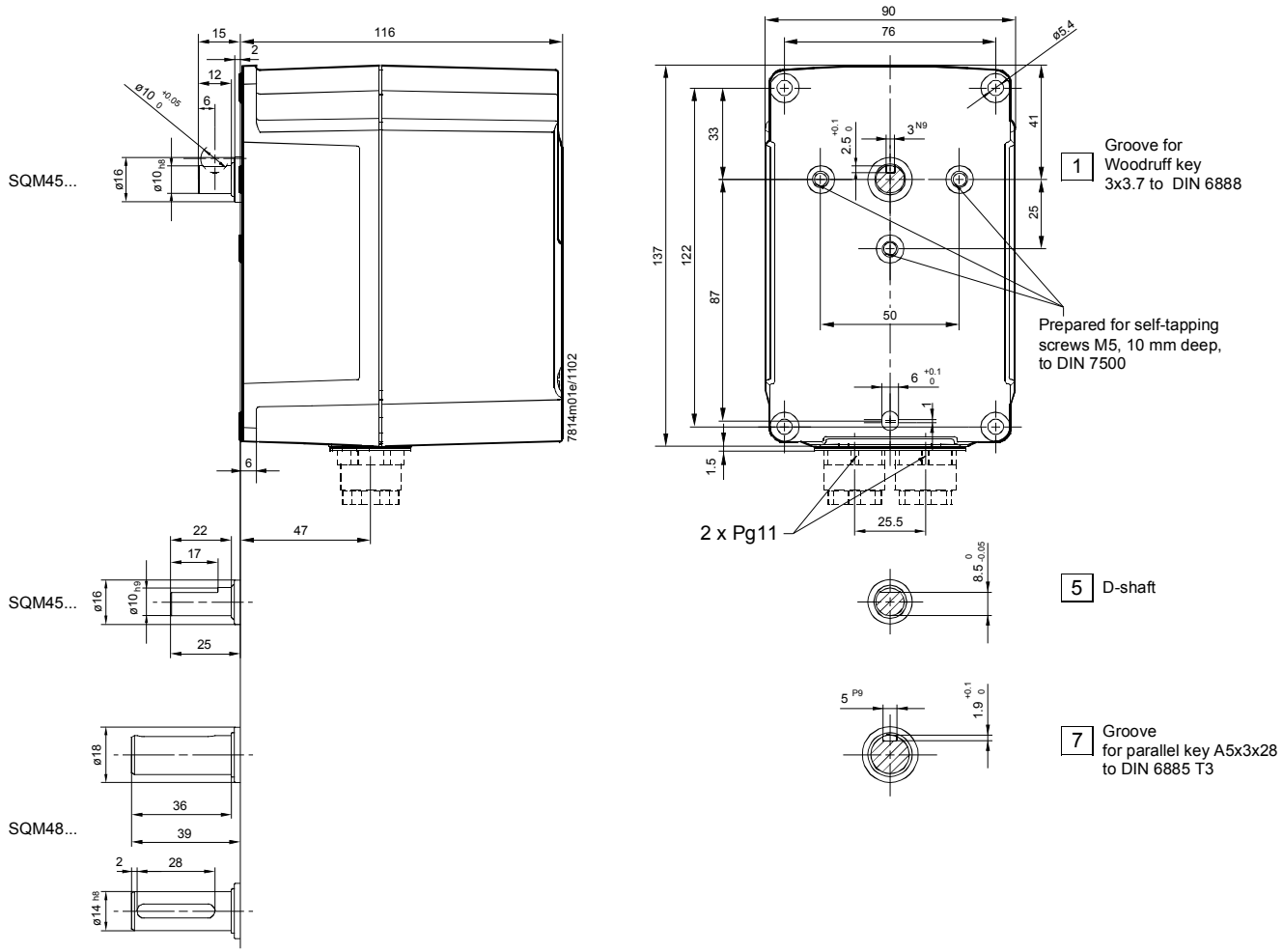
Assignment of terminals

The 2 terminal blocks (X1 and X2) are identical.

Dimensions

Dimensions in mm

SQM45... / SQM48...



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SCC Inc.

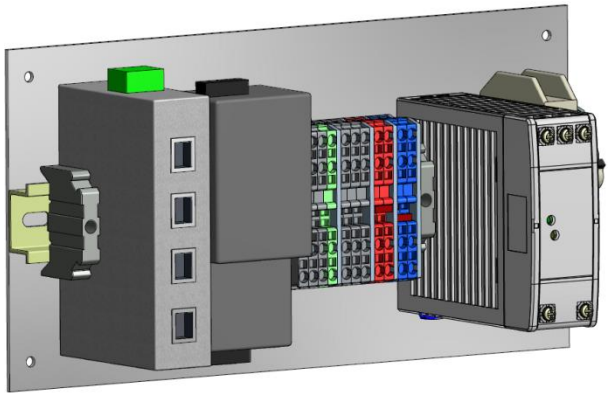
Technical Instructions

Document No. TS-6000

March 15, 2016

TS Series

TS… Protocol Converter
for use with LMV3..., LMV5.., RWF… and TS… Series Controls



Description

A TS… series protocol converter provides a flexible communication interface to the building management system (BMS) for streamlined data collection and monitoring.

Features

- Converts native Modbus/RTU to BACnet/IP, BACnet MS/TP, Metasys N2, Modbus TCP/IP or LonWorks
- Allows simultaneous connection of up to 64 devices via serial connections and up to 12 devices via Ethernet Modbus TCP/IP connections
- Easily configured using web browser
- 61 data points per LMV3...
- 153 data points per LMV5...
- 13 data points per RWF10
- 57 data points per RWF40
- 73 data points per RWF55
- 364 data points per TS Series Touchscreen Kit
- 23 data points per TS Series Lead/Lag Master
- 85 data points per TS Series Lead/Lag Master (each boiler)
- 52 data points per TS Series Deaerator/Surge Tank Master

Application

TS… protocol converter kits are suited for applications when a BMS protocol other than Modbus TCP/IP or RTU is required. All SCC products that natively communicate using Modbus/RTU are compatible.

Components

All TS… protocol converter kits include the following components:

- Protocol converter module
- Plate kit including power supply and branch circuit protection
- Interconnect terminals for field wiring
- Field port for various protocols

The following options are available:

- Host Port for Modbus RTU RS232
- Host port for Modbus RTU RS485
- Ethernet switch to support up to 12 TS… series devices via Ethernet TCP/IP to BMS

Product Part Numbers

See Table 1 for available kits for protocol converter part number identification. .

TS - P X 2 - X

Touchscreen

Protocol Converter

FIELD Port

X = RS-485 FIELD port.
Supports: BACnet/IP
BACnet MS/TP
Metasys N2
Modbus TCP/IP

L = LonWorks FIELD port.
Supports: LonWorks

HOST Port

2 = RS-232 HOST port.
Supports: One(1) LMV5...

4 = RS-485 HOST port. (for up to 64 Devices)
Supports: LMV3... (via OCI412.10)
LMV5... (via TS-5X-KT)
RWF10, RWF55, RWF40

Ethernet Switch
(Host Port option 4 above must selected)

Supports all TS series…Lead Lag Master Panel, Touchscreen Kits, Combustion Enclosures, and Deaerator/Surge Panels.

X = None included
3 = 5-port switch (For up 3 TS series devices)
6 = 8-port switch (For up to 6 TS series devices)
9 = 13-port switch (For up 9 TS series devices)
12 = 16-port switch (For up 12 TS series devices)

Product Part Numbers (continued)

Table 1: TS… Protocol Converter Part Numbers

	FIELD Port		HOST Port		Ethernet Switch				
Part Number	RS-485	LonWorks	RS-232	RS-485	None	5-port	8-port	13-port	16-port
TS-PX2-X	x		x		x				
TS-PX4-X	x			x	x				
TS-PX4-3	x			x		x			
TS-PX4-6	x			x			x		
TS-PX4-9	x			x				x	
TS-PX4-12	x			x					x
TS-PL2-X		x	x		x				
TS-PL4-X		x		x	x				
TS-PL4-3		x		x		x			
TS-PL4-6		x		x			x		
TS-PL4-9		x		x				x	
TS-PL4-12		x		x					x

Specifications

Physical characteristics	Operating Voltage	110-120 VAC
	Operating Frequency	50-60 HZ
	Protocessor power	24 VDC
	Power consumption	24 VA
Operating environment	Operating temperature	32 to 131 °F [0 to 55 °C]
	Humidity	Max. 85% with no condensation

Dimensions

TS-PX2-X

LMV5 Modbus RTU to: BACnet/IP, BACnet MS/TP, Metasys N2, or Modbus TCP/IP

TS-PL2-X

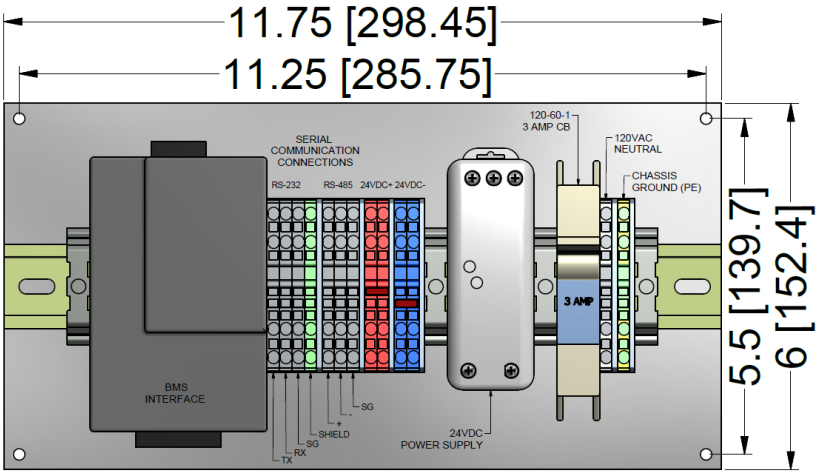
LMV5 Modbus RTU to: LonWorks

TS-PX4-X

LMV3, LMV5, RWF10, RWF40, and/or RWF55 to:
BACnet/IP, or BACnet MS/TP, or Metasys N2, or Modbus TCP/IP

TS-PL4-X

LMV3, LMV5, RWF10, RWF40, and/or RWF55 to: LonWorks



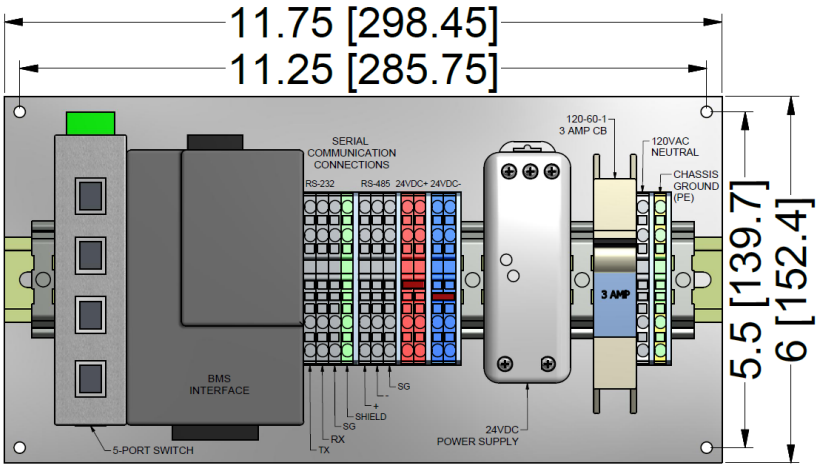
Dimensions (continued)

TS-PX4-3

Up to 3 TS…Series Modbus TCP/IP to: BACnet/IP, or BACnet MS/TP, or Metasys N2

TS-PL4-3

Up to 4 TS…Series Modbus TCP/IP to: LonWorks

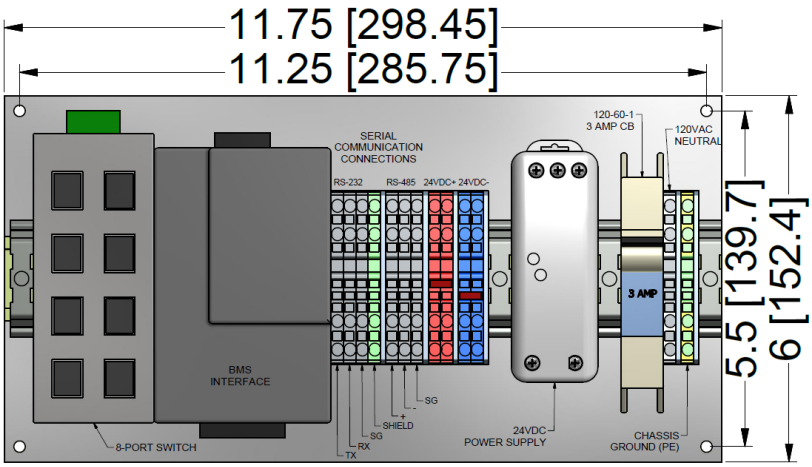


TS-PX4-6

Up to 6 TS… Series Modbus TCP/IP to: BACnet/IP, or BACnet MS/TP, or Metasys N2

TS-PL4-7

Up to 6 TS… Series Modbus TCP/IP to: LonWorks



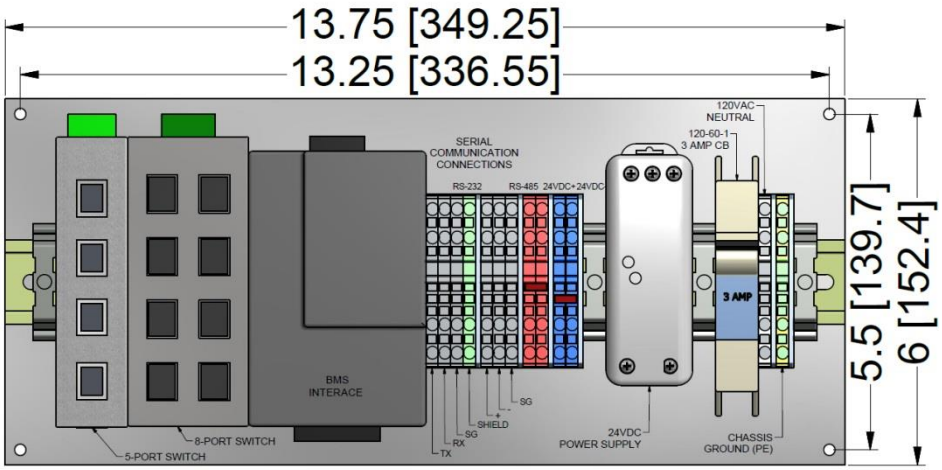
Dimensions (continued)

TS-PX4-9

Up to 9 TS… Series Modbus TCP/IP to: BACnet/IP, or BACnet MS/TP, or Metasys N2

TS-PL4-10

Up to 9 TS… Series Modbus TCP/IP to: LonWorks

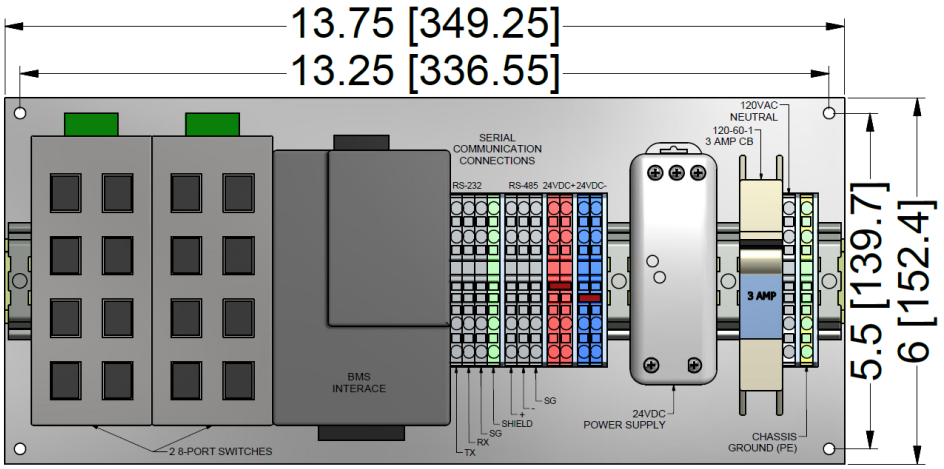


TS-PX4-12

Up to 12 TS… Series Modbus TCP/IP to: BACnet/IP, or BACnet MS/TP, or Metasys N2

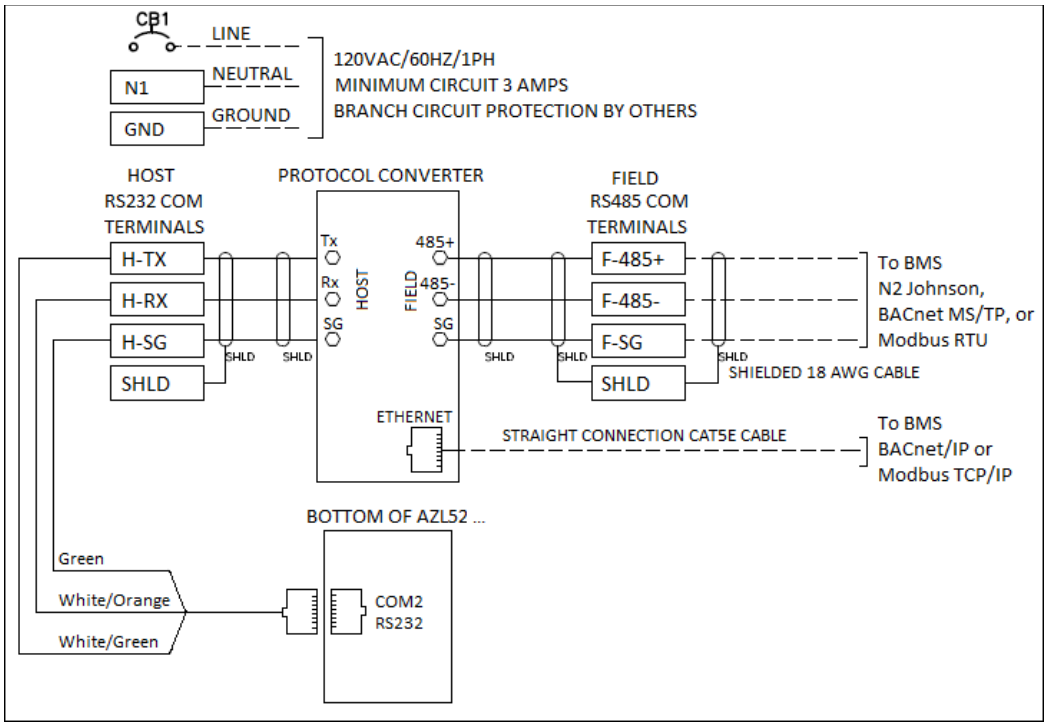
TS-PL4-13

Up to 12 TS… Series Modbus TCP/IP to: LonWorks

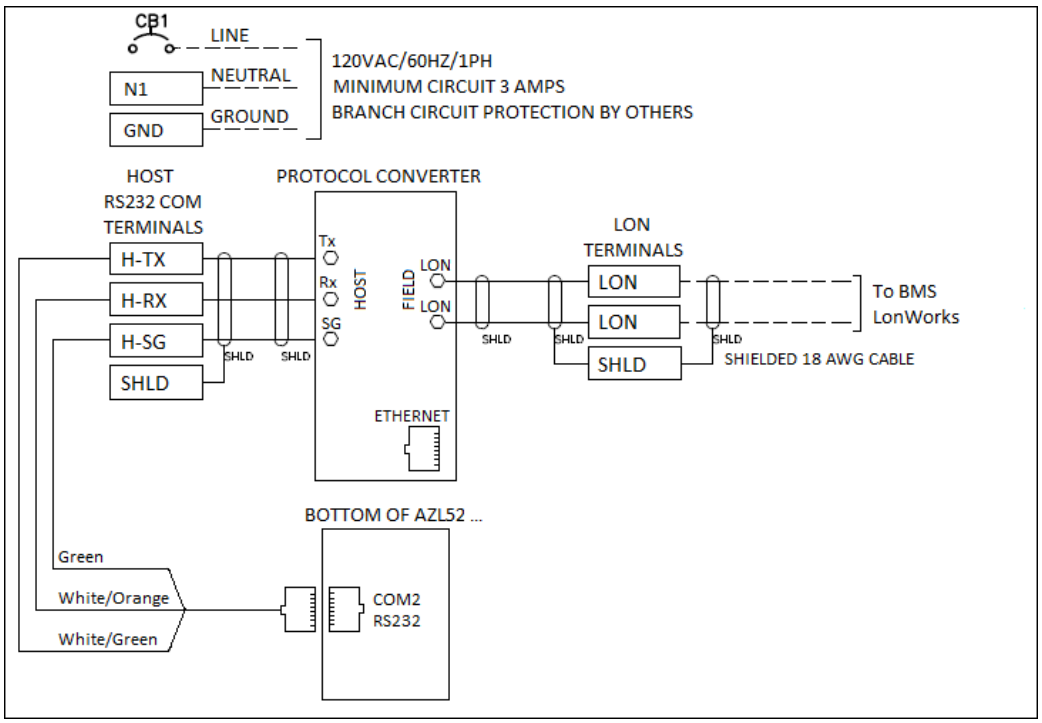


Connections

TS-PX2-X (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)

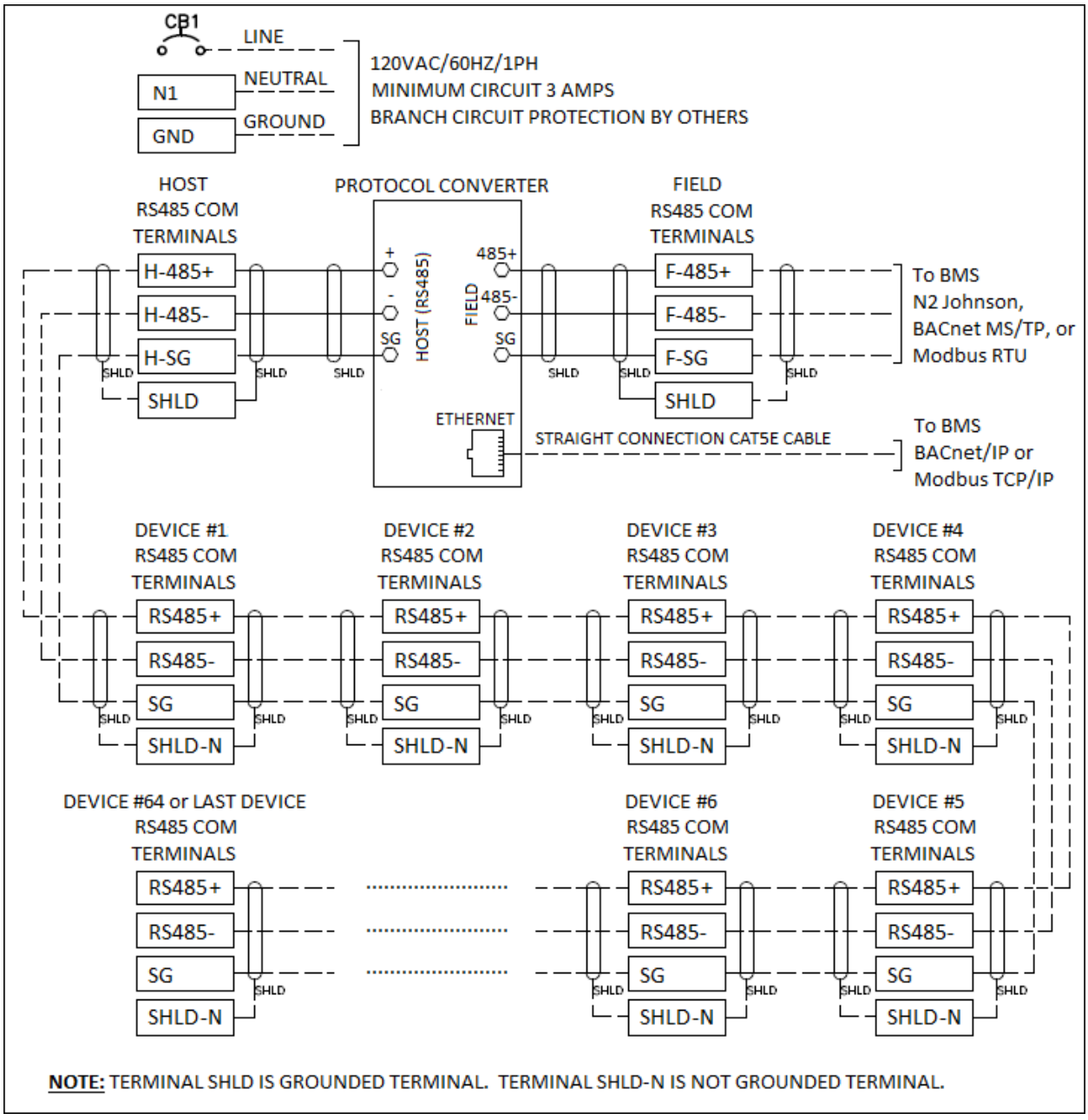


TS-PL2-X (LonWorks)



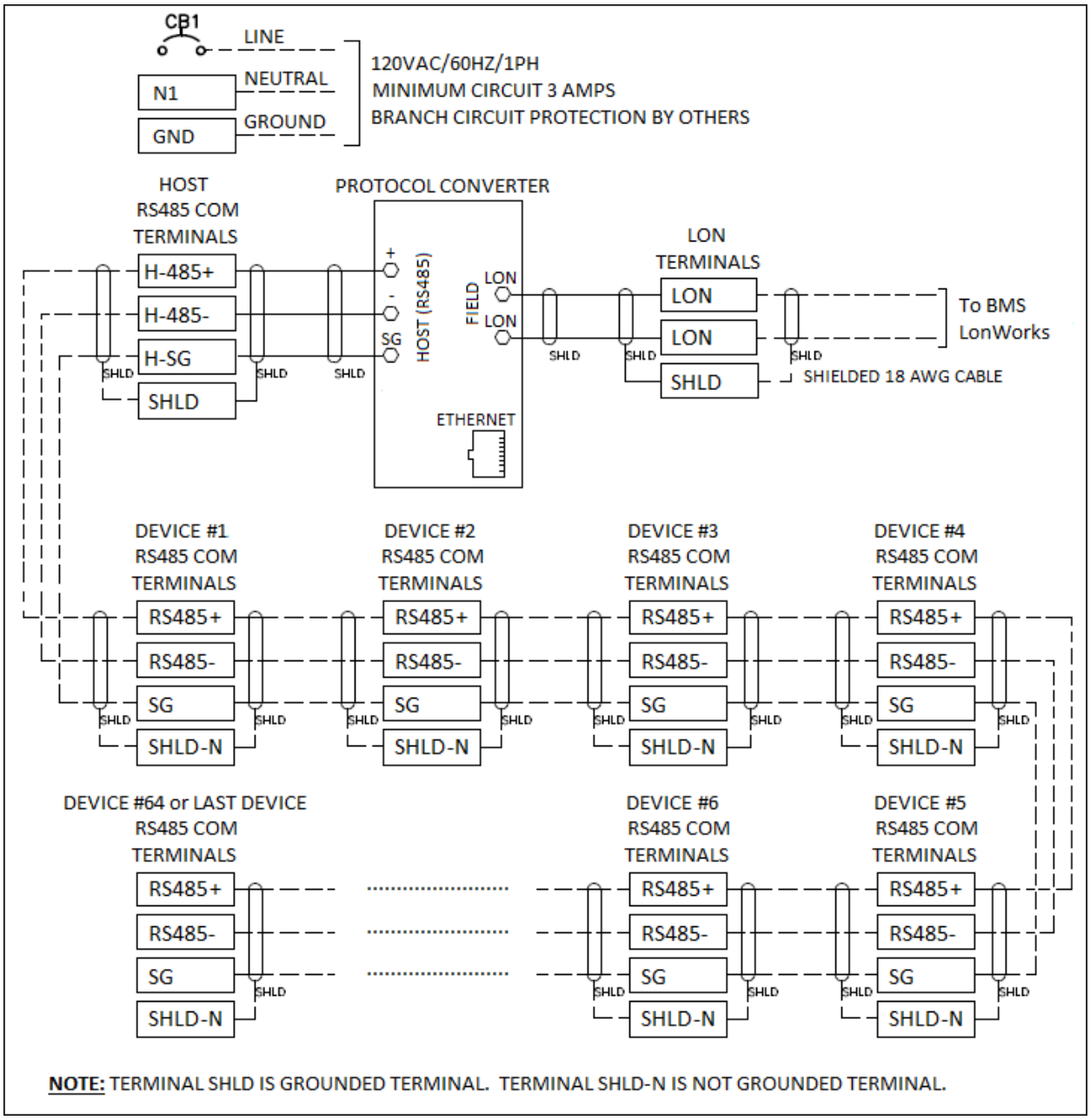
Connections (Continued)

TS-PX4-X (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



Connections (Continued)

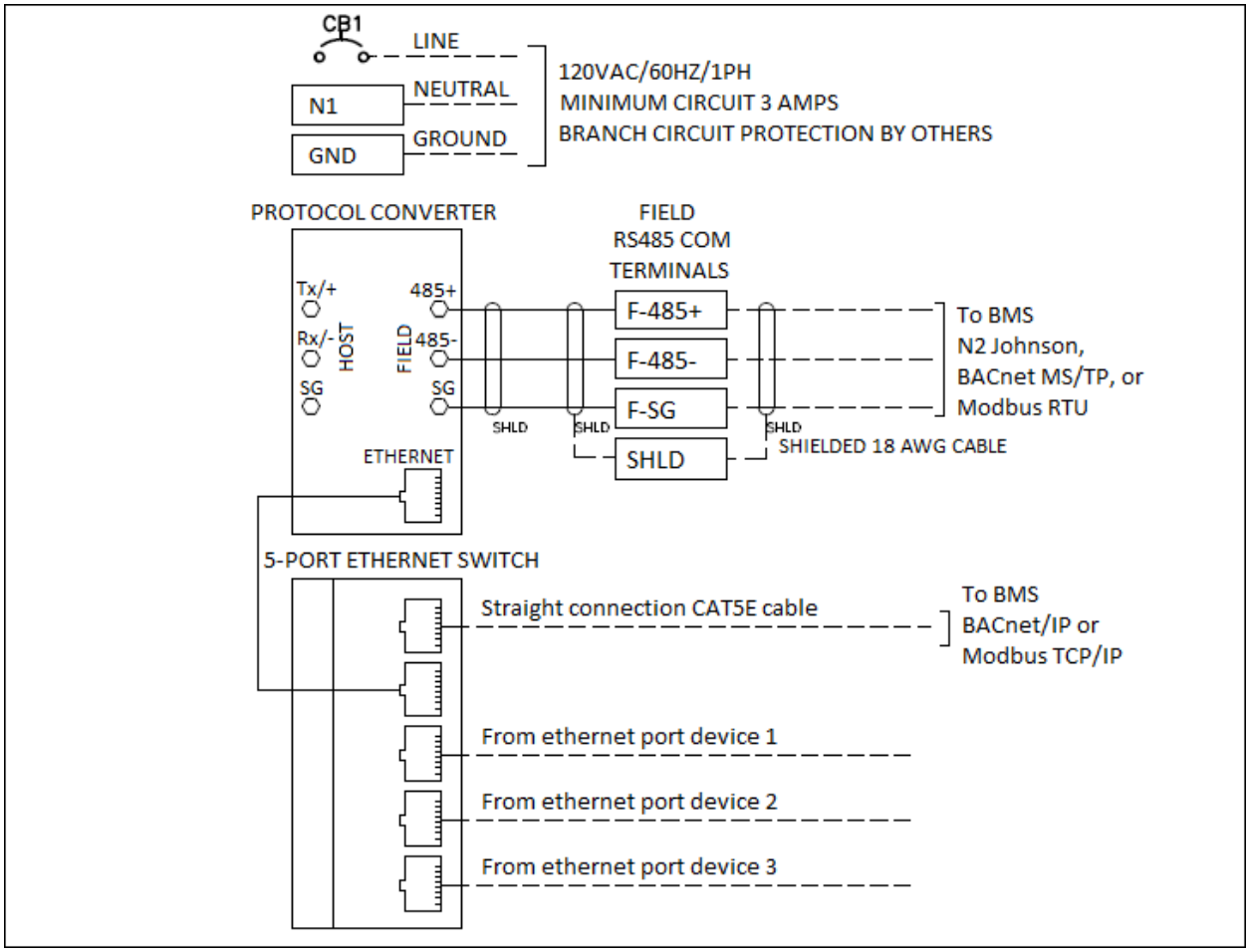
TS-PL4-X (LonWorks)



NOTE: TERMINAL SHLD IS GROUNDED TERMINAL. TERMINAL SHLD-N IS NOT GROUNDED TERMINAL.

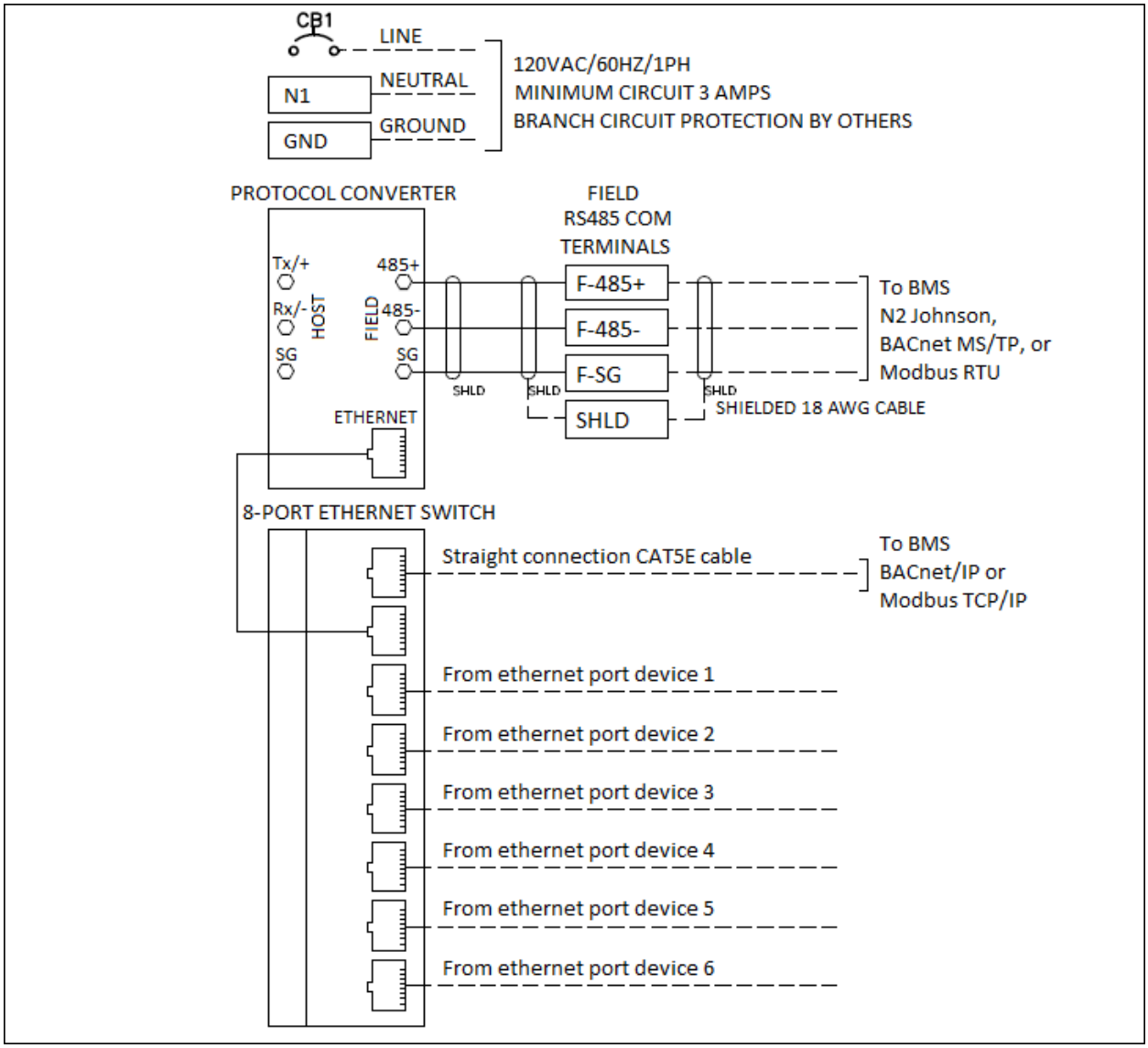
Connections (Continued)

TS-PXx-3- 5 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



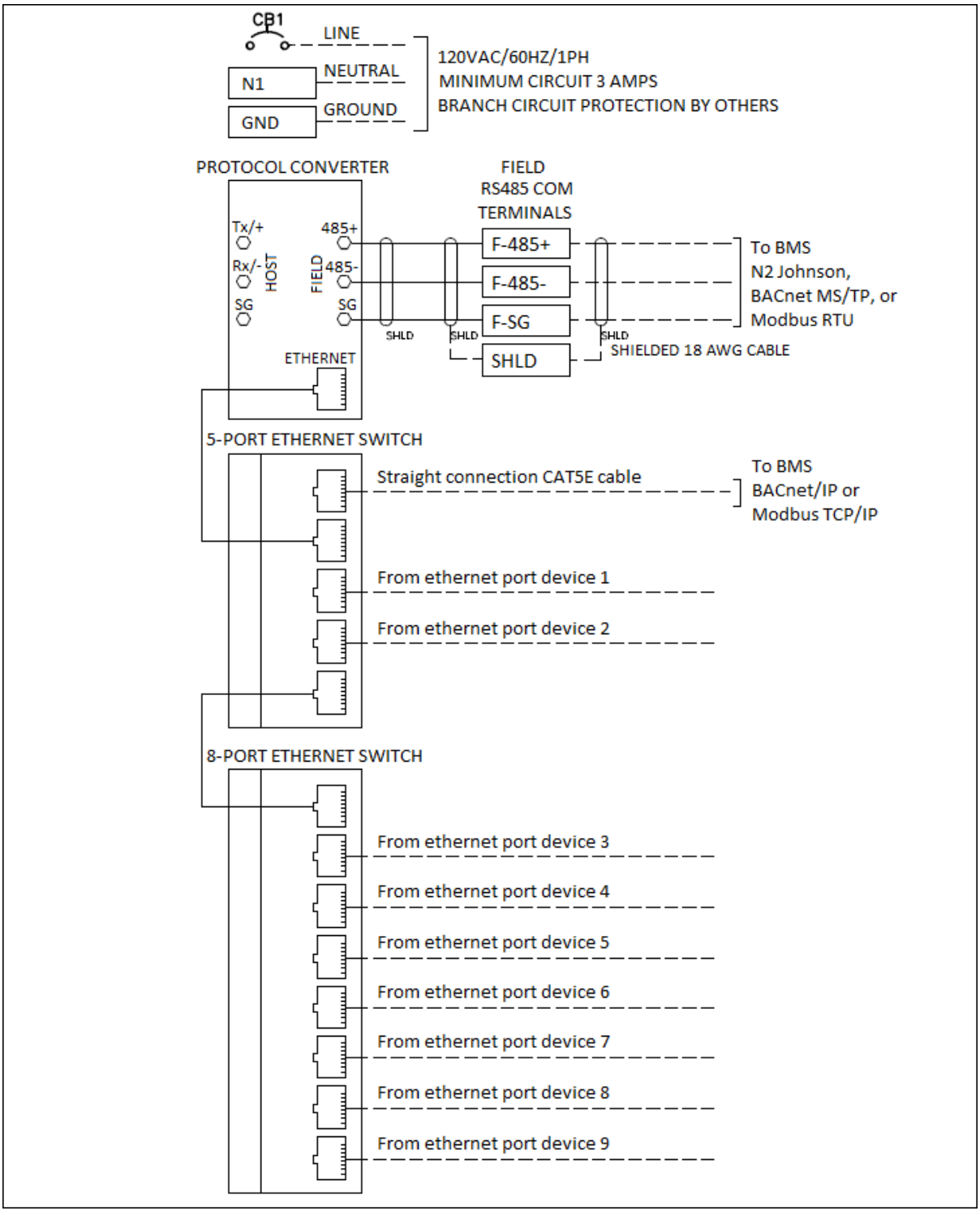
Connections (Continued)

TS-PXx-6 – 8 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



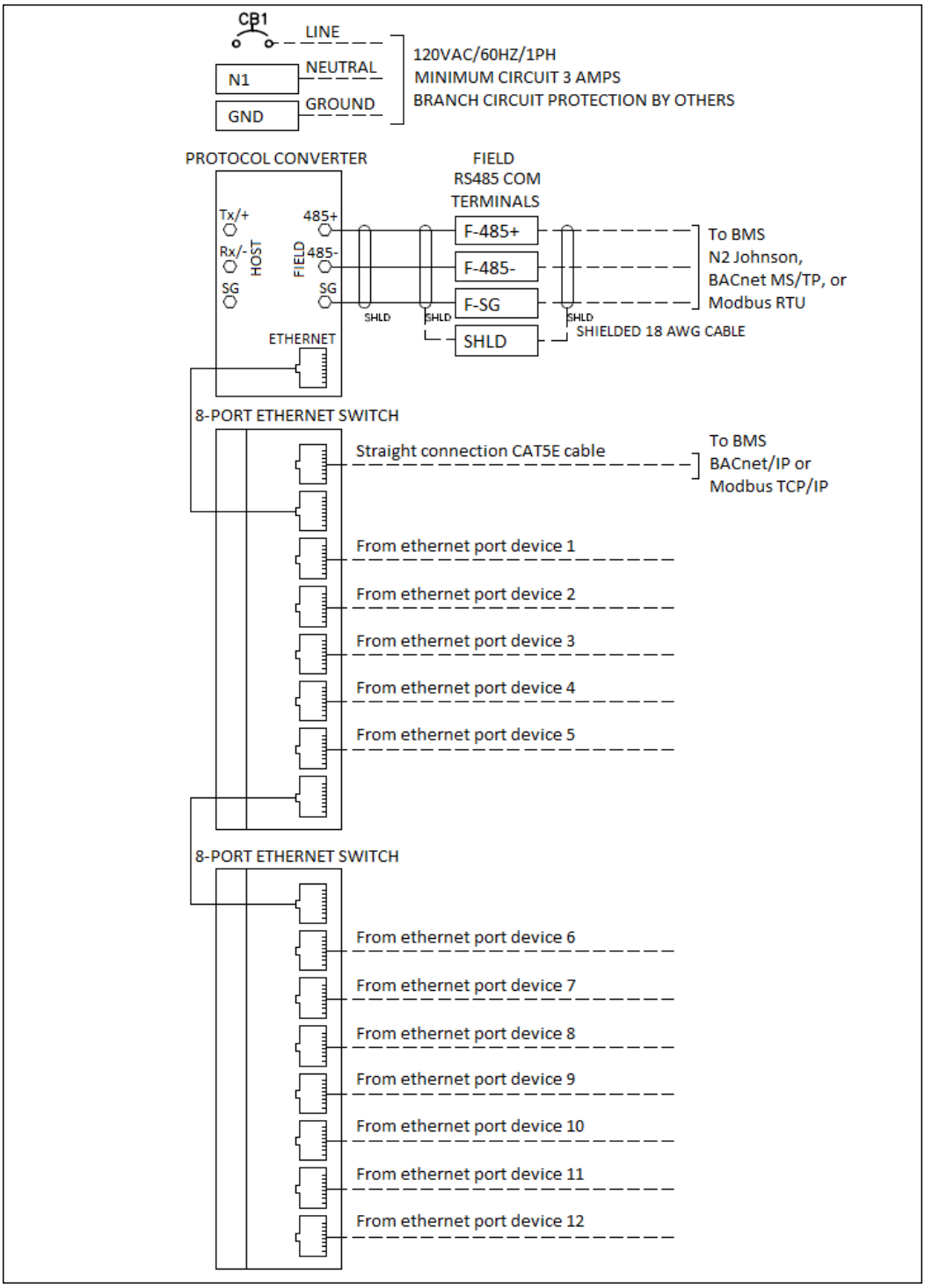
Connections (Continued)

TS-PXx-9- 13 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



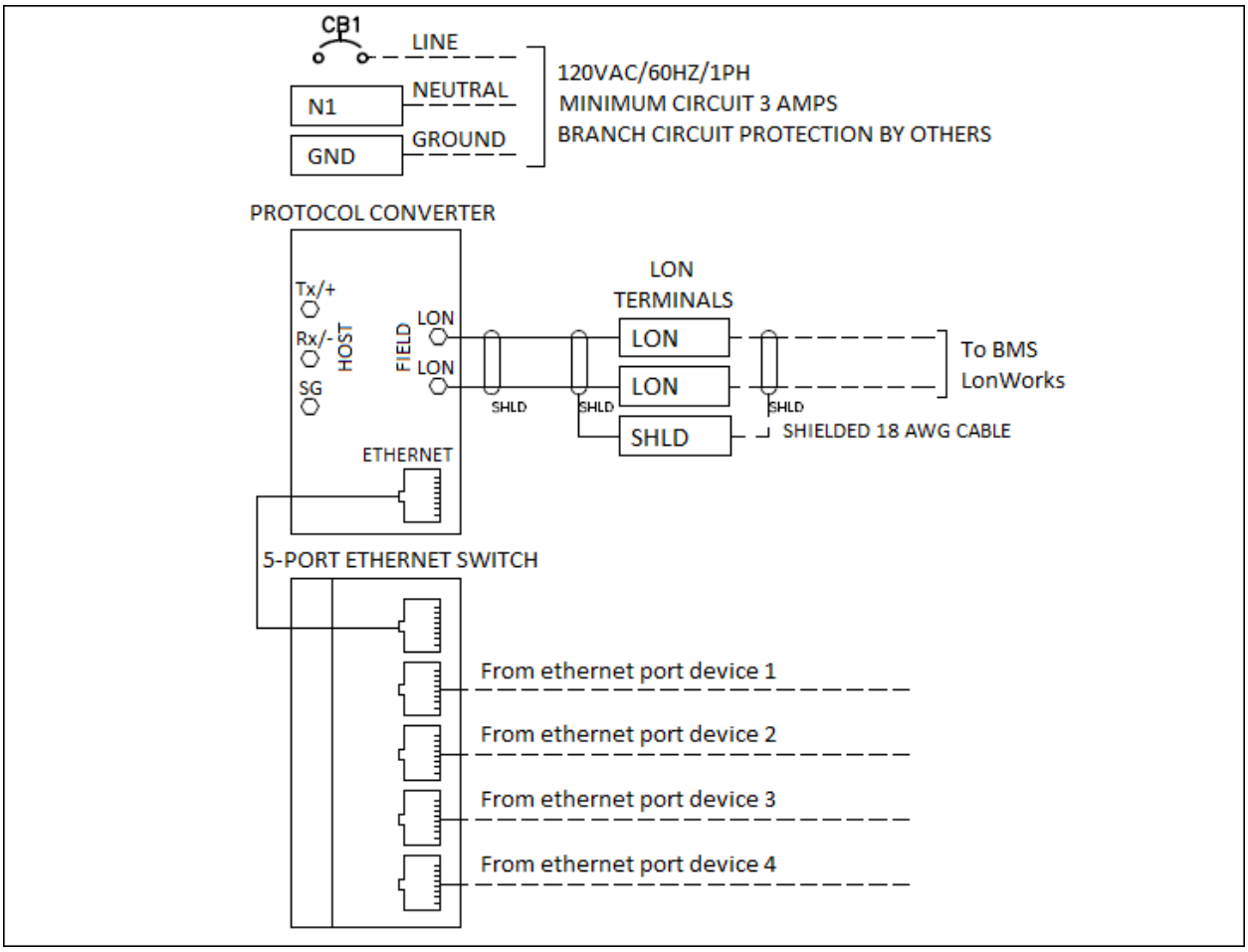
Connections (Continued)

TS-PXx-12- 16 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



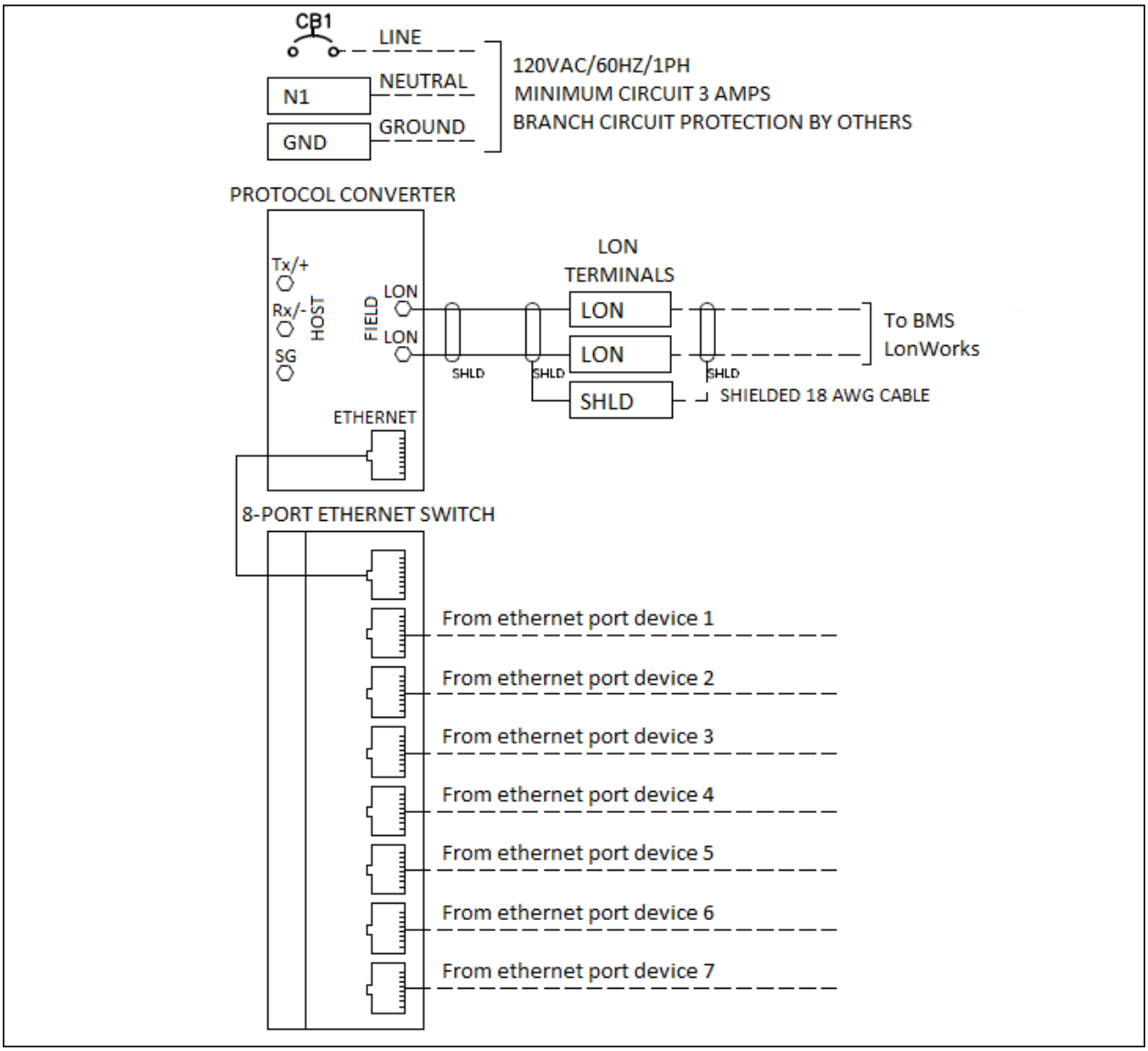
Connections (Continued)

TS-PLx-3- 5 Port Ethernet Switch (LonWorks)



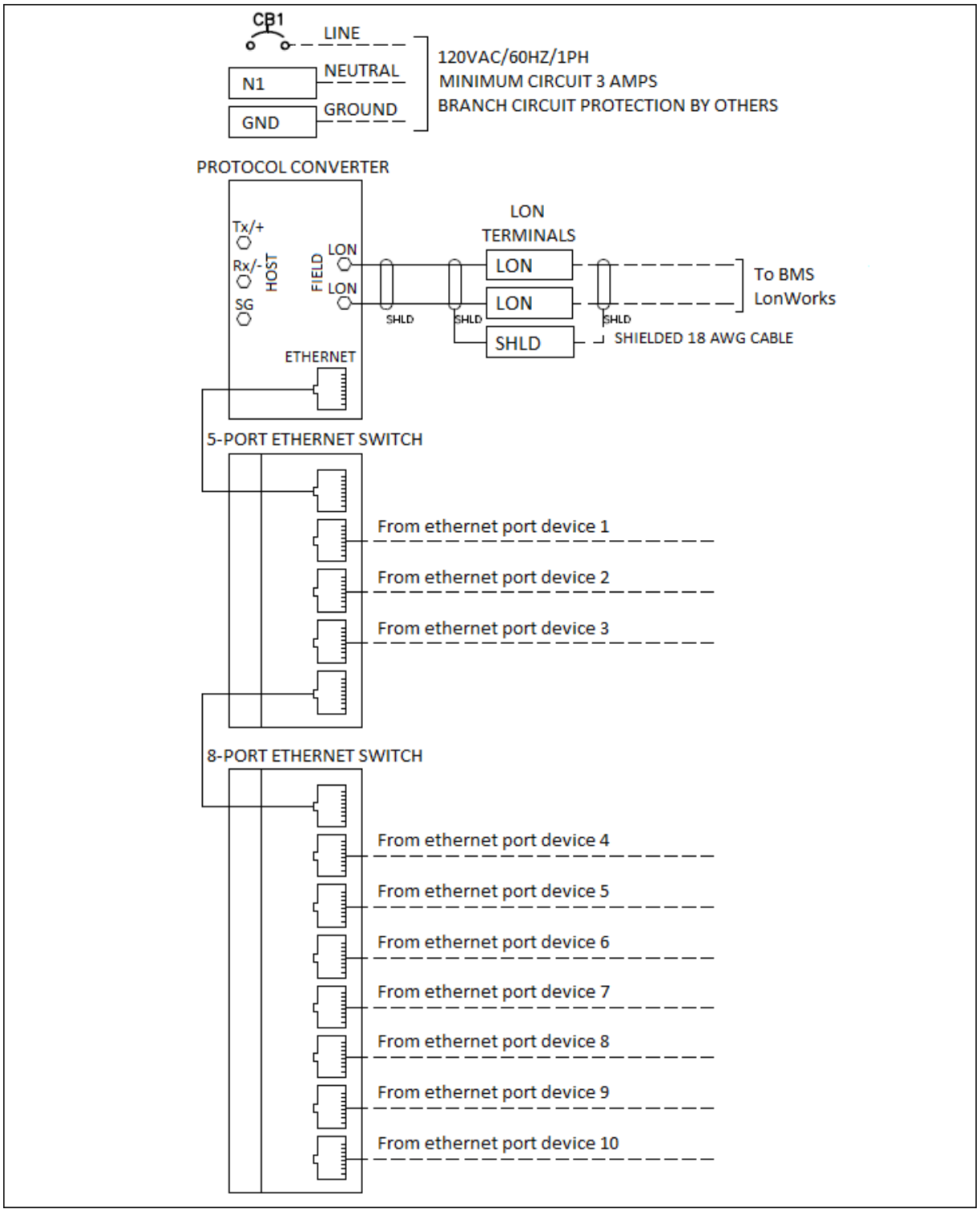
Connections (Continued)

TS-PLx-6 - 8-Port Ethernet Switch (LonWorks)



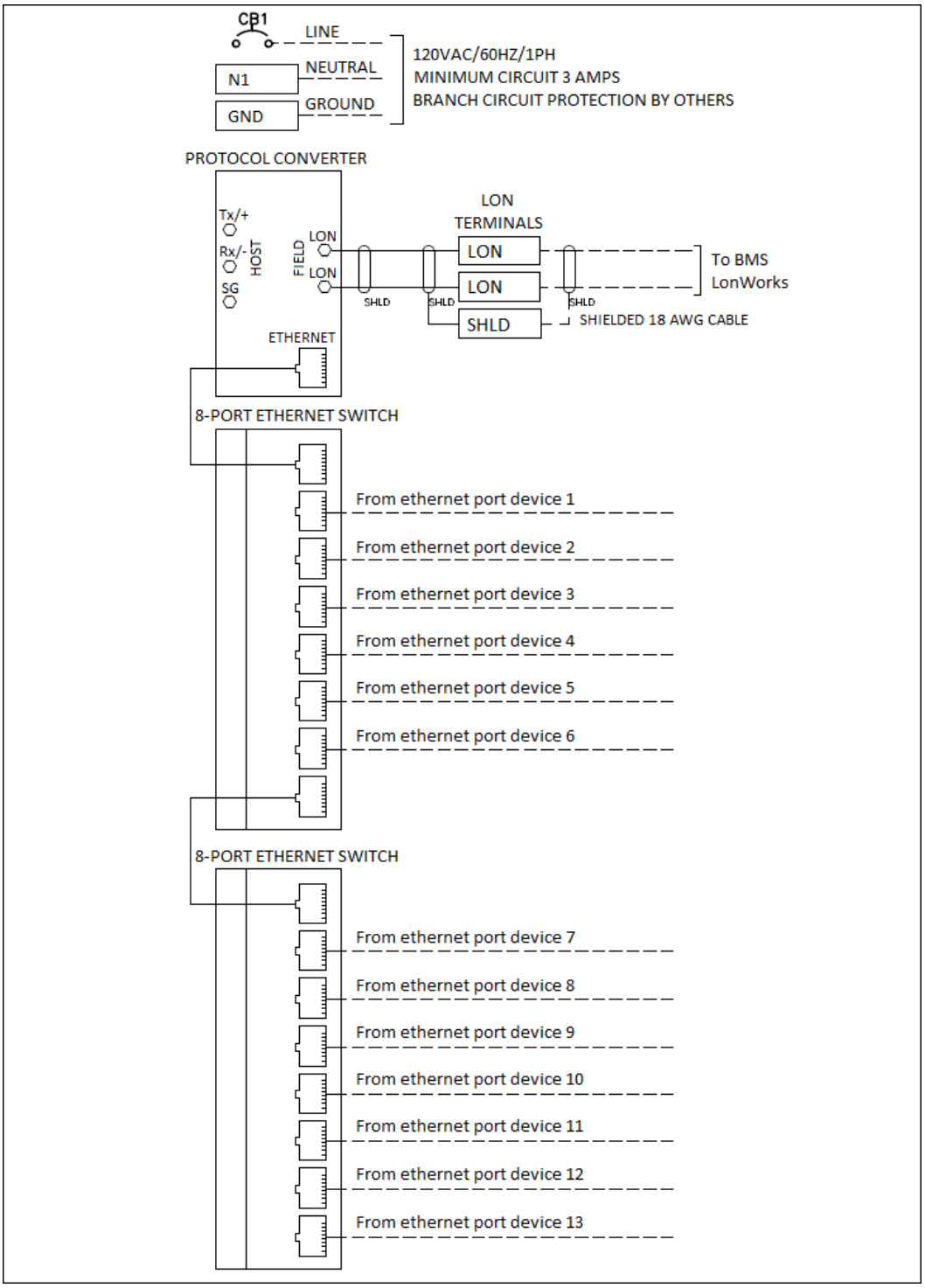
Connections (Continued)

TS-PLx-9 – 13 Port Ethernet Switch (LonWorks)



Connections (Continued)

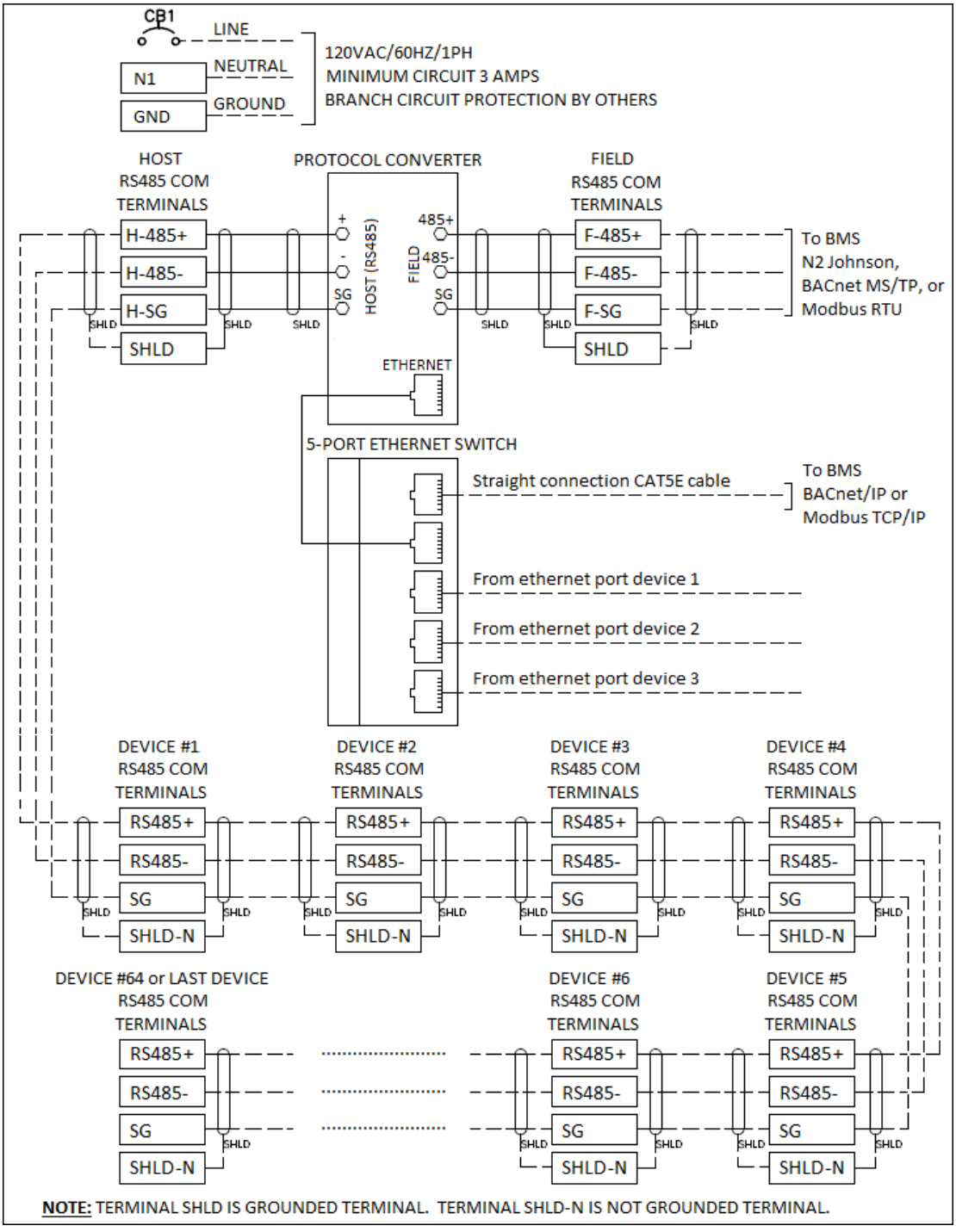
TS-PLx-12 – 16 Port Ethernet Switch (LonWorks)



Connections (Continued)

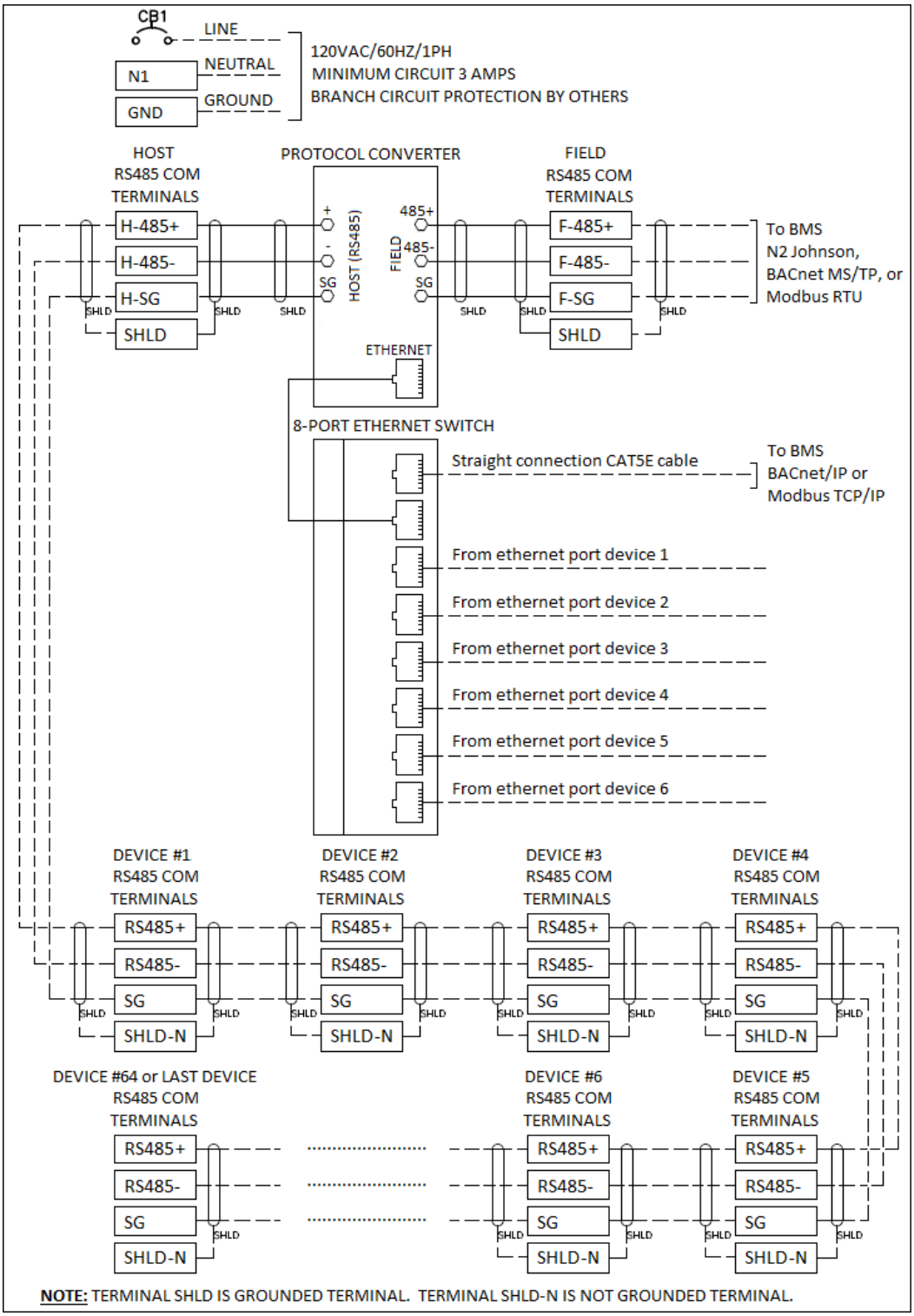
(Host: Ethernet and Serial)

TS-PX4-3- 5 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



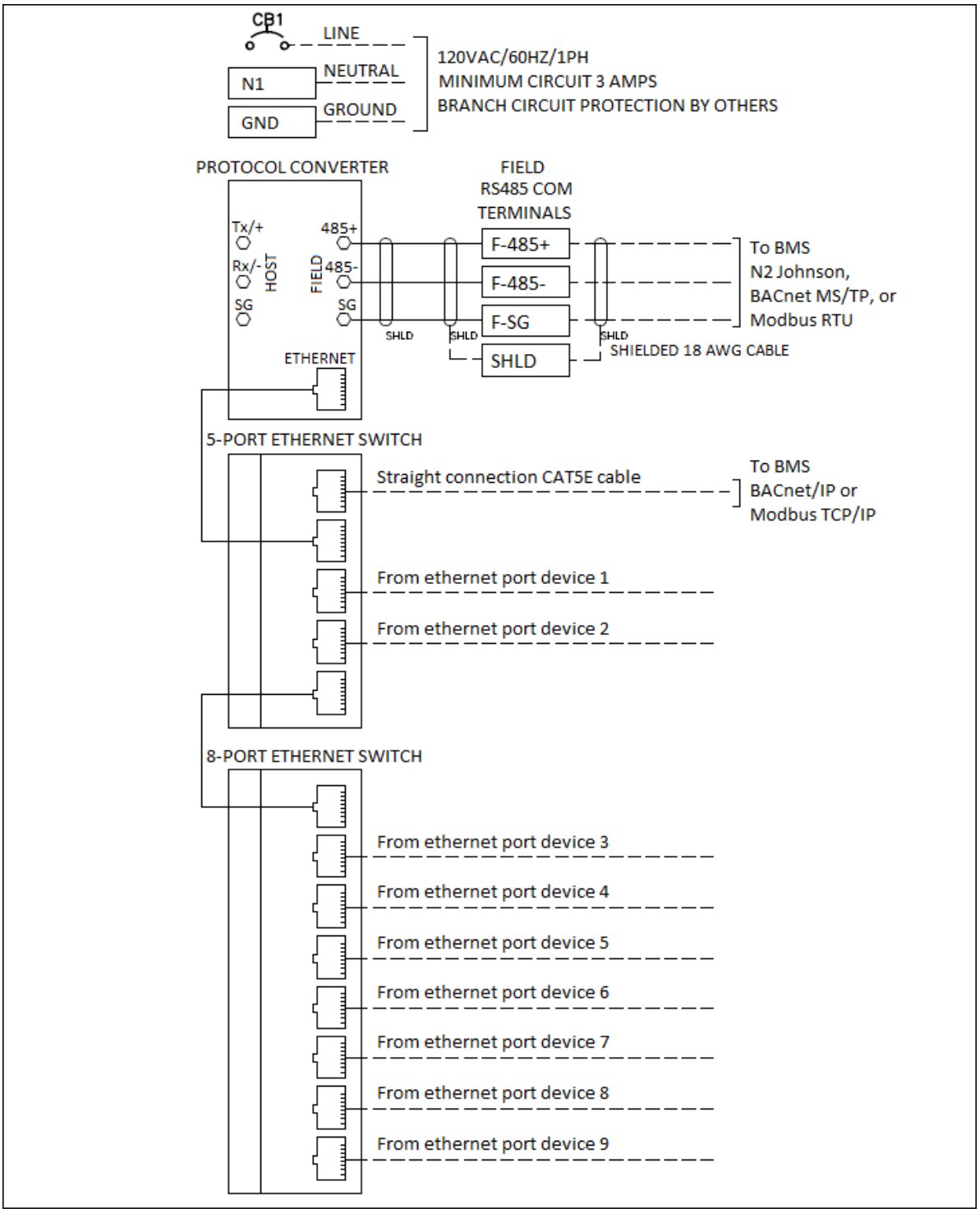
Connections (Continued)

TS-PX4-6 – 8 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



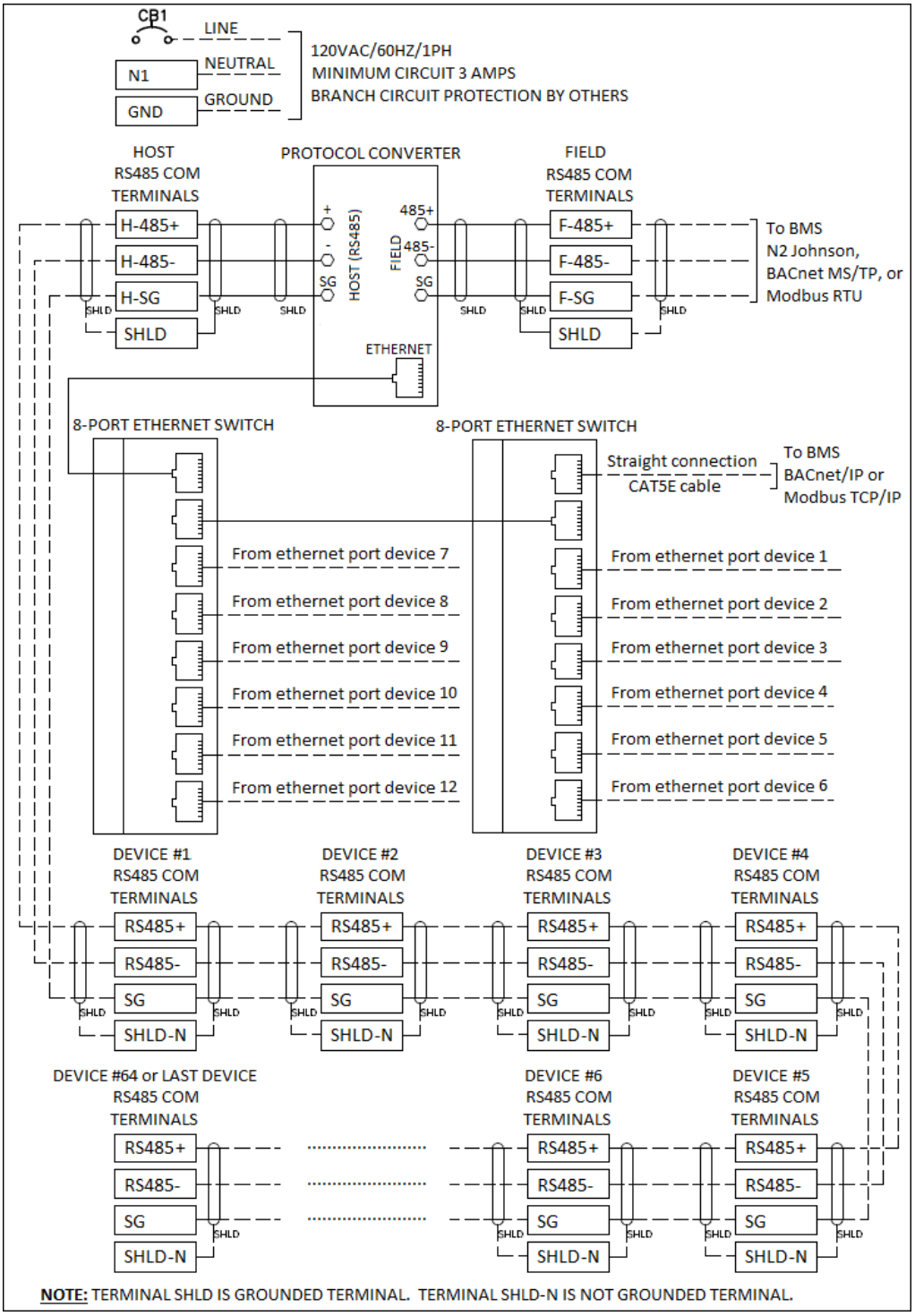
Connections (Continued)

TS-PX4-9- 13 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



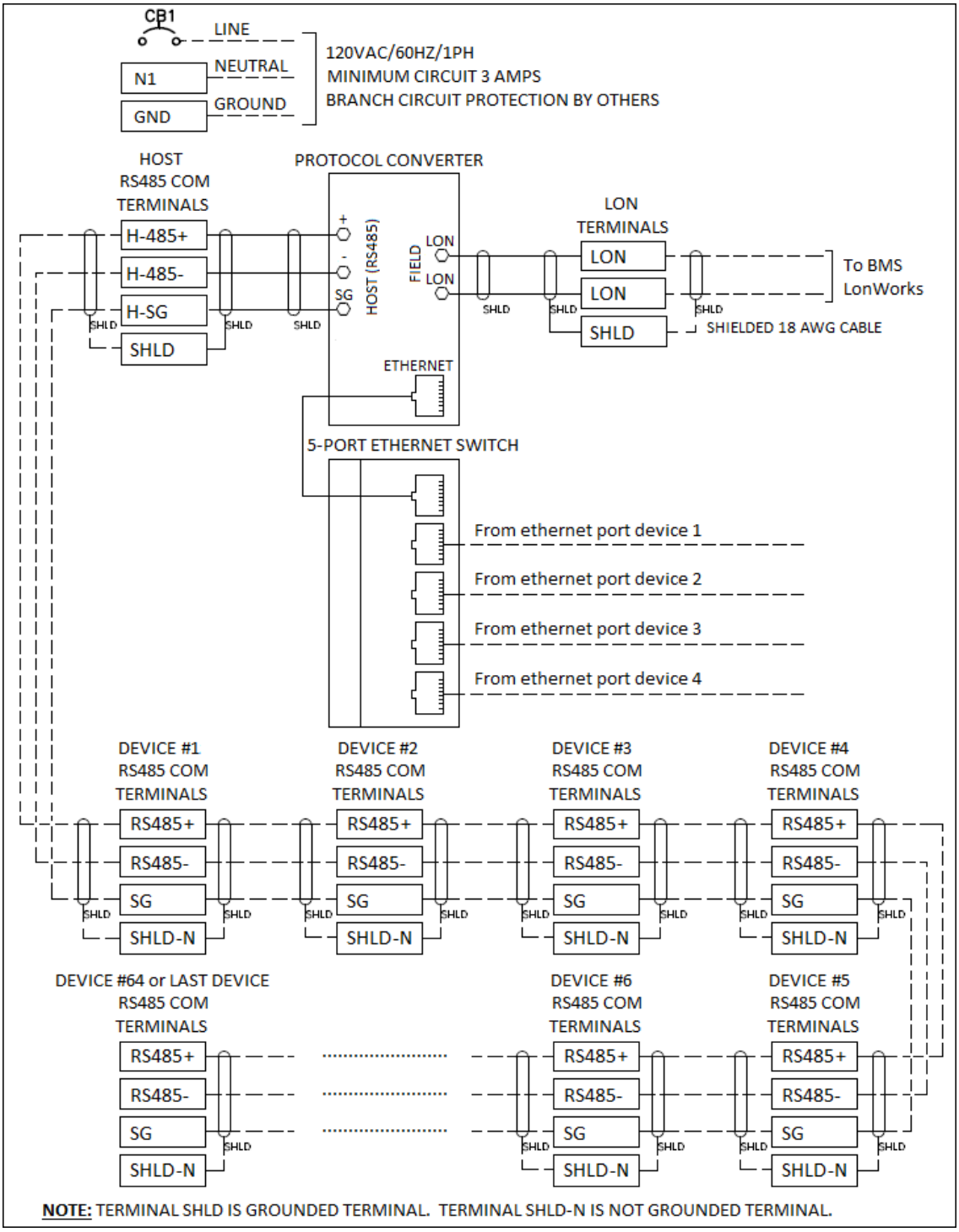
Connections (Continued)

TS-PX4-12- 16 Port Ethernet Switch (BACnet/IP, BACnet MS/TP, N2 Johnson or Modbus RTU)



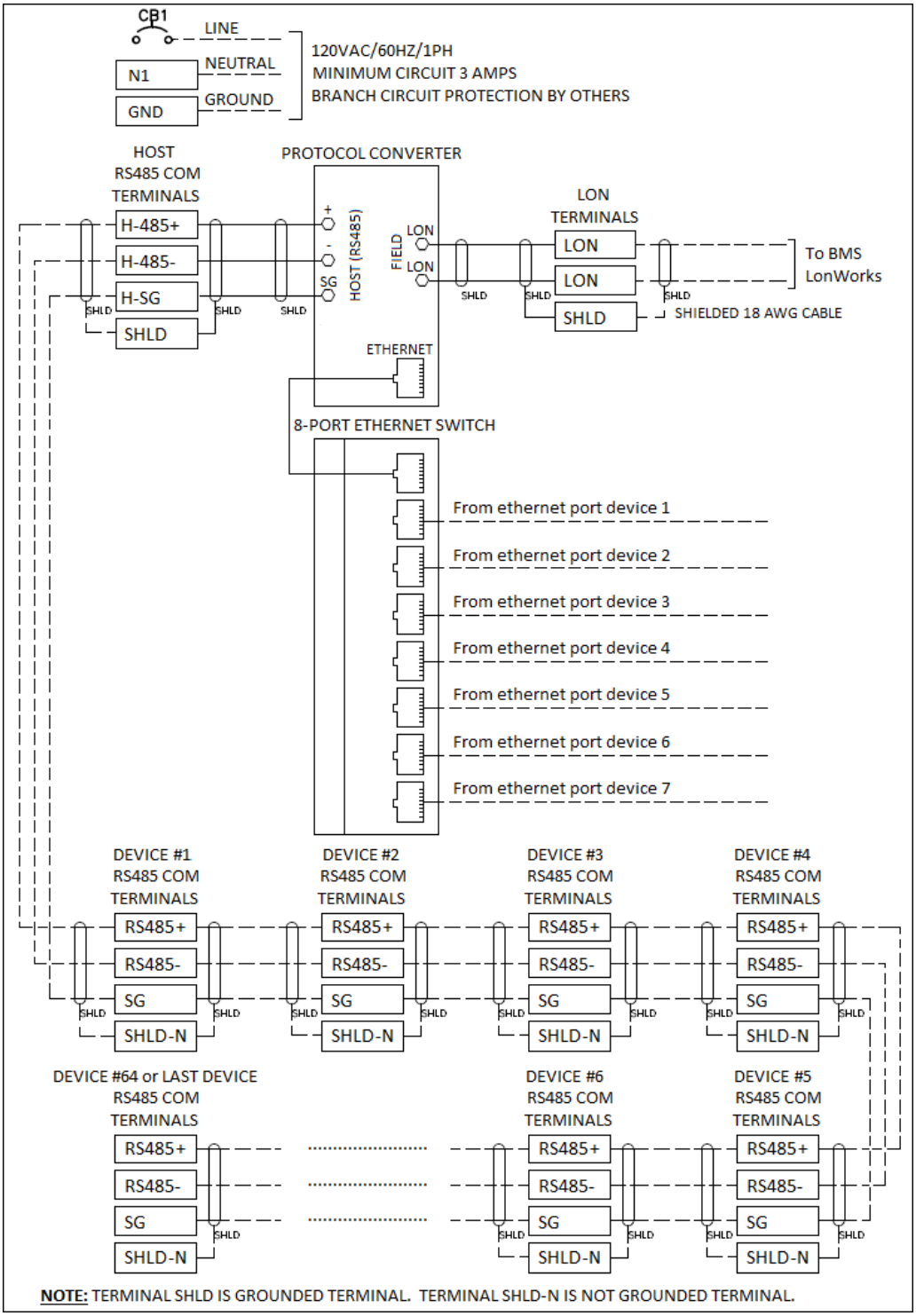
Connections (Continued)

TS-PL4-3- 5 Port Ethernet Switch (LonWorks)



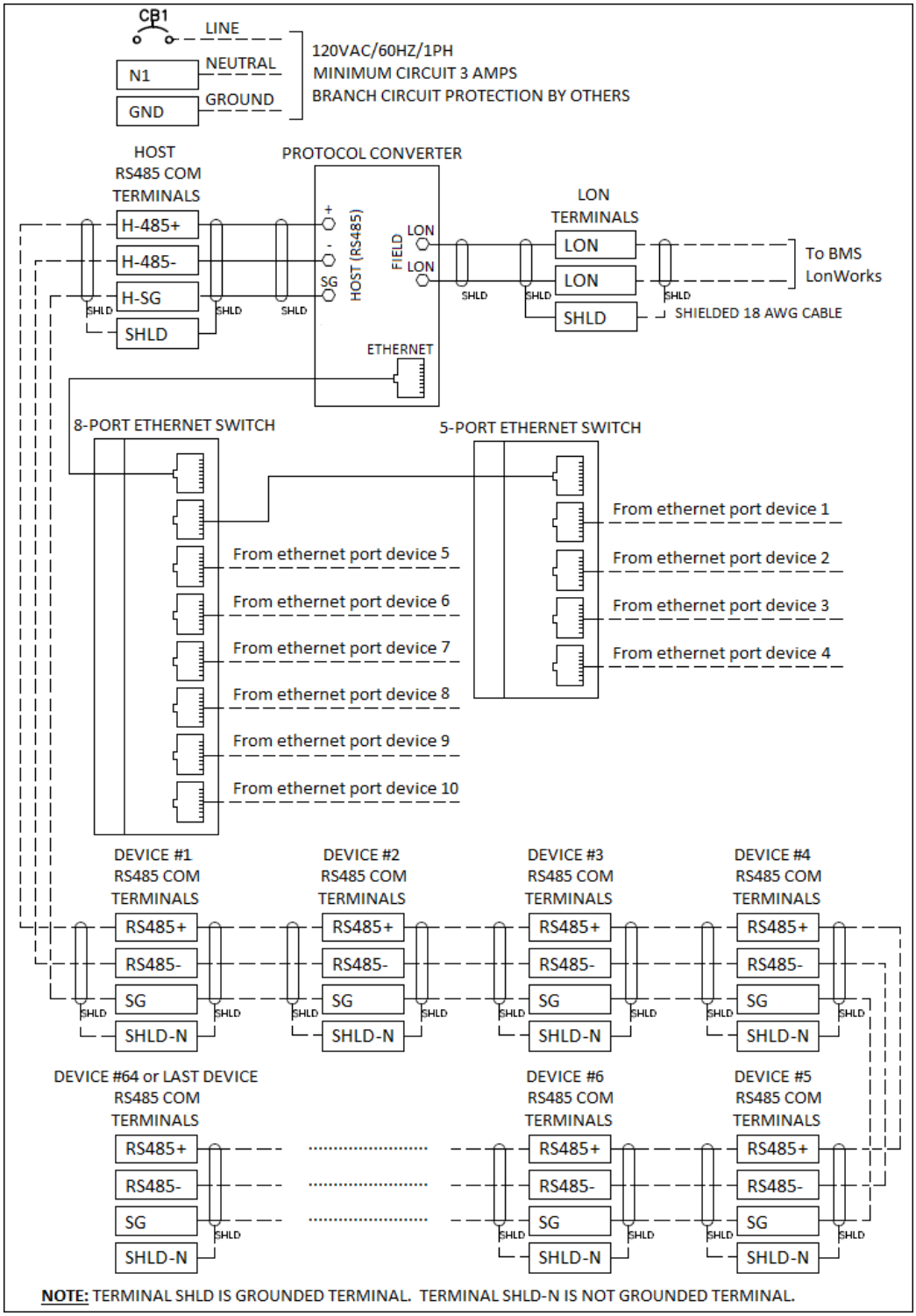
Connections (Continued)

TS-PL4-6- 8 Port Ethernet Switch (LonWorks)



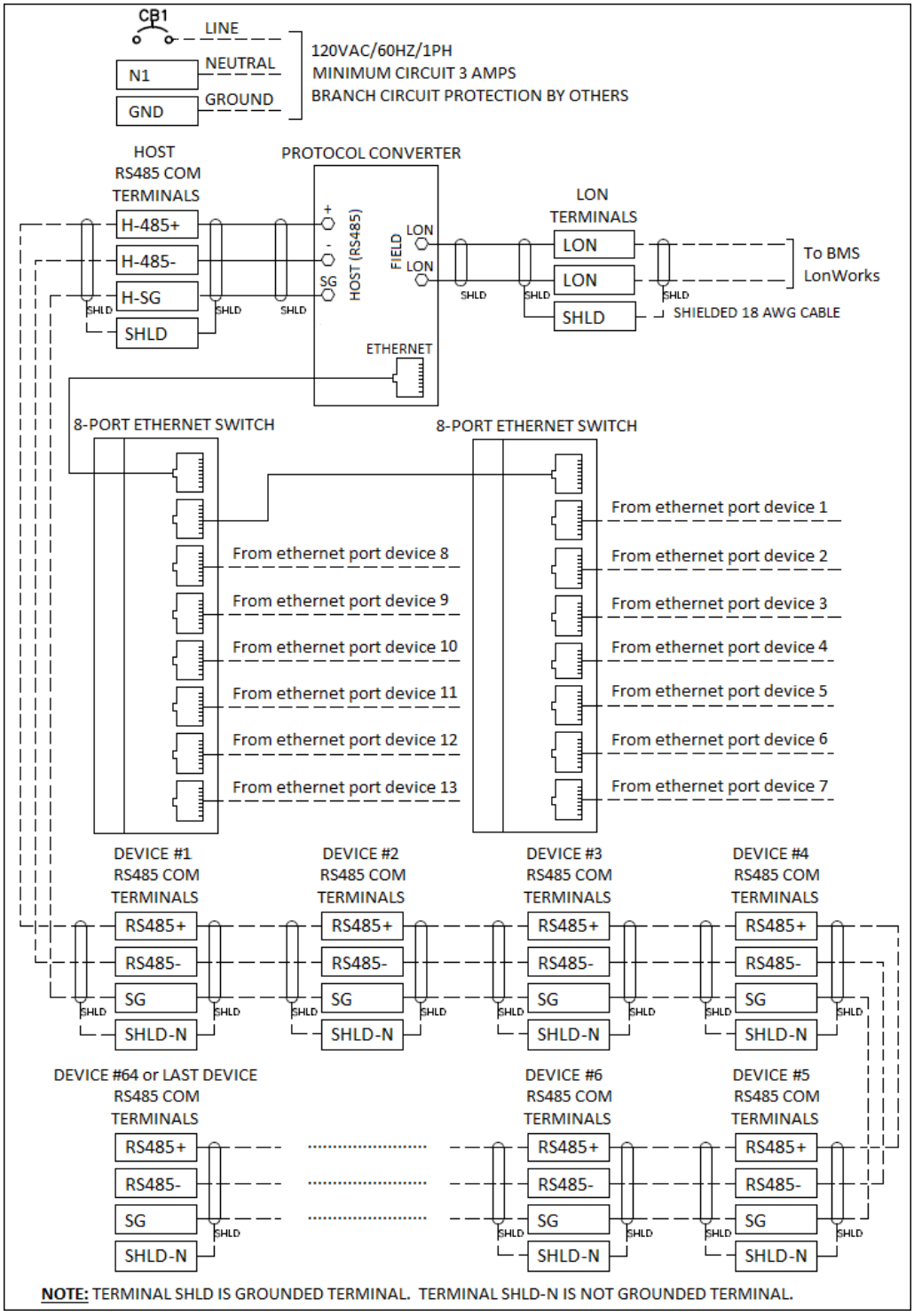
Connections (Continued)

TS-PL4-9- 13 Port Ethernet Switch (LonWorks)



Connections (Continued)

TS-PL4-12 – 16 Port Ethernet Switch (LonWorks)



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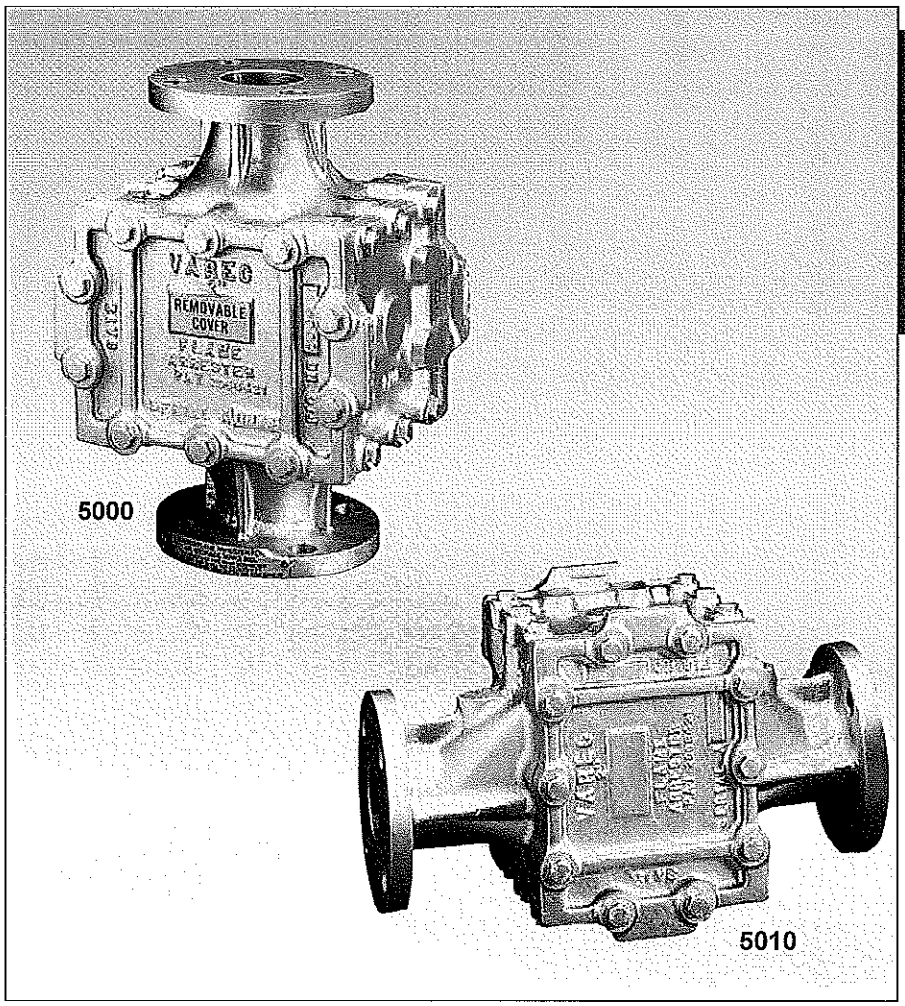
Varec

The 5000/5010 Series end-of-line flame arresters are used in gas piping systems, petroleum storage tank roofs and digester covers to prevent the propagation of a flame into the system.



INTRODUCTION

The VAREC 5000/5010 Series Flame Arresters are used in gas piping systems or on petroleum storage tank roofs or digester covers. They are designed to stop the propagation of flame (Group "D" gases) from external sources and can be mounted up to 15 feet upstream of the ignition source in accordance with UL Approval; or 10 pipe diameters in accordance with FM approval requirements.

5000 Series is for vertical installation. 5010 Series is for horizontal or vertical installation.

OPERATION

VAREC 5000/5010 Series Flame Arresters stop the propagation of a flame by absorbing and dissipating heat through the surface area of the bank sheets. Ignited vapor attempting to pass through the arrester is forced through small passages within the bank assembly. Heat is absorbed, lowering the temperature of the gas below its ignition point and quenching the flame.

DESIGN FEATURES

The net free area through all 5000 and 5010 Series Flame Arrester banks is three to four times the unit pipe size. The result is increased flow capacity with minimal pressure drop. The large surface area of the bank also improves heat dissipation.

VAREC 5000/5010 Series Flame Arresters are designed with a unique extensible aluminum bank frame (see photo on page 3). The corrugated sheets can be individually inspected and routinely cleaned without removal from the frame. Should the bank assembly require replacement, it slides easily out of the arrester, therefore, it is not necessary to jack apart the end housings or connecting piping.

Additionally, the unitized housing does not require support for proper bank alignment during maintenance as may be necessary with spiral bank arresters. This is especially useful in applications where frequent inspection and cleaning is anticipated.

The 5010 Series is designed with an "off-set" housing, providing an advantage over symmetrical housings and spiral bank designs. Generally, flow capacity is not affected by condensate accumulation, even when installed in horizontal piping. By design, the bank is positioned above any area where condensate would accumulate. Each unit is fitted with a 1/2" NPT drain plug at the low point, providing a convenient means for routine draining.

A Varec Biogas Drip Trap should be specified for field installation at this connection to provide for safe removal of condensate.

TECHNICAL DATA

- Removable cover plate and extensible bank assembly for easy inspection and cleaning
- Three to four times net free area through bank
- UL approved
- Heavy wall cast housing in 356 HT aluminum, steel, or 316 S.S.
- Vertical or horizontal configuration

Varec BIOGAS

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SPECIFICATIONS

Sizes

2", 3", 4", 6", 8", 10", 12"

Connections

Aluminum drilled to ANSI Class125 dimensions, flat face flange

Carbon Steel and 316 Stainless Steel Carbon Steel drilled to ANSI Class 150 dimensions, raised face flange.

Special drilling of flange connections to DIN, JPI or JIS standards available upon request. Consult factory or your local sales representative for further details.

Pressure Rating

Leak proof to 10 psi [69.0 kPa], standard

Higher Ratings Available: Consult factory

Pressure Drop

Should not exceed 1 psi(6.9kPa)

Location

Within 15 feet (4.6m) upstream of flame source

Configuration

Net Free Area

Three to four times the corresponding size standard pipe.

Bank Assembly

Extensible Aluminum bank frame with corrugated rectangular shaped bank sheets.

Fixed 316 Stainless Steel bank frame.

Provisions for Draining

5000 Series self draining.

5010 Series includes 1/2" NPT connection at low point.

Housing Materials

356 - T6 Low Copper Aluminum - standard

Carbon Steel (ASTM A216 grade WCB) - optional

316 Stainless Steel - optional

Bank Assembly Material

Low Copper Aluminum extensible frame with Aluminum bank sheets - standard

Low Copper Aluminum extensible frame with 316 Stainless Steel bank sheets - optional

All 316 Stainless Steel fixed frame with 316 Stainless Steel bank sheets - optional (available with Carbon Steel or 316 Stainless Steel housing only)

Approvals

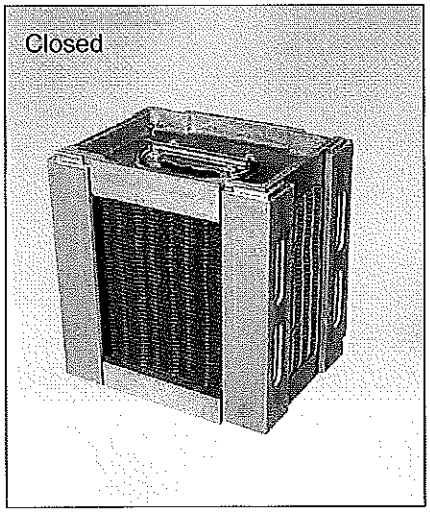
5000 Series UL (Underwriters Laboratories) listed in all Aluminum construction with extensible bank assembly in 2", 3" 4" 6" and 10" sizes.[1]

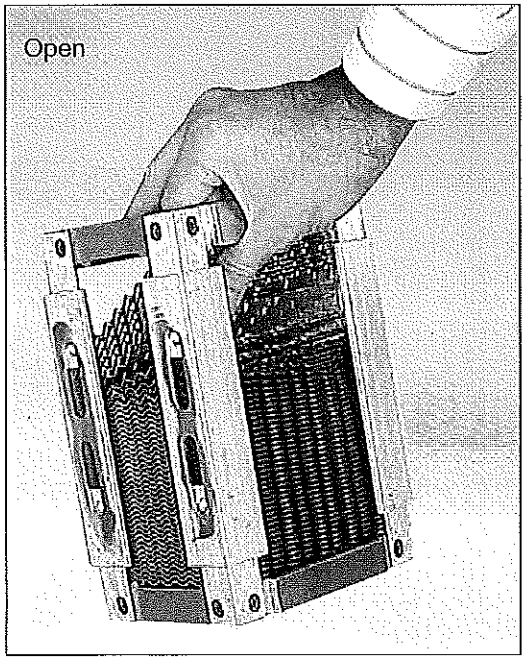
5010 Series UL listed in all Aluminum construction as above in 2", 3" and 4" sizes.[1]

Note

1. For use on hydrocarbon storage tanks, installed NOT MORE THAN 15 FEET from the open end of the vent pipe. These test conditions may not represent the actual service conditions of piping system design. It is recommended that the arrester be independently tested under actual service conditions before installation.

EXTENSIBLE ALUMINUM BANK FRAME - 5000 AND 5010 SERIES





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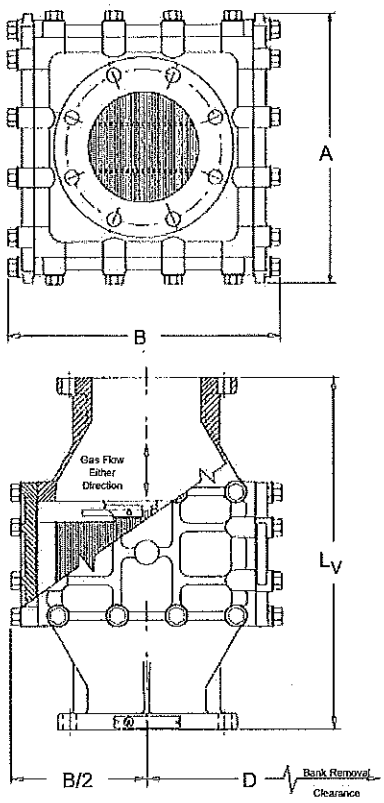
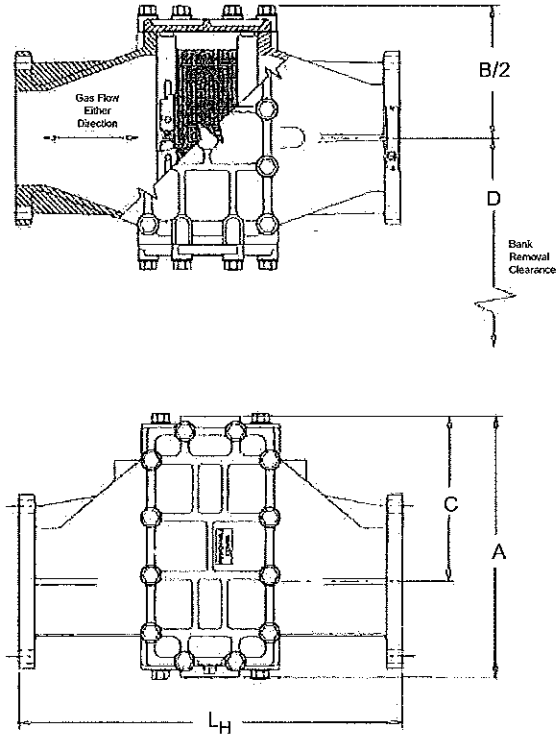
SPECIFICATIONS

5000 Series



5010 Series



Dimensions, inches and pounds [millimeters and kilograms]

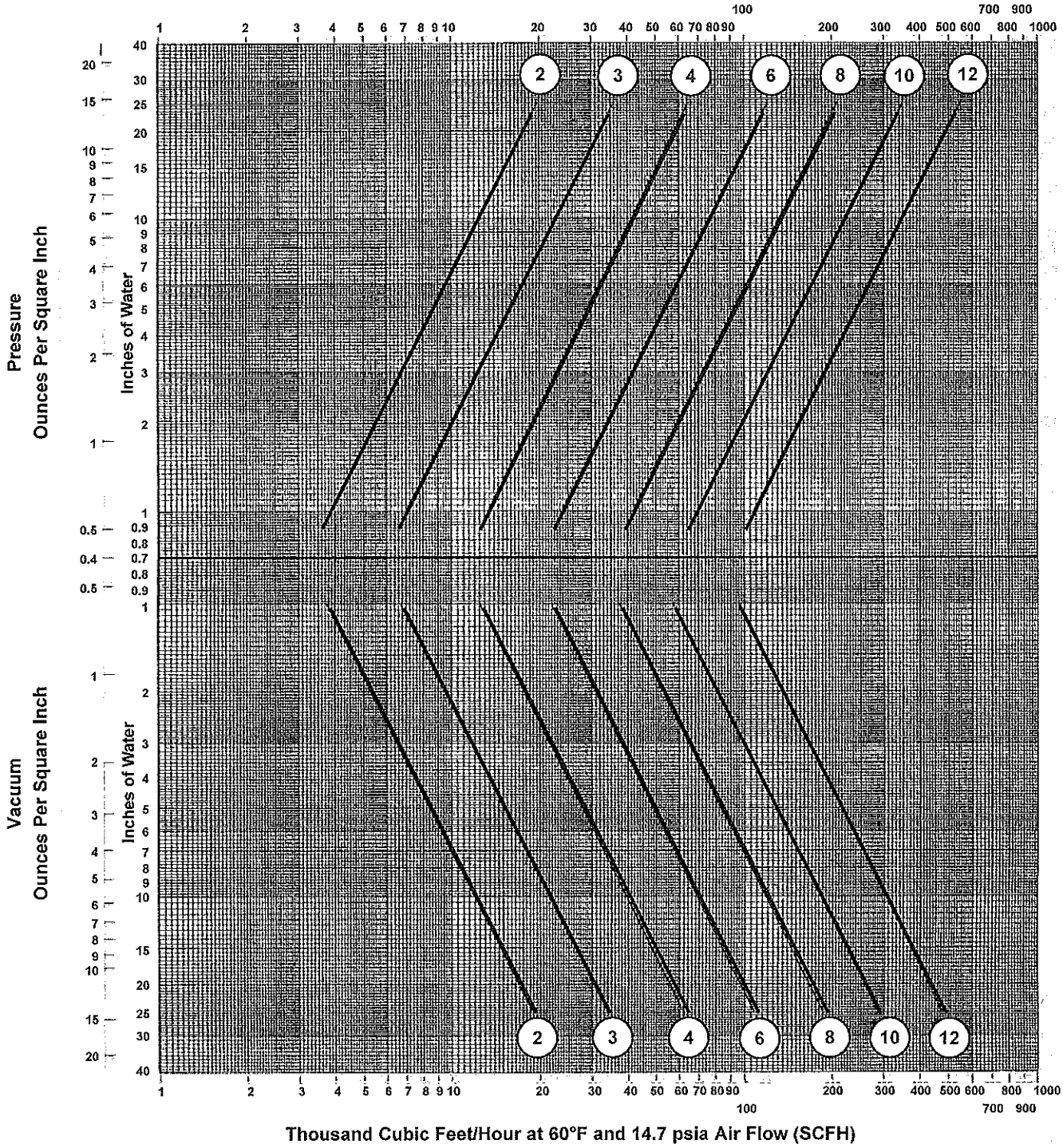
Size Code		2	3	4	6	8	0	1
Nominal Pipe Size		2 [50]	3 [80]	4 [100]	6 [150]	8 [200]	10 [250]	12 [300]
L_V	Length (5000)	12 5/8 [321]	13 7/8 [352]	16 5/8 [422]	21 1/2 [546]	27 1/4 [692]	28 3/8 [721]	34 3/8 [873]
L_H	Length (5010)	14 1/2 [368]	16 [406]	20 [508]	24 3/8 [619]	32 1/8 [816]	35 1/2 [902]	34 3/8 [873]
A	Width	9 [229]	11 3/4 [298]	14 1/2 [368]	16 1/2 [419]	21 5/8 [549]	24 [610]	31 [787]
B	Depth	8 5/8 [219]	11 1/2 [292]	14 3/4 [375]	16 3/4 [425]	21 3/4 [552]	23 3/4 [603]	29 1/4 [743]
C	CL Offset (5010)	5 3/8 [137]	7 1/4 [184]	9 [229]	10 3/4 [273]	14 3/8 [365]	16 [406]	20 [508]
D	Bank Clearance	19 [483]	23 1/4 [591]	28 1/8 [714]	31 1/8 [791]	38 5/8 [981]	41 5/8 [1057]	50 [1270]
Aluminum Shipping Wt. (5000)		25 [11]	45 [20]	65 [30]	100 [45]	200 [91]	240 [109]	350 [159]
Aluminum Shipping Wt. (5010)		30 [14]	50 [23]	70 [32]	115 [52]	220 [100]	270 [123]	375 [170]

Flange drilling per ANSI Class 125 flat face flange (Aluminum) per ANSI Class 150 raised face flange (Carbon Steel and 316 Stainless Steel)

Dimensions are for preliminary general information and should not be used for construction purposes. Certified dimensional drawings are available upon request.

FLOW CURVES

5000 AND 5010 FLAME ARRESTERS



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ORDERING INFORMATION

Model	Description
50	Flame Arrester

Code	Configuration
00	Vertical
10	Horizontal

Code	Size
2	2"
3	3"
4	4"
6	6"
8	8"
0	10"
1	12"

Code	Housing/Bank Assembly Frame/Sheet Material
1	Aluminum, aluminum extensible frame, aluminum sheets
2	Aluminum, aluminum extensible frame, 316 SS sheets
3	Steel, 316 SS fixed frame, 316 SS sheets
6	316 SS, 316 SS fixed frame, 316 SS sheets

Code	Insert Material
S	Stainless Steel
*	Zn plated Steel (std) - leave blank

50	**00**	**2**	**6**	**S**	**(Example)**

Example: Vertical configuration flame arrester. 2" size all 316SS construction with stainless steel hardware.

Varec
BIOGAS

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1-866-4BIOGAS

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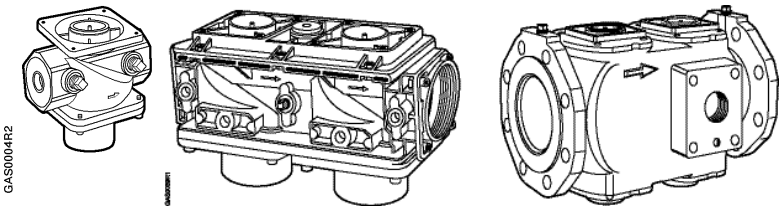
SIEMENS

Technical Instructions
Document No. 155-512P25
VG…
August 1, 2012

VG Series

VGG… and VGD… Gas Valves for use with SKP… Electro-hydraulic Actuators



VGG… **VGD20…** **VGD40…**

GAS0001R2

ISO 9000 and 14000
REGISTERED FIRM

LISTED

APPROVED

Only when assembled to Series SKP… actuators

Description

The normally closed VG… Series of modular single and double-body gas valves combined with SKP… Series electro-hydraulic actuators provide safety shut-off, gas pressure regulation and air/gas ratio control for commercial and industrial gas burners.

Table 1. Legend.

Model Numbers	Body Style	Connection
VGG…	Single	NPT Threaded
VGD…	Double	NPT Threaded or ANSI Flanged

Features

All Models

- UL listed, FM approved, CSA certified, IRI approvable, ISO 9001 and 14000 certified. European, Australian and Japanese approved versions available.
- Stainless steel mesh inlet filter protects the valve seat(s) as well as downstream components.
- 1/4-inch NPT pressure taps on the inlet and outlet. (See Table 2 for details).
- Dual stem guides ensure precise disc alignment and tight shut-off.

VGG… Models

- Contoured valve disc provides smooth release of gas and stable regulating control.
- 3/4-inch NPT port for pilot or vent line connection on 2-1/2 and 3-inch VGG…valves.

VGD20… Models

- Compact VGD20… double-valve bodies consist of two safety shut-off valves in series. The first (inlet) valve has a flat valve disc applicable for safety shut-off function only. The second (outlet) valve has a contoured valve disc for use with pressure regulating actuators (SKP2…, SKP5…, SKP7…).
- A 1-inch NPT vent connection between the valves.
- Each VGD20… double-valve requires two threaded mounting flanges (AGAxxU). Each flange includes the necessary installation hardware (bolts, nuts and O-ring). Each mounting flange has a 1/4-inch NPT pressure tap. The flanges can be pre-mounted onto the pipe, and then bolted onto the VGD20… gas valve body. This feature eliminates the use of pipe unions and permits the gas valve assembly to be easily removed from a gas train.
- The overall dimensions of both the 1-1/2-inch and 2-inch AGAxxU flanges are identical. This permits a 1-1/2-inch flange to be mounted on a 2-inch valve body or vice versa.

NOTE: VGD20… valves and AGAxxU threaded flanges must be ordered as separate items (See Table 2).

VGD40… Models

- Compact VGD40… double-valve bodies consist of two safety shut-off valves in series.
- Each individual safety shut-off valve has double seats to achieve high flow.
- Patented seat construction with individual closing spring for each seat to assure reliable shut-off and high close-off pressure rating.
- Full port vent line connection plates are available.

NOTE: VGD40… valves and AGA… vent connection plates must be ordered as separate items (See Table 2).

Application

All VG… valves can be combined with any SKP… Series actuator. The actuator can be mounted while the valve is installed and under pressure.

SKP… regulating actuators are applicable for both low and high supply gas pressure applications, eliminating excessive regulator inventories. Maximum pressure ratings vary with valve size (See Table 2).

All VG… valves perform these functions in combination with each of the following actuators:

SKP15…	Safety shut-off
SKP25…	Safety shut-off and constant pressure regulation or zero governor.
SKP55…	Safety shut-off, pressure regulation and differential pressure air/gas ratio control.
SKP75…	Safety shut-off, pressure regulation and adjustable air/gas ratio control.

Since more than one function can be performed by a single valve, fewer components and fittings are required to assemble a gas train - significantly reducing both the size and weight of the gas train. In addition, smaller diameter gas valves can be used. For details on valve sizing see the Flow Charts (Figures 5 and 6).

CAUTION:

Do not oversize valves equipped with a regulating SKP… actuator. Oversizing may limit turndown and could cause oscillations.

Ordering Information

Gas valves and actuators are ordered separately. For additional SKP… actuator information, see the following Technical Instructions:

SKP15…	155-751P25
SKP25…	155-752P25
SKP55…	155-753P25
SKP75…	155-754P25

Accessories

Manual adjusting throttle attachment AGA61 permits VG… series valves to be used as adjustable limiting orifice valves. Once adjusted, the AGA61 has a provision to be sealed from tampering (See Table 3).

Adapter plate AGA60 permits VG… series valves to be used for modulating flow control when fitted with an SQX… series modulating actuator (See Table 3).

NOTE: The VG… /SQX… valve/actuator combination is designed strictly for modulating flow control and does not provide safety shut-off function.

Table 2. Product Numbers.

Product Number	Product Number (with stroke limiter)	Size	Maximum Operating Pressure psi	Close-off Pressure psi	Capacity CFH Natural Gas at ΔP=1" W.C.	Number of Test Points, 1/4" NPT		Valve Body Material
						Inlet	Outlet	
VGG10.154U	VGG10.1541U	1/2" NPT	20	75	327/242◆	2	2	Aluminum
VGG10.204U	VGG10.2041U	3/4" NPT	20	75	614/442◆	2	2	Aluminum
VGG10.254U	VGG10.2541U	1" NPT	20	75	914/686◆	2	2	Aluminum
VGG10.404U	VGG10.4041U	1-1/2" NPT	20	75	2,047/1,643◆	2	2	Aluminum
VGG10.504U	VGG10.5041U	2" NPT	15	75	3,511	2	2	Aluminum
VGG10.654U	VGG10.6541U	2-1/2" NPT	10	25	5,085	1	1	Cast Iron
VGG10.804U	VGG10.8041U	3" NPT	10	25	6,158	1	1	Cast Iron
*VGD20.403U		1-1/2"	20	30	1,890	Two 1/4-inch and one 1-inch port between valves		Aluminum
*VGD20.503U		2"	15	30	2,300			Aluminum
*AGA41U	Single 1-1/2" connecting flange with 1/4-inch port for VGD 20.403U							Two (2) needed per valve. Order separately
*AGA51U	Single 2" connecting flange with 1/4-inch port for VGD 20.503U							
VGD40.065U		2-1/2" NPT	10	75	3,880	1	1	Aluminum
VGD40.080U		3" NPT	10	75	5,370	1	1	Aluminum
VGD40.100U		4" Flanged	10	30	9,680	1	1	Aluminum
VGD40.150U		6" Flanged	10	30	17,490	1	1	Aluminum

* VGD20… double valves require 2 AGAxxU threaded flanges for installation.

◆ VGG… valves, 1/2- through 1-1/2 inch have reduced flow when used with AGA66 (NEMA 4 kit). Capacities shown are without/with NEMA 4 kit (See Figure 4a).

Table 3. Accessories.

Part Number	Description	Notes
AGA40.6580U	Vent connection plate with 1-1/4" NPT vent connection and 1/4" NPT test port	Order separately. For use with VGD40… only.
AGA40.0100U	Vent connection plate with 2" NPT vent connection and 1/4" NPT test port	
AGA40.0150U	Vent connection plate with 2-1/2" NPT vent connection and 1/4" NPT test port	
AGA60	Adapter for use with SQX… actuators	
AGA61	Manual operation kit, allows VG… valves to be used as adjustable limiting orifice valve.	
AGA66	Sealing gasket to provide NEMA 3, NEMA 3R, and NEMA 4 protection.	

Specifications

Approvals	Agency approvals/standards	UL/429, FM/7400, CSA/AINSI Z21.21/CGA 6.5 Commercial/Industrial IRI approvable Agency marks apply only for VGxxx.xxxU series gas valve bodies assembled with SKPxx.xxxU actuators.
Operating Environment	Maximum operating pressure	See Table 2
	Maximum back pressure (differential)	2.5 psi (150 mbar)
	Close-off pressure	See Table 2
	Permissible gases	Natural gas, propane, butane, air, and other non-corrosive gases.
	Permissible gas temperature	5°F to 140°F (-15°C to 60°C)
	Permissible operating temperature	5°F to 140°F (-15°C to 60°C)
	Mounting	Any position except upside down
Physical Characteristics	Body materials	See Table 2
	Weight	See Tables 4 through 7
Connections	Pipe connections	NPT or ANSI Class 150 flange (See Table 2)
	Pressure and vent taps	See Table 2

Operation

All VG… gas valves are normally closed, two-way valves. The valves have a standard, integral, stainless steel mesh filter (0.8 mm) in the inlet to protect the downstream components against contamination.

VGG… series gas valves have a contoured valve disc for stable regulating control and smooth release of gas (see Figure 1). VGG10.xx41U series gas valves have a stroke limiter.

VGD20… double valves consist of two valves in series. The first (inlet) valve has a flat valve disc suitable for the safety shut-off function only. The second (outlet) valve has a contoured valve disc for stable regulating control and smooth release of gas (see Figure 2).

VGD40… double valves consist of two valves in series. Each valve has a double seat to achieve high flow (see Figure 3).

All valves have 1/4-inch NPT ports for pressure test connection. The 2-1/2-inch and 3-inch VGG… valves have an additional 3/4-inch NPT port for a pilot connection. The VGD20… valves have a 1-inch NPT port for a vent line connection. The VGD40… valves can be equipped with a full size vent connection plate.

See Table 1 for details on ports and vent connection plates.

Operation, Continued

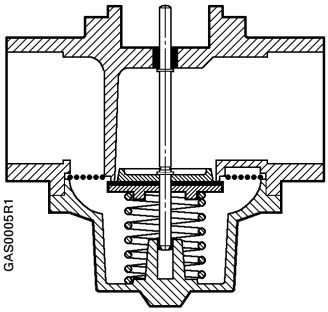


Figure 1. VGG… Models.

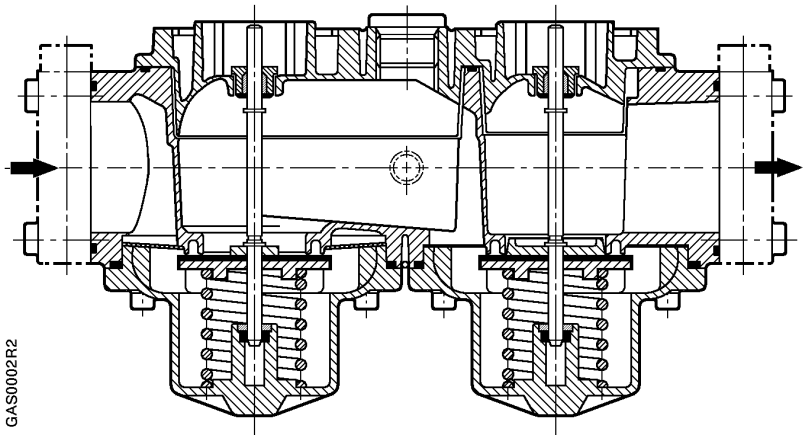


Figure 2. VGD20… Models.

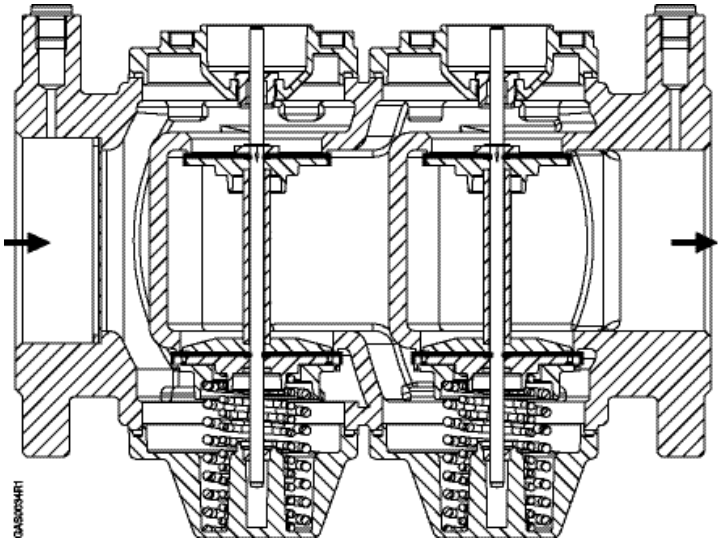


Figure 3. VGD40… Models.

Gas Flow Charts

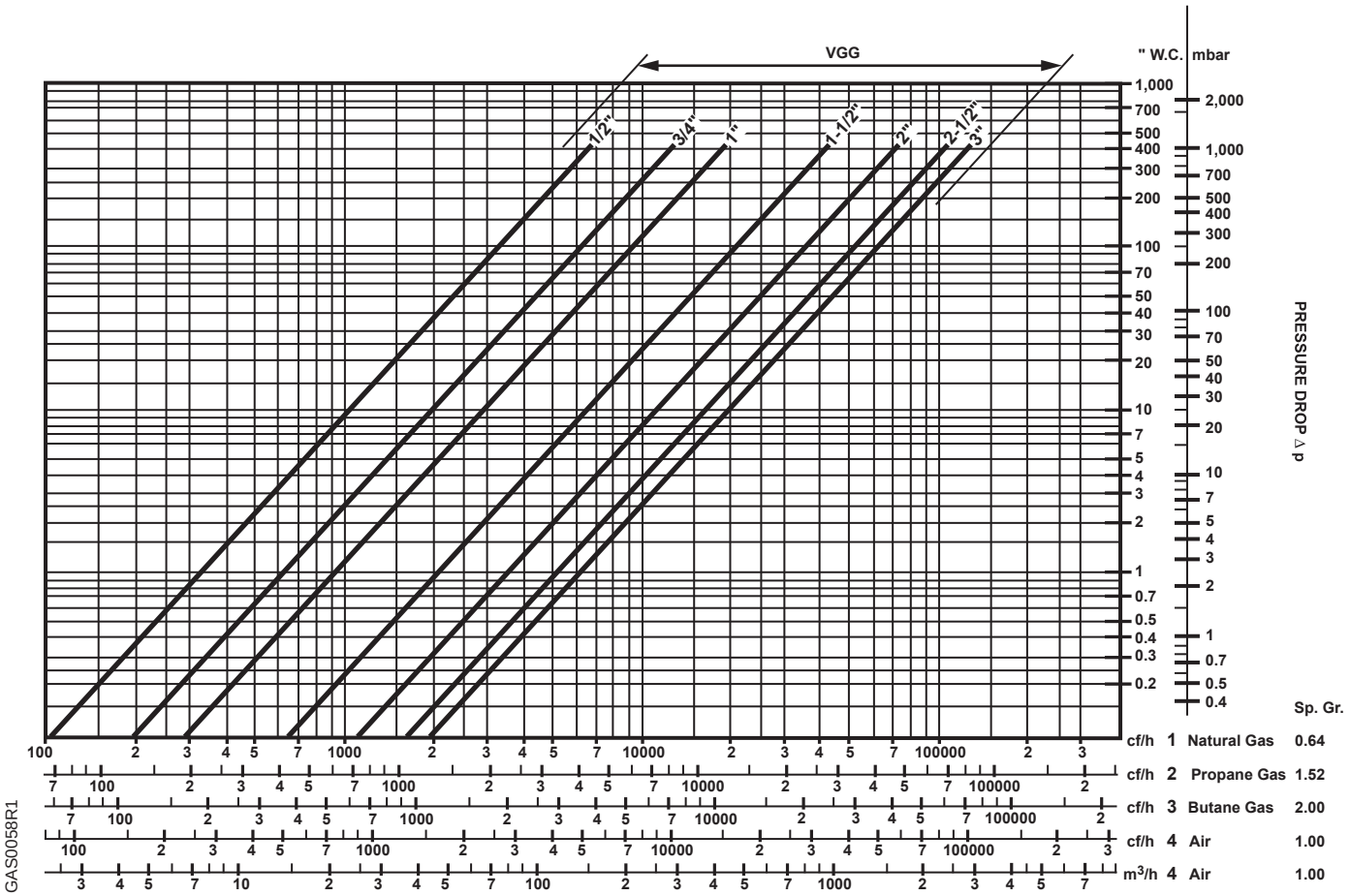


Figure 4. Sizing Single Valves Without NEMA 4 Kit.

NOTE: Pressure drop is for one valve when using an SKPx5…actuator without a NEMA 4 kit (AGA66).

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Gas Flow Charts, Continued

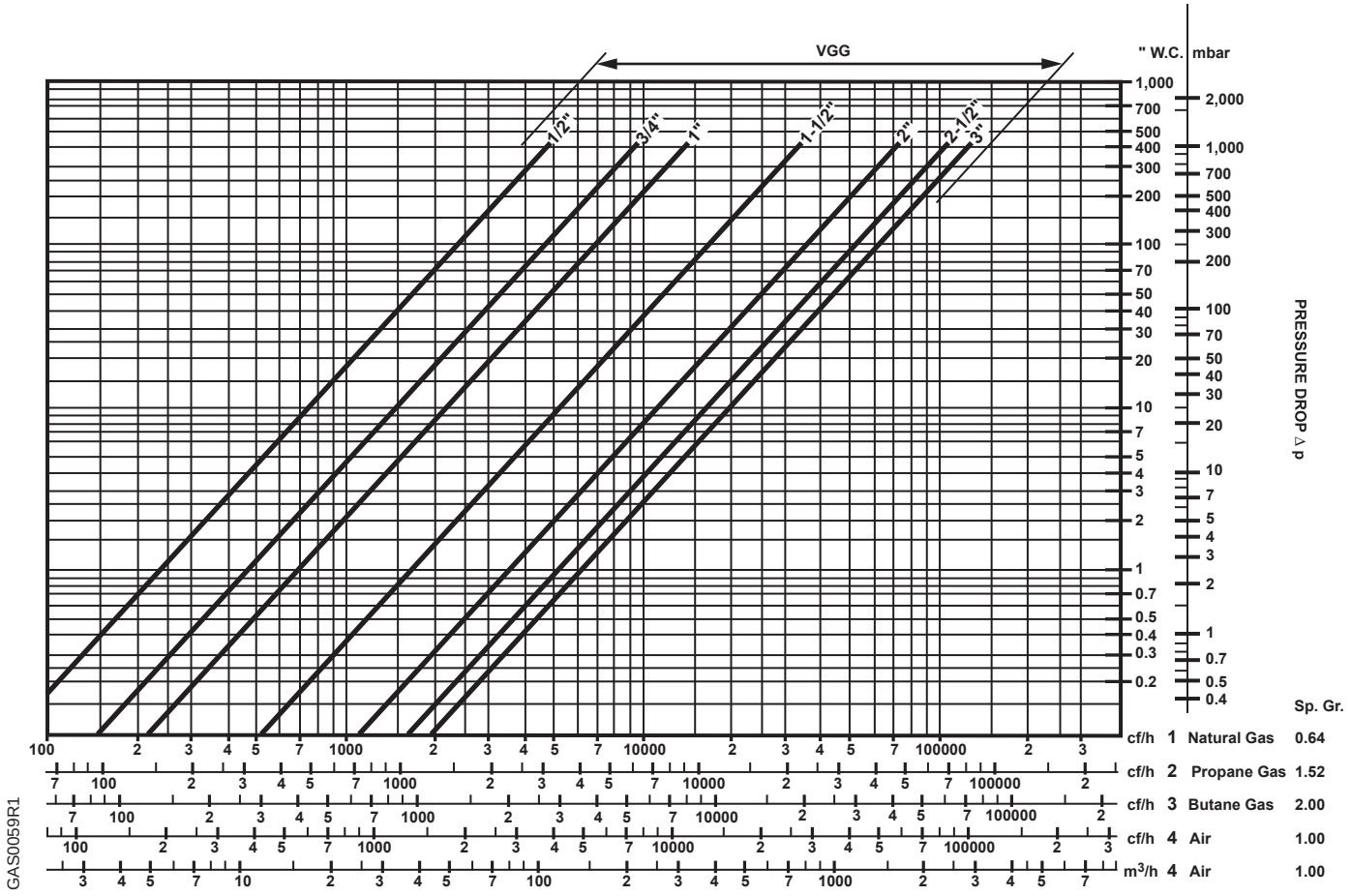


Figure 4a. Sizing Single Valves With a NEMA 4 Kit.

NOTE: Pressure drop is for one valve when using an SKPx5…actuator and a NEMA 4 kit (AGA66).

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Gas Flow Charts, Continued

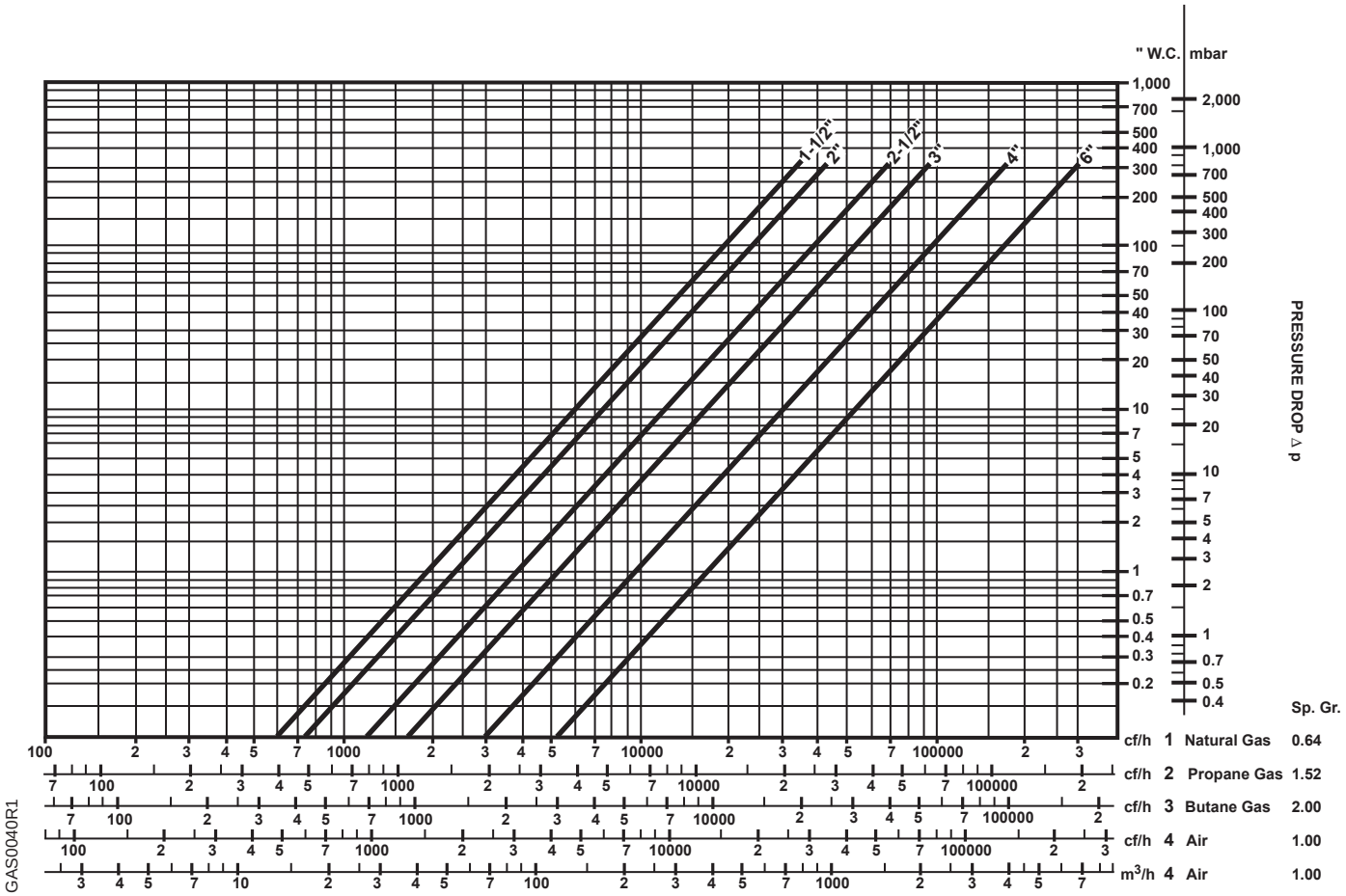


Figure 5. Sizing Double Valves.

NOTE: Pressure drop is total drop across both valves when using an SKPx5… actuator, with or without an AGA66.

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Dimensions

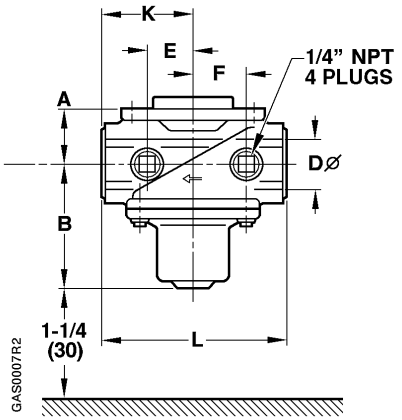


Table 4. VGG… Models.

Valve Model	Nominal Size D Inches	A Inches (mm)	B Inches (mm)	E Inches (mm)	F Inches (mm)	K Inches (mm)	L Inches (mm)	Weight Pounds (kg)
VGG…	1/2	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	3/4	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	1	1-1/4 (32)	3-18 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.5 (0.7)
	1-1/2	1-5/8 (41)	4 (102)	1-5/16 (34)	1-5/16 (34)	3 (75)	5-15/16 (150)	3.3 (1.5)
	2	2 (50)	4-1/4 (107)	1-5/16 (34)	1-5/16) (34)	3-3/8 (85)	6-3/4 (170)	4.0 (1.8)
	2-1/2	3-5/8 (92)	6-7/16 (163)	—	2-7/16 (62)	5-11/16 (145)	11-7/16 (290)	32.5 (14.8)
	3	3-15/16 (100)	6-7/16 (163)	—	2-7/16 (62)	6-1/16 (155)	12-3/16 (310)	34 (15.5)

Dimensions, Continued

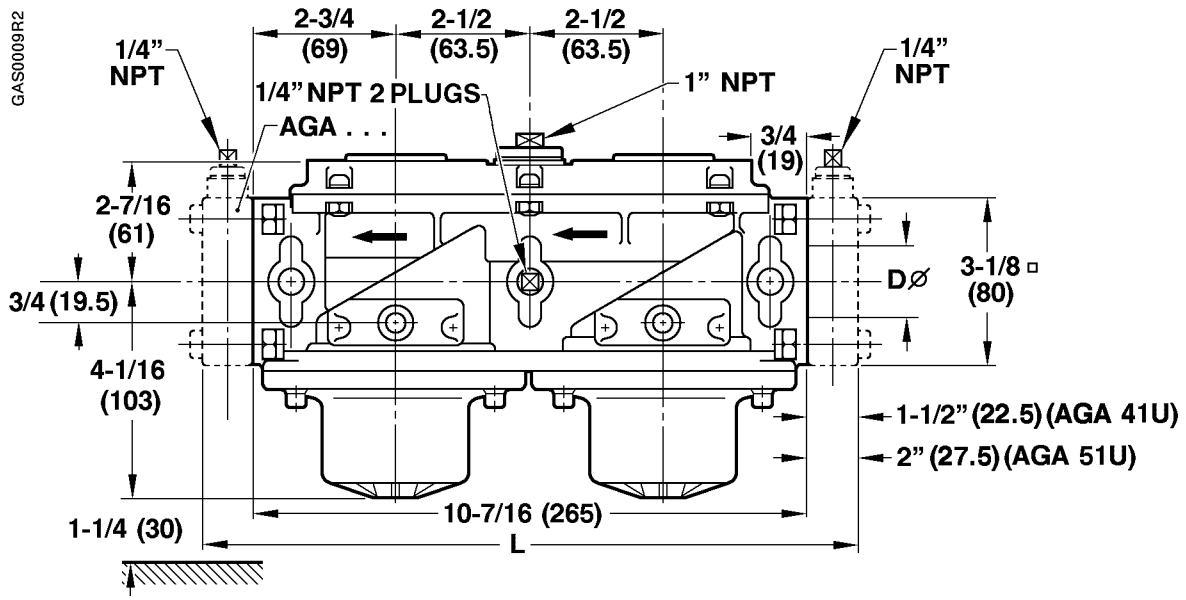


Table 5. VGD20… Models.

Valve Model	Nominal Size D Inches	L Inches (mm)	Weight Pounds (kg)
VGD20…	1-1/2	12-3/16 (310)	7 (3.2)
	2	12-5/8 (320)	6 (3.15)

Dimensions, Continued

Dimensions in Inches (mm)

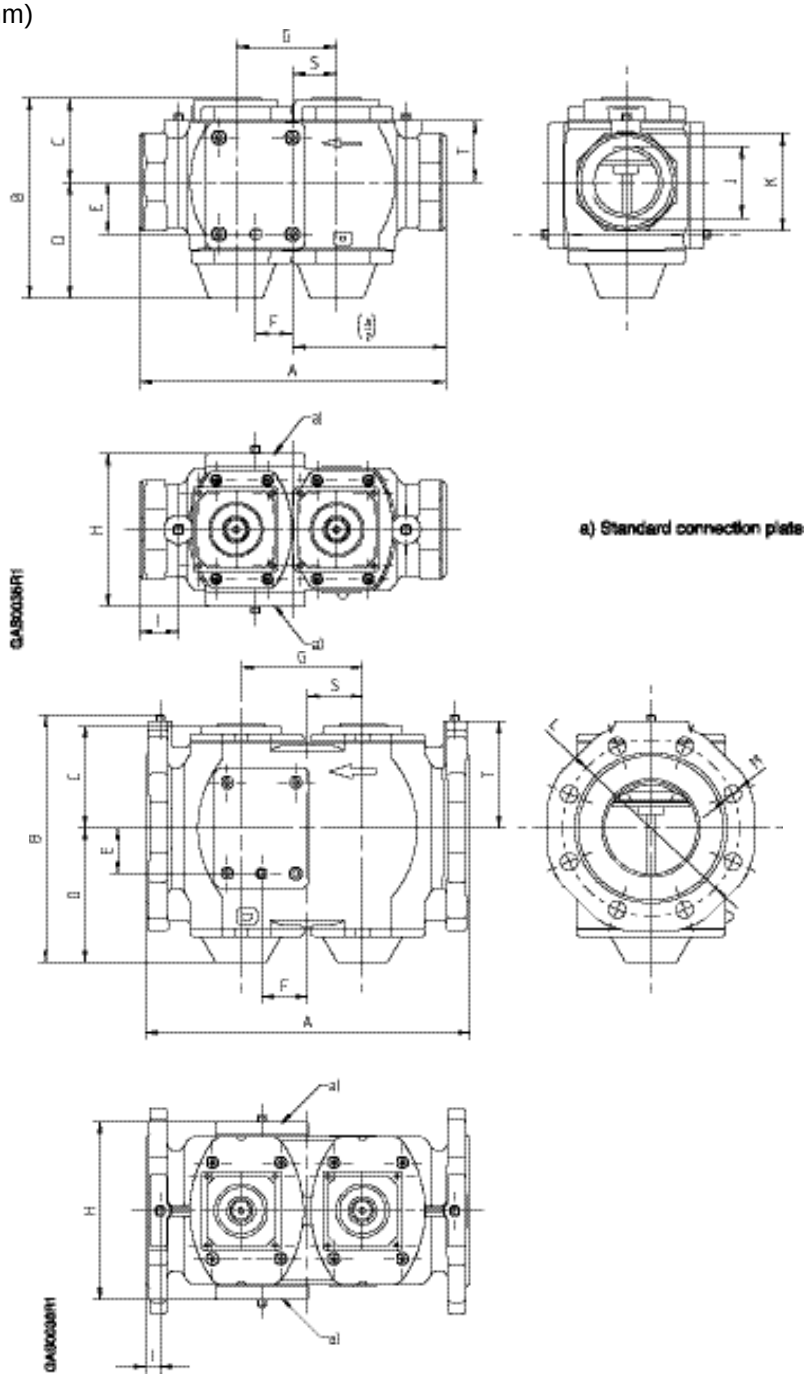


Table 6. VGD40… Models.

Valve Model	A	B	C	D	E	F	G	H	I	J	K *	L	M	S	T
VGD40.065U	12.09 (307)	7.00 (203)	3.25 (83)	4.63 (118)	2.09 (53)	1.46 (37)	4.02 (102)	6.14 (156)	1.57 (40)	2-1/2" NPT	SW 100	—	—	1.77 (45)	2.44 (62)
VGD40.080U	12.87 (327)	8.94 (227)	3.64 (93)	5.18 (132)	1.85 (47)	0.79 (20)	4.21 (107)	6.30 (160)	1.85 (47)	3" NPT	SW 120	—	—	2.34 (60)	2.83 (72)
VGD40.100U	13.78 (350)	10.50 (267)	4.33 (110)	5.70 (145)	1.93 (49)	1.95 (50)	5.16 (131)	7.56 (192)	0.63 (16)	—	—	d=7.50 (191)	d=0.75 (19)	2.34 (60)	4.55 (116)
VGD40.150U	18.90 (480)	13.29 (338)	5.71 (145)	7.40 (188)	2.09 (53)	2.30 (59)	6.61 (168)	10.31 (262)	0.63 (16)	—	—	d=9.49 (241)	d=0.91 (23)	3.54 (90)	5.61 (143)

* Spanner width in millimeters

Dimensions, Continued

Option a) Connection plate with 1/4" NPT plugged pressure test port
b) Vent connection plate with vent line connection and 1/4" NPT plugged pressure test port

Note: Plates a) and b) are interchangeable

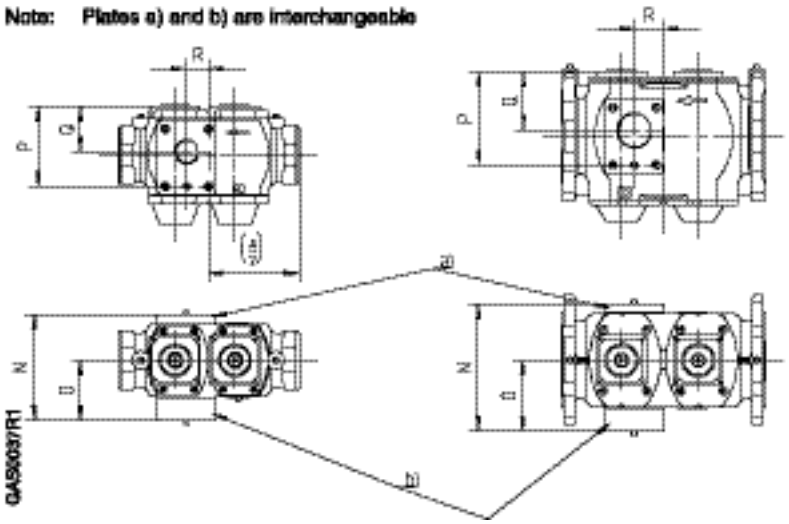
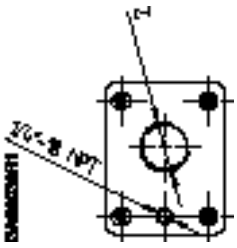


Table 7. VGD40… Dimensions in Inches (Millimeters).

Valve Model	N	O	P	Q	R	Weight Pounds (kg)
VGD40.065U	7.13 (181)	4.06 (103)	5.34 (136)	3.02 (77)	1.46 (37)	16 (7)
VGD40.080U	7.28 (185)	4.13 (105)	5.49 (140)	3.17 (81)	0.79 (20)	19 (8)
VGD40.100U	8.54 (217)	4.76 (121)	6.26 (159)	3.94 (100)	1.95 (50)	29 (13)
VGD40.150U	11.30 (287)	6.14 (156)	7.80 (198)	5.47 (139)	2.30 (59)	53 (24)

Table 8. Vent Connection Plate Dimensions.



	VGD40.065U	VGD40.080U	VGD40.100U	VGD40.150U	Thread Vent Connection Size
AGA40.6580U	X	X			1-1/4" NPT
AGA40.0100U			X		2" NPT
AGA40.0150U				X	2-1/2" NPT

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Technical Instructions

Document No. 155-751
SKP15…U..
June 17, 2010

SKP Series

SKP15…U.. Gas Valve Actuator with Safety Shutoff Function

ISO 9001 and 14000 REGISTERED FIRM
GAS0001R2
LISTED
APPROVED

Only when assembled to Series VG… Gas valves

Description

SKP15… electro-hydraulic actuators are used in combination with VG… series gas valves to provide safety shut-off control for industrial and commercial burner applications.

The compact SKP15… actuator opens slowly and closes immediately when power is interrupted. The modular design allows the SKP15… to be used in combination with all VG… series gas valves bodies from 1/2-inch to 6 inches in size. The actuator is easily mounted on the square flange of any VG… valve with four pre-mounted screws. A visible position indicator on the front of the actuator displays the entire stroke of the valve. A light indicates when the actuator is powered.

Features

- UL listed, FM approved, CSA certified for USA and Canada, IRI approvable, and ISO 9001 certified. European, Australian and Japanese approved versions available.
- Proof of Closure with Over Travel (POC) versions are available.
- Optional NEMA 4 protection.
- Visual position indication.
- "Power on" indication light
- Quick connect wiring terminals
- Optional adjustable auxiliary switch available.
- Modular design with 360^{o} actuator rotation for easy field wiring and installation.
- Low, 13.5 VA power consumption.

Application

SKP15… series actuators are combined with 1/2-inch to 6-inch VG… series gas valve bodies. VG… series gas valves must be ordered separately (See *VG…U... Technical Instructions*, P/N 155-512P25).

Product Numbers

Table 1.

Product Number[1]	Operating Voltage	Proof of Closure Switch [2]	Auxiliary Switch [2]	Type of Switch
SKP15.013U1	110 to 120 Vac	–	–	–
SKP15.012U1		X	X	SPDT SPDT
SKP15.011U1		X	–	SPDT
SKP15.013U2	220 to 240 Vac	–	–	–
SKP15.012U2		X	X	SPDT SPDT

Note:

1. European, CE certified models are available (see *data sheet 7643*)
2. Proof of closure and auxiliary switches cannot be field installed.

Accessories

AGA66 Sealing gasket to provide NEMA 3, 3R, and 4 protection (for VGG…/VGD…valves)

Specifications	As safety shut-off valve	UL/429, FM/7400, ANSI Z21.21/CGA6.5 C/I
Agency approvals		Agency marks apply only for SKPxx.xxxU actuators with VGxxx.xxxU series gas valve bodies.
Power supply	Operating voltage	110 to 120 Vac + 10% to -15% 220 to 240 Vac + 10% to -15%
	Operating frequency	50 to 60 Hz ± 6%
	Power consumption	13.5 VA
	Duty cycle	continuous
Operating environment	Ambient operating temperature	5°F to 140°F (–15°C to 60°C)
	Mounting position	Any position except upside down
Physical characteristics	Weight	2.4 lb (1.1 kg)
	Enclosure	NEMA 1, 2, 5, and 12 for indoor use NEMA 3, 3R, and 4 with optional AGA66 gasket
	Dimensions	See Figure 3
	Specification for valve bodies	See *gas valve Technical Instructions,* P/N 155-512P25
	Conduit connection	Two 1/2-inch NPSM threaded knock-outs
	Electrical connection	Spring loaded terminals for 14 AWG wires
Operating characteristics	Output force	100 lb (450 N)
	Maximum stroke	1 inch (26 mm)
	Opening time for maximum stroke	Varies with valve size, 14 seconds for max. stroke
	Closing time	<0.8 seconds
Auxiliary features	Proof of closure switch	Non-adjustable
	Setting range of auxiliary switch	40% to 100% of stroke
	Switch rating	6A/250 Vac resistive; 3A/120 Vac pilot duty

Operation

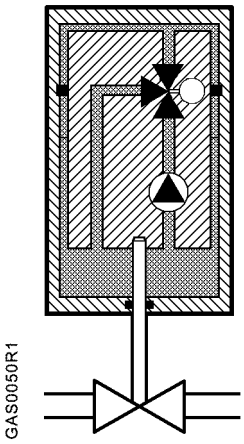


Figure 1. SKP15… Operation.

The electro-hydraulic actuator consists of a cylinder filled with oil, a piston containing an electric oscillating pump, and a relief system. When power is supplied to the actuator, the relief system closes, and the pump moves oil from the reservoir into the pressure chamber. This action causes the piston to move downward in the cylinder, opening the gas valve. When power to the actuator is interrupted, the relief system opens and the gas valve closes in less than 0.8 seconds.

A position indicator, visible through the transparent portion of the terminal cover, shows the entire stroke range of the actuator. A light, which is visible through the lower left transparent portion of the terminal cover, indicates when the actuator receives power. An optional, non-adjustable SPDT proof of closure over travel switch signals the closed position after the gas valve has closed. An optional SPDT auxiliary switch is adjustable between 40% and 100% of the stroke. The adjustment screw and scale are located on the right side in the terminal box, and are visible through the transparent portion of the terminal cover.

Installation

WARNING:

- Personal injury or loss of life may occur if procedures are not followed as specified.
- All installations must be performed by qualified personnel only.
- Do not pull the actuator shaft.
- The AGA66 gasket must be installed between the actuator and the gas valve body to provide NEMA 3, 3R, and 4 protection rating for VGG… and VGD… valves.

- The SKP15… actuator is directly coupled to the VG… series valve body by four pre-mounted 4 mm Allen key screws.
- The square mounting flange can be rotated in steps of 90^{o} to provide four different mounting positions. The SKP15… actuator can be mounted in any position except upside down.
- The actuator can be mounted or replaced while the valve body is under pressure.
- The SKP15… actuator has two knock-outs for the installation of 1/2”-14 NPSM conduit connections.
- When conduit routing is connected, flexible conduit must be used.
- Liquid tight conduit must be used in combination with AGA66 to provide NEMA 3, 3R, and 4 protection.
- The terminal marked GND, located above the wiring terminals, must be connected to the electrical ground.

Installation, Continued

NOTE: Wiring must meet all relevant electrical codes.

Wiring and Switch Adjustment

(See *Terminal Designations*)

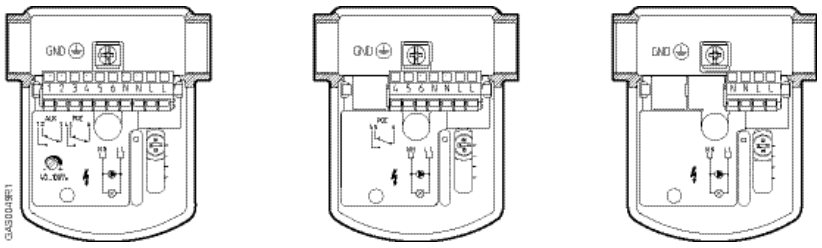
- The actuator is equipped with spring-loaded terminals for 14 AWG wires.
- The actuator has two line and two neutral terminals.
- Insert one wire into the opening of the terminal while pressing the lever downward with a screwdriver or hard object. Make sure that all strands insert into the opening.
- Adjust the auxiliary switch (if provided) according to the wiring diagram on the label below the terminals (see Figure 2). The adjustment screw and scale are located on the right side of the terminal box, and are visible through the transparent portion of the terminal cover.

NOTES:
1. The auxiliary switch is adjustable between 40% and 100% of the stroke. The factory setting is at 40%.
2. The auxiliary switch must not be used for proof of closure detection or other safety interlock functions.
3. The Proof of Closure Switch is non-adjustable.

Service

There are no serviceable parts on the SKP15… series actuators. If inoperative, replace the entire actuator. Tag wires before servicing.

Terminal Designations



SKP15.012U… SKP15.011U… SKP15.013U…

Figure 2. Terminal Designations.

Dimensions

(Dimensions in inches; millimeters in parentheses)

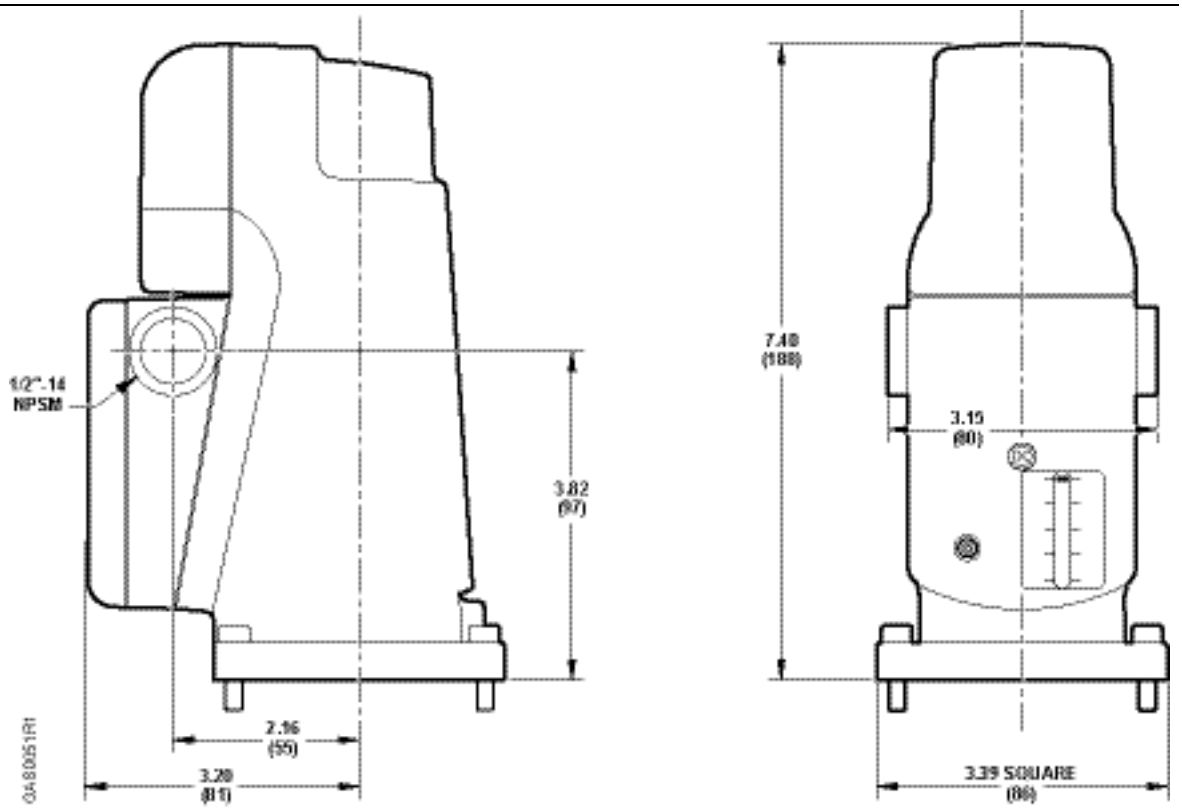


Figure 3. SKP15…U.. Dimensions.

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Technical Instructions
Document No. 155-752
SKP25…U..
November 1, 2007

SKP Series

SKP25…U.. Pressure Regulating Gas Valve Actuator with Safety Shut-off Function

ISO 9001 and 14000 REGISTERED FIRM
GAS0001 R2
LISTED
APPROVED

Only when assembled to Series VG… Gas valves

Description

SKP25… pressure regulating electro-hydraulic actuators are used in combination with VG… series gas valve bodies to provide safety shut-off and gas pressure regulation for industrial and commercial burners. The SKP25… can also be applied as a 1:1 air/gas ratio regulator or zero governor.

Since a single valve performs two or more functions, fewer gas train components and fittings are required. This significantly reduces both the size and weight of the gas train. In addition, smaller diameter gas valves can be used.

The compact SKP25… actuator opens slowly and closes immediately when power is interrupted. The modular design allows the SKP25… to be used in combination with all VG… series gas valve bodies from 1/2-inch to 6-inch in size. The actuator is easily mounted on the square flange of any VG… valve with four pre-mounted screws. A visible position indicator on the front of the actuator displays the entire stroke of the valve. A light indicates when the actuator is powered.

Features

- UL listed, FM approved, CSA certified for USA and Canada, IRI approvable, ISO 9001 certified. European, Australian and Japanese approved versions available.
- Certified as a ventless pressure regulator.
- Safety shut-off function and pressure regulating function in one compact unit.
- Proof of Closure with Over Travel (POC) versions are available.
- Optional NEMA 4 protection.
- Visual position indication.
- "Power on" indication light
- Quick connect wiring terminals
- Optional adjustable auxiliary switch available.
- Applicable as 1:1 air/gas ratio regulator or zero governor.
- Accurate pressure control characteristics, and zero offset (droop).
- Modular design with 360^{o} actuator rotation for easy field wiring and installation.
- Low, 13.5 VA power consumption.

Application

SKP25… series actuators are combined with 1/2-inch to 6-inch VG… series gas valve bodies. VG… series gas valves must be ordered separately (See *VG…U...Technical Instructions*, P/N 155-512P25).

Product Numbers

Table 1.

Product Number[1]	Operating Voltage	Function	Proof of Closure Switch [5]	Auxiliary Switch [5]	Type of Switch
SKP25.011U1	110 to 120 Vac	regulator	x	–	SPDT
SKP25.012U1		regulator	x	x	SPDT SPDT
SKP25.013U1		regulator	–	–	–
SKP25.411U1 [2]		regulator	x	–	SPDT
SKP25.611U1 [3]		ratio regulator	x	–	SPDT
SKP25.011U1P [4]		ratio regulator	x	–	SPDT
SKP25.012U2	220 to 240 Vac	regulator	x	x	SPDT SPDT
SKP25.013U2		regulator	–	–	–

NOTES:

1. European, CE certified models are available (see *data sheet 7643*)
2. High outlet pressure model for 1.5 to 20 psi outlet pressure regulation
3. High bias air/gas ratio regulator with factory installed spring for 0" to –4" WC bias.
4. Low bias air/gas ratio regulator with factory installed spring for 0" to –0.6" WC bias.
5. Proof of closure and auxiliary switches cannot be field installed.

Accessories

Table 2.

Product Number	Description
AGA22	Yellow setpoint spring for 6” to 48” WC (1.5 to 10 psi for SKP25.411U1)
AGA23	Red setpoint spring for 40” to 100” WC (8.5 to 20 psi for SKP25.411U1)
AGA25	Damping orifice for mounting into vent connection of SKP25.0…models
AGA28	Black bias spring to install if SKP25.0… is used as air/gas ratio regulator or zero governor
AGA29	Unpainted setpoint spring for 0” to 8.5” WC (included in SKP25.0… as standard)
AGA66	Sealing gasket to provide NEMA 3, 3R, and 4 protection (for VGG…/VGD…valves)

Specifications

Agency approvals	As a safety shut-off valve	UL/429, FM/7400, ANSI Z21.21/CGA 6.5 C/I Agency marks apply only for SKPxx.xxxU actuators assembled with VGxxx.xxxU series gas valve bodies.
	As a pressure regulator	ANSI Z21.18/CGA 6.3
Power supply	Operating voltage	110 to 120 Vac + 10% to -15% 220 to 240 Vac + 10% to -15%
	Operating frequency	50 to 60 Hz ±6%
	Power consumption	13.5 VA
	Duty cycle	continuous
Operating environment	Ambient operating temperature	5°F to 140°F (-15°C to 60°C)
	Mounting position	Any position
	Maximum inlet gas pressure	Same as VG… series

Specifications, Continued

Physical characteristics	Weight	3.5 lb (1.6 kg)
	Enclosure	NEMA 1, 2, 5 and 12 for indoor use NEMA 3, 3R, and 4 with optional AGA66 gasket
	Dimensions	See Figure 4
	Specification for valve bodies	See *gas valve Technical Instructions,* P/N 155-512P25
Connections	Conduit connection	Two 1/2-inch NPSM threaded knock-outs
	Electrical connection	Spring loaded terminals for 14 AWG wires
	Gas connection	1/4” NPT
	Air connection	1/4” NPT
	Gas pressure test connection	Hose barb with close-off screw
Operating characteristics	Output force	100 lb (450 N)
	Maximum stroke	1 inch (26 mm)
	Opening time for maximum stroke	Varies with valve size, 14 seconds for max. stroke
	Closing time	< 0.8 seconds
Operation/installation	Outlet pressure spring range	
	SKP25.0…	0" to 8.5" WC (factory-installed, unpainted spring, AGA29) 6" to 48" WC (yellow spring, AGA22) 40" to 100" WC (red spring, AGA23)
	SKP25.411U1	1.5 to 10 psi (factory-installed, yellow spring, AGA22) 8.5 to 20 psi (red spring, AGA23)
	SKP25.0… (1:1 air/gas ratio regulator or zero governor)	± 0.4" WC bias (replace with black spring AGA28)
	SKP25.**6**11U1 (1:1 air/gas ratio regulator)	0" to –4.0" WC bias (factory installed, white spring)
	SKP25.011U1P (1:1 air/gas ratio regulator)	0” to –0.6 “ WC (factory installed, lavender spring)
	Maximum sensing line pressure	20 psi
	Maximum sensing line vacuum	3 psi for SKP25.0… models
	Minimum sensing line diameter	1/4" inside diameter
	Minimum distance between sensing line and gas valve outlet	5 times the pipe diameter
	Minimum time required for high to low fire load changes	5 seconds
Auxiliary features	Proof of closure switch	Non-adjustable
	Setting range of auxiliary switch	40% to 100% of stroke
	Switch rating	6A/250 Vac resistive; 3A/120 Vac pilot duty

Operation

(See Figure 1)

Safety Shut-off Function

The electro-hydraulic actuator consists of a cylinder filled with oil, a piston containing an electric oscillating pump, and a relief system. When power is supplied to the actuator, the relief system closes, and the pump moves oil from the reservoir into the pressure chamber. This action causes the piston to move downward in the cylinder, opening the gas valve. When power to the actuator is interrupted, the relief system opens and the gas valve closes in less than 0.8 seconds.

A position indicator, visible through the transparent portion of the terminal cover, shows the entire stroke range of the actuator. A light, which is visible through the lower left transparent portion of the terminal cover, indicates when the actuator receives power. An optional, non-adjustable SPDT proof of closure over travel switch signals the closed position after the gas valve has closed. An optional SPDT auxiliary switch is adjustable between 40% and 100% of the stroke. The adjustment screw and scale are located on the right side in the terminal box, and are visible through the transparent portion of the terminal cover.

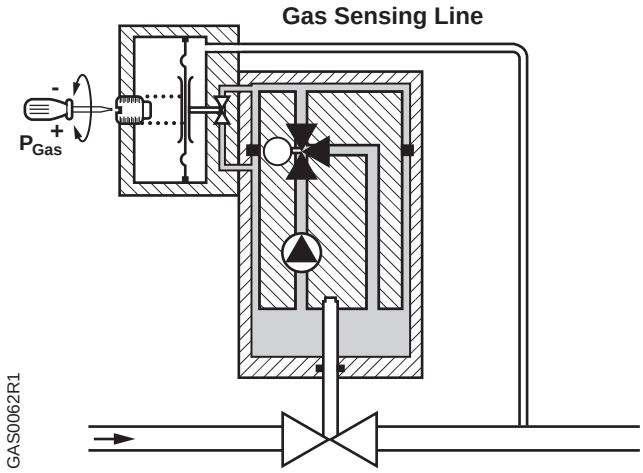


Figure 1. SKP25… Operation.

Constant Pressure Regulation Function

(See Figure 1)

The outlet gas pressure sensing line is connected to the 1/4“ NPT port marked GAS on the back of the pressure regulator housing. The outlet pressure acts on the regulator diaphragm. The diaphragm is opposed by an adjustable setpoint spring force, which represents the desired gas pressure value. The movement of the diaphragm modulates a hydraulic bypass valve connecting the pressure chamber to the hydraulic fluid reservoir. When the outlet gas pressure is lower than the desired value, the bypass valve is closed by the movement of the diaphragm, causing the actuator piston to open the gas valve. The opposite occurs when the outlet gas pressure is higher than the desired value; the diaphragm moves to open the bypass causing the actuator piston to close the gas valve. The movement of the actuator piston stops once the outlet gas pressure is equal to the setpoint. In this position the bypass valve is partially open so that the oil flow supplied by the pump is identical to the return flow. Unlike the conventional direct acting regulators, the SKP25… servo operated regulating system displays virtually zero droop (offset) across the turndown range.

Air/Gas Ratio Regulator Function

The SKP25.**0**… models may be applied as a 1:1 air/gas ratio regulator or as a zero governor. For either application, the standard spring has to be replaced with the black AGA28 spring, which allows to bias the gas pressure between 0.4" and –0.4" WC.

The low bias model SKP25.011U1**P** air/gas ratio regulator is designed as 1:1 air/gas ratio regulator which allows to bias the gas pressure between 0" and –0.6" WC. with the factory installed lavender spring. The actuator has a built in proof of closure switch.

The high bias model SKP25.**6**11U1 air/gas ratio regulator model is designed as 1:1 air/gas ratio regulator which allows to bias the gas pressure between 0" and –4" WC. with the factory installed white spring. The actuator has a built in proof of closure switch.

For air/gas ratio regulation, the air pressure sensing line must be connected to the port marked "AIR".

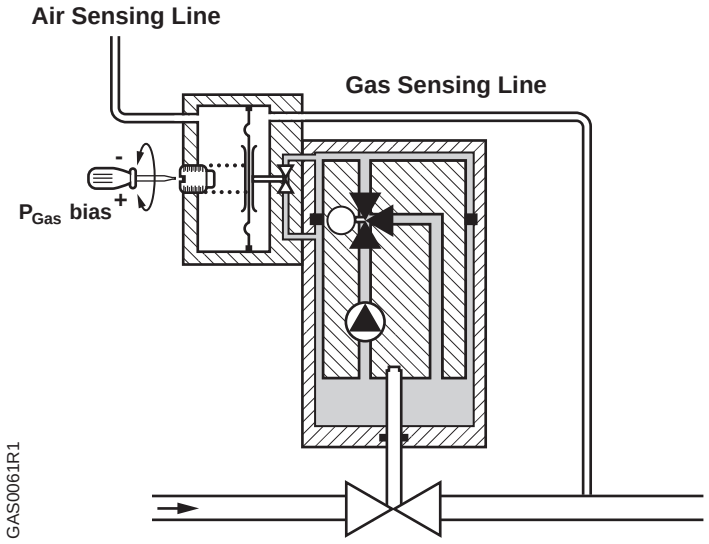


Figure 2. SKP25… Operation as 1:1 Air/Gas Ratio Regulator.

NOTES:

1. The gas bias has the greatest effect at low fire.
2. To adjust the gas pressure or bias, remove the brass cap in the center of the regulator cover.
3. To increase the downstream gas pressure, turn the adjustment screw clockwise.
4. SKP25.**4**… models must not be used as air/gas ratio regulator.
5. When using the double valve VGD…, mount the SKP2… on the downstream valve.
6. To avoid oscillation, do not oversize the VG… valve body. (See *Technical Instructions,* P/N 155-512P25.)

Installation

WARNING:

- Personal injury or loss of life may occur if procedures are not followed as specified.
- All installations must be performed by qualified personnel only.
- Do not pull the actuator shaft.
- If minimum gas pressure detection is required, the pressure switch must be mounted upstream of the regulating gas valve to ensure sufficient gas pressure before starting the burner. If maximum gas pressure detection is required the pressure switch must be mounted downstream.
- The AGA66 gasket must be installed between the actuator and the gas valve body to provide NEMA 3, 3R, and 4 protection rating for VGG… and VGD… valves.
- The gas pressure sensing line must be at least 1/4-inch inside diameter.
- The gas pressure sensing line connection must be flush with the inner wall of the gas pipe in order to sense turbulence free pressure. The gas sensing line connection should be located at least five pipe diameters downstream of the valve, elbow, coupling, or other flow disturbing fitting. **Do not use the taps on the valve body for the gas sensing line connection since these locations typically have strong turbulence.** The pressure connection pipe should be as short as possible to allow the regulator to react to sudden changes.

- The SKP25… actuator is directly coupled to the VG… series valve body by four pre-mounted 4 mm Allen key screws.
- The square mounting flange can be rotated in steps of 90^{o} to provide four different mounting positions. The SKP25… actuator can be mounted in any position with the diaphragm vertical, except upside down.
- The actuator can be mounted or replaced while the valve body is under pressure.
- The SKP25… actuator has two knock-outs for the installation of 1/2”-14 NPSM conduit connections.
- When conduit routing is connected, flexible conduit must be used.
- Liquid tight conduit must be used in combination with AGA66 to provide NEMA 3, 3R, and 4 protection.
- The terminal marked GND, located above the wiring terminals, must be connected to the electrical ground.

NOTE: Wiring must meet all relevant electrical codes.

Start-up

Regulator

The gas outlet pressure setpoint adjustment screw is located at the center of the regulator cover. Clockwise rotation of the setpoint adjustment screw increases the outlet gas pressure. The hexagonal cap must be tightened after the setpoint screw has been adjusted and may be sealed from tampering by means of a wire and lead seal. The outlet gas pressure can be measured at the hose barb at the back of the regulator housing. Turn the screw 1/2 turn counterclockwise before attaching the hose and tighten the screw after removing the hose.

The SKP25.0… models are available with three interchangeable setpoint springs for an adjustable range outlet pressure range of 0" to 100" WC. The factory-installed unpainted spring ranges from 0" to 8.5" WC. Other springs need to be ordered separately. (See Table 2.)

The SKP25.411U… models are available with two interchangeable setpoint springs for an adjustable range of 1.5 to 20 psi. The factory installed yellow spring ranges from 1.5 to 10 psi. The red spring (AGA23) for an adjustable range of 8.5 to 20 psi needs to be ordered separately.

Air/Gas Ratio Regulators

For SKP25.**0**… models used as 1:1 air/gas ratio regulator connect the air sensing line to the port marked AIR and replace the factory installed spring with the black spring (AGA28) which needs to be ordered separately. The gas bias can be adjusted at the center of the regulator housing. For bias pressure ranges of all 1:1 air/gas ratio regulators see *Operation, Specifications* or Tables 1 and 2.

WARNING:

When firing at maximum burner capacity, ensure that the SKP25… /VG… is not in the fully open position. If this is the case, either the gas valve is sized too small or the gas supply pressure is too low.

Wiring and Switch Adjustment

(See *Terminal Designations*)

- The actuator is equipped with spring-loaded terminals for 14 AWG wires.
- The actuator has two line and two neutral terminals.
- Insert one wire into the opening of the terminal while pressing the lever downward with a screwdriver or hard object. Make sure that all strands insert into the opening.
- Adjust the auxiliary switch (if provided) according to the wiring diagram on the label below the terminals (see Figure 3). The adjustment screw and scale are located on the right side of the terminal box, and are visible through the transparent portion of the terminal cover.

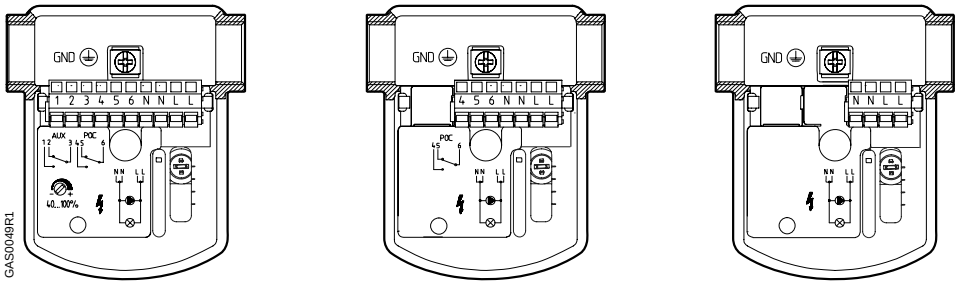
NOTES:

1. The auxiliary switch is adjustable between 40% and 100% of the stroke. The factory setting is at 40%.
2. The auxiliary switch must not be used for proof of closure detection or other safety interlock functions.
3. The Proof of Closure Switch is non-adjustable.

Service

There are no serviceable parts on the SKP25… series actuators. If inoperative, replace the actuator. Tag wires before servicing.

Terminal Designations



SKP25.012U.. SKP25.011U.. SKP25.013U..

Figure 3. Terminal Designations.

Dimensions

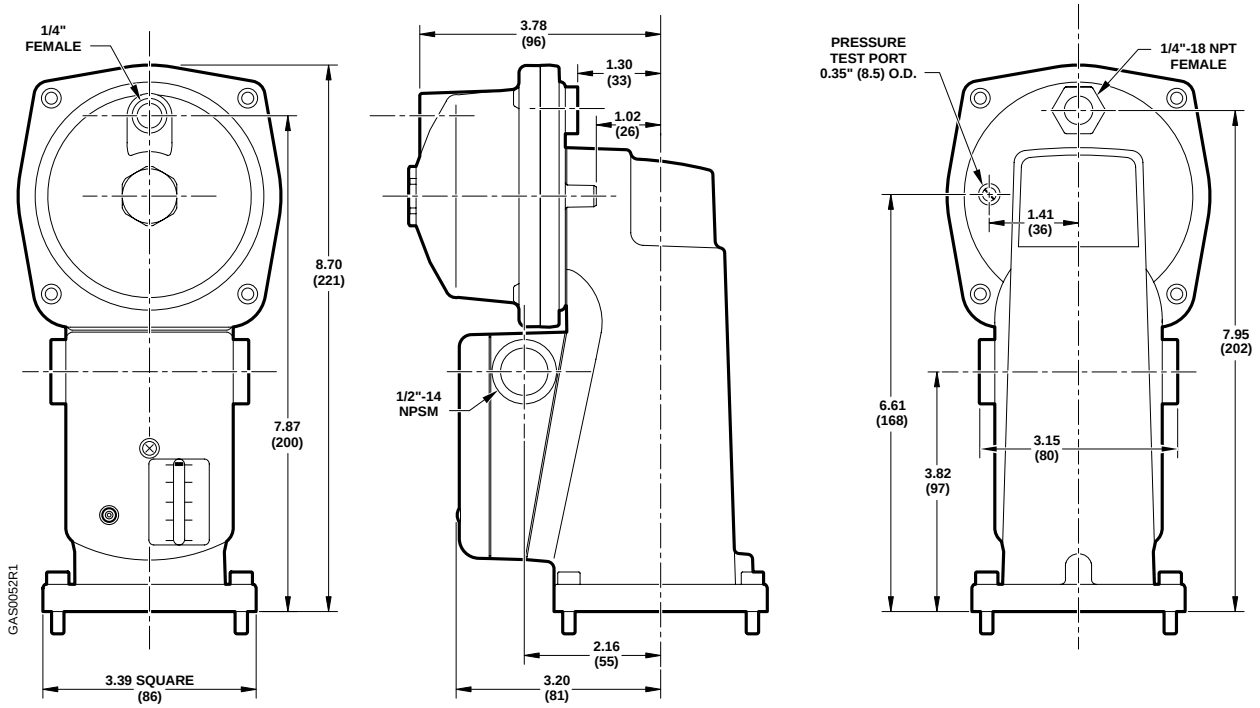


Figure 4. SKP25…U.. Dimensions in Inches, Millimeters in Parentheses.

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SIEMENS

Technical Instructions

Document No. 155-292

December 11, 2012

QP Series

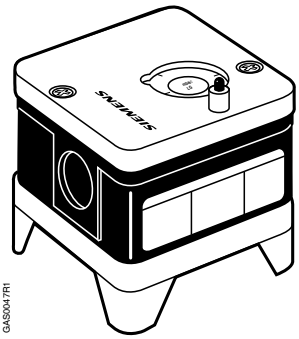
Pressure Switches for Gas and Air

GAS0048R1

ISO 9001
REGISTERED FIRM

C UL US
LISTED

FM
APPROVED



GAS0047R1

Description

QP… pressure switches are used for gas and air pressure supervision on industrial and commercial burner applications.

The QPL31… series pressure switches break the electrical circuit when the pressure drops below the adjusted value.

The QPH31… series pressure switches break the electrical circuit when the pressure increases above the adjusted value.

Features

- UL listed for USA and Canada, FM approved, ISO 9001 certified; European approved versions available.
- Adjustable pressure range from 1 to 112 inches water column (WC).
- Automatic and manual reset models.
- Surge protected up to 15 psi.

Product Numbers

Table 1.

Product Number	Pressure Range		Execution
	Inches Water Column (WC)	mbar	
QPL31.010M00	0.5 to 4	1.2 to 10	Manual Reset Low
QPL31.050M00	1 to 20	2.5 to 50	
QPL31.140M00	7 to 55	17.5 to 137	
QPH31.050M00	2 to 20	5 to 50	Manual Reset High
QPH31.150M00	10 to 60	25 to 150	
QPL31.010A00	0.5 to 4	1.2 to 10	Automatic Reset Low
QPL31.050A00	1 to 20	2.5 to 50	
QPL31.075A00	5 to 30	12.5 to 75	
QPL31.280A00	28 to 112	70 to 280	
QPH31.010A00	0.8 to 4	2 to 10	Automatic Reset High
QPH31.050A00	2 to 20	5 to 50	
QPH31.090A00	5 to 35	12.5 to 87	
QPH31.280A00	28 to 112	70 to 280	

Specifications

Electrical rating	10A @ 125 to 250 Vac 1/3 HP @ 125 to 250 Vac
Maximum operating pressure	6 psi (400 mbar)
Maximum surge pressure	15 psi (1 bar) for 2 seconds
Operating temperature	–40°F to 140°F (–40°C to 60°C)

Operation

Range Adjustment

Remove the cover to adjust the pressure cut-off setting. Turn the range dial clockwise to increase the pressure setting, or counterclockwise to decrease the pressure setting.

Manual reset models

If the yellow ring of the reset button is above the cover, the switch is in the open position and must be manually reset before continuing burner operation.

Wiring

NOTE: Wiring must be performed by a licensed electrician.

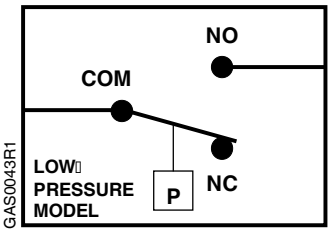


Figure 1. Typical Wiring for Low Pressure Models.

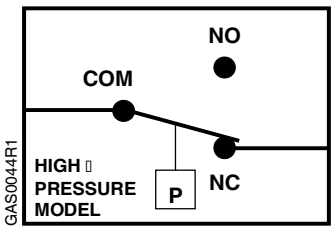
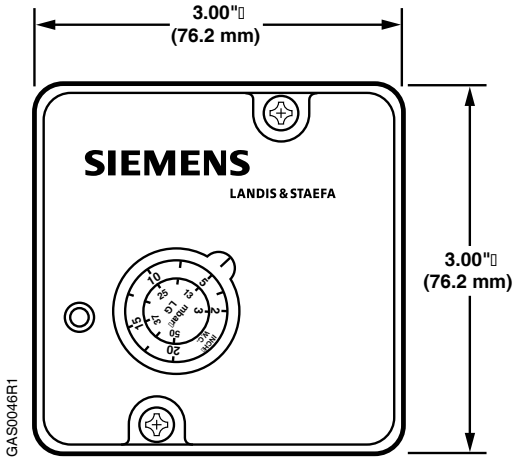


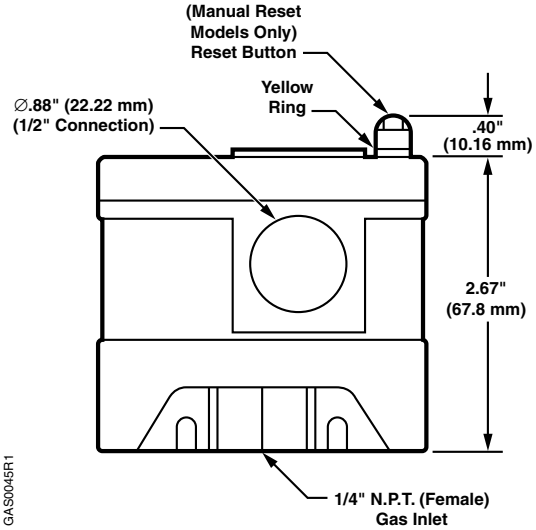
Figure 2. Typical Wiring for High Pressure Models.

Mounting

- All switches can be mounted in either a horizontal or vertical position.
- All models have a 1/4-inch NPT female pressure connection on the metal base.
- Check connections for leakage after installation.

Dimensions





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SCC Inc.

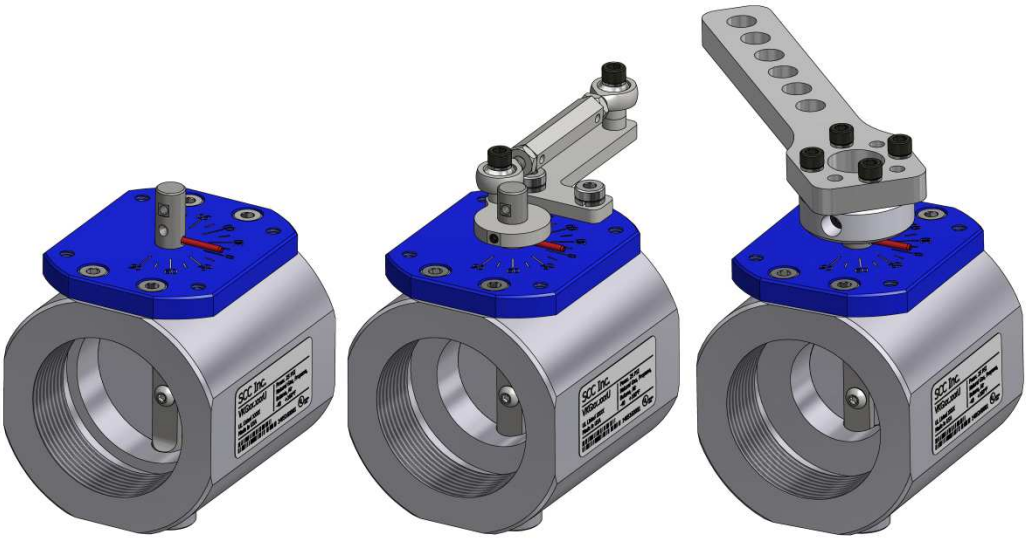
Technical Instructions

Document No. CVLV-2000

August 4, 2015

VKG… Series

VKG… Butterfly Valves



Description

VKG… series threaded butterfly valves control the flow of natural gas, propane, butane, or air.

Features

- UL approved, ½" to 4" NPT thread
- CE approved, ½" to 3" Rp thread
- Full, medium, or reduced port versions available to optimize pressure drop and flow control
- Shaft supported by precision bearings for repeatable performance
- Low leakage rate at full closed position without a beveled disk
- Low pressure loss at the full open position
- Corrosion-resistant for outdoor applications
- Clear position indication on a 2" laser-etched, anodized dial
- 90° clockwise or counterclockwise rotation
- Manual kits available for fixed position adjustment
- Crank arm kit available for linkage applications
- Valve actuator assemblies available (Document No. VA-1000)
- Flow in either direction

Application

VKG… series butterfly valves control the flow of natural gas, propane, butane, or air. Valves are positioned using either a manual kit, crank arm kit, or rotary actuator. VKG… series butterfly valves are not intended for use as shutoff valves. The valve body contains (2) identical female pipe threads for a gas tight seal with piping. Full, medium, and reduced port sizes are offered to optimize control and ease of installation.

Product Part Numbers

The part number structure includes port size, pipe size, and thread type. The example part number is a VKG… series full port, 2" NPT butterfly valve.

VKG 10 . 050 U

Model

Port Size

10	=	Full Port
20	=	Medium Port
30	=	Reduced Port

Pipe Size

(mm)		(inches)	
015	=	1/2"	→ Full Port only
020	=	3/4"	→ Full Port only
025	=	1"	→ Full Port & Medium Port
032	=	1-1/4"	→ Full Port & Medium Port
040	=	1-1/2"	
050	=	2"	
065	=	2-1/2"	
080	=	3"	
100	=	4"	→ NPT only

Thread Type

U	=	NPT
E	=	Rp

Product Part Numbers (continued)

UL approved butterfly valve part numbers, ratings, and port diameters are tabulated below. The VKG…U butterfly valves are NPT thread type.

Table 1: UL Approved Butterfly Valve Part Numbers

Port Type	Part Number	Max Operating Pressure	Max Surge Pressure	Temperature Range	Pipe Size inch	Port Diameter inch [mm]
Full	VKG10.015U	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1/2	0.61 [15.5]
	VKG10.020U				3/4	0.87 [22.1]
	VKG10.025U				1	1.10 [27.9]
	VKG10.032U				1-1/4	1.46 [37.1]
	VKG10.040U				1-1/2	1.65 [41.9]
	VKG10.050U				2	2.13 [54.1]
	VKG10.065U				2-1/2	2.64 [67.1]
	VKG10.080U				3	3.23 [82.0]
	VKG10.100U	15 psig [100 kPa]			4	4.17 [105.9]
Medium	VKG20.025U	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1	0.87 [22.1]
	VKG20.032U				1-1/4	1.10 [27.9]
	VKG20.040U				1-1/2	1.46 [37.1]
	VKG20.050U				2	1.65 [41.9]
	VKG20.065U				2-1/2	2.13 [54.1]
	VKG20.080U				3	2.64 [67.1]
	VKG20.100U				4	3.23 [82.0]
Reduced	VKG30.040U	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1-1/2	1.10 [27.9]
	VKG30.050U				2	1.46 [37.1]
	VKG30.065U				2-1/2	1.65 [41.9]
	VKG30.080U				3	2.13 [54.1]
	VKG30.100U				4	2.64 [67.1]

Product Part Numbers (continued)

CE approved butterfly valve part numbers, ratings, and port diameters are tabulated below. The VKG…E butterfly valves are Rp thread type.

Table 2: CE Approved Butterfly Valve Part Numbers

Port Type	Part Number	Max Operating Pressure	Max Surge Pressure	Temperature Range	Pipe Size inch	Port Diameter inch [mm]
Full	VKG10.015E	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1/2	0.61 [15.5]
	VKG10.020E				3/4	0.87 [22.1]
	VKG10.025E				1	1.10 [27.9]
	VKG10.032E				1-1/4	1.46 [37.1]
	VKG10.040E				1-1/2	1.65 [41.9]
	VKG10.050E				2	2.13 [54.1]
	VKG10.065E				2-1/2	2.64 [67.1]
	VKG10.080E				3	3.23 [82.0]
Medium	VKG20.025E	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1	0.87 [22.1]
	VKG20.032E				1-1/4	1.10 [27.9]
	VKG20.040E				1-1/2	1.46 [37.1]
	VKG20.050E				2	1.65 [41.9]
	VKG20.065E				2-1/2	2.13 [54.1]
	VKG20.080E				3	2.64 [67.1]
Reduced	VKG30.040E	25 psig [170 kPa]	75 psig [510 kPa]	-40 to 160°F [-40 to 70°C]	1-1/2	1.10 [27.9]
	VKG30.050E				2	1.46 [37.1]
	VKG30.065E				2-1/2	1.65 [41.9]
	VKG30.080E				3	2.13 [54.1]

Accessories

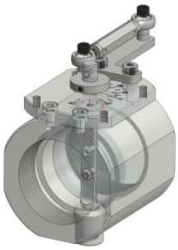
VA… Valve Actuator Assemblies

Valve actuator assemblies ensure proper shaft alignment and engagement. A VKG… valve, SQM… actuator, coupling, and bracket are built, tested, and shipped as a VA… assembly. Valve actuator assemblies are available with the following Siemens actuators:

- SQM45…
- SQM33…
- SQM40/41…
- SQM5…

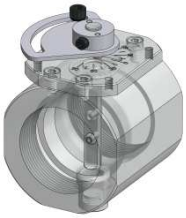
For additional information see Document No. VA-1000.

AGA92.1



A manual kit with fine adjustment can be added to any VKG… butterfly valve for use as a flow restrictor. The kit allows for precision position adjustment by turning a hex coupling; (14) revolutions make a 90° stroke. Locking nuts maintain the precise position at all rated flow pressures.

AGA92.2



A manual kit with coarse adjustment can be added to any VKG… butterfly valve.

AGA92.3

A crank arm kit with (6) 3/8” clearance holes can be added to any VKG… series butterfly valve for use with a linkage system.

Materials

Below is a typical valve cross-section that identifies the materials used in the VKG product line.

Table 3: VKG Components

Item	Description	Material
A	Valve body	Aluminum-6061
B	Seal	Buna-N
C	Shaft	Stainless Steel (300-series)
D	Dial	Aluminum-6061
E	Shim	Teflon
F	Bearing (ball)	Steel
G	Shim	Stainless Steel
H	Fastener	Steel (Zinc-plated)
I	Disk	Stainless Steel (300-series)
J	Bearing (sleeve)	Acetal
K	Bearing (thrust)	Acetal
L	Spring	Stainless Steel (17-4 PH)
M	Plug	Aluminum-6061

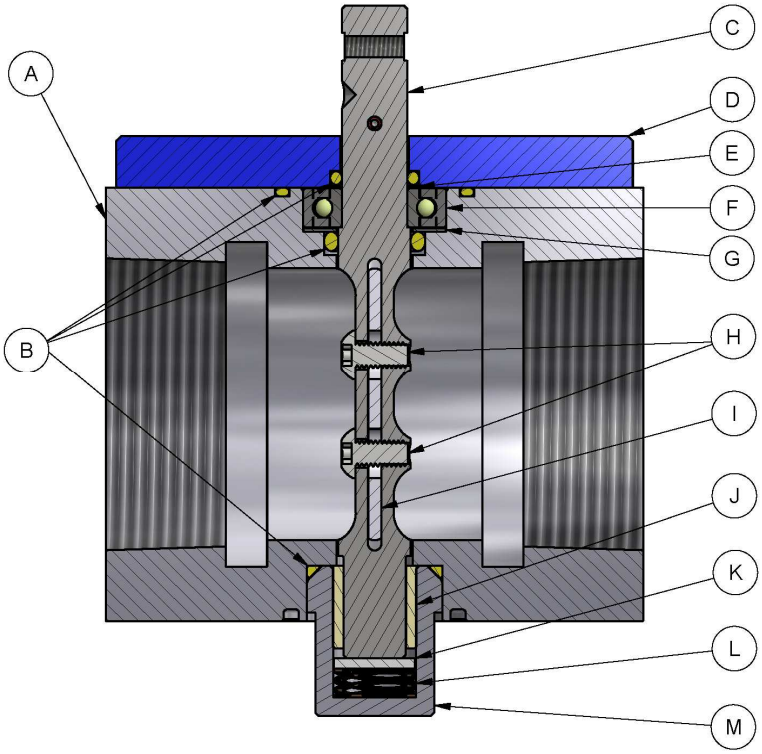


Figure 1: Cross-section of a VKG10.040U

Installation

- Use suitable pipe thread sealant on all piping connections.
- **DO NOT** use the “plug” or “shaft” as a wrench grip. **ALWAYS** use a wrench on the provided valve body wrench flats when piping.
- Valve can be mounted in any orientation.
- Do not interfere with or modify the butterfly valve.
- All activities (mounting, installation, service work, etc.) must be performed by qualified staff.
- Fall or shock can adversely affect the function of these valves. Such valves must not be put into operation, even if they do not exhibit any damage.
- No special tools are required.
- Ensure the installation complies with relevant local and national codes.
- VKG… butterfly valves do not require maintenance.
- From the 0˚ full closed position, disk may turn in either direction to increase flow.
- Accomodates flow in either direction.

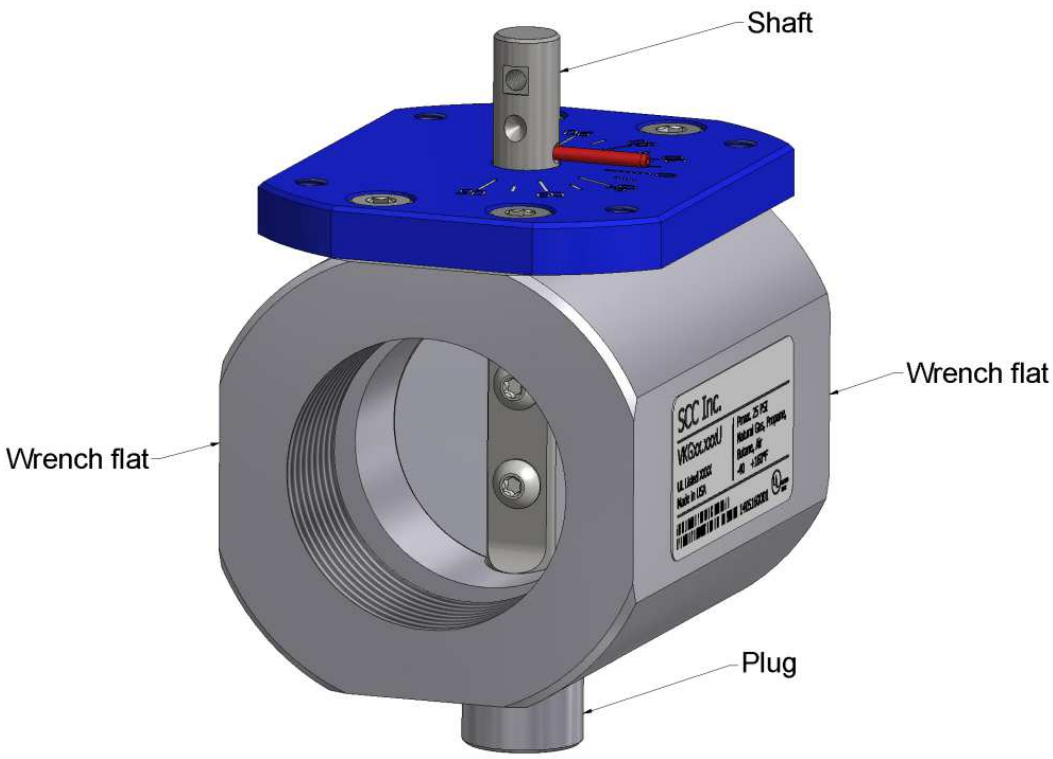


Figure 2: Isometric View of a VKG10.040U

Flow Data

Natural gas flow (SCFH) through the valve body and the corresponding boiler horsepower (BHP) are tabulated at common differential pressures. Calculated values assume a boiler efficiency of 85% and a natural gas heating value of 1000 BTU/SCF. Valve data is sorted by ascending Cv value for ease of selection. Cv values can be utilized to calculate flow at any operating condition (see page 13).

Flow is calculated with an inlet pressure of 15 inWC at a flowing temperature of 60°F.

Multiplier from natural gas flow (SCFH) to: Air = 0.80, Propane = 0.65, Butane = 0.57
Multiplier from boiler horsepower (BHP) to: Propane = 1.81, Butane = 1.62

Table 4: Flow Rates of Natural Gas at Full Open Position (0.5-3 inWC Differential Pressure)

Part Number	Thread Size	Port*	Cv	0.5 inWC		1 inWC		1.5 inWC		2 inWC		3 inWC	
				SCFH	BHP	SCFH	BHP	SCFH	BHP	SCFH	BHP	SCFH	BHP
VKG10.015x	1/2	FULL	5	195	5	276	7	338	9	391	10	478	12
VKG20.025x	1	MED.	19	743	19	1,050	27	1,286	33	1,484	38	1,817	46
VKG10.020x	3/4	FULL	20	782	20	1,105	28	1,353	34	1,562	40	1,912	49
VKG30.040x	1-1/2	RED.	30	1,173	30	1,658	42	2,030	52	2,343	60	2,868	73
VKG10.025x	1	FULL	31	1,212	31	1,713	44	2,098	53	2,421	61	2,964	75
VKG20.032x	1-1/4	MED.	41	1,603	41	2,266	58	2,774	70	3,203	81	3,920	100
VKG30.050x	2	RED.	62	2,424	62	3,427	87	4,195	107	4,843	123	5,928	151
VKG10.032x	1-1/4	FULL	75	2,932	74	4,145	105	5,075	129	5,858	149	7,171	182
VKG30.065x	2-1/2	RED.	76	2,971	75	4,200	107	5,143	131	5,937	151	7,266	185
VKG20.040x	1-1/2	MED.	81	3,166	80	4,477	114	5,481	139	6,327	161	7,745	197
VKG20.050x	2	MED.	97	3,792	96	5,361	136	6,564	167	7,577	192	9,274	235
VKG10.040x	1-1/2	FULL	100	3,909	99	5,527	140	6,767	172	7,811	198	9,561	243
VKG30.080x	3	RED.	147	5,746	146	8,124	206	9,947	253	11,483	292	14,055	357
VKG20.065x	2-1/2	MED.	170	6,645	169	9,395	239	11,503	292	13,279	337	16,254	413
VKG10.050x	2	FULL	180	7,036	179	9,948	253	12,180	309	14,060	357	17,210	437
VKG30.100U	4	RED.	204	7,975	202	11,274	286	13,804	351	15,935	405	19,505	495
VKG10.065x	2-1/2	FULL	255	9,968	253	14,093	358	17,255	438	19,919	506	24,381	619
VKG20.080x	3	MED.	275	10,750	273	15,198	386	18,609	473	21,481	545	26,293	668
VKG20.100U	4	MED.	431	16,848	428	23,820	605	29,165	741	33,667	855	41,208	1,046
VKG10.080x	3	FULL	438	17,122	435	24,207	615	29,638	753	34,213	869	41,878	1,063
VKG10.100U	4	FULL	828	32,367	822	45,761	1,162	56,029	1,423	64,677	1,642	79,166	2,010

***** MED. = Medium; RED. = Reduced

Flow Data (continued)

Flow is calculated with an inlet pressure of 1 psig at a flowing temperature of 60°F.

Multiplier from natural gas flow (SCFH) to: Air = 0.80, Propane = 0.65, Butane = 0.57
Multiplier from boiler horsepower (BHP) to: Propane = 1.81, Butane = 1.62

Table 5: Flow Rates of Natural Gas at Full Open Position (4-12 inWC Differential Pressure)

Part Number	Thread Size	Port*	Cv	4 inWC		6 inWC		8 inWC		10 inWC		12 inWC	
				SCFH	BHP	SCFH	BHP	SCFH	BHP	SCFH	BHP	SCFH	BHP
VKG10.015x	1/2	FULL	5	560	14	685	17	790	20	882	22	965	25
VKG20.025x	1	MED.	19	2,128	54	2,603	66	3,002	76	3,353	85	3,668	93
VKG10.020x	3/4	FULL	20	2,240	57	2,740	70	3,160	80	3,529	90	3,862	98
VKG30.040x	1-1/2	RED.	30	3,360	85	4,110	104	4,740	120	5,294	134	5,792	147
VKG10.025x	1	FULL	31	3,472	88	4,247	108	4,898	124	5,470	139	5,985	152
VKG20.032x	1-1/4	MED.	41	4,592	117	5,617	143	6,479	165	7,235	184	7,916	201
VKG30.050x	2	RED.	62	6,943	176	8,494	216	9,797	249	10,941	278	11,971	304
VKG10.032x	1-1/4	FULL	75	8,399	213	10,275	261	11,851	301	13,234	336	14,481	368
VKG30.065x	2-1/2	RED.	76	8,511	216	10,412	264	12,009	305	13,411	341	14,674	373
VKG20.040x	1-1/2	MED.	81	9,071	230	11,097	282	12,799	325	14,293	363	15,639	397
VKG20.050x	2	MED.	97	10,863	276	13,289	337	15,327	389	17,117	435	18,728	476
VKG10.040x	1-1/2	FULL	100	11,199	284	13,700	348	15,801	401	17,646	448	19,308	490
VKG30.080x	3	RED.	147	16,463	418	20,139	511	23,228	590	25,940	659	28,382	721
VKG20.065x	2-1/2	MED.	170	19,039	483	23,290	591	26,862	682	29,998	762	32,823	833
VKG10.050x	2	FULL	180	20,159	512	24,661	626	28,443	722	31,763	807	34,754	882
VKG30.100U	4	RED.	204	22,846	580	27,949	710	32,235	819	35,998	914	39,388	1,000
VKG10.065x	2-1/2	FULL	255	28,558	725	34,936	887	40,294	1,023	44,997	1,143	49,235	1,250
VKG20.080x	3	MED.	275	30,798	782	37,676	957	43,454	1,103	48,526	1,232	53,096	1,348
VKG20.100U	4	MED.	431	48,268	1,226	59,048	1,499	68,104	1,729	76,054	1,931	83,216	2,113
VKG10.080x	3	FULL	438	49,052	1,246	60,007	1,524	69,210	1,757	77,289	1,963	84,568	2,147
VKG10.100U	4	FULL	828	92,729	2,355	113,438	2,880	130,836	3,322	146,109	3,710	159,868	4,059

***** MED. = Medium RED. = Reduced

Flow Data (continued)

Flow is calculated with an atmospheric outlet pressure at a flowing temperature of 60°F.

Multiplier from natural gas flow (SCFH) to: Air = 0.80, Propane = 0.65, Butane = 0.57

Table 6: Leakage Rate (SCFH) of Natural Gas at Full Closed Position (1-16 inWC Inlet Pressure)

Part Number	Thread Size	Port	1 inWC	2 inWC	4 inWC	8 inWC	16 inWC
			SCFH	SCFH	SCFH	SCFH	SCFH
VKG10.015x	1/2	FULL	TBD	TBD	TBD	TBD	TBD
VKG20.025x	1	MEDIUM	TBD	TBD	TBD	TBD	TBD
VKG10.020x	3/4	FULL	TBD	TBD	TBD	TBD	TBD
VKG30.040x	1-1/2	REDUCED	TBD	TBD	TBD	TBD	TBD
VKG10.025x	1	FULL	TBD	TBD	TBD	TBD	TBD
VKG20.032x	1-1/4	MEDIUM	TBD	TBD	TBD	TBD	TBD
VKG30.050x	2	REDUCED	TBD	TBD	TBD	TBD	TBD
VKG10.032x	1-1/4	FULL	TBD	TBD	TBD	TBD	TBD
VKG30.065x	2-1/2	REDUCED	TBD	TBD	TBD	TBD	TBD
VKG20.040x	1-1/2	MEDIUM	4.2	7.4	13.0	22.5	33.9
VKG20.050x	2	MEDIUM	4.2	9.1	17.1	27.4	40.6
VKG10.040x	1-1/2	FULL	2.8	6.8	14.1	24.2	36.5
VKG30.080x	3	REDUCED	TBD	TBD	TBD	TBD	TBD
VKG20.065x	2-1/2	MEDIUM	TBD	TBD	TBD	TBD	TBD
VKG10.050x	2	FULL	3.3	8.1	16.0	26.1	39.7
VKG30.100U	4	REDUCED	TBD	TBD	TBD	TBD	TBD
VKG10.065x	2-1/2	FULL	TBD	TBD	TBD	TBD	TBD
VKG20.080x	3	MEDIUM	TBD	TBD	TBD	TBD	TBD
VKG20.100U	4	MEDIUM	TBD	TBD	TBD	TBD	TBD
VKG10.080x	3	FULL	TBD	TBD	TBD	TBD	TBD
VKG10.100U	4	FULL	TBD	TBD	TBD	TBD	TBD

Flow Data (continued)

Approximate pressure drops for a given valve at a flow rate may be determined using the chart below. When pressure drop is more than 50% of the inlet pressure (P_1), choked flow occurs and the chart is no longer accurate.

Flow is calculated with an inlet pressure of 1 psig at a flowing temperature of 60°F.

Multiplier from natural gas flow (SCFH) to: Air = 0.80, Propane = 0.65, Butane = 0.57

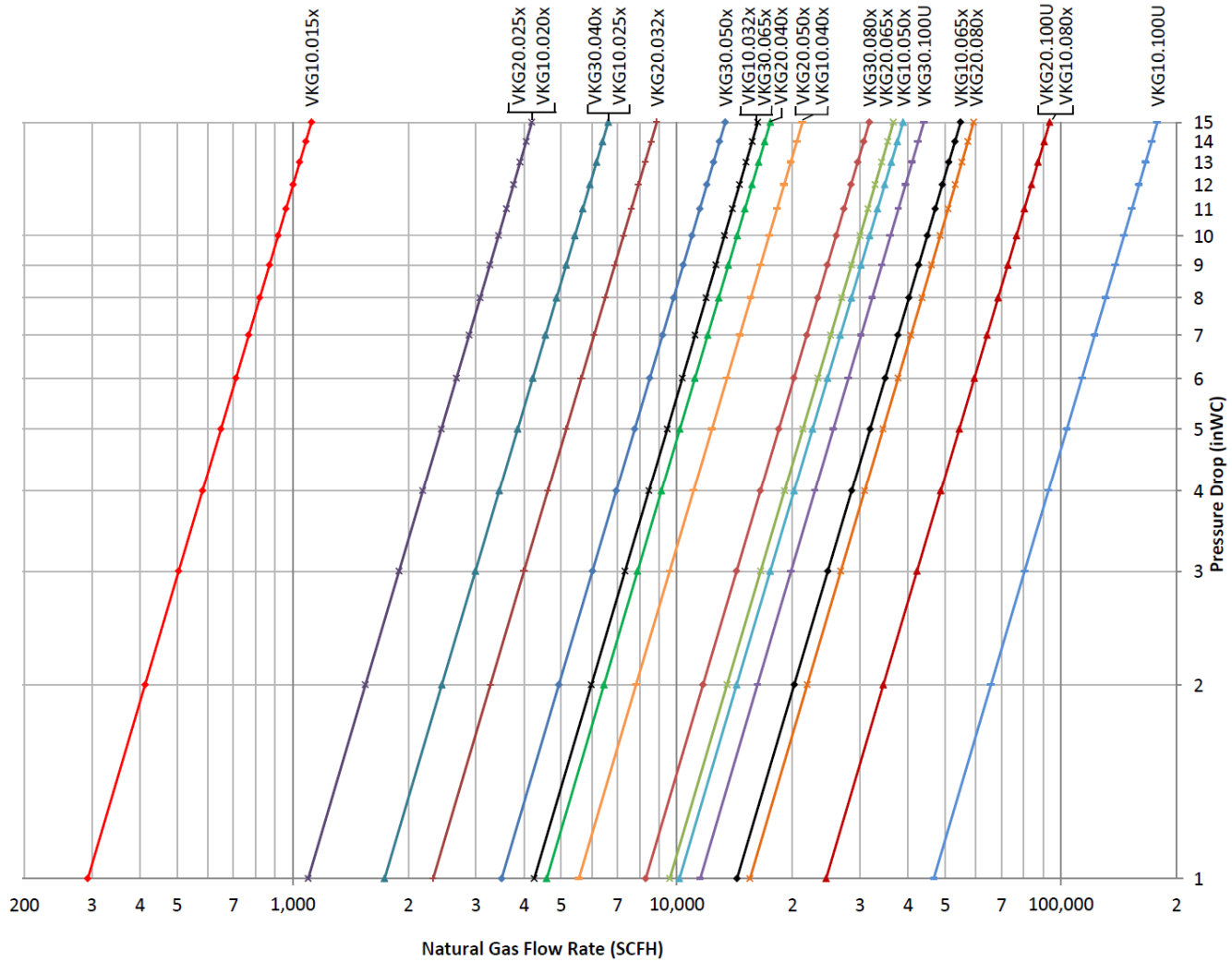


Figure 3: Logrithmic Scale Plot of VKG Natural Gas Flow Capacities for Full Open Position

Flow Data (continued)

Flow rate (SCFH) through the valve body at the full open position can be estimated using the equation below and the C_v values from Table 4.

$$Q = 1360 \times C_v \times \left(\sqrt{\frac{P_1 + P_2}{GT_f}}\right) \times \left(\sqrt{\frac{P_1 - P_2}{2}}\right)$$

…where…

C_v = Flow coefficient (see Table 4)
G = Specific gravity of gas (see Table 7)
P_1 = Inlet pressure in PSIA (PSIG + 14.7)
P_2 = Outlet pressure in PSIA (PSIG + 14.7)
Q = Flow rate in SCFH
T_f = Flowing temperature in degrees Rankine (°F + 460)

Boiler horsepower is calculated using the equation below.

$$Boiler\ hp = Q \times (HHV) \times \eta \times \frac{1\ Boiler\ hp}{33{,}475\ BTU/HR}$$

…where…

Q = Flow rate (SCFH)
HHV = Higher Heating Value (BTU/SCF)
η = Boiler efficiency (assume: 85% efficiency or 0.85)

Table 7: Constants for Boiler Horsepower Calculations by Applicable Gases

Type of Gas	Specific Gravity	Higher Heating Value (Btu/SCF)
Natural Gas	0.64	1000
Air	1.00	-
Propane	1.52	2500
Butane	2.00	3200

Actuator Torque

Torque requirements for the 4" full port valve (VKG10.100U) are tabulated at various differential pressures to ensure proper actuator selection. The VKG10.100U valve requires more torque than all other models. Maximum torque occurs at approximately the 60 degree position at high flow rates. A maximum of 20 in-lbs is required to modulate any VKG… valve.

Table 8: Maximum Torque Values at Various Pressure Differentials

Differential Pressure		Torque	
psi	**kPa**	**in-lbs**	**N-m**
6	41	10	1.13
10	69	15	1.69
15	100	20	2.26

Dimensions

Dimensions in inches; millimeters in brackets

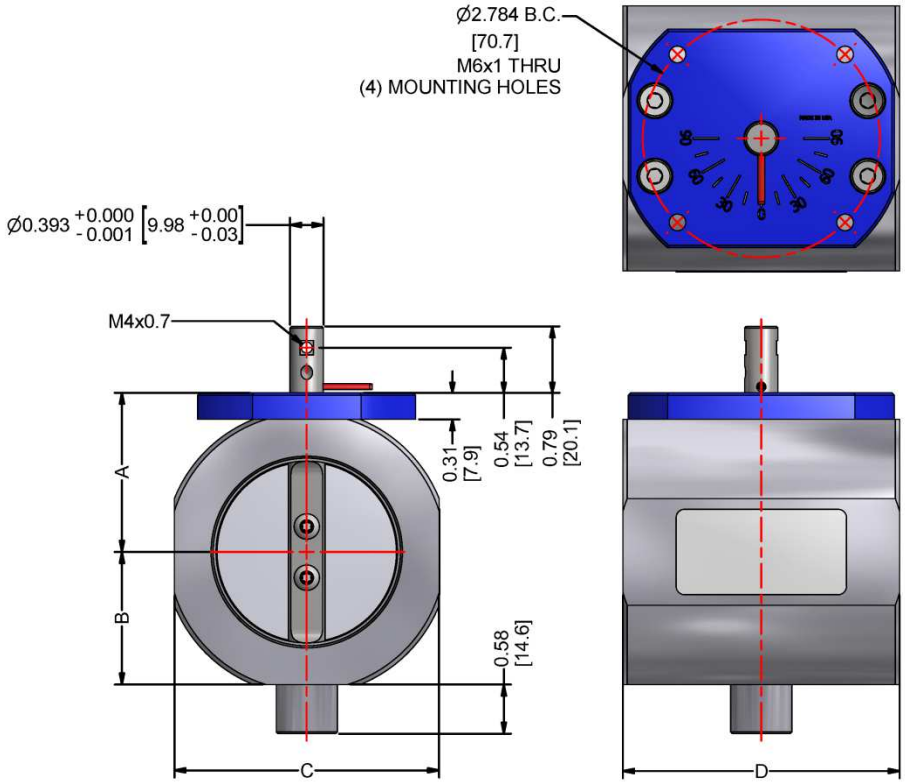


Figure 4: Dimensions of the VKG… Valve Shown on a VKG10.050U

Table 9: VKG… Valve Dimensions

Part Number	A	B	C	D	E*
VKGxx.015x	1.35 [34]	1.04 [26]	2.08 [53]	3.25 [83]	2.52 [64]
VKGxx.020x	1.35 [34]	1.04 [26]	2.08 [53]	3.25 [83]	2.52 [64]
VKGxx.025x	1.35 [34]	1.04 [26]	2.08 [53]	3.25 [83]	2.52 [64]
VKGxx.032x	1.53 [39]	1.22 [31]	2.44 [62]	3.25 [83]	2.70 [69]
VKGxx.040x	1.63 [41]	1.31 [33]	2.63 [67]	3.25 [83]	2.80 [71]
VKGxx.050x	1.87 [47]	1.55 [39]	3.11 [79]	3.25 [83]	3.03 [77]
VKGxx.065x	2.18 [55]	1.87 [47]	3.74 [95]	4.38 [111]	3.29 [84]
VKGxx.080x	2.44 [62]	2.13 [54]	4.26 [108]	4.38 [111]	3.58 [91]
VKGxx.100U	2.96 [75]	2.64 [67]	5.28 [134]	5.00 [127]	4.09 [104]

* Dimension E shown on page 17

Dimensions

Dimensions in inches; millimeters in brackets

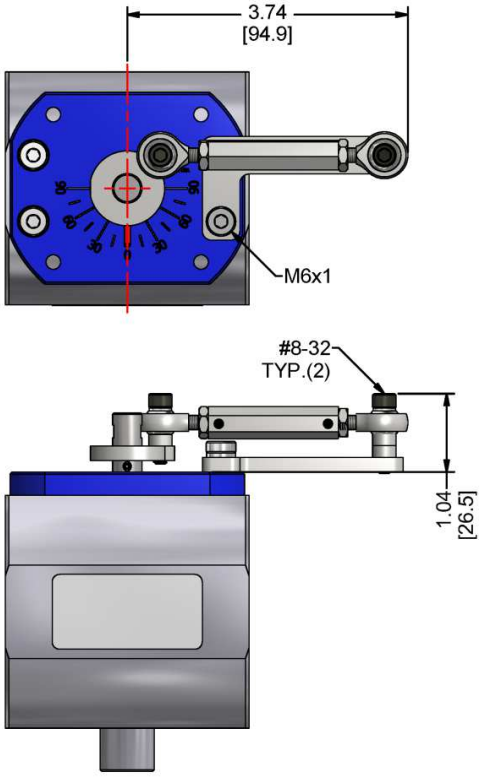


Figure 5: Dimensions of the AGA92.1 Manual Kit

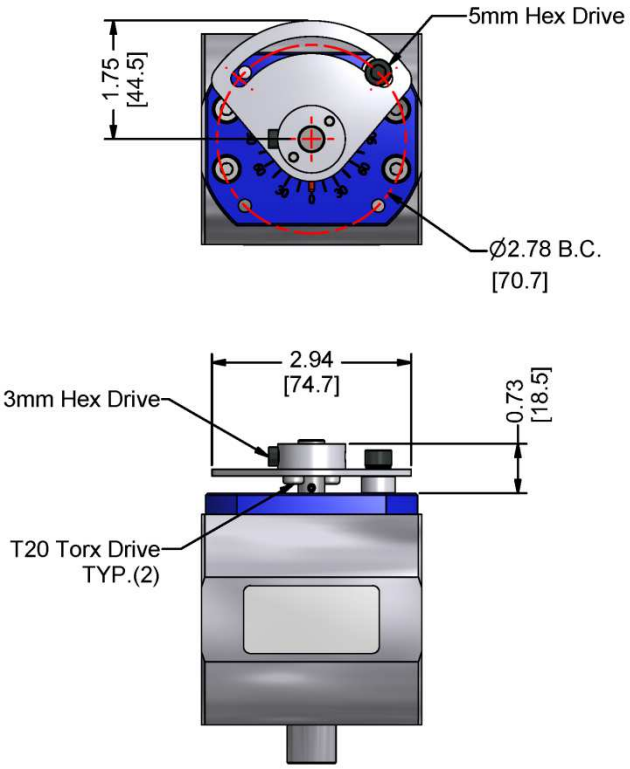


Figure 6: Dimensions of the AGA92.2 Manual Kit

Dimensions

Dimensions in inches; millimeters in brackets

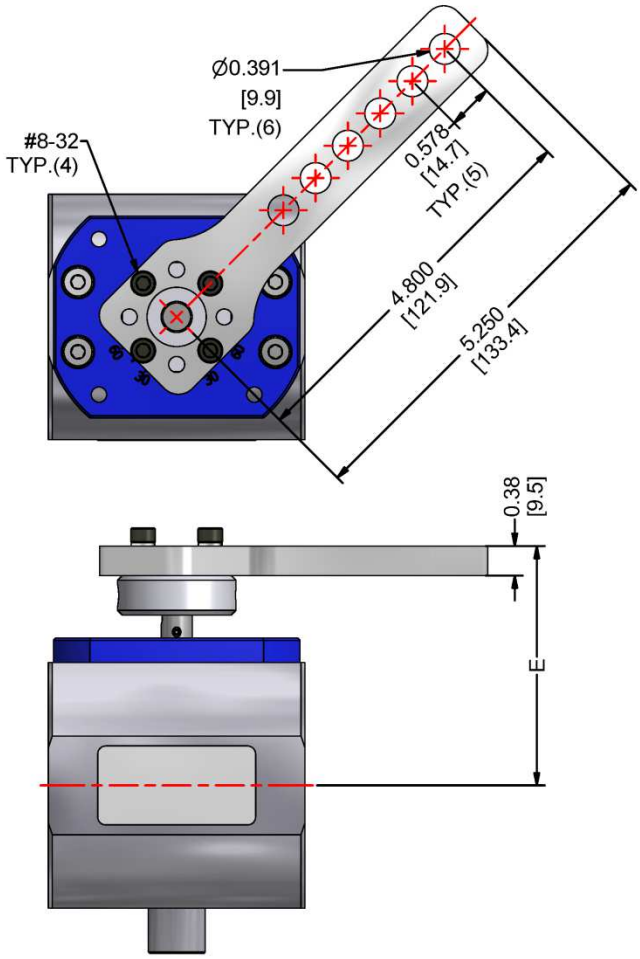


Figure 7: Dimensions of the AGA92.3 Linkage Kit

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SIEMENS

7649

Double valves for biogases and recycling gases

VRD4...

- **Valve (class A) for installation in gas trains**
- **Safety shutoff valves in connection with actuators (conforming to EN 161)**
- **Suited for use with slightly aggressive biogases and recycling gases and for air**
- **Valves in connection with actuators open slowly and close rapidly**
- **2-port valves with flange connection of the normally closed type**
- **DN40...DN150**
- **Driven by actuator type SKP..., SKL... or SAX31...**
- **Supplementary Data Sheet on actuators (see Mechanical Design)**

The VRD4... and this Data Sheet are intended for use by OEMs which integrate the valves in their products.

CC1N7649en
07.12.2012

Building Technologies Division
Infrastructure & Cities Sector

Functionally, the valves correspond to Siemens gas valves in accordance with EN 161.
They are also designed for use with slightly aggressive and dry gases

- For maximum 60 °C
- Gases to G262 like:
  Biogases, waste gases, digester gases, other recycling gases, process gases and air

- The valves are designed for special use (processes) in industrial companies.

The valve is used as:

- Shutoff valve (in connection with SKP1...)
- Control valve with shutoff function (in connection with SKP2..., SKP5… or SKP7…)
  SKP... with pressure regulation function (SKP2..., SKP5... and SKP7...) must be looked at in consultation with Siemens with regard to suitability for use with the relevant type of recycling gases.

The chemical composition and aggressiveness of each type of biogas or recycling gas is different, not constant and depends on various factors.

Aggressiveness of the gas augments especially

- as the hydrogen sulfide content H_2S increases
- as the moisture content of the gas increases. Condensation in the valve is not permitted.

The user must decide after consultation with Siemens whether the valve materials are suited for the relevant type of recycling gas.
The composition of the gases and the concentration of the components may vary.
It is therefore impossible to give a guarantee for any information provided regarding life expectancy.
The suitability in principle is based on tests carried out on the gases to be used.

For safety reasons, we strongly recommend to

- install a valve proving device
- visually inspect the valves at 6- to 12-month intervals
- the used of SKPx5... with valve closure contact

All types of valves can be combined with any of these actuators.

Warning notes

To avoid injury to persons, damage to property or the environment, the following warning notes must be observed!

- Do not open, interfere with or modify the valves
- All activities (mounting, installation and service work, etc.) must be performed by qualified staff. If this is not observed, there is a risk of loss of safety functions
- In connection with SAX31... or SKL... actuators, the valves must **not** be used as safety devices. No closing in accordance with EN 161 takes place
- Fall or shock can adversely affect the safety functions. Such valves must not be put into operation, even if they do not exhibit any damage
- Not suitable gases or gas components causes loss of the safety shutoff function
- It may not join contaminant / particles in the valve, because that could adversely affect the safety shutoff function
- Gases with concentrations >1% for H2S and NH3 and condensation are not permitted. If not observed, there is a risk of impairment of safety functions

Mounting notes

- Ensure that the relevant national safety regulations are complied with
- The actuator can be mounted or replaced while the valve is under gas pressure
- Refer also following Mounting Instructions:

AGA66	M7643.2	74 319 0421 0
VRD4...	M7636/M7631	4 319 2072 0
VRD4...	M7631.1	74 319 0244 0

Sealing/tightness

- Check to make certain that the bolts of the flanges are properly tightened and afterwards check to ensure that the valve is tight when all components are connected
- Check to ensure that the gaskets between the flanges and the valve must be fitted
- Recommendation when exposed to humidity from outside: Gasket kit AGA66 (IP65 kit)

Mounting position

The permissible mounting positions of the used actuator must be observed, (refer to the relevant Data Sheet).

Direction of flow

The direction of gas flow must be in accordance with the direction of the arrow on the valve body.

Function

The inactive valve is closed and opens when the actuator opens.
It is recommended to install a SKPx5.xxx1xx to report the CLOSED position of the valve.

Standards and certificates

CE

Conformity to EEC directives
- Directive for gas appliances 2009/142/EC
- Directive for pressure devices 97/23/EEC

ISO 9001: 2008
Cert. 00739

ISO 14001: 2004
Cert. 38233

Service notes

- Each time a valve has been replaced, check to ensure that the valve operates correctly as well as the internal and external tightness
- Siemens valves may only be repaired by Siemens Repair Centers

Life cycle

The combination valve and actuator have a designed lifetime* of 100,000 burner startup cycles which, under use of gases to EN 437 (or specification G260). This lifetime is based on the endurance tests specified in standard EN 161 and the table containing the relevant test documentation as published by the European Association of Component Manufacturers (Afecor) (www.afecor.org).

The designed lifetime is based on use of the valve and actuator according to the manufacturer's Data Sheet. After reaching the designed lifetime in terms of the number of burner startup cycles, or the respective time of usage, the valve and actuator are to be replaced by authorized personnel.

* The designed lifetime is not the warranty time specified in the Terms of Delivery

The use of gases outside of EN 437 / G260, such as G262, may lead to a limited life cycle.

Disposal notes

Local and currently valid legislation must be observed.

Mechanical design

VRD4...

The valves are in connection with actuator normally closed.

Strainer

A strainer made of stainless steel is fitted in the valve's inlet and protects the valve, the seat and flap as well as downstream devices against dirt.

Actuators

The valves can be combined with the following types of actuators:

- SKP15... (refer to Data Sheet N7643)
- Other actuators (SKP2..., SKP5... and SKP7...) following tests on gas suitability

☞ Note!
Option for all SKPx5.xx1xx with valve closing contact to report the CLOSED position of the valve.

Type summary (other types of valves on request)

DN (mm)	Type reference	Perm. operating pressure mbar	Air flow rate m³/h at Δp = 10 mbar	Number of test points Rp ¼ ¹)	Number of pilot gas connections G ¾ ²)
40	VRD40.040	1000	85	3	1
50	VRD40.050	1000	100	3	1
65	VRD40.065	700	160	3	1
80	VRD40.080	700	250	3	1
100	VRD40.100	700	400	3	1
125	VRD40.125	700	650	3	1
150	VRD40.150	700	800	3	1

¹) Both sides, inlet and outlet side
²) Inlet side

Ordering

When ordering, please give complete valve type reference.
Actuator and valve are supplied as single packs.

Example:
1 VRD40.080 (double flange valve DN80 for biogas)
2 SKP15.000E2 (actuator OPEN/CLOSED)

Accessories

Pilot gas connecting plate for VRD4... **AGA40.40**
- Spare part (kit incl. grommet and gaskets)
- See Mounting Instruction M7631.1 (4 319 2142 0)

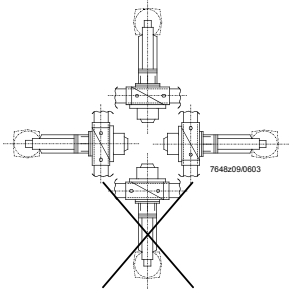
Pressure switch connecting plate for VRD4... **AGA40.41**
- Spare part (kit incl. grommet and gaskets)
- See Mounting Instruction M7631.1 (4 319 2142 0)

Manual adjuster **AGA61**

Adapter for actuators SAX31..... **AGA60**
Consisting of 2 stem parts and one connecting flange.

Gasket kit to SKP.../SKL25... **AGA66**
- Between actuator SKP…/SKL25… and valve VRD4…
- For increasing of degree of protection from IP54 up to IP65
- Refer to Mounting Instruction M7643.2 (74 319 0421 0)
- recommended for installation in humid environments

Technical data

General unit data	Valve class in connection with actuator	A conforming to EN 161 (except with SAX31.../SKL...)
	Group	2 (EN161)
	Perm. medium temperature	0...60 °C
	Weight	See Dimensions
	Connecting flanges	PN16 to ISO 7005-2
	Required flow rate	See Flow chart
	Perm. mounting position	 See Mounting notes
	Operating pressure	See Type summary
	Types of gases	Suitable for biogases and recycling gases - up to maximum 1 vol.% H2S, dry - up to maximum 1 vol.% NH3, dry Nonferrous (except in extremely small quantities bound in plastic components) For more information see *Use*.
	Strainer	Built-in, mesh size 0.9 mm
Environmental conditions	**Storage**	DIN EN 60721-3-1
	Climatic conditions	Class 1K3
	Mechanical conditions	Class 1M2
	Temperature range	-20...+60 °C
	Humidity	<95% r.h.
	Transport	DIN EN 60721-3-2
	Climatic conditions	Class 2K2
	Mechanical conditions	Class 2M2
	Temperature range	-15...+60 °C
	Humidity	<95% r.h.
	Operation	DIN EN 60721-3-3
	Climatic conditions	Class 3K5
	Mechanical conditions	Class 3M2
	Temperature range	-10...+60 °C
	Humidity	<95% r.h.

Warning!
Condensation is not permitted!
If this is not observed, there is a risk of loss of safety functions.

Permissible gas pressures / volumes

Type reference	Static pressure (perm. inlet pressure with double gas valve fully closed) mbar	Dynamic pressure (perm. operating pressure) mbar	Volume between V1/V2 (liters)
VRD40.040	1,500	1,000 (700)*	0.8
VRD40.050	1,500	1,000 (700)*	0.8
VRD40.065	1,500	700	1.3
VRD40.080	1,500	700	1.5
VRD40.100	1,500	700	3
VRD40.125	1,500	700	5.2
VRD40.150	1,500	700	8.7

* Only for use in Australia

VRD4...

The valves are designed to withstand gas pressures up to 1,500 mbar in burner standby mode. At a pressure of 1,500 mbar, the valve remains safely shut or will safely close when shutdown is initiated by an upstream pressure signal. Proper functioning and outer tightness will not be affected.

Note

Owing to the internal design of the valves, increasing inlet pressure causes the valve to close (class «A» conforming to EN 161).

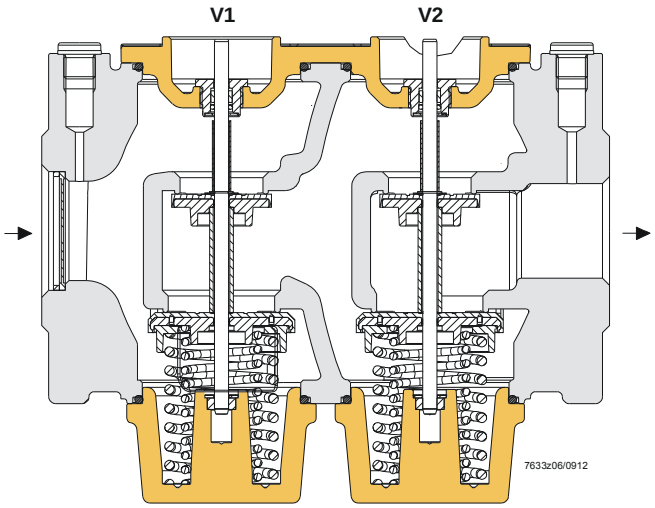
This means that safety shutoff or venting devices that – in addition to the high-pressure regulator – are normally used for protecting the gas valve on the burner are no longer required if the following conditions are satisfied:

- If, in the event the high-pressure regulator upstream of the valve fails, 1,500 mbar at the inlet of the valve are not exceeded and,
- in the event the permissible pressure of the valve is exceeded (DN 65...150: 700 mbar or DN 40...50: 1,000 mbar) a shutoff device (e.g. gas pressure switch) causes the valve to close.

Function

VRD4...

Sectional view of VRD4... valve



Closing springs

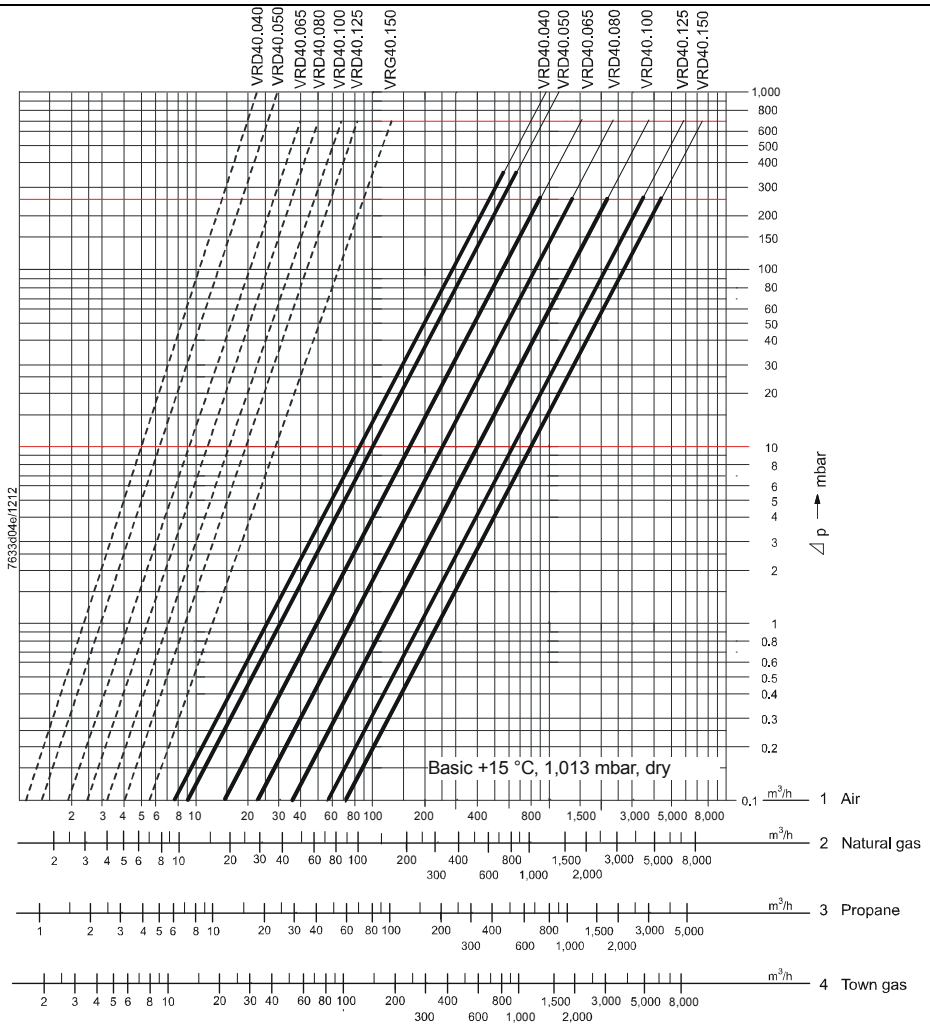
Each double seat uses one pair of springs. The spring forces act separately as closing forces on the individual valve seats.

Application example

VRD40.080 with SKP15... (mounted on valve **V1** and **V2**).

Flow chart (only for fully open valves)

VRD4...



Legend ___ Line of maximum flow (valve fully open)

Determination of pressure drop for gases with a density ratio **dv** other than that of the chart scales above:

Required variables

p(gas) Gas density in kg/m³
V(gas) Gas volume in m³/h

Procedure

– Calculate the gas density ratio [dv(gas)]:

$$dv(gas) = \frac{\text{Density (gas) in kg/m}^3}{\text{1.22 kg/m}^3 \text{ (= density of air)}}$$

– Determine the air volume [V(air)] that produces the same pressure drop **Δp** as gas volume [V(gas)]

$$V(air) = \frac{\text{V(gas) in m}^3/\text{h}}{\sqrt{dv(gas)}}$$

– Determine the gas pressure drop **Δp** with the help of the flow chart, based on the calculated volume of air [V(air)] of the chart scale.

Practical experience shows that applications outside the range confined by the bold characteristics could produce significant noise

Attention!

- **When used in connection with burners having a small low-fire rate, the selected nominal valve size should not be too large (refer to Data Sheet on actuators).**
- **If the available gas pressure exceeds the maximum permissible operating pressure, lower it with a pressure controller fitted upstream of the valve.**
- **The pressure drop (lines of maximum flow) is based on a fully open valve.**

Example: Possibilities of fittings for VRD4... (here installed with SKP15...)

Pressure switch plate ① facilitates attachment of a number of commercially available pressure switches or valve proving devices.
Pilot gas flange ② and pressure switch plate can be fitted on either side of the valve.

Dimensions

(not to scale)

VRD4...

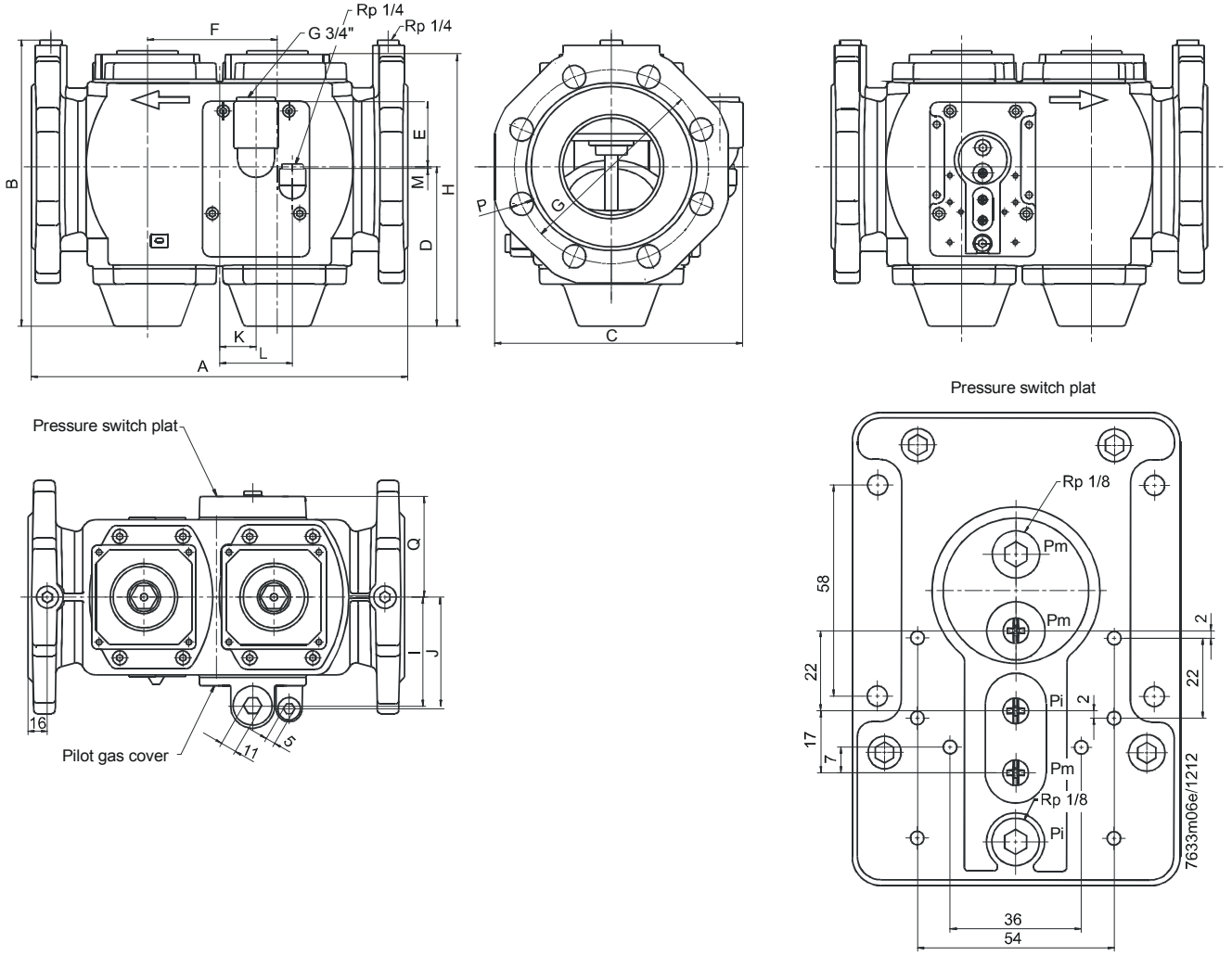


Table of dimensions

Type	DN [1])	A	B	C	D	E	F	G	H	I	J	K	L	M	P	Q	R	kg
VRD40.040	40	240	195	168	115	58	88	110	194	77	79	20	50	2	19	70	4	7.0
VRD40.050	50	240	202	174	115	58	88	125	194	77	79	20	50	2	19	70	4	7.2
VRD40.065	65	290	215	194	118	60	102	145	200	87	90	30	60	4	19	81	4	8.4
VRD40.080	80	310	236	204	132	54	107	160	224	90	92	30	60	2	19	88	8	9.6
VRD40.100	100	350	259	227	145	43	131	180	255	105	108	41	71	13	19	99	8	12.9
VRD40.125	125	400	305	255	175	31	150	210	303	119	122	41	71	25	19	113	8	18.2
VRD40.150	150	480	335	293	188	20	168	240	333	140	143	39	69	36	23	134	8	24.1

1) Flanges to ISO 7005-2
DN Nominal width, dimension connection of medium)
R Number of boreholes in the flange

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