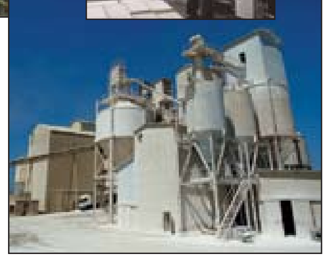
CONTINENTAL
HYDRAULICS™

Catalog
PowrFlow™ Electro-hydraulic Proportional and ServoControl



Your source for electro-hydraulic controls for the most demanding applications.

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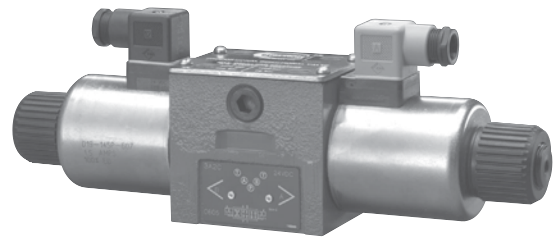
ELECTRO-HYDRAULIC PRODUCTS

FEATURES - “DESIGNED FOR THE WAY YOU WORK”

CONTINENTAL HYDRAULICS

Proportional Valves

- Fast Response
- Flows to 150 gpm (567 lpm)
- Standard mountings – NFPA & ISO standard or line mount
- LVDT for closed inner loop applications
- Hysteresis of 1% with LVDT

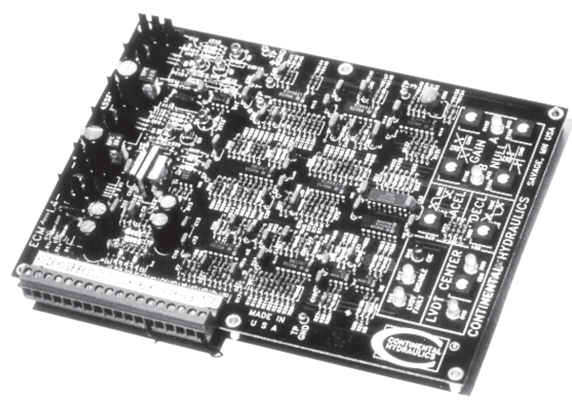


Proportional Valves With On-Board Electronics

- Fast Response
- Standard mountings – NFPA & ISO standard or line mount
- Hall effect for closed inner loop
- Programmable interface
- Hysteresis of 1% with hall effect
- More spool metering options

Electronic Control Boards

- “User-Friendly” Electronics
- Easy to set-up – On board L.E.D. simplifies startup and adjustment
- Can be interfaced with a variety of input signals from transducers, PLC, computers, potentiometers

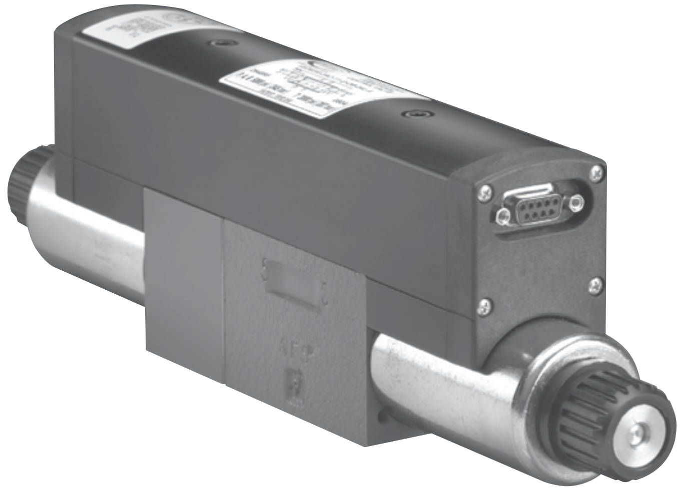


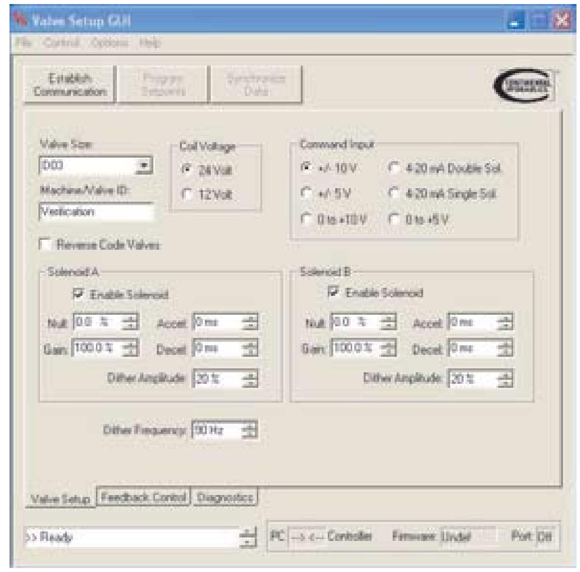
VALVES

VED03M

Proportional Directional Control Valves

SOLENOID ACTUATED, DIRECT ACTING W/ON-BOARD ELECTRONICS





DESCRIPTION

NFPA D03/ISO 4401 Size 03 manifold mounted 4-way valves. These proportional directional flow control valves are direct operated, sliding spool and spring centered valves. They are used to control flow rate and direction. The valve features an on-board electronic amplifier and a Hall Effect spool position sensor for closed spool inner loop operation.

The on-board amplifier is a single or dual output amplifier designed to operate from a wide range of supply voltages. The supply voltage is efficiently converted to output current by using pulse width modulation (PWM). The output current is controlled to reduce the effects of temperature change on the valve solenoid. Each output is current limited to prevent overdriving the valve and to protect against short circuits with automatic fold back current limiting.

The on-board amplifier is packaged within a fully potted, anodized aluminum housing providing a minimum of IP65 environmental protection.

All set points are factory preset to catalog specifications. Changes to the programming are only accessible through the RS-232 9-pin connection using a Graphic User Interface (GUI) from a desktop, laptop or PDA. The GUI program is compatible with Windows 95, 98, 2000, NT and XP operating systems. PDA operating systems pocket PC 2000-2002 and CE.

Power and control connections are made using the 7/8 – 20UNEF 7-pin connector. (Shell size “14S” with a “A7” pin arrangement).

Command signals may be bipolar or unipolar voltage or current (4 - 20mA). The amplifier is designed to work with a position sensor for valve spool position feedback, providing maximum performance.

TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE	NFPA/T3.5.1M R2-2002 (D03) ANSI/B93.7M-1986 ISO/4401 SIZE 03		
SPOOL FLOW RATING @ 145 psi (10 bar) (Full Loop Drop)	Nominal ranges from 0.8 to 8.2 gpm (3 to 26 lpm) See Spool Flow Charts on Page 7		
MAXIMUM OPERATING PRESSURE	P, A, B Ports	5000 psi	345 bar
	T Port	3000 psi	207 bar
TYPICAL RESPONSE TIME	Centered to 100% Spool Travel		55 ms
	100% Spool Travel Back to Center		65 ms
HYSTERESIS	Nominal w/Dither	<1%	
THRESHOLD	Nominal w/Dither	<0.5%	
REPEATABILITY	Nominal w/Dither	<0.5%	
OVERLAP	VED03M valves are factory preset to compensate for the effect of spool overlap.		
COIL DATA	Code 12L — Voltage	12 VDC	
	Code 12L — Current	3.8 ohms (+/-10%)	
	Code 12L — Wattage	19 (@ 76°F./24°C.)	
	Code 12L — Continuous Amps	2.2 Max.	
	Code 24L — Voltage	24 VDC	
	Code 24L — Current	15.2 ohms (+/-10%)	
	Code 24L — Wattage	19 (@ 76°F./24°C.)	
	Code 24L — Continuous Amps	1.1 Max.	
	Insulation	Class H	
	Duty Cycle	Continuous	
MOUNTING		Unrestricted (Horizontal Preferred)	
FLUID	Any hydraulic fluid compatible with Viton A or Buna N elastomers. Fluid temperatures up to 150°F. (65°C.) will not appreciably affect valve performance, however, for safety, temperatures above 130°F. (54°C.) are not recommended. Minimum temperatures are determined by the maximum startup viscosity of 4000 SUS (863 Cs). Minimum viscosity is 30 SUS (0.3 Cs). Fluid Cleanliness should be ISO 4406 Code 17/15/12 up to 3000 psi (315 bar); 15/13/11 for 3000 psi (315 bar) and above.		

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs).

PROGRAMMING REQUIREMENTS

	PC	PDA
OPERATING SYSTEM	Win 95, 98, 2000, NT, XP	Win Pocket PC 2000-2002 Win CE
REQUIRED DISK SPACE	1021kb	320kb
COMMUNICATION PORT	Com1, or next available	Compact Flash Slot, Type II
COMMUNICATION CABLE	DB9/RS-232 male to female	Compact Flash to RS-232, Type I or Type II

ELECTRICAL/CONTROL SPECIFICATIONS

POWER INPUT CONNECTION			7/8-20UNEF Thread 14S-A7
POWER INPUT (Typical)	10 to 32 VDC*	@ 12 VDC	3.4 amps
		@ 24 VDC	1.7 amps
POWER INPUT PROTECTION	No damage from reversed power leads or noise spikes. Board will not power if polarity is reversed.		
ENABLE/ DISABLE	Close contact enable. To enable the outputs, power enable pin C to 9 - 32 VDC power source. This source may come from power pin A and may include a safety switch.		
COMMAND INPUTS		- signal drives A output + signal drives B output	+/-5 VDC +/-10 VDC 0 to 5 VDC 0 to 10 VDC 4 - 20 mA
NULL ADJUSTMENT RANGE		in 0.5% increments	0 to 50%
GAIN ADJUSTMENT RANGE		in 0.5% increments	50 to 100%
RAMP RATE ADJUSTMENT	Limits the rate at which the valve opens or closes. Each solenoid has its own independent Accel and Decel adjustments.	in 5 ms increments	0 to 30 seconds
POWER OUTPUT	Selectable Independent outputs Short circuit and overload protection Open load detection 15kHz PWM high frequency output		
DITHER FREQUENCY (Programmable)		in 5 Hz increments	30 to 360 Hz
DITHER AMPLITUDE (Programmable - % of I-max.)		in 1% increments	0 to 20%
TEMPERATURE RANGE	-40°F. to 185°F. (-40°C. to 86°C.) will not appreciably affect valve performance. However, for safety, temperatures above 130°F. (54°C.) are not recommended.		
INTERNAL POSITION FEEDBACK			Factory calibrated
ENVIRONMENTAL PROTECTION			IP65 / NEMA 4

***NOTE:** For full valve shift, voltage must be at least the rated solenoid voltage.

System Control Spools

Selecting the correct spool is critical for best control in any application. A valve sized incorrectly can be the difference between correct consistent operation and poor overall control. Continental Hydraulics offers not only a wide variety of flow rates, but also offers a variety of metering functions. These metering functions are designed to match the load, actuator and circuit characteristics for the best possible control.

It is important to choose the correct spool for your application. Typically choose a spool that will pass the flow you need at approximately a 200 - 300 psid full loop pressure drop for best overall performance. Refer to the Flow Curve Charts. This pressure drop and/or back pressure provide system stiffness that is required for optimum control.

The metering characteristics of the spool will be based on the load characteristics and/or circuit design. Spool metering options available are combination metering, meter-in, meter-out, 2:1 ratio, 1.3:1 ratio and position control.

Code "C" - Combination metering spools meter fluid into and out of the actuator equally in either direction. Combination metering spools are highly recommended for motor circuits to provide both good acceleration and deceleration load control.

Code "I" - Meter-in spools meter fluid into the actuator. This style of metering should be used in circuits where the actuator is always working against a resisitive load or when a counterbalance valve is used to hold or keep the load from running away. This spool is not recommended for use to decelerate a load within the use of other devices.

Code "O" - Meter-out spools meter fluid out of the actuator. This style of metering is typically used in circuits where the load will create a run away condition.

Code "PC" - Position control spools are combination metering style spools, slightly under lapped in the center condition to provide better control at the null condition when used in closed loop cylinder positioning applications.

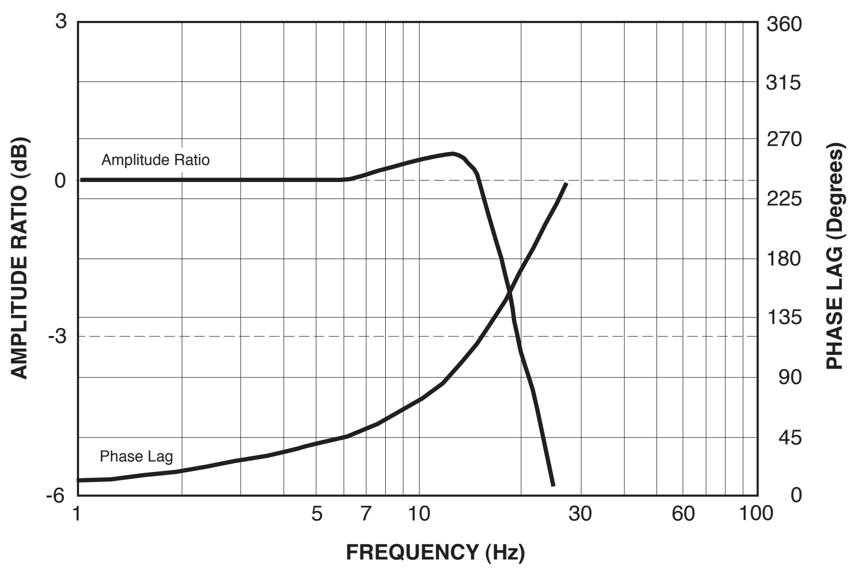
Code "T" - This 2:1 ratio metering spool is designed to give equal metering and excellent control over hydraulic cylinders that have a 2:1 bore to rod effective area ratio.

Code "CY" - This 1.3:1 ratio metering spool is designed to give the equivalent of an equal metering characteristic for most standard catalog bore and rod combination hydraulic cylinders giving better control than other styles of spools.

Combination, meter-in, 2:1 ratio and 1.3:1 ratio spools can easily be used with pressure compensators to provide proportional pressure compensated flow control.

FREQUENCY RESPONSE CURVES

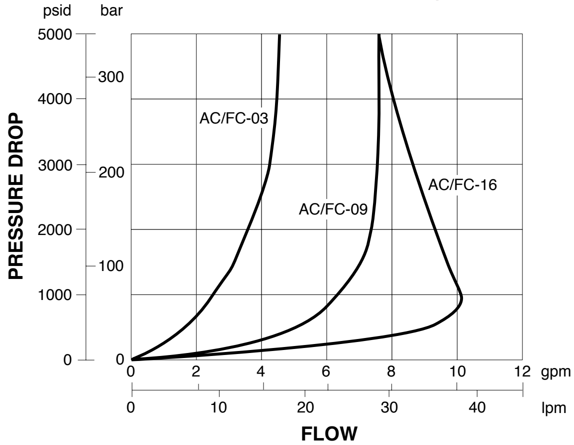
+/- 25% Command @ 50% Offset - Amplitude and Phase Lag



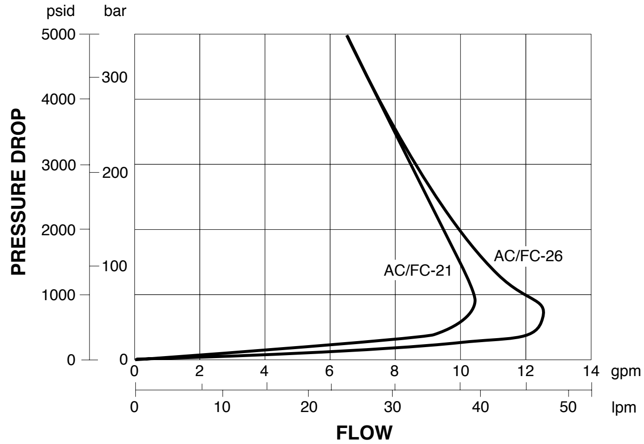
LIMITING POWER ENVELOPE CURVES

Full Loop @ 100% Command Signal

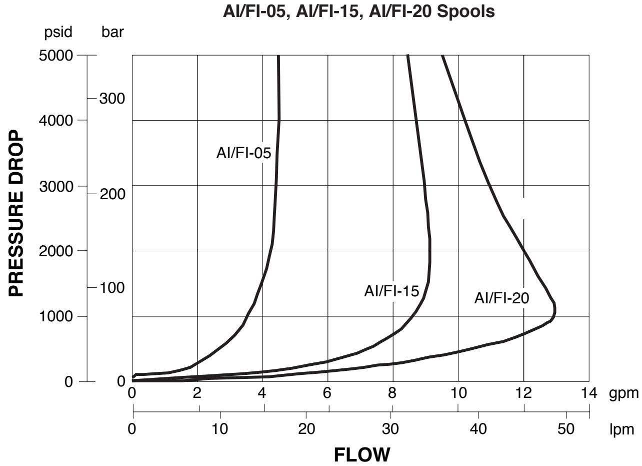
AC/FC-03, AC/FC-09, AC/FC-16 Spools



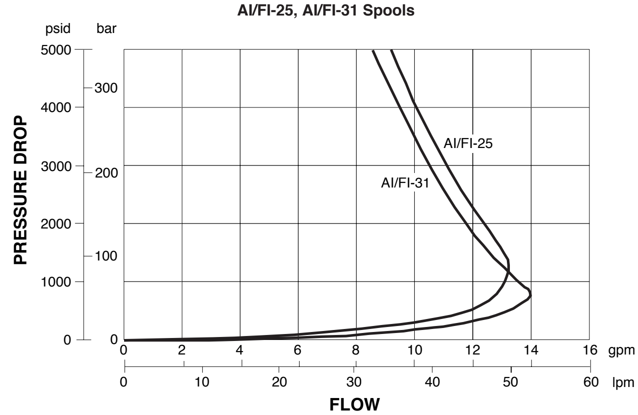
AC/FC-21, AC/FC-26 Spools



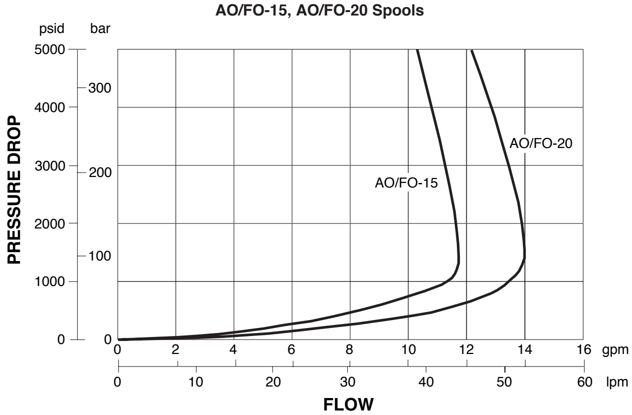
AI/FI-05, AI/FI-15, AI/FI-20 Spools



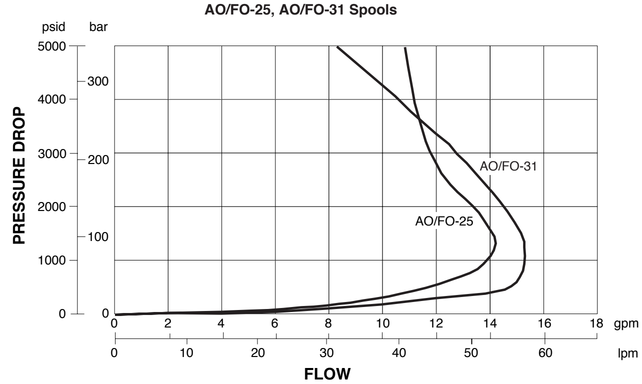
AI/FI-25, AI/FI-31 Spools



AO/FO-15, AO/FO-20 Spools

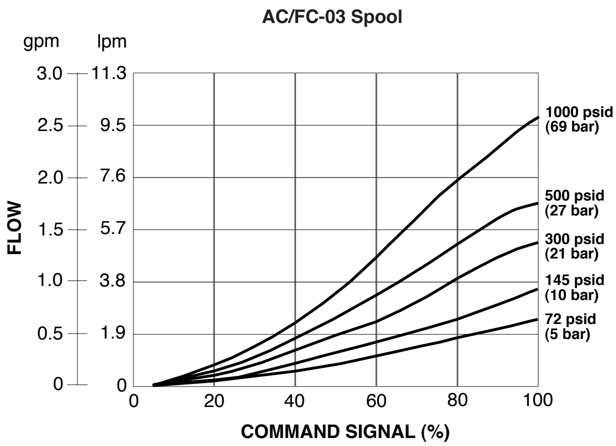


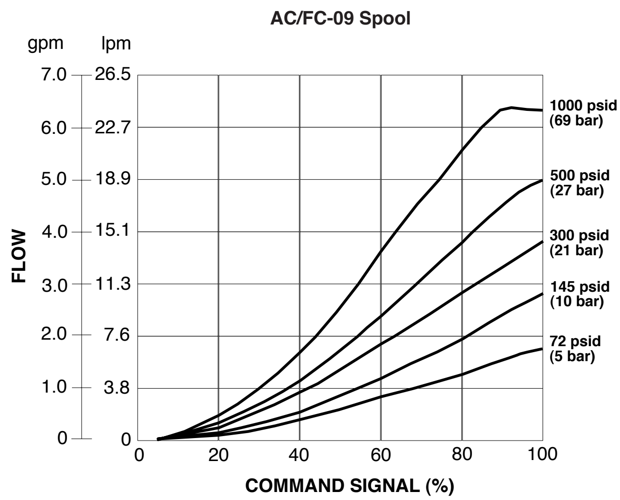
AO/FO-25, AO/FO-31 Spools

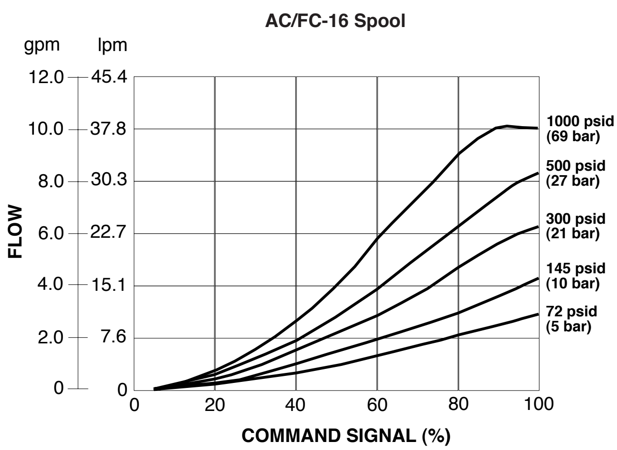


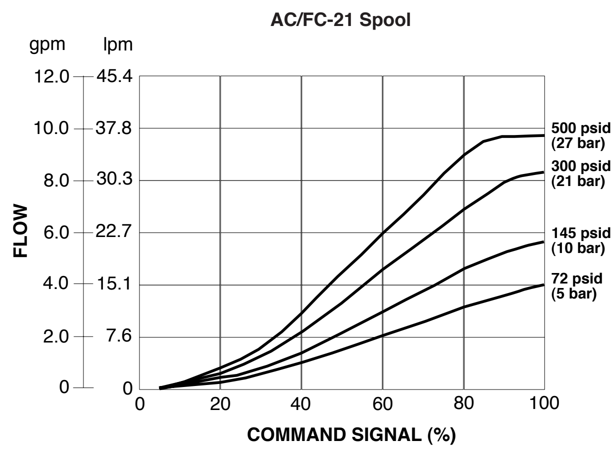
FLOW CURVES AT CONSTANT PRESSURE DROP - AC/FC Spools

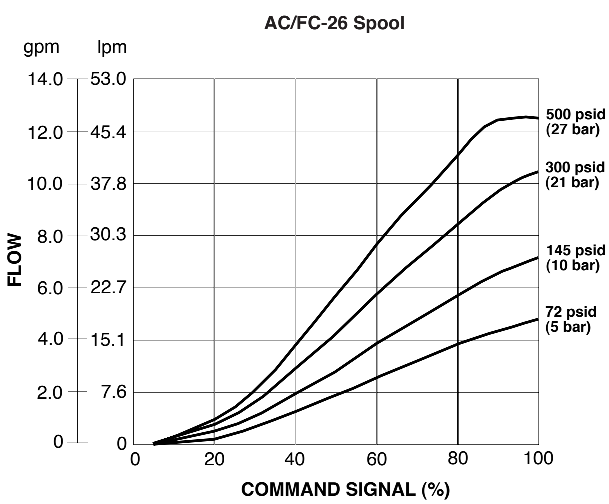
P to A, B to T or P to B, A to T Null @ 20% of Full Current





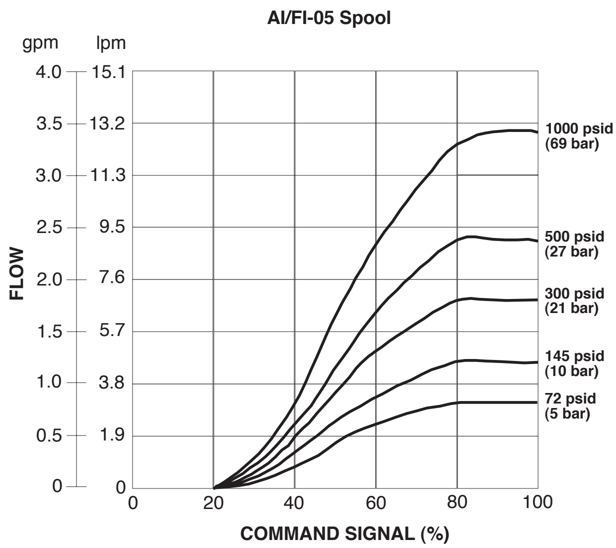


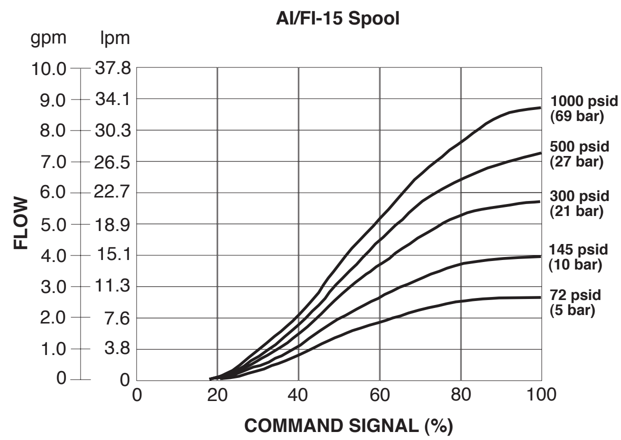


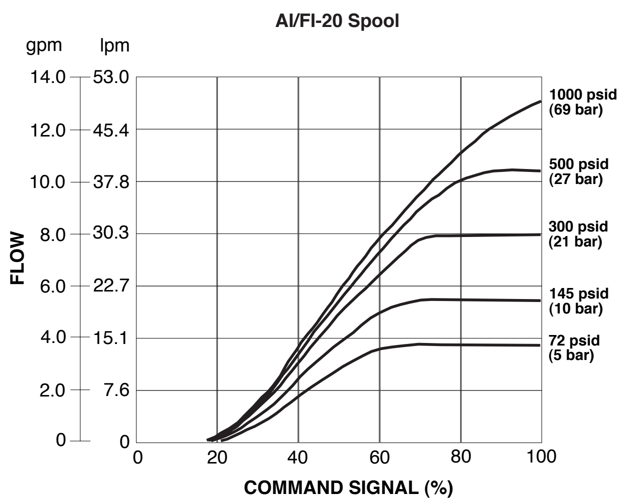


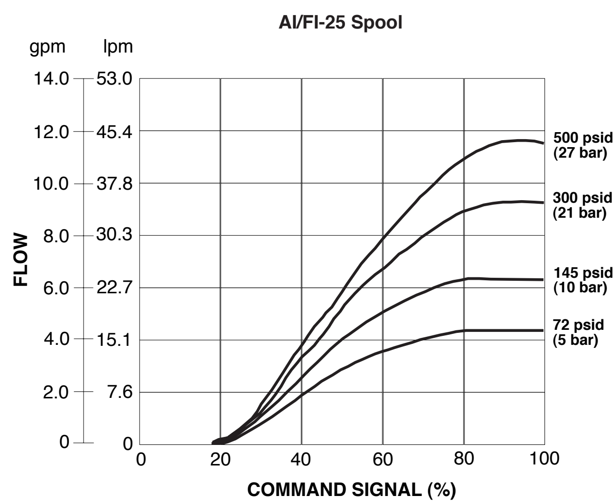
FLOW CURVES AT CONSTANT PRESSURE DROP - AI/FI Spools

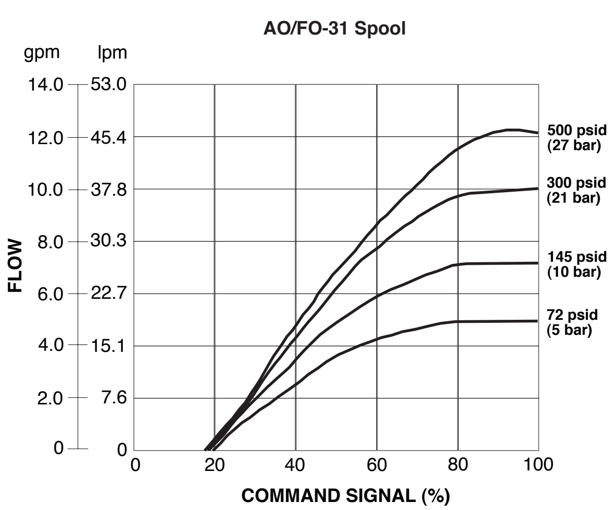
P to A, B to T or P to B, A to T Null @ 20% of Full Current







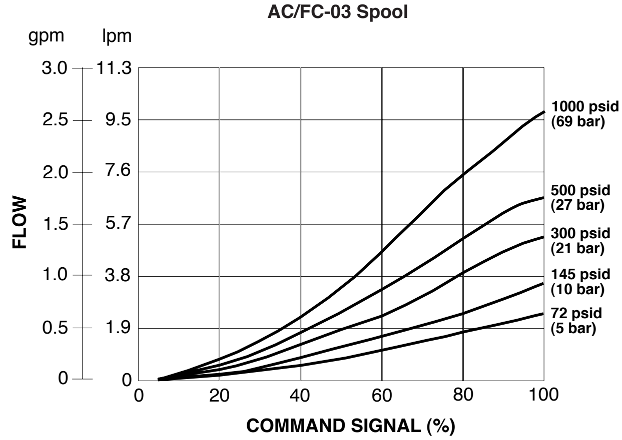




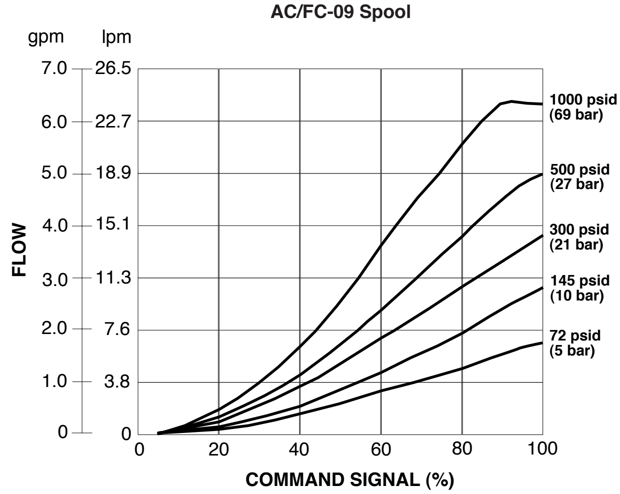
FLOW CURVES AT CONSTANT PRESSURE DROP - AC/FC Spools

P to A, B to T or P to B, A to T   Null @ 20% of Full Current

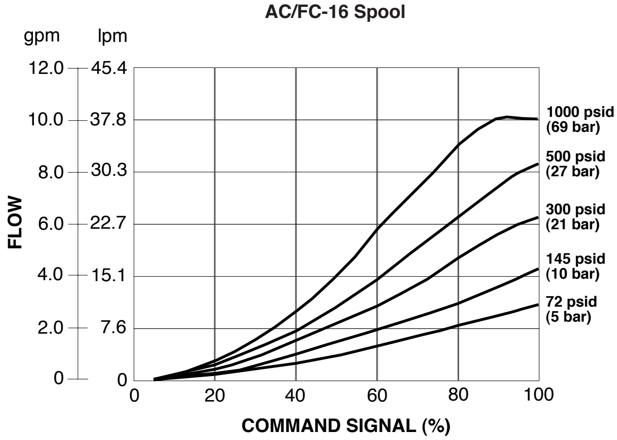
AC/FC-03 Spool



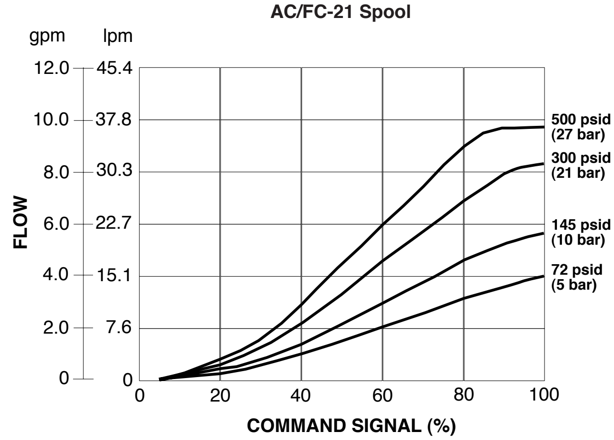
AC/FC-09 Spool



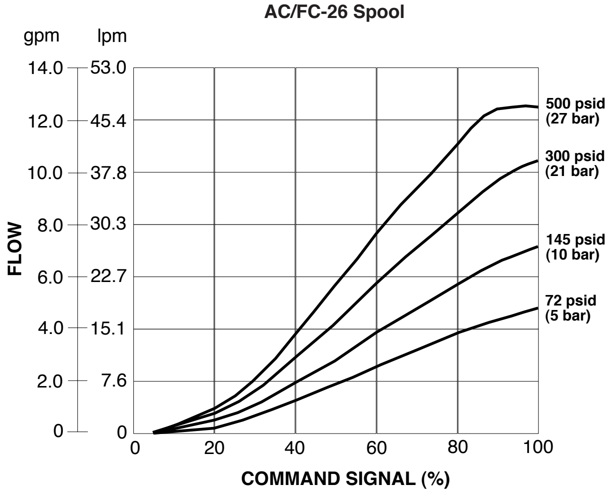
AC/FC-16 Spool



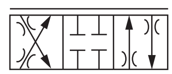
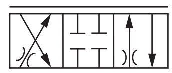
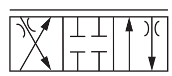
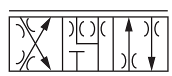
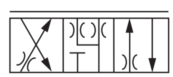
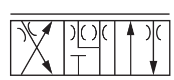
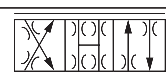
AC/FC-21 Spool



AC/FC-26 Spool



SPOOL and SPOOL FLOW RATES CODES

SPOOL FUNCTION CODE**	DESCRIPTION	SYMBOL	FUNCTION
AC	METER IN METER OUT		MOTION CONTROL
AI	METER IN		
AO	METER OUT		
FC	METER IN METER OUT		
FI	METER IN		
FO	METER OUT		
PC	METER IN METER OUT		POSITION CONTROL
CY	1.3:1 Flow Ratio		CYLINDER SPOOL
T	2:1 Flow Ratio		

****NOTE:** Consult factory for spool availability.

SPOOL FLOW RATE CODE**	NOMINAL FLOW* gpm (lpm)
26	7.0 (26)
21	5.5 (21)
16	4.2 (16)
09	2.4 (9)
03	0.8 (3)
31	8.2 (31)
25	6.5 (25)
20	5.2 (20)
15	4.0 (15)
05	1.3 (5)
31	8.2 (31)
25	6.5 (25)
20	5.2 (20)
15	4.0 (15)
05	1.3 (5)
26	7.0 (26)
21	5.5 (21)
16	4.2 (16)
09	2.4 (9)
03	0.8 (3)
31	8.2 (31)
25	6.5 (25)
20	5.2 (20)
15	4.0 (15)
05	1.3 (5)
31	8.2 (31)
25	6.5 (25)
20	5.2 (20)
15	4.0 (15)
16	4.2 (16)
05	1.3 (5)

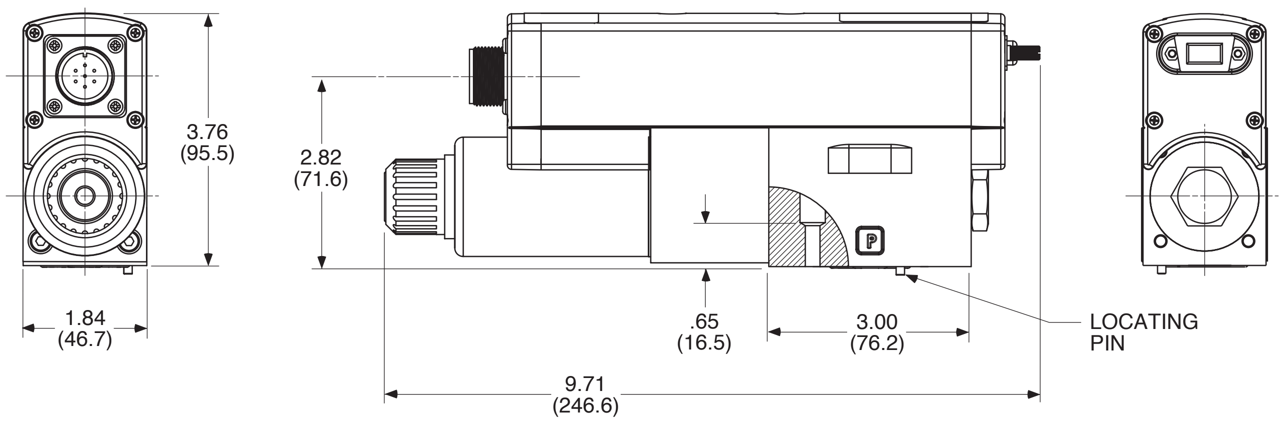
***NOTE:** Flow at 145 psi (10.0 bar) pressure drop (full loop).
****NOTE:** Consult factory for spool availability.

CONTINENTAL HYDRAULICS.

DIMENSIONS With On-Board Electronics

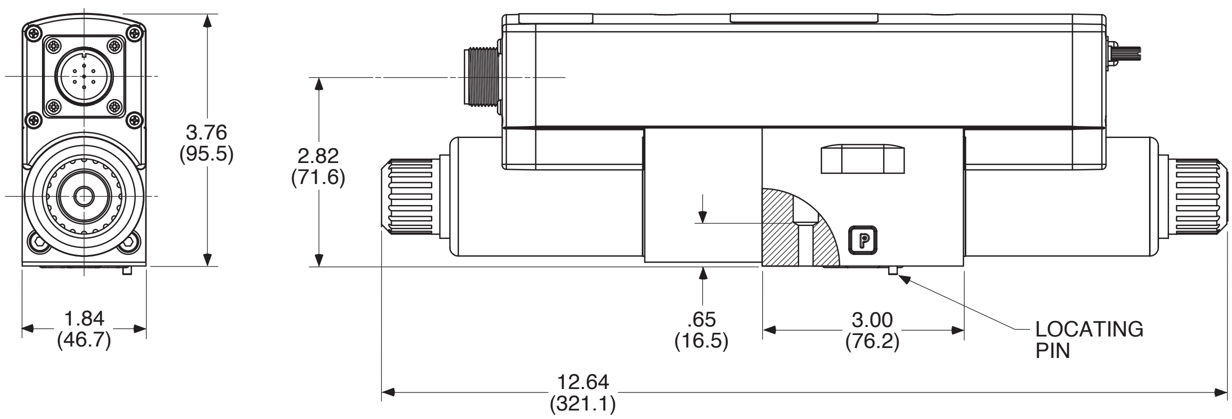
Dimensions shown in: Inches (millimeters)

Single Solenoid

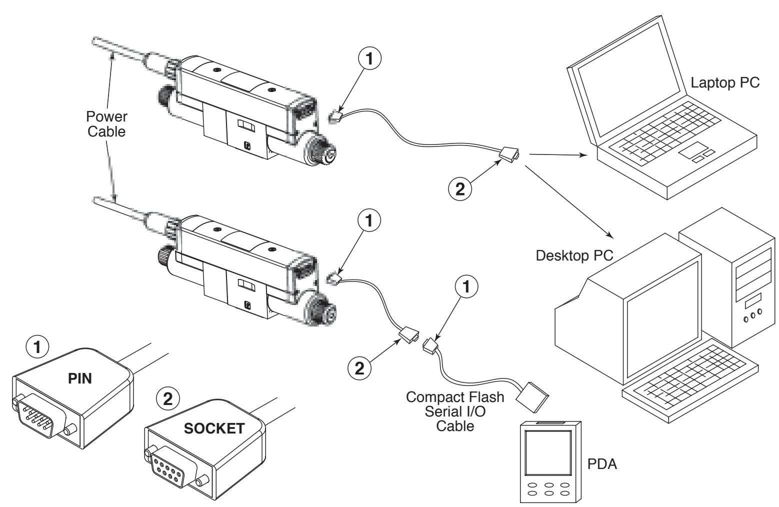


NOTE: Valve mounting bolts torque: 4 - 5 lbs.-ft. (5.4 Nm - 6.8 Nm).

Double Solenoid

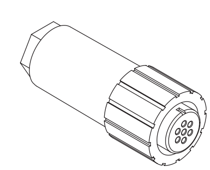


CONNECTION to COMPUTER or PDA

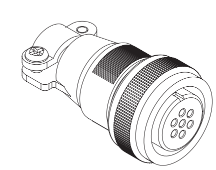


7-PIN CONNECTORS

VEA-3P7P-A



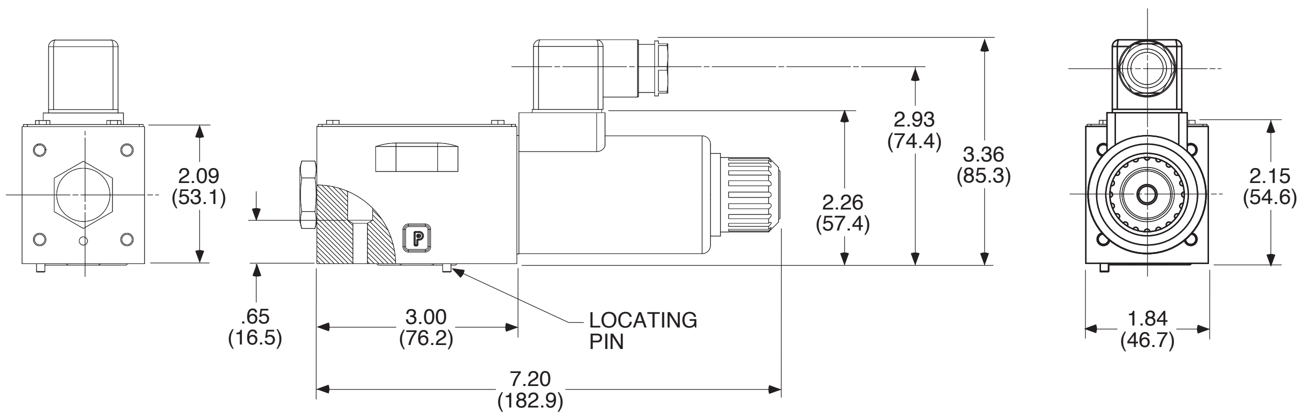
VEA-3P7M-A



DIMENSIONS With DIN Connectors

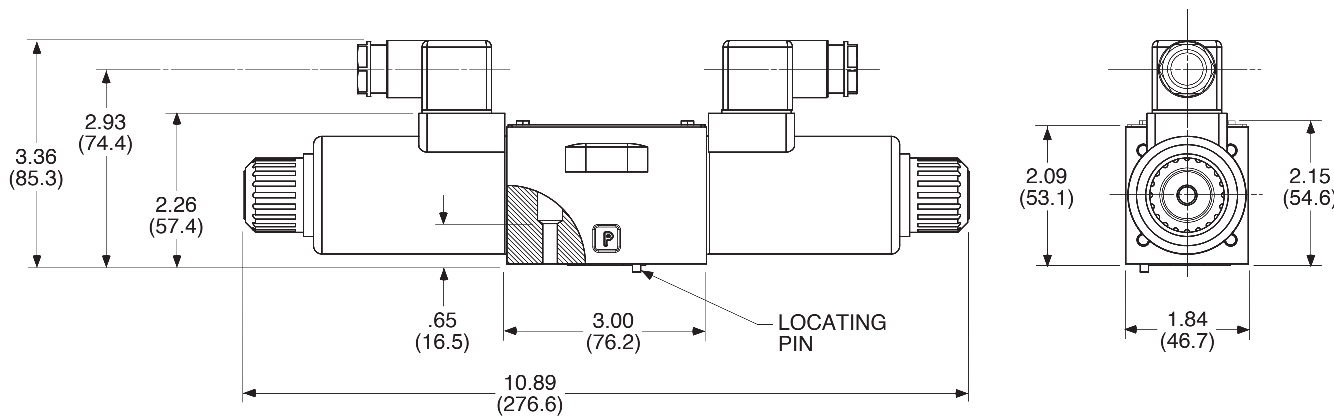
Dimensions shown in: Inches (millimeters)

Single Solenoid



NOTE: Valve mounting bolts torque: 4 - 5 lbs.-ft. (5.4 Nm - 6.8 Nm).

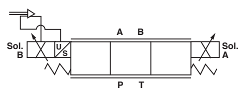
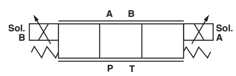
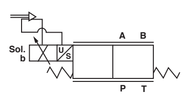
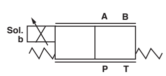
Double Solenoid



ORDERING INFORMATION

	SELECT ONE	SELECT ONE	SELECT ONE		SELECT IF REQ'D	SELECT IF REQ'D	SELECT ONE		DESIGN LETTER
VED03M –	☐	☐ –	☐ –	G –	☐ –	☐ –	☐	L –	A

BASIC VALVE

CODE	DESCRIPTION	SYMBOL
3	DOUBLE OPERATOR 3 POSITION SPRING CENTERED	 w/OB
		 Standard Valve
5	SINGLE OPERATOR 2 POSITION SPRING CENTERED	 w/OB
		 Standard Valve

ELECTRICAL OPTIONS

CODE	DESCRIPTION
D	DIN 43650 SOLENOID CONNECTORS
OB	ON-BOARD ELECTRONICS 7 PIN CONNECTION INTERNAL HALL LOOP

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

MECHANICAL OPTIONS

CODE	DESCRIPTION
OMIT	STANDARD DOUBLE SOLENOID AND SINGLE SOLENOID "A" PORT END
R	SINGLE SOLENOID "B" PORT END

SPOOL FUNCTION

CODE
REFER TO CHART FOR SPOOL AVAILABILITY PAGE 9

FLOW RATES

CODE
REFER TO CHART FOR FLOW RATES PAGE 9

SEALS

CODE
VITON SEALS STANDARD

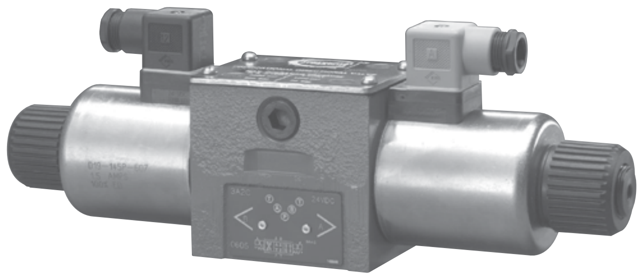
TYPICAL ORDERING CODE:

VED03M-3AC-26-G-OB-24L-A

ED05M

Proportional Directional Control Valves

DIRECT OPERATED WITHOUT LVDT



DESCRIPTION

These proportional directional control valves are 4-way, direct operated, spring centered, sliding spool valves. They can be used to control flow direction and rate. Directional control is achieved by solenoid selection; flow rate is a function of the solenoid current. If electrical power is lost, the valve spool will return to center position.

SPOOL METERING

Combination metering spools (code "C") meter oil into and out of the hydraulic actuator. These spools provide excellent control in most applications. Combination metering spools are highly recommended where deceleration control of a hydraulic motor is required or in velocity feedback applications. Combination metering spools can be used with a pressure-compensated module to provide proportional pressure compensated flow.

Meter-in spools (code "I") meter oil into the actuator. These spools are commonly used in applications where the actuator is always working against a positive (resistive) load. Meter-in spools can also be used with a pressure compensated module.

Meter-out spools (code "O") meter flow out of the actuator. These spools are commonly used in applications with "run away" loads such as over-center loads. Meter-out spools are also used with high ratio cylinders.

It is important to properly size a proportional valve to achieve good resolution. A common mistake when specifying proportional valves is selecting too high a rated flow. The result may be poor control of the actuator, particularly with respect to velocity and resolution. Ideal valve size is usually one that provides just enough maximum flow capability to achieve the desired velocity. Consult with Continental about special metering characteristics: unequal-metering, step metering, other nominal flows and other spool configurations.

Use caution when applying a separate internally-drained pressure control valve between the actuator and the proportional valve. Back pressure created by meter-out or combination metering proportional valves can add to the spring load of the pressure control valve, resulting in a change of the control pressure level.

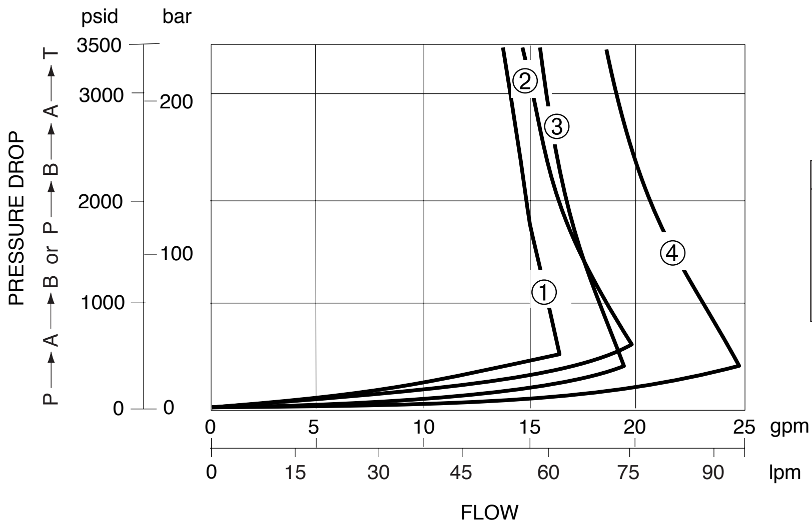
TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE			NFPA/T3.5.1M R2-2002 (D05) ANSI/B93.7M-1986 ISO/4401 SIZE 05	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	1O, 1I Spool	Nominal	15 gpm	57 lpm
	1C Spool	Nominal	13 gpm	50 lpm
	2O, 2I Spools	Nominal	10 gpm	38 lpm
	2C Spool	Nominal	9 gpm	34 lpm
MAXIMUM OPERATING PRESSURE		P, A, B Ports	3500 psi	241 bar
		T Port	1000 psi	69 bar
TYPICAL RESPONSE TIME** (Nominal)	Centered to 90% Spool Travel			125 ms
	90% Spool Travel Back to Center			75 ms
	30% Spool Travel to 90% Spool Travel			115 ms
	90% Spool Travel Back to 30% Spool Travel			75 ms
	90% Spool Travel to 90% Spool Travel			170 ms
SPOOL STROKE		Center to Offset	0.15 in.	3.05 mm
HYSTERESIS		Nominal w/Dither	< 6%	
THRESHOLD		Nominal w/Dither	< 6%	
REPEATABILITY		Nominal w/Dither	< 3%	
DEADBAND			10% nominal of spool travel	
VOLTAGE (Nominal)		Code 12	12 VDC	
		Code 24	24 VDC	
CURRENT (Maximum)		Code 12	3.0 Amp	
		Code 24	1.5 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)		Code 12	26	
		Code 24	26	
COIL RESISTANCE @ 68° F. (20° C.)		Code 12	2.9 Ohms	
		Code 24	11.4 Ohms	
DUTY CYCLE			Continuous @ rated operating with 120° F. (49° C.) fluid and 100° F. (38° C.) ambient temperature	
WEIGHT		Code 12	18 lbs.	8.2 kg
		Code 24	12 lbs.	5.4 kg

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.

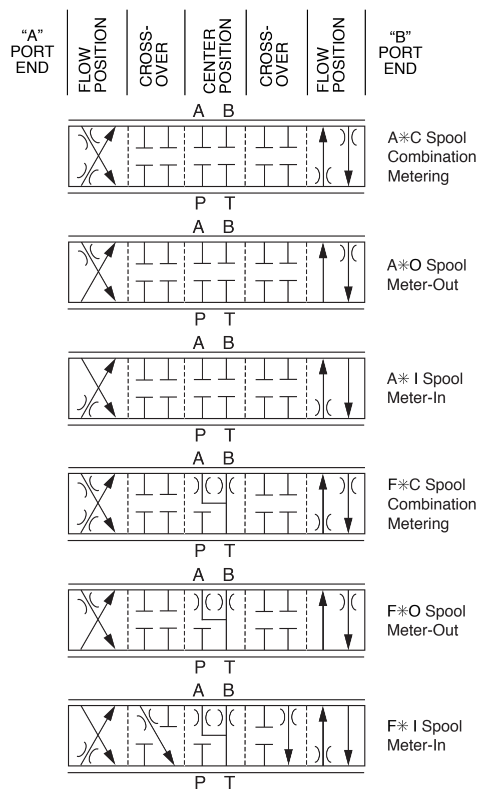
****NOTE:** Response times are effected by pressure, viscosity and flow rate.

LIMITING POWER ENVELOPE CURVE



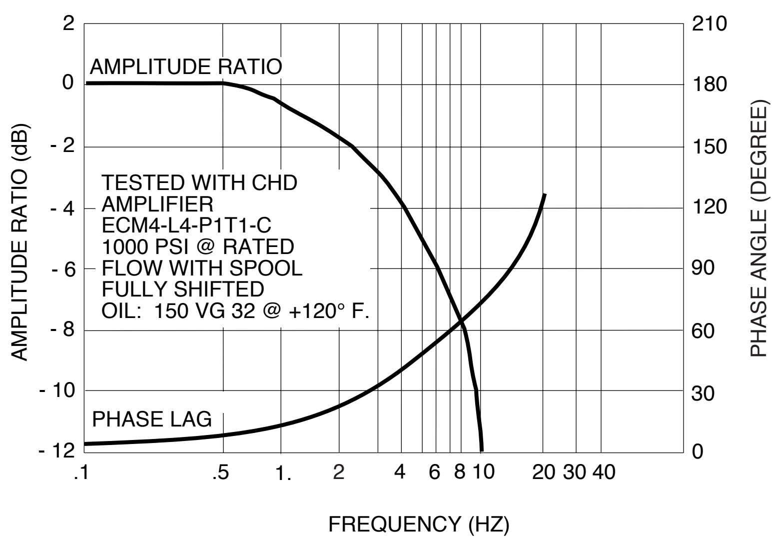
CURVE NO.	1	2	3	4
SPOOL	A2C	A2O	A1C	A1O
	F2C	A2I	F1C	A1I
		F2O		F1O
		F2I		F1I

SPOOL CONFIGURATIONS



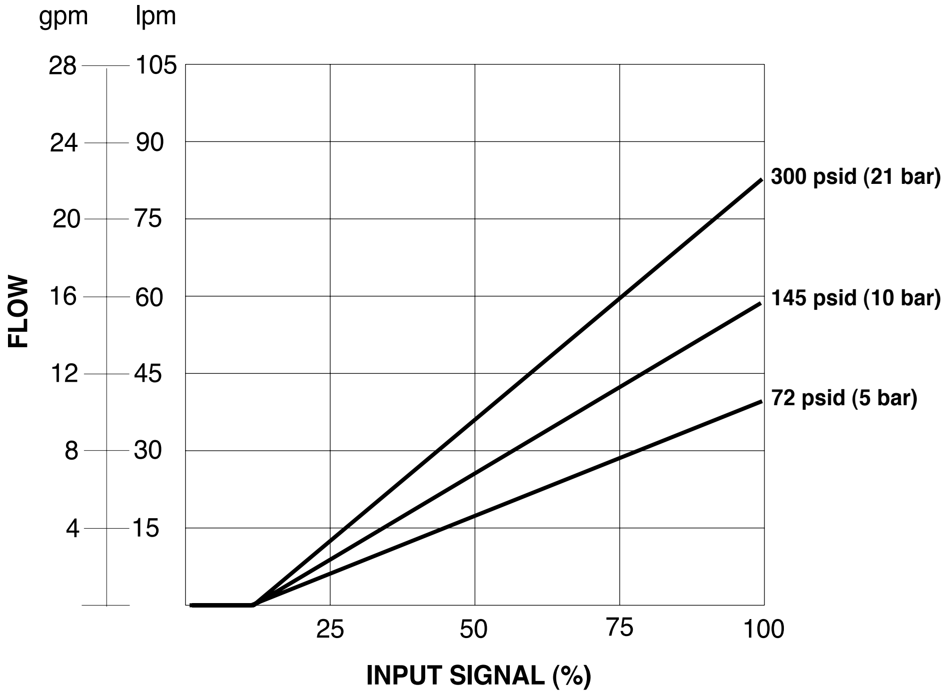
FREQUENCY RESPONSE CURVES

9 gpm FLOW @ FULL SHIFT
± 100% Command Signal



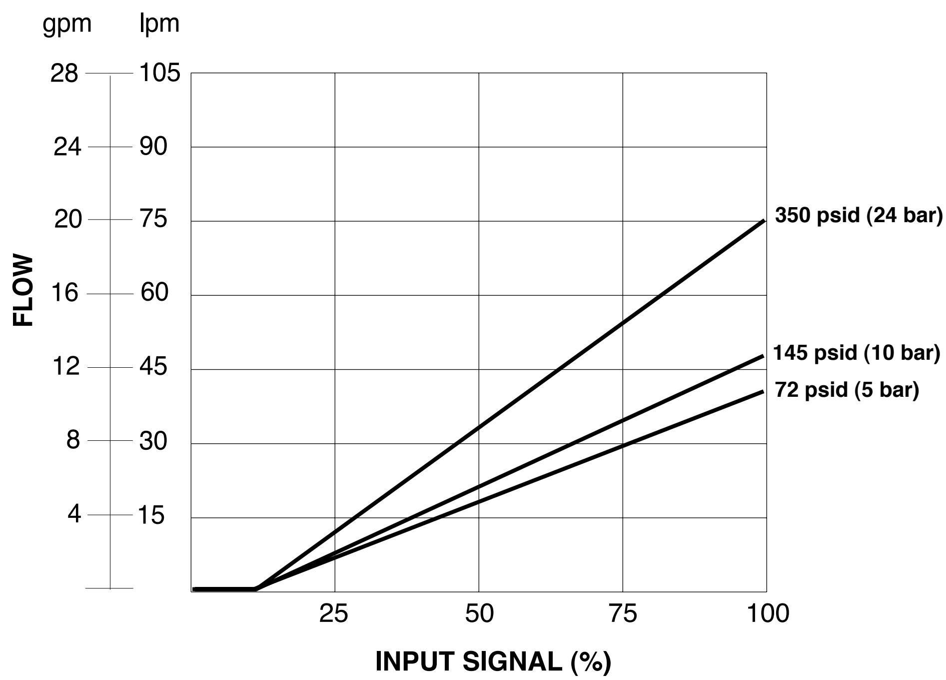
FLOW VS. INPUT SIGNAL CURVES

A1O, F1O, A1I, and F1I Spools
Nominal 15 gpm (57 lpm)



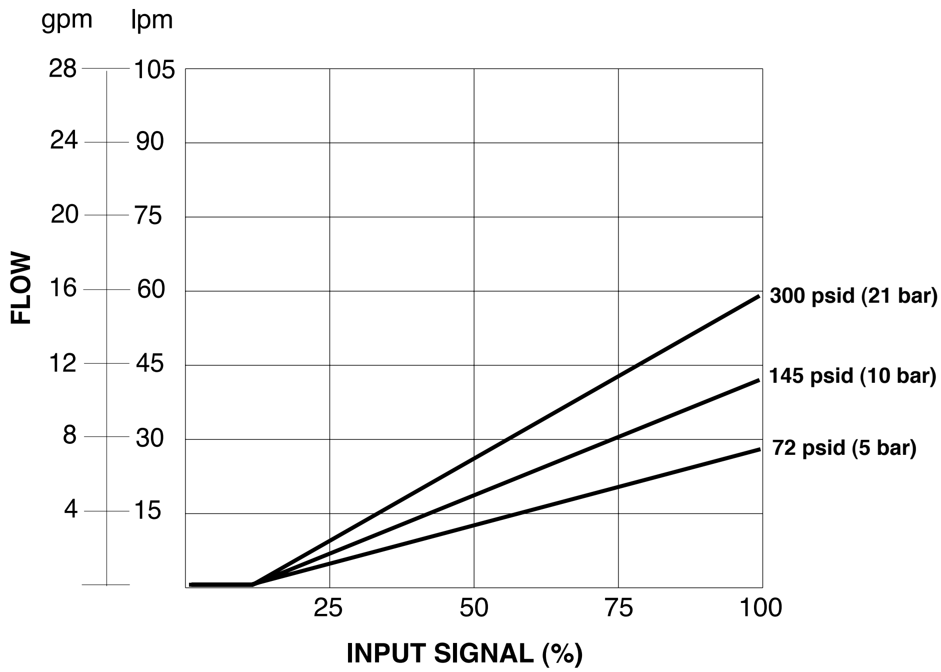
NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

A1C and F1C Spools
Nominal 13 gpm (50 lpm)



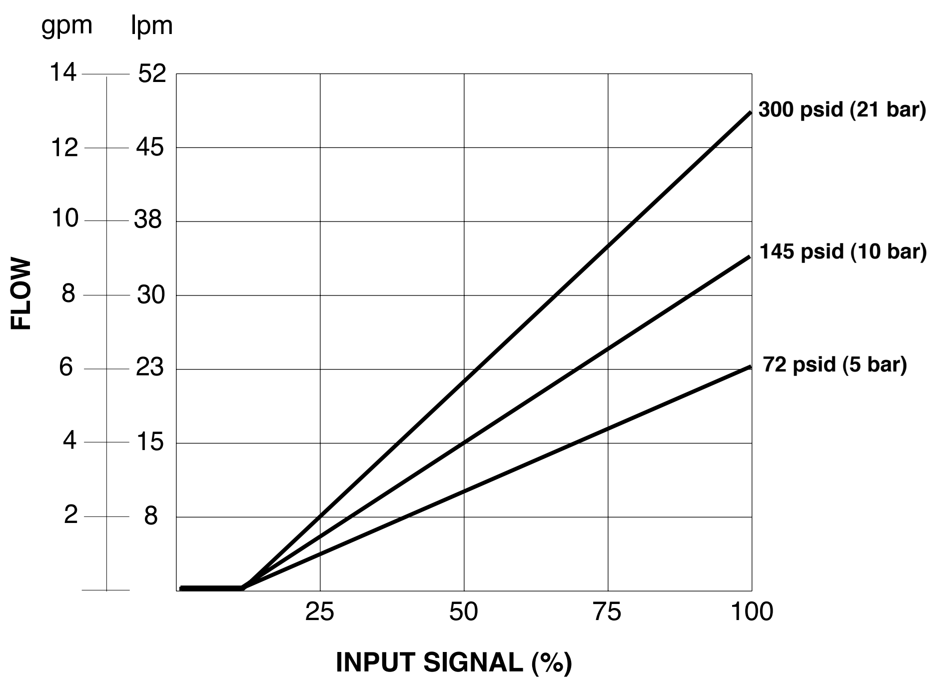
FLOW VS. INPUT SIGNAL CURVES

A2O, F2O, A2I, and F2I Spools
Nominal 10 gpm (38 lpm)



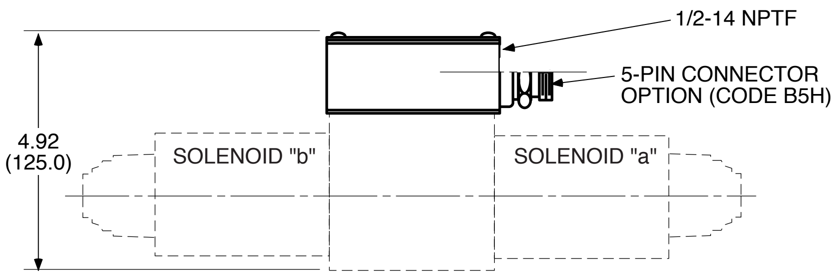
NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

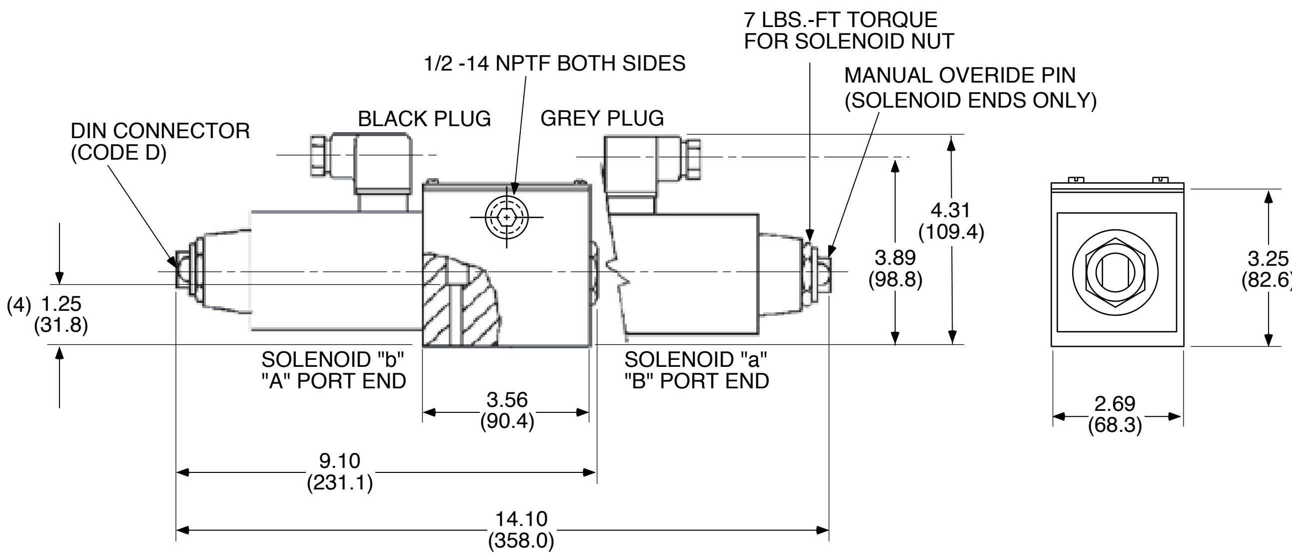
A2C and F2C Spools
Nominal 9 gpm (34 lpm)



DIMENSIONS

Dimensions shown in: Inches (millimeters)

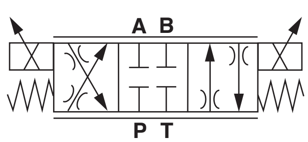




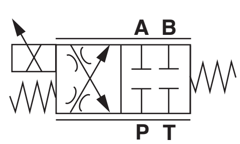
NOTES:
1. Electrical box may be rotated 180° (Codes B, BT, and B5H).
2. 5-pin disconnect meets NFPA recommende standard T3.5.29 R1 - 2003.
3. Two (2) lead wires for each solenoid 6 inches (152.4 mm) long (except Code D) and ground screw are provided by removing the top cover plate.
4. Four (4) mounting bolts are torqued to 10 - 12 lbs.-ft. (13.5 - 16.3 Nm).

SCHEMATICS

Code 3



Code 5



CONTINENTAL HYDRAULICS

ORDERING CODE INFORMATION

ED05M	–	SELECT ONE	SELECT ONE	–	G	SELECT IF REQ'D	SELECT IF REQ'D	–	SELECT ONE	L	–	DESIGN LETTER
ED05M	–	☐	☐	–	G	☐	☐	–	☐	L	–	C
		FUNCTION	SPOOLS		SEALS	MECHANICAL OPTIONS	ELECTRICAL OPTIONS		SOLENOID	SOLENOID MFG.		

FUNCTION

CODE	DESCRIPTION
3	DOUBLE SOLENOID 3 POSITION SPRING CENTERED
5	SINGLE SOLENOID 2 POSITION SPRING CENTERED

SEALS

CODE
VITON SEALS STANDARD

ELECTRICAL OPTIONS

CODE	DESCRIPTION
OMIT	LEAD WIRE
D	DIN 43650/ ISO 4400 (FORM A) CONNECTORS
B	TOP ELECT. BOX WITHOUT TERMINAL POSTS
BT	TOP ELECT. BOX WITH TERMINAL POSTS & GROUND
B5H	TOP ELECT. BOX WITH 5-PIN MALE MINI RECEPTACLE, FOR 1 OR 2 SOLENOIDS

NOTE: Electrical options available only on solenoid operated valves with lead wires.

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

SPOOLS

CODE	NOMINAL FLOW (gpm)	METERING
A1C	13	COMBINATION
A1I	15	IN
A1O	15	OUT
A2C	9	COMBINATION
A2I	10	IN
A2O	10	OUT
F1C	13	COMBINATION
F1I	15	IN
F1O	15	OUT
F2C	9	COMBINATION
F2I	10	IN
F2O	10	OUT

MECHANICAL OPTIONS

CODE	DESCRIPTION
OMIT	NONE
R	REVERSE ASSEMBLY SINGLE SOLENOID ON "B" PORT END

TYPICAL ORDERING CODE:

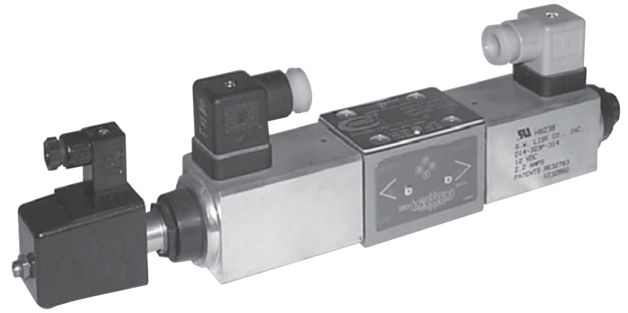
ED05M-3A2C-GB-24L-C

CONTINENTAL HYDRAULICS

ED05M

Proportional Directional Control Valves

DIRECT OPERATED WITH LVDT



DESCRIPTION

These proportional directional control valves are 4-way, direct operated, spring centered, sliding spool valves. They can be used to control flow direction and rate. Directional control is achieved by solenoid selection while the flow rate is a function of the input signal amplitutde. This model features spool position feedback via a LVDT for improved valve performance. In the event of a loss of electrical power, the valve spool will return to center position.

SPOOL METERING

Combination metering spools (code "C") meter oil into and out of the hydraulic actuator. These spools provide excellent control in most applications. Combination metering spools are highly recommended where deceleration control of a hydraulic motor is required or in velocity feedback applications. Combination metering spools can be used with a pressure-compensated module to provide proportional pressure compensated flow.

Meter-in spools (code "I") meter oil into the actuator. These spools are commonly used in applications where the actuator is always working against a positive (resistive) load. Meter-in spools can also be used with a pressure compensated module.

Meter-out spools (code "O") meter flow out of the actuator. These spools are commonly used in applications with "run away" loads such as over-center loads. Meter-out spools are also used with high ratio cylinders.

It is important to properly size a proportional valve to achieve good resolution. A common mistake when specifying proportional valves is selecting too high a rated flow. The result may be poor control of the actuator, particularly with respect to velocity and resolution. Ideal valve size is usually one that provides just enough maximum flow capability to achieve the desired velocity. Consult with Continental about special metering characteristics: unequal-metering, step metering, other nominal flows and other spool configurations.

Use caution when applying a separate internally-drained pressure control valve between the actuator and the proportional valve. Back pressure created by meter-out or combination metering proportional valves can add to the spring load of the pressure control valve, resulting in a change of the control pressure level.

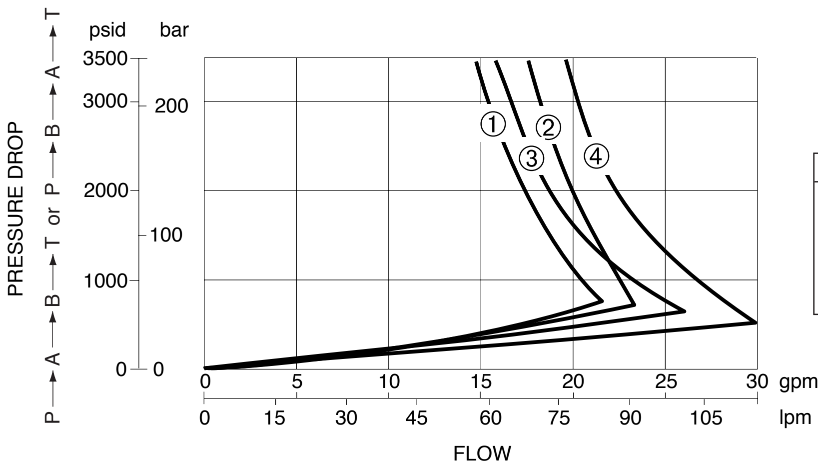
TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE			NFPA/T3.5.1M R2-2002 (D05) ANSI/B93.7M-1986 ISO/4401 SIZE 05	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	1O, 1I Spool	Nominal	15 gpm	57 lpm
	1C Spool	Nominal	13 gpm	50 lpm
	2O, 2I Spools	Nominal	10 gpm	38 lpm
	2C Spool	Nominal	9 gpm	34 lpm
MAXIMUM OPERATING PRESSURE		P, A, B Ports	3500 psi	241 bar
		T Port	1000 psi	69 bar
TYPICAL RESPONSE TIME** (Nominal)	Centered to 90% Spool Travel			65 ms
	90% Spool Travel Back to Center			50 ms
	30% Spool Travel to 90% Spool Travel			45 ms
	90% Spool Travel Back to 30% Spool Travel			35 ms
	90% Spool Travel to 90% Spool Travel			100 ms
SPOOL STROKE		Center to Offset	0.15 in.	3.05 mm
HYSTERESIS		Nominal w/Dither	< 1%	
THRESHOLD		Nominal w/Dither	< 1%	
REPEATABILITY		Nominal w/Dither	< 1%	
DEADBAND			10% nominal of spool travel	
VOLTAGE (Nominal)		Code 12	12 VDC	
		Code 24	24 VDC	
CURRENT (Maximum)		Code 12	3.0 Amp	
		Code 24	1.5 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)		Code 12	26	
		Code 24	26	
COIL RESISTANCE @ 68° F. (20° C.)		Code 12	2.9 Ohms	
		Code 24	11.4 Ohms	
DUTY CYCLE			Continuous @ rated operating with 120° F. (49° C.) fluid and 100° F. (38° C.) ambient temperature	
WEIGHT		Code 12	18 lbs.	8.2 kg
		Code 24	12 lbs.	5.4 kg

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.

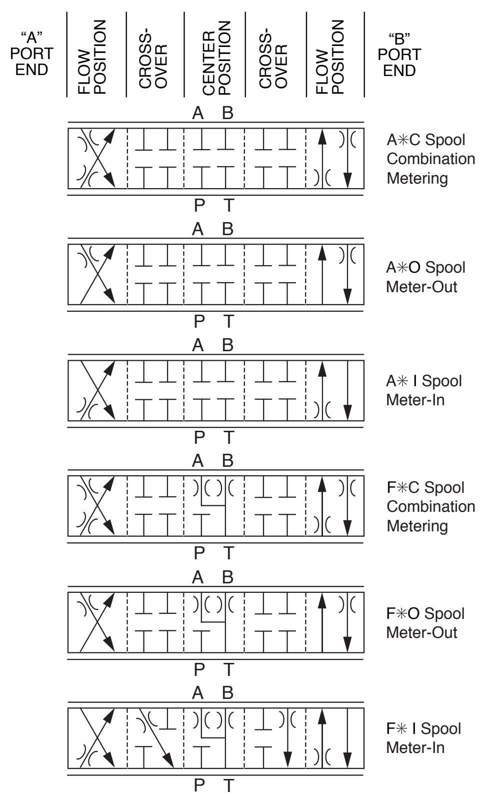
****NOTE:** Response times are effected by pressure, viscosity and flow rate.

LIMITING POWER ENVELOPE CURVE



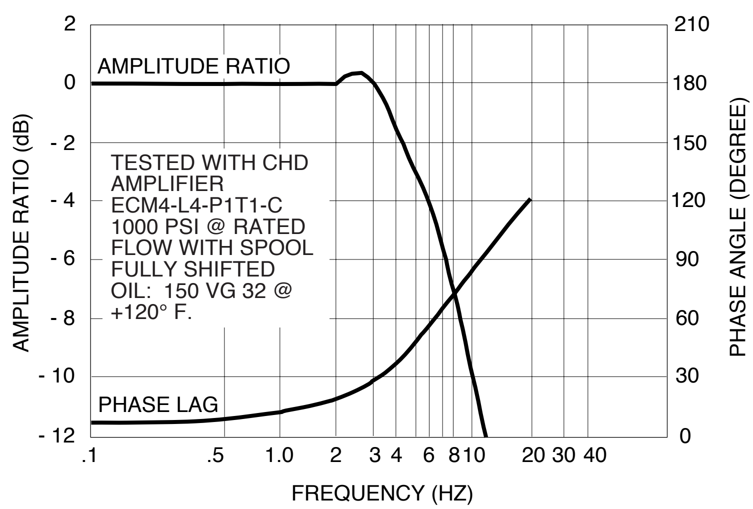
CURVE NO.	1	2	3	4
SPOOL	A2C	A2O	A1C	A1O
	F2C	A2I	F1C	A1I
		F2O		F1O
		F2I		F1I

SPOOL CONFIGURATIONS



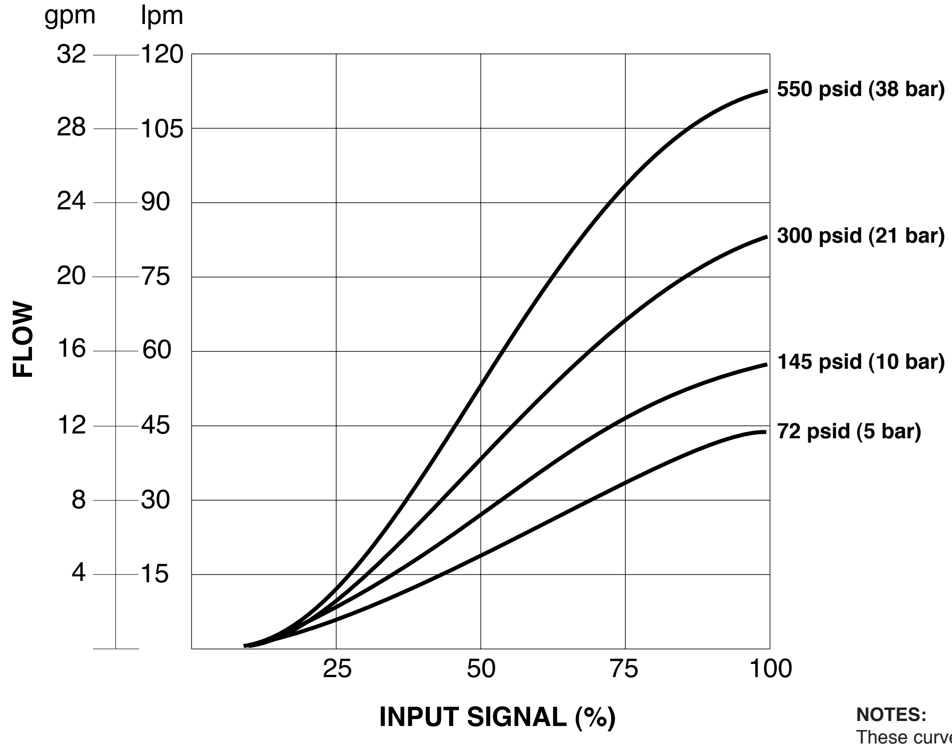
FREQUENCY RESPONSE CURVES

9 gpm FLOW @ FULL SHIFT
± 100% Command Signal



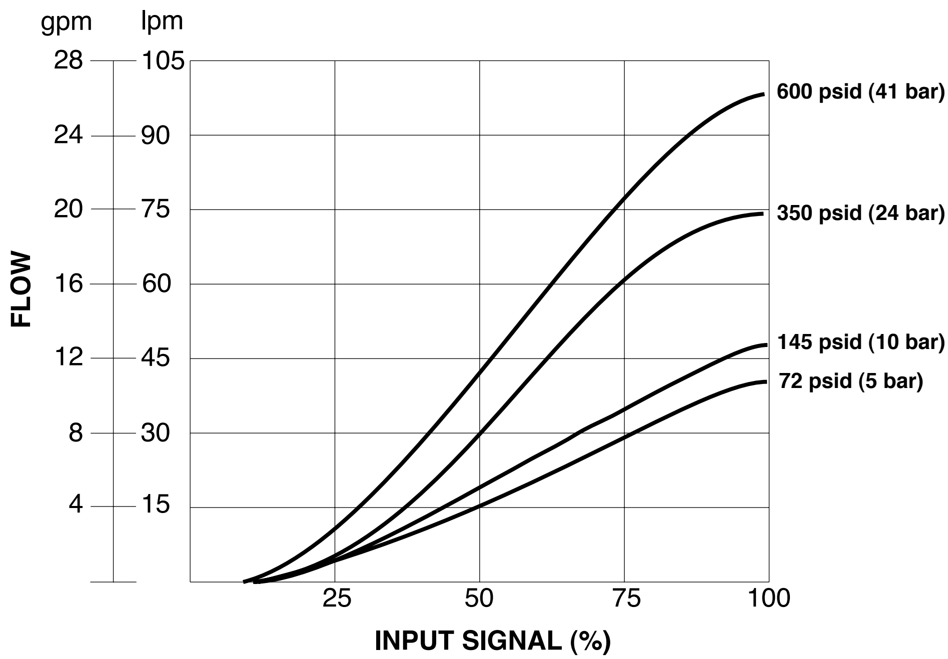
FLOW VS. INPUT SIGNAL CURVES

A1O, F1O, A1I, and F1I Spools
Nominal 15 gpm (57 lpm)



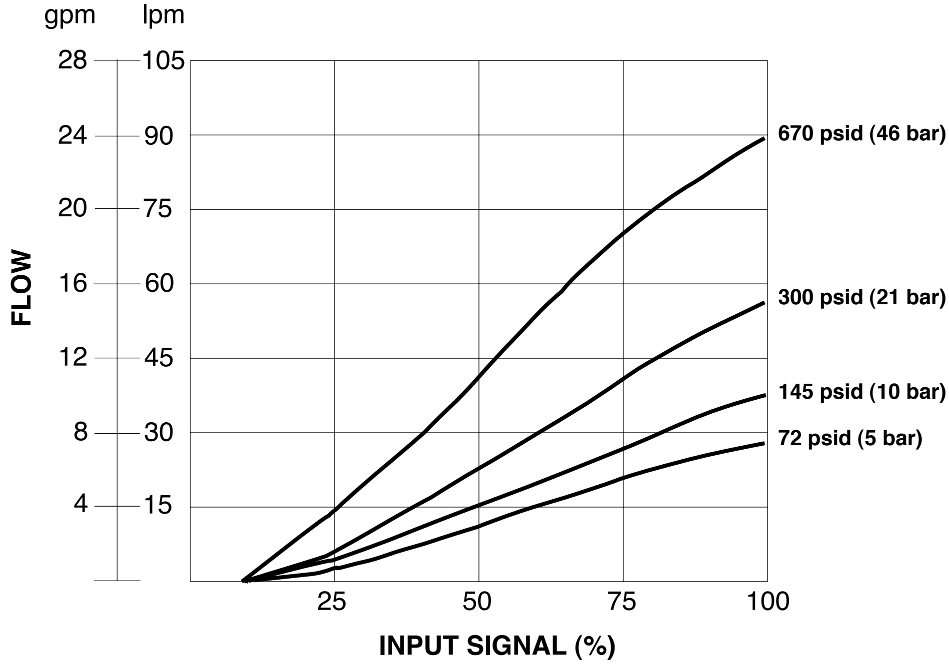
NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

A1C and F1C Spools
Nominal 13 gpm (50 lpm)



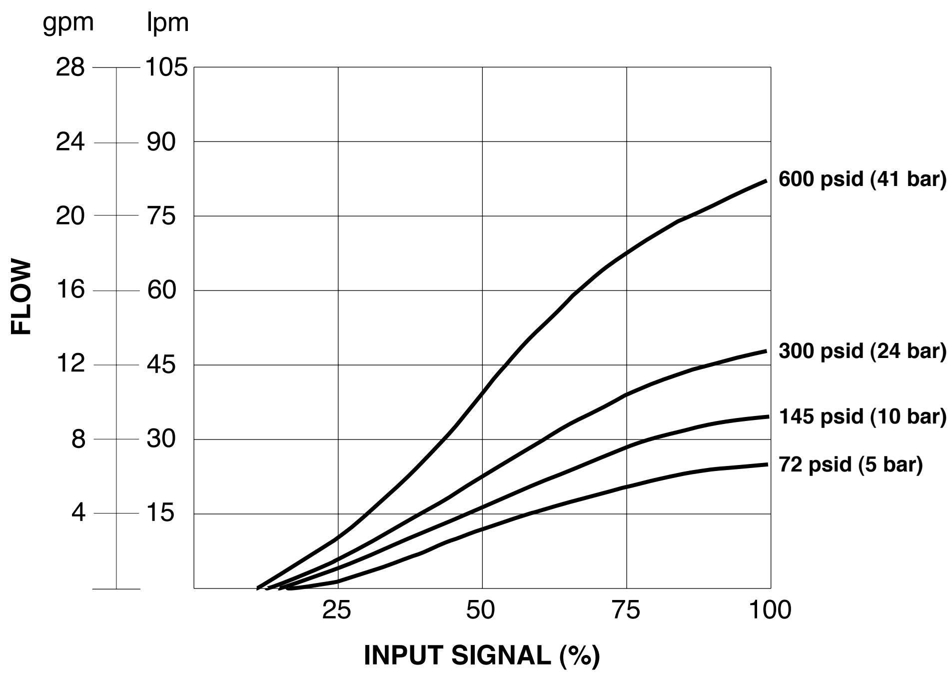
FLOW VS. INPUT SIGNAL CURVES

A2O, F2O, A2I, and F2I Spools
Nominal 10 gpm (38 lpm)



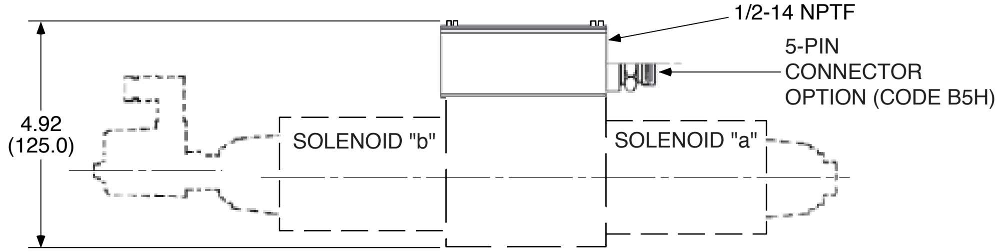
NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

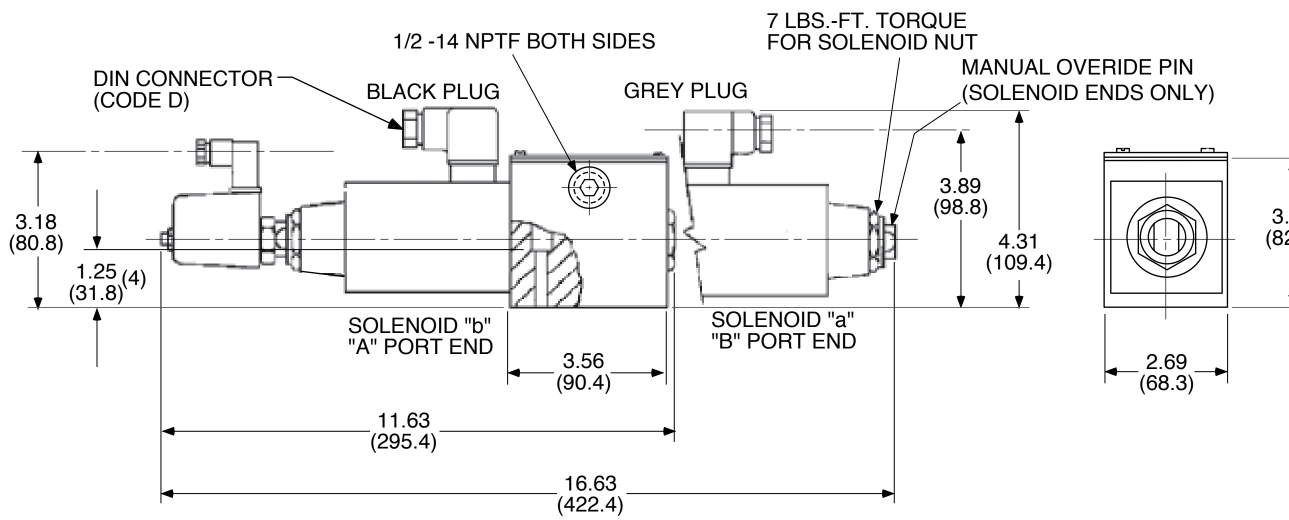
A2C and F2C Spools
Nominal 9 gpm (34 lpm)



DIMENSIONS

Dimensions shown in: Inches (millimeters)

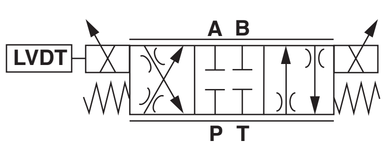




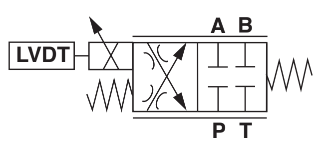
NOTES:
1. Electrical box may be rotated 180° (Codes B, BT, and B5H).
2. 5-pin disconnect meets NFPA recommende standard T3.5.29 R1 - 2003.
3. Two (2) lead wires for each solenoid 6 inches (152.4 mm) long (except Code D) and ground screw are provided by removing the top cover plate.
4. Four (4) mounting bolts are torqued to 10 - 12 lbs.-Ft. (13.5 - 16.3 Nm).

SCHEMATICS

Code 3



Code 5



ORDERING CODE INFORMATION

ED05M – [SELECT ONE] [SELECT ONE] – G [SELECT IF REQ'D] [SELECT IF REQ'D] – [SELECT ONE] L – C (DESIGN LETTER)

FUNCTION

CODE	DESCRIPTION
3	DOUBLE SOLENOID 3 POSITION SPRING CENTERED
5	SINGLE SOLENOID 2 POSITION SPRING CENTERED

SEALS

CODE
VITON SEALS STANDARD

ELECTRICAL OPTIONS

CODE	DESCRIPTION
OMIT	LEAD WIRE
D	DIN 43650/ ISO 4400 (FORM A) CONNECTORS
B	TOP ELECT. BOX WITHOUT TERMINAL POSTS
BT	TOP ELECT. BOX WITH TERMINAL POSTS & GROUND
B5H	TOP ELECT. BOX WITH 5-PIN MALE MINI RECEPTACLE, FOR 1 OR 2 SOLENOIDS

NOTE: Electrical options available only on solenoid operated valves with lead wires.

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

SPOOLS

CODE	NOMINAL FLOW (gpm)	METERING
A1C	13	COMBINATION
A1I	15	IN
A1O	15	OUT
A2C	9	COMBINATION
A2I	10	IN
A2O	10	OUT
F1C	13	COMBINATION
F1I	15	IN
F1O	15	OUT
F2C	9	COMBINATION
F2I	10	IN
F2O	10	OUT

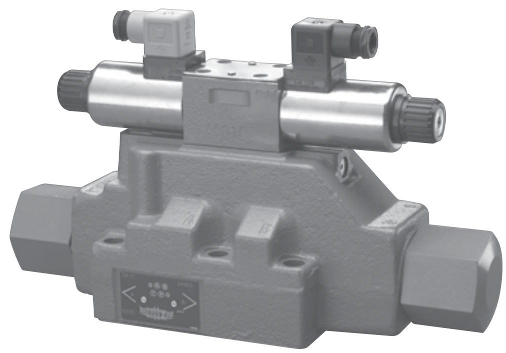
MECHANICAL OPTIONS

CODE	DESCRIPTION
L	LVDT ON "A" PORT END
LR	REVERSE ASSEMBLY LVDT ON "B" PORT END

TYPICAL ORDERING CODE:

ED05M-3A2C-GB-24L-C

ED08M
Proportional Directional Control Valves
PILOT OPERATED WITHOUT LVDT



DESCRIPTION

These proportional directional control valves are 4-way, pilot operated, spring centered, sliding spool valves. They can be used to control flow direction and rate. Directional control is achieved by solenoid selection; flow rate is a function of the solenoid current. If electrical power is lost, the valve spool will return to center position.

SPOOL METERING

Combination metering spools (code "C") meter oil into and out of the hydraulic actuator. These spools provide excellent control in most applications. Combination metering spools are highly recommended where deceleration control of a hydraulic motor is required or in velocity feedback applications. Combination metering spools can be used with a pressure-compensated module to provide proportional pressure compensated flow.

Meter-in spools (code "I") meter oil into the actuator. These spools are commonly used in applications where the actuator is always working against a positive (resistive) load. Meter-in spools can also be used with a pressure compensated module.

Meter-out spools (code "O") meter flow out of the actuator. These spools are commonly used in applications with "run away" loads such as over-center loads. Meter-out spools are also used with high ratio cylinders.

It is important to properly size a proportional valve to achieve good resolution. A common mistake when specifying proportional valves is selecting too high a rated flow. The result may be poor control of the actuator, particularly with respect to velocity and resolution. Ideal valve size is usually one that provides just enough maximum flow capability to achieve the desired velocity. Consult with Continental about special metering characteristics: unequal-metering, step metering, other nominal flows and other spool configurations.

Use caution when applying a separate internally-drained pressure control valve between the actuator and the proportional valve. Back pressure created by meter-out or combination metering proportional valves can add to the spring load of the pressure control valve, resulting in a change of the control pressure level.

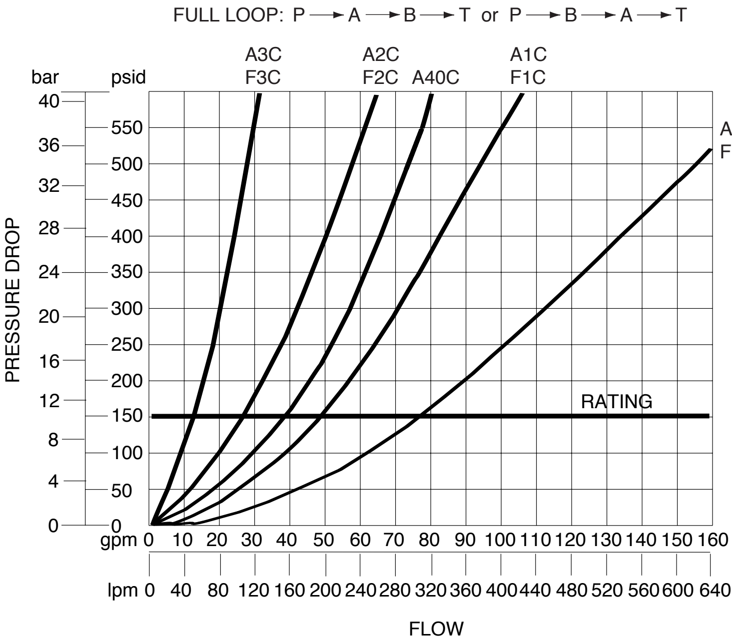
TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE		NFPA/T3.5.1M R2-2002 (D08) ANSI/B93.7M-1986 ISO 4401 SIZE 08	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	AC, FC Spool	75 gpm	285 lpm
	A1C, F1C Spool	46 gpm	175 lpm
	A2C, F2C Spool	26 gpm	99 lpm
	A3C, F3C Spool	12 gpm	46 lpm
	A40C Spool	38 gpm	144 lpm
MAXIMUM OPERATING PRESSURE	P, A, B, X Ports	3500 psi	241 bar
	T Port	3000 psi	207 bar
	Y Port †	10 psi	0.7 bar
MINIMUM PILOT PRESSURE		250 psi	17 bar
TYPICAL STEP RESPONSE TIME ** (Nominal)	Power On	75 ms	
	Spring Return	85 ms	
SPOOL STROKE	Center to Offset	0.45 in.	11.43 mm
SPOOL DISPLACEMENT	Offset to Offset	1.1 cu. in.	18 ml
HYSTERESIS	With Dither	< 6%	
THRESHOLD	With Dither	< 6%	
QUIESCENT FLOW	Nominal @ 3000 psi (210 bar)	36 cipm	0.59 lpm
REPEATABILITY	With Dither	< 3%	
DEADBAND		10% nominal of spool travel	
VOLTAGE (Nominal)	Code 12	12 VDC	
	Code 24	24 VDC	
CURRENT (Maximum)	Code 12	2.2 Amp	
	Code 24	1.1 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)	Code 12	19	
	Code 24	19	
COIL RESISTANCE @ 68° F. (20° C.)	Code 12	3.8 Ohms	
	Code 24	15.2 Ohms	
DUTY CYCLE		Continuous @ rated operating with 120° F. (49° C.) fluid and 100° F. (38° C.) ambient temperature	
WEIGHT	Code 3	32 lbs.	14.5 kg
	Code 5	31 lbs.	14.0 kg

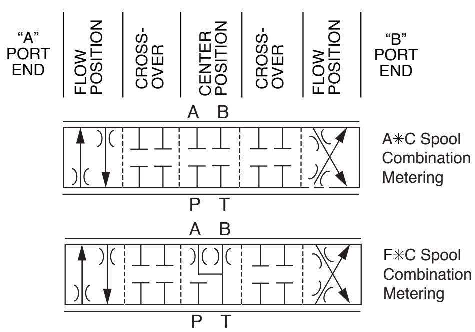
***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.
****NOTE:** Response times are effected by pressure, viscosity and flow rate.
† NOTE: Drain port (Y) must be connected solely to tank below fluid level. Back pressure or flucuation of pressures in the drain line may reflect on controlled pressure in the pilot valve and thus the flow output of the main valve.

PRESSURE DROP CURVE

SPOOLS FULLY SHIFTED

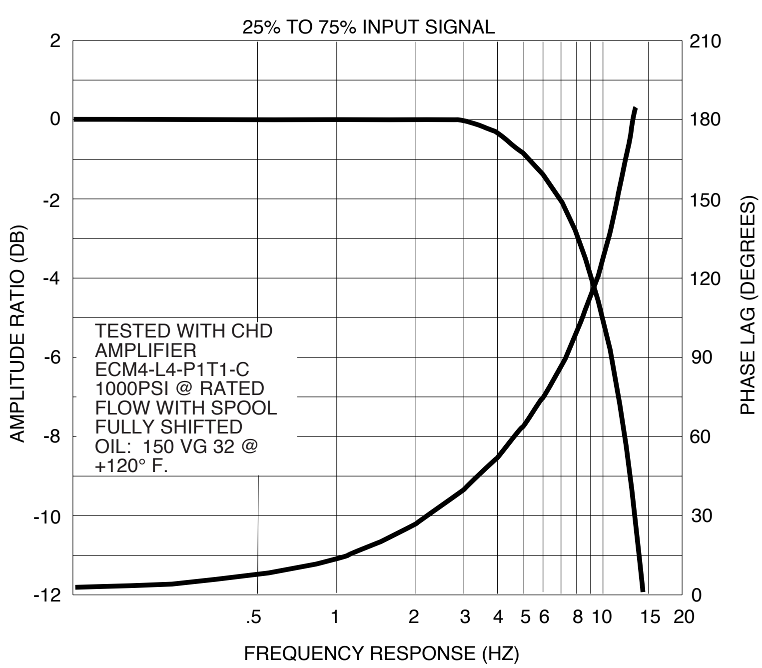


SPOOL CONFIGURATIONS



FREQUENCY RESPONSE CURVE

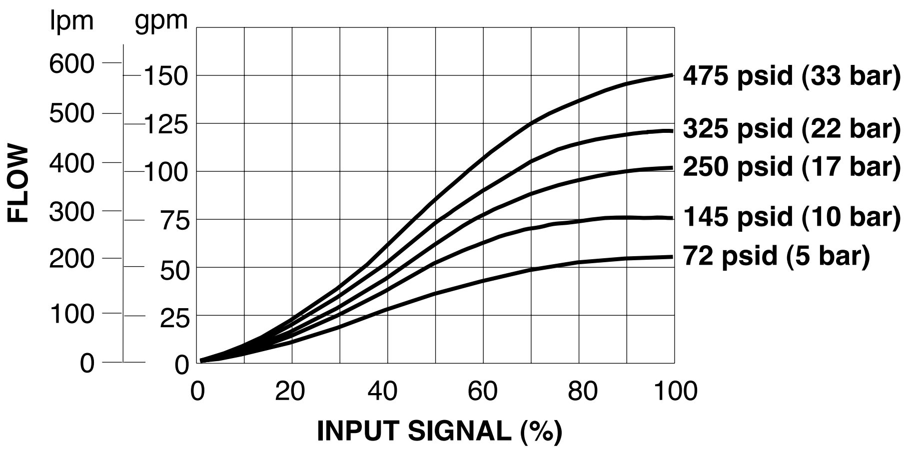
25% TO 75% INPUT SIGNAL



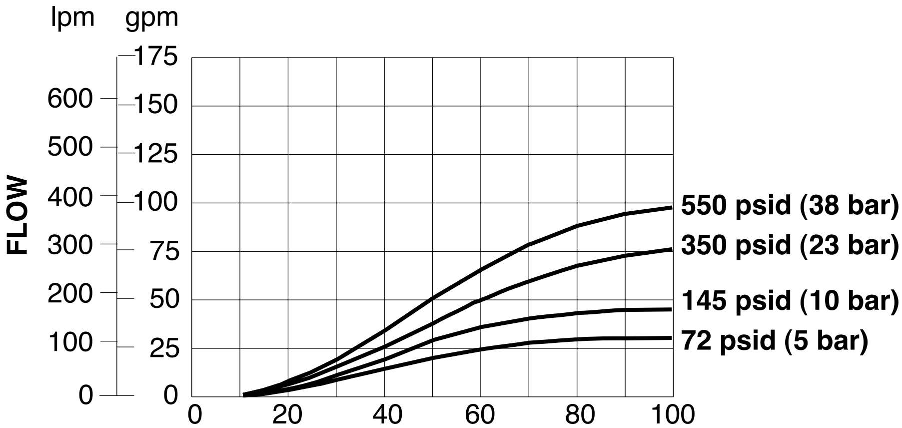
FLOW VS. SIGNAL PRESSURE DROP CURVES
RATED FLOW @ 145 psi ΔP

NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

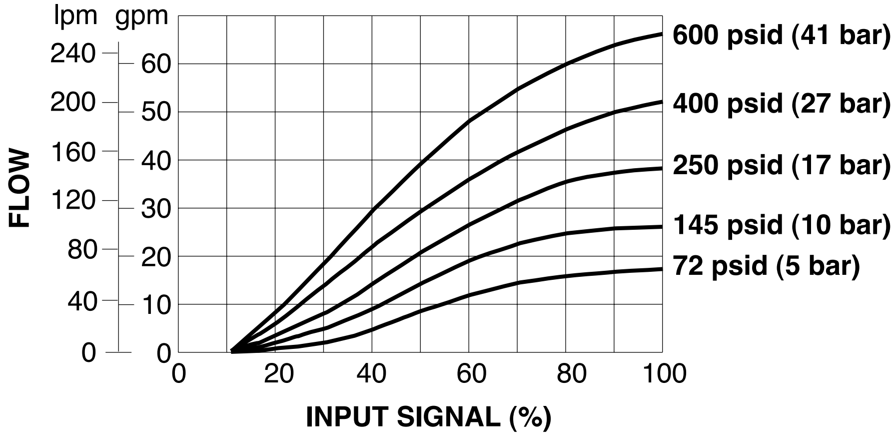
AC and FC Spools
Rated @ 75 gpm (285 lpm)



A1C and F1C Spools
Rated @ 46 gpm (175 lpm)



A2C and F2C Spools
Rated @ 26 gpm (99 lpm)



CONTINENTAL HYDRAULICS

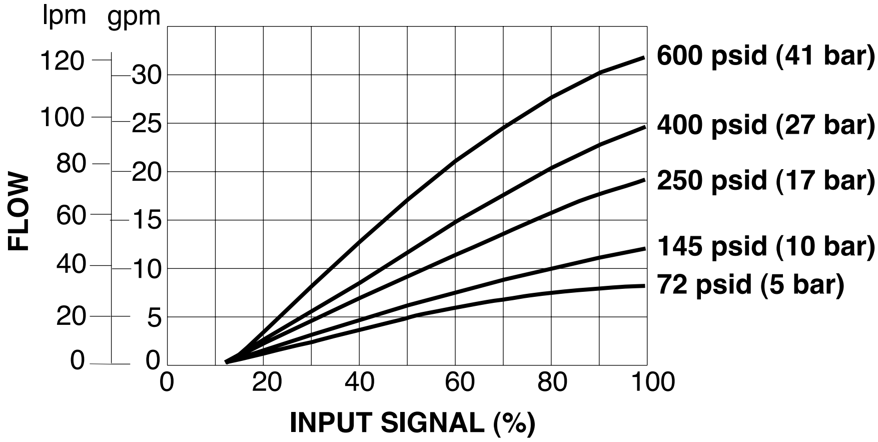
FLOW VS. SIGNAL PRESSURE DROP CURVES

RATED FLOW @ 145 psi ΔP

NOTES:
These curves were run at no load flow condition, ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

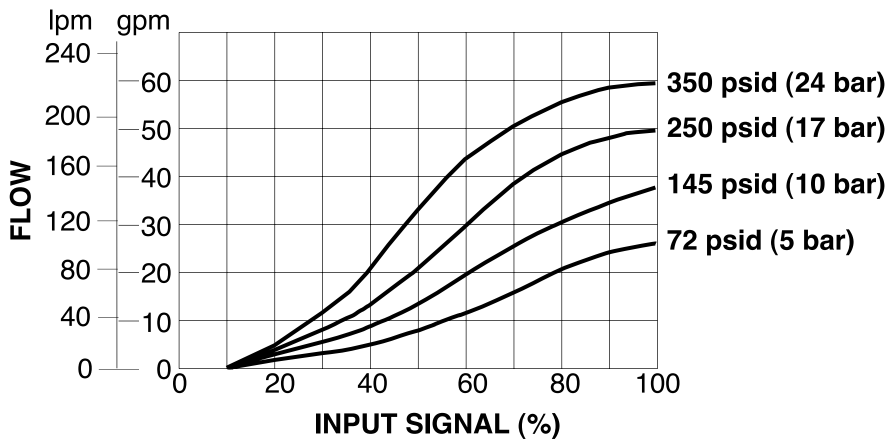
A3C and F3C Spools

Rated @12 gpm (46 lpm)



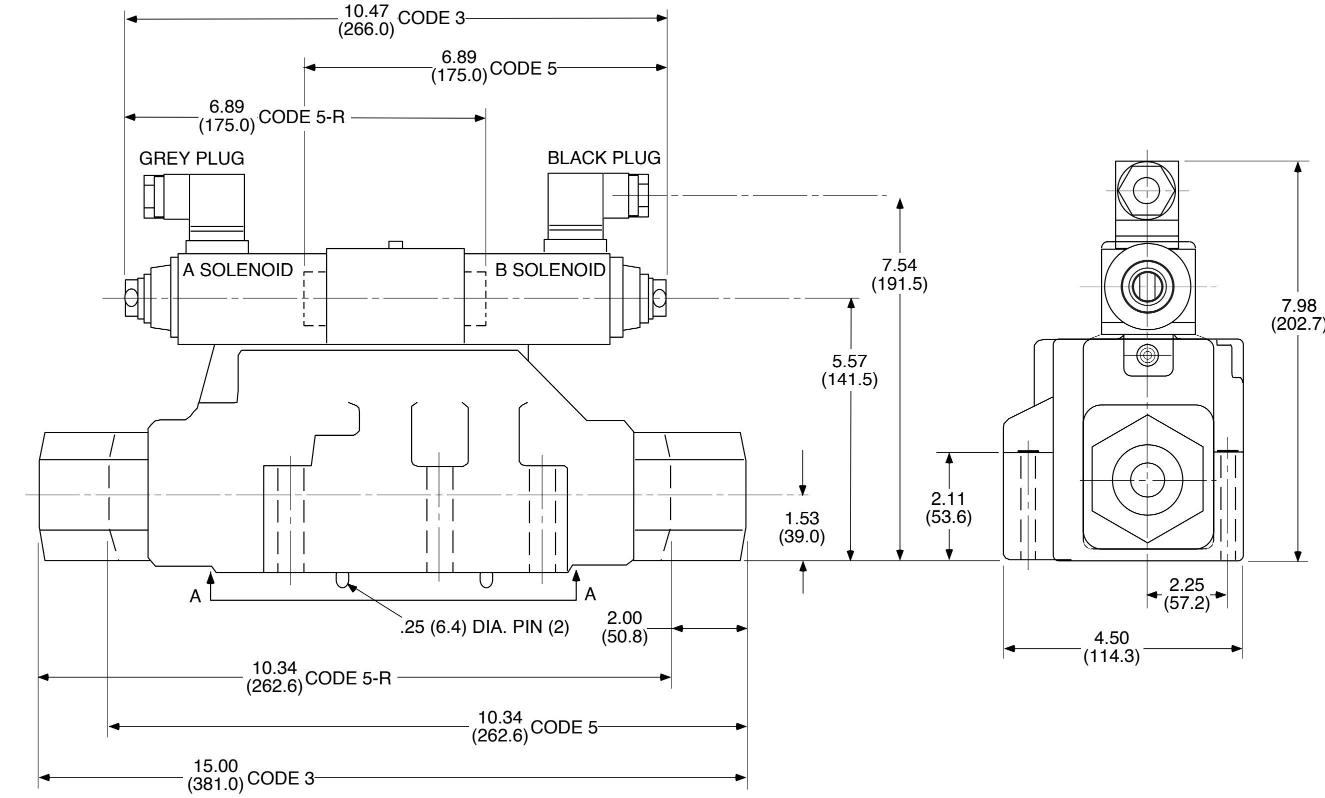
A40C Spool

Rated @ 38 gpm (145 lpm)

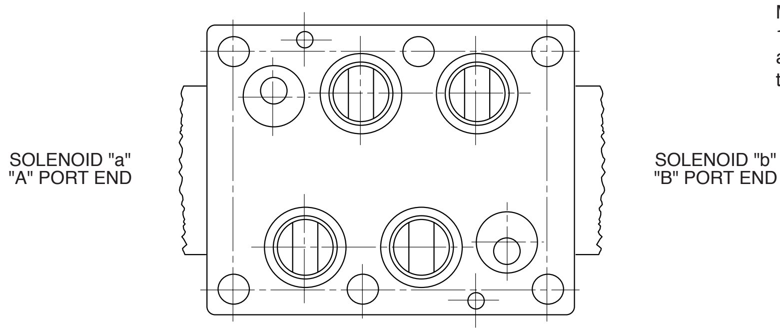


DIMENSIONS
CODE D

Dimensions shown in: Inches (millimeters)



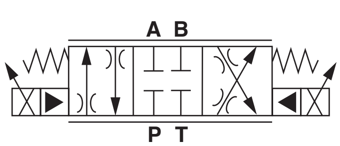
Mount to NFPA surface (D08) manifold with six (6) 1/2-13NC x 2-1/2 long socket head cap screws and lockwashers. Bolt kits are available as accessory code BD08-250. Recommended bolt torque is 50 to 60 lbs.-ft. (67.8 to 81.3 Nm).



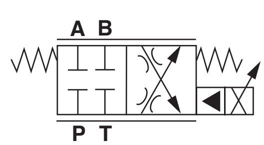
VIEW A - A

SCHEMATICS

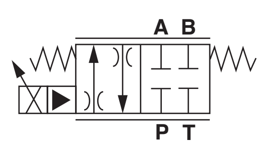
Code 3



Code 5



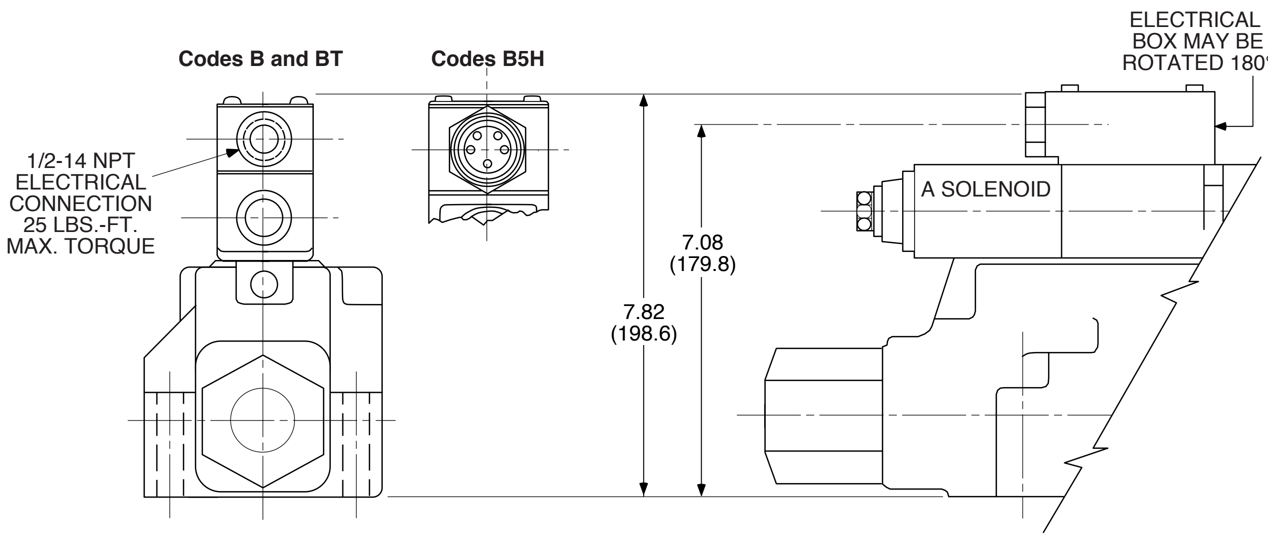
Code 5-R



DIMENSIONS

CODES B, BT and B5H

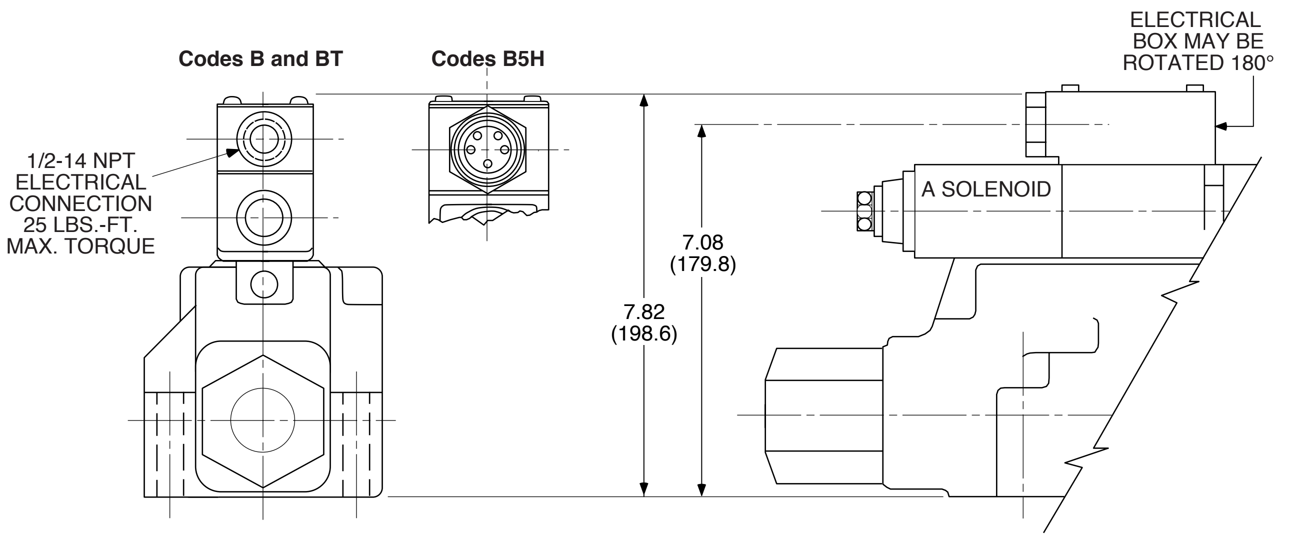
Dimensions shown in: Inches (millimeters)



DIMENSIONS

CODES B, BT and B5H

Dimensions shown in: Inches (millimeters)



ORDERING CODE INFORMATION

		SELECT ONE	SELECT ONE			SELECT ONE	SELECT IF REQ'D	SELECT IF REQ'D		SELECT ONE			DESIGN LETTER
ED08M	–	☐	☐	–	G	☐	☐	☐	–	☐	L	–	C
		FUNCTION	SPOOLS		SEALS	PILOT DRAIN	MECHANICAL OPTIONS	ELECTRICAL OPTIONS		SOLENOID	SOLENOID MFG.		

FUNCTION

CODE	DESCRIPTION
3	DOUBLE SOLENOID 3 POSITION SPRING CENTERED
5	SINGLE SOLENOID 2 POSITION SPRING CENTERED

SEALS

CODE
VITON SEALS STANDARD

MECHANICAL OPTIONS

CODE	DESCRIPTION
OMIT	DOUBLE SOLENOID VALVES AND SINGLE SOLENOID VALVES WITH “B” SOLENOID
R	SINGLE SOLENOID VALVES WITH “A” SOLENOID ENERGIZE: P TO A

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

SPOOLS

CODE	NOMINAL FLOW (gpm)
AC	75
A1C	46
A2C	26
A3C	12
A40C	38
FC	75
F1C	46
F2C	26
F3C	12

PILOT DRAIN

CODE	DESCRIPTION
1	INTERNAL PILOT EXTERNAL DRAIN
2	EXTERNAL PILOT EXTERNAL DRAIN

ELECTRICAL OPTIONS

CODE	DESCRIPTION
D	DIN 43650/ ISO 4400 (FORM A) CONNECTORS
B	TOP ELECT. BOX WITHOUT TERMINAL POSTS
BT	TOP ELECT. BOX WITH TERMINAL POSTS & GROUND
B5H	TOP ELECT. BOX WITH 5-PIN MALE MINI RECEPTACLE, FOR 1 OR 2 SOLENOIDS

TYPICAL ORDERING CODE:

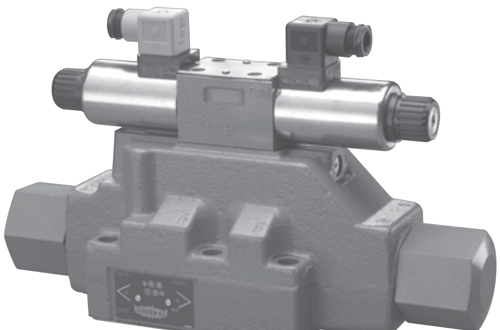
ED08M-3A1C-GB-24L-C

ED08M

Proportional Directional Control Valves

PILOT OPERATED WITH LVDT

CONTINENTAL HYDRAULICS



DESCRIPTION

These proportional directional control valves are 4-way, pilot operated, spring centered, sliding spool valves. They can be used to control flow direction and rate. Directional control is achieved by solenoid selection; flow rate is a function of the solenoid current. This model features spool position feedback via a LVDT for improved valve performance. In the event of a loss of electrical power, the valve spool will return to center position.

SPOOL METERING

Combination metering spools (code "C") meter oil into and out of the hydraulic actuator. These spools provide excellent control in most applications. Combination metering spools are highly recommended where deceleration control of a hydraulic motor is required or in velocity feedback applications. Combination metering spools can be used with a pressure-compensated module to provide proportional pressure compensated flow.

Meter-in spools (code "I") meter oil into the actuator. These spools are commonly used in applications where the actuator is always working against a positive (resistive) load. Meter-in spools can also be used with a pressure compensated module.

Meter-out spools (code "O") meter flow out of the actuator. These spools are commonly used in applications with "run away" loads such as over-center loads. Meter-out spools are also used with high ratio cylinders.

It is important to properly size a proportional valve to achieve good resolution. A common mistake when specifying proportional valves is selecting too high a rated flow. The result may be poor control of the actuator, particularly with respect to velocity and resolution. Ideal valve size is usually one that provides just enough maximum flow capability to achieve the desired velocity. Consult with Continental about special metering characteristics: unequal-metering, step metering, other nominal flows and other spool configurations.

Use caution when applying a separate internally-drained pressure control valve between the actuator and the proportional valve. Back pressure created by meter-out or combination metering proportional valves can add to the spring load of the pressure control valve, resulting in a change of the control pressure level.

TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE		NFPA/T3.5.1M R2-2002 (D08) ANSI/B93.7M-1986 ISO 4401 SIZE 08	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	AC, FC Spool	75 gpm	285 lpm
	A1C, F1C Spool	46 gpm	175 lpm
	A2C, F2C Spool	26 gpm	99 lpm
	A3C, F3C Spool	12 gpm	46 lpm
	A40C Spool	38 gpm	144 lpm
MAXIMUM OPERATING PRESSURE	P, A, B, X Ports	3500 psi	241 bar
	T Port	3000 psi	207 bar
	Y Port †	10 psi	0.7 bar
MINIMUM PILOT PRESSURE		250 psi	17 bar
TYPICAL STEP RESPONSE TIME ** (Nominal)	Power On	75 ms	
	Spring Return	60 ms	
SPOOL STROKE	Center to Offset	0.45 in.	11.43 mm
SPOOL DISPLACEMENT	Offset to Offset	1.1 cu. in.	18 ml
HYSTERESIS	With Dither	< 2%	
THRESHOLD	With Dither	< 1%	
QUIESCENT FLOW	Nominal @ 3000 psi (210 bar)	36 cipm	0.59 lpm
REPEATABILITY	With Dither	< 1%	
DEADBAND		10% nominal of spool travel	
VOLTAGE (Nominal)	Code 12	12 VDC	
	Code 24	24 VDC	
CURRENT (Maximum)	Code 12	2.2 Amp	
	Code 24	1.1 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)	Code 12	19	
	Code 24	19	
COIL RESISTANCE @ 68° F. (20° C.)	Code 12	3.8 Ohms	
	Code 24	15.2 Ohms	
DUTY CYCLE		Continuous @ rated operating with 120° F. (49° C.) fluid and 100° F. (38° C.) ambient temperature	
WEIGHT	Code 3	32 lbs.	14.5 kg
	Code 5	31 lbs.	14.0 kg

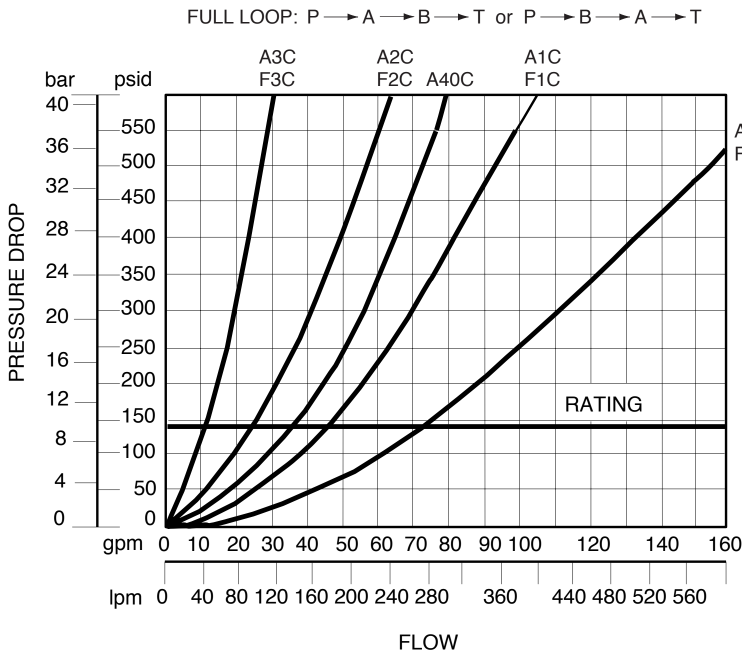
***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.

****NOTE:** Response times are effected by pressure, viscosity and flow rate.

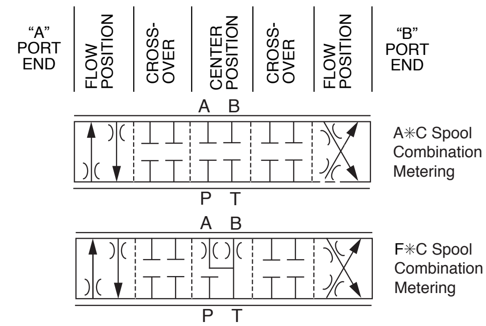
† NOTE: Drain port (Y) must be connected solely to tank below fluid level. Back pressure or flucuation of pressures in the drain line may reflect on controlled pressure in the pilot valve and thus the flow output of the main valve.

PRESSURE DROP CURVE

SPOOLS FULLY SHIFTED

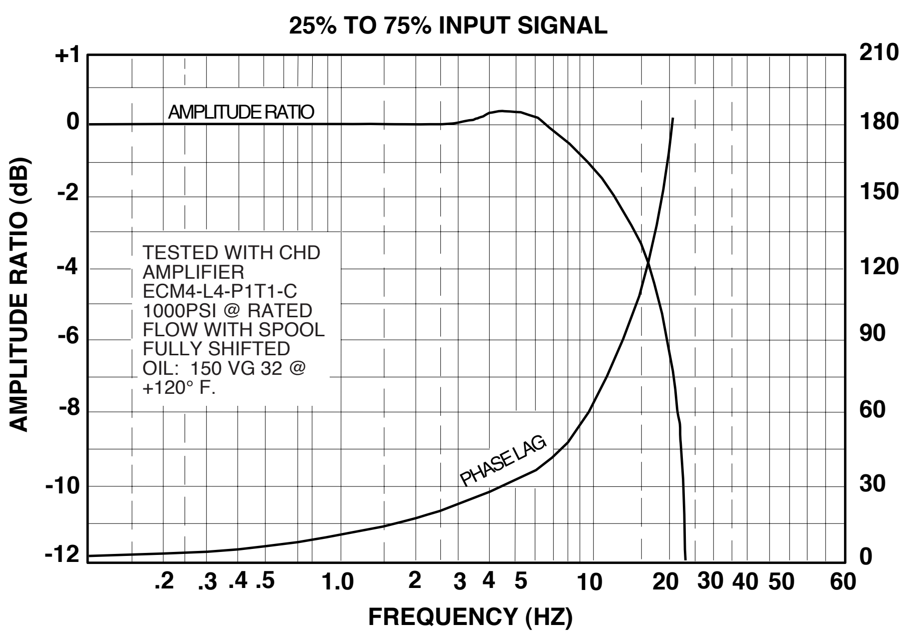


SPOOL CONFIGURATIONS



FREQUENCY RESPONSE CURVE

25% TO 75% INPUT SIGNAL



CONTINENTAL HYDRAULICS

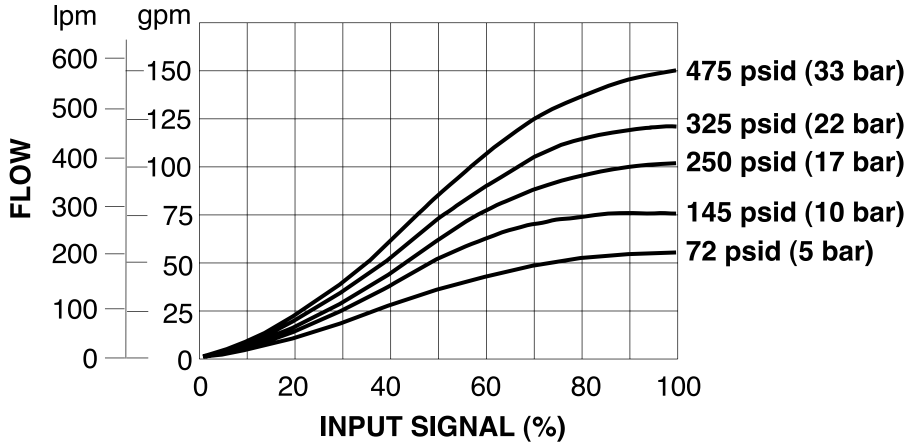
FLOW VS. SIGNAL PRESSURE DROP CURVES

RATED FLOW @ 145 psi ΔP

NOTES:
These curves were run at no load flow condition,
ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

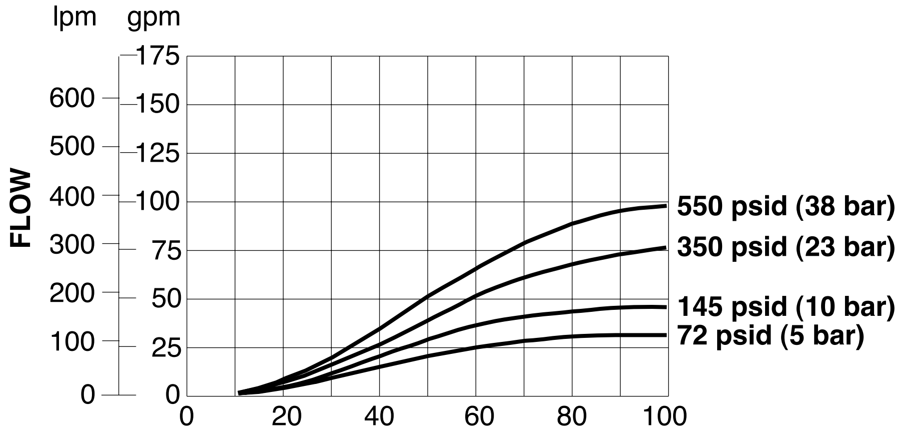
AC and FC Spools

Rated @ 75 gpm (285 lpm)



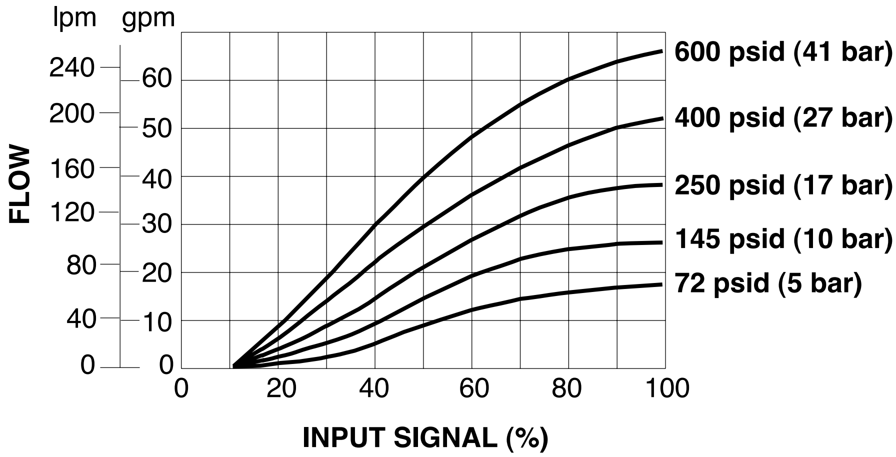
A1C and F1C Spools

Rated @ 46 gpm (175 lpm)



A2C and F2C Spools

Rated @ 26 gpm (99 lpm)



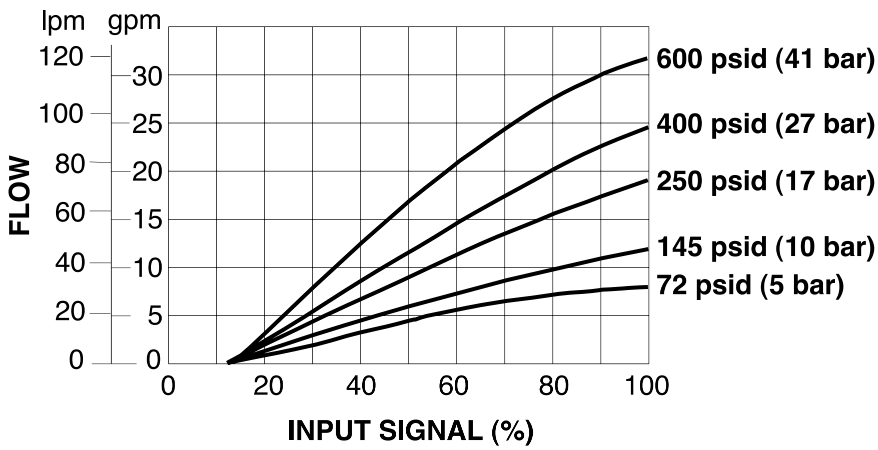
FLOW VS. SIGNAL PRESSURE DROP CURVES

RATED FLOW @ 145 psi ΔP

NOTES:
These curves were run at no load flow condition,
ISO VG32 fluid @ 120° F. (49° C.).
Pressure drop will change with viscosity.
Curves are full flow ΔP.
Conversions: 1 gpm = 3.79 lpm; 1 bar = 14.5 psi.

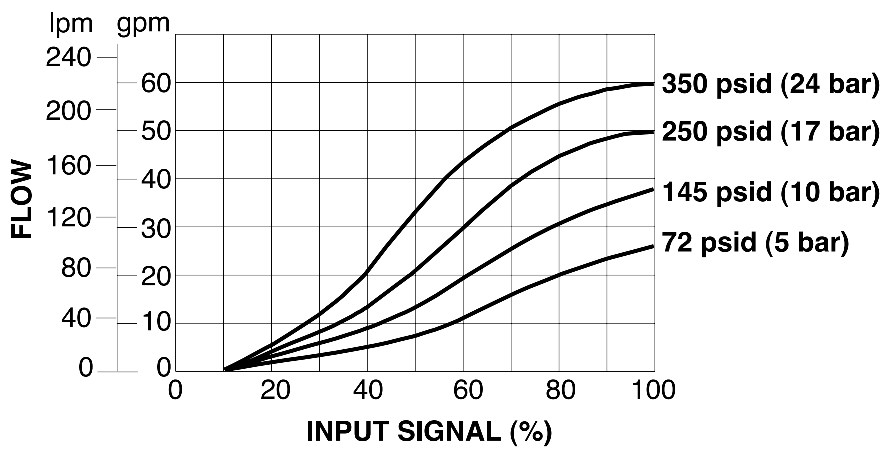
A3C and F3C Spools

Rated @12 gpm (46 lpm)



A40C Spool

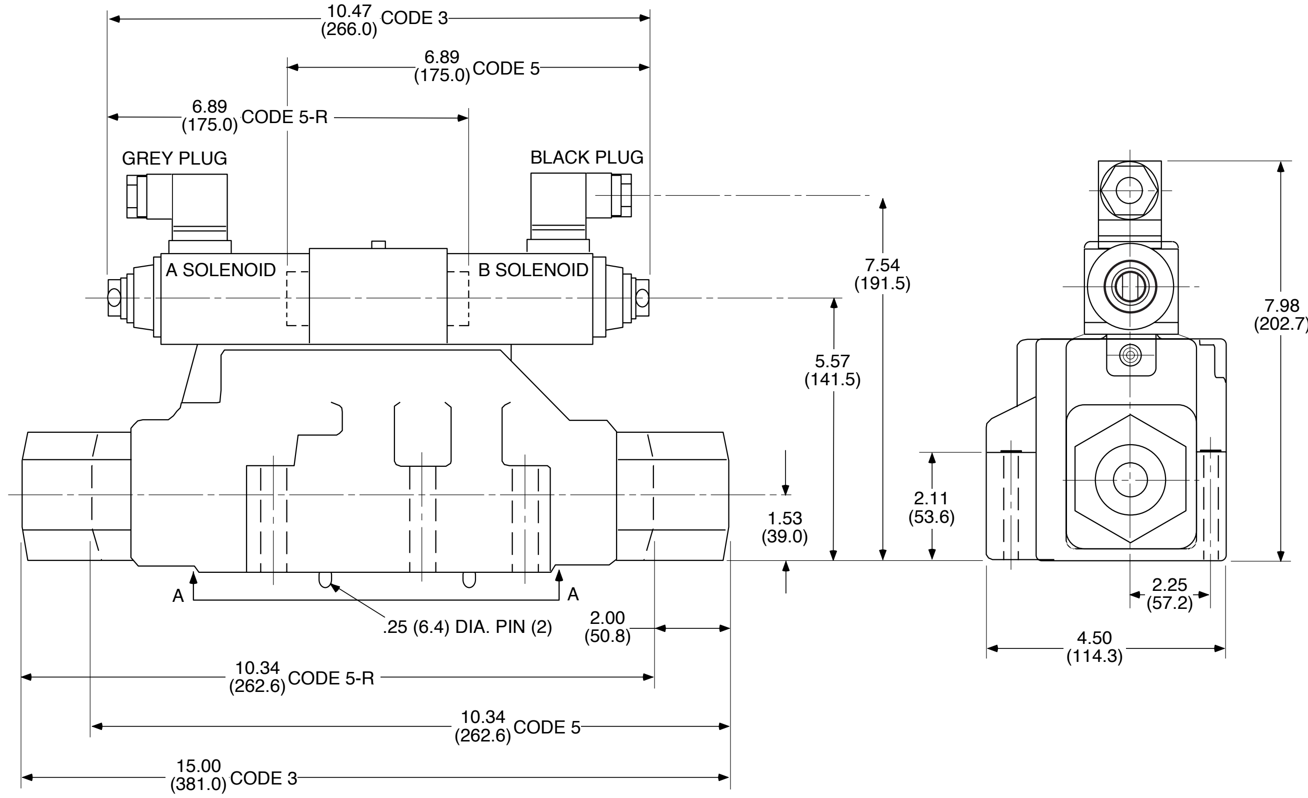
Rated @ 38 gpm (145 lpm)

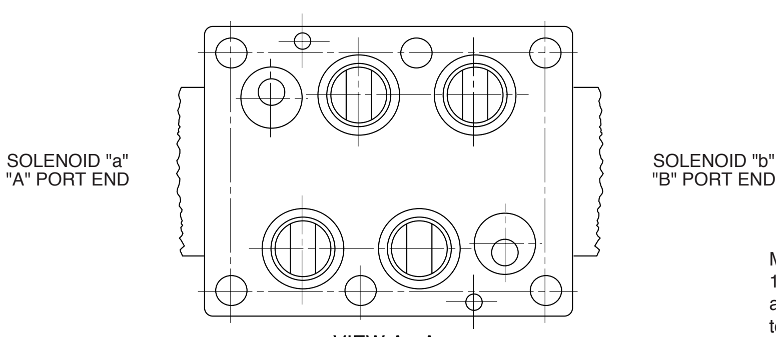


DIMENSIONS

CODE D

Dimensions shown in: Inches (millimeters)



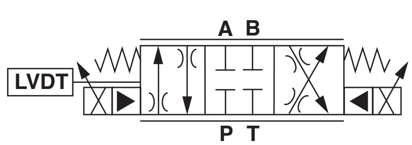


VIEW A - A

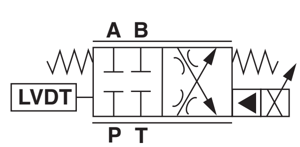
Mount to NFPA surface (D08) manifold with six (6) 1/2-13NC x 2-1/2 long socket head cap screws and lockwashers. Bolt kits are available as accessory code BD08-250. Recommended bolt torque is 50 to 60 lbs./ft. (67.8 to 81.3 Nm).

SCHEMATICS

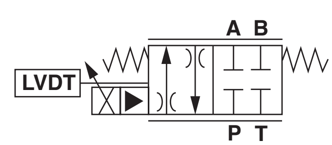
Code 3



Code 5

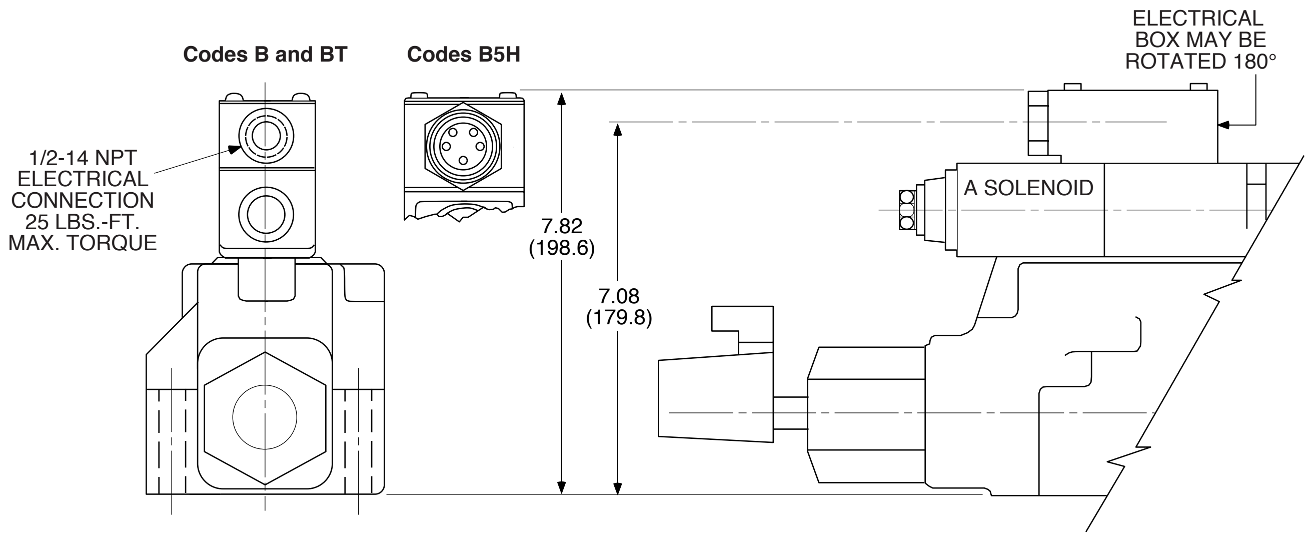


Code 5-R



DIMENSIONS
CODES B, BT and B5H

Dimensions shown in: Inches (millimeters)



CONTINENTAL HYDRAULICS.

ORDERING CODE INFORMATION

ED08M – [SELECT ONE] [SELECT ONE] – G [SELECT ONE] [SELECT IF REQ'D] [SELECT IF REQ'D] – [SELECT ONE] L – C (DESIGN LETTER)

FUNCTION

CODE	DESCRIPTION
3	DOUBLE SOLENOID 3 POSITION SPRING CENTERED
5	SINGLE SOLENOID 2 POSITION SPRING CENTERED

SEALS

CODE
VITON SEALS STANDARD

MECHANICAL OPTIONS

CODE	DESCRIPTION
L	LVDT ON "A" PORT END
LR	SINGLE SOLENOID PILOT VALVE WITH LVDT. PILOT SOLENOID ON "A" PORT END OF SLAVE VALVE

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

SPOOLS

CODE	NOMINAL FLOW (gpm)
AC	75
A1C	46
A2C	26
A3C	12
A40C	38
FC	75
F1C	46
F2C	26
F3C	12

PILOT DRAIN

CODE	DESCRIPTION
1	INTERNAL PILOT EXTERNAL DRAIN
2	EXTERNAL PILOT EXTERNAL DRAIN

ELECTRICAL OPTIONS

CODE	DESCRIPTION
D	DIN 43650/ ISO 4400 (FORM A) CONNECTORS
B	TOP ELECT. BOX WITHOUT TERMINAL POSTS
BT	TOP ELECT. BOX WITH TERMINAL POSTS & GROUND
B5H	TOP ELECT. BOX WITH 5-PIN MALE MINI RECEPTACLE, FOR 1 OR 2 SOLENOIDS

TYPICAL ORDERING CODE:

ED08M-3A1C-G2LD-24L-C

DESCRIPTION

The Continental Hydraulics EF10C is a direct operated, flow control cartridge valve that exhibits pressure compensation characteristics. This valve is available for use in existing or new applications using meter in, meter out, bleed-off priority/bypass control circuit configurations.

This cartridge valve design incorporates a single proportional solenoid acting directly on a spool via a drive pin and is opposed by an offset spring.

Without current applied to the solenoid the offset spring will hold the valve spool in a blocked flow condition. Applying an electrical current to the solenoid will shift the spool against the offset spring and create an orifice between Ports 2 and 3. This orifice size is proportional to the applied solenoid current.

Continental Hydraulics' unique design offers the following:
- Direct operation
  - Fewer moving parts
  - No minimum pressures
  - Valve response times effected less due to varying viscosities
  - Less sensitive to contamination
- Mountings
  - C10-3 cartridge
  - In-line body
- Pressure compensator not required
- Pressure compensation
- Flow from port 2-3, or 3-2 (bi-directional flow)
- Standard C10-3 mounting cavity
- Full flow at full system pressure drop
- Minimal hysteresis
- Excellent linearity
- Multiple flow sizes to match system requirements
- Hardened spool and sleeve for long life
- Standard Viton seals
- Cartridge voltage interchangeable
- Low internal leakage
- Manual override pin

TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE		C10-3 Cavity In-Line Body	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	Code 16	4.3 gpm	16.2 lpm
	Code 28	7.5 gpm	28.4 lpm
MAXIMUM OPERATING PRESSURE	Ports 2 and 3	3500 psi	241 bar
	(Drain) Port 1 **	3000 psi	207 bar
TYPICAL RESPONSE TIME † (Nominal)	10 to 90% Spool Travel	25 ms	
	90 to 10% Spool Travel	45 ms	
	30 to 90% Spool Travel	20 ms	
	90 to 30% Spool Travel	30 ms	
SPOOL STROKE	Closed to open	1.20 in.	3.05 mm
HYSTERESIS	With Dither	< 6%	
THRESHOLD	With Dither	< 3%	
REPEATABILITY	With Dither	< 3%	
DEADBAND		16% nominal of spool travel	
VOLTAGE (Nominal)	Code 12	12 VDC	
	Code 24	24 VDC	
CURRENT (Maximum)	Code 12	2.2 Amp	
	Code 24	1.1 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)	Code 12	19	
	Code 24	19	
COIL RESISTANCE @ 68° F. (20° C.)	Code 12	3.8 Ohms	
	Code 24	15.2 Ohms	
DUTY CYCLE		Continuous @ rated specifications	
FLUID VISCOSITY	Operating	80-350 SUS	
	Maximum	30-4000 SUS	
FLUID CLEANLINESS LEVEL		ISO 4406 Code 16/13 (SAE Class 4) or cleaner	
MOUNTING		Unrestricted	
WEIGHT (Cartridge Only)		2.4 lbs.	1.1 kg

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.

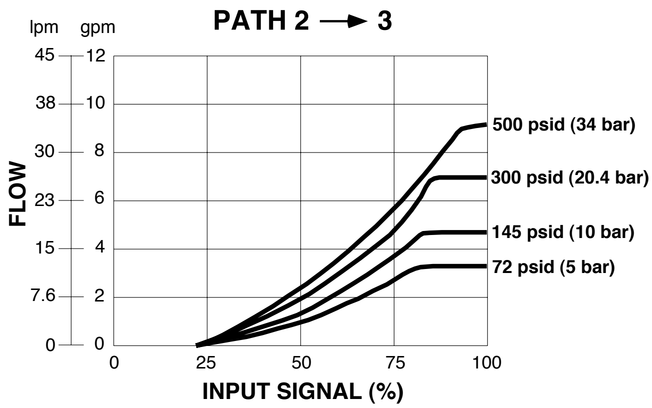
****NOTE:** Drain port must be used for pressures above 3000 psi (207 bar) including pressure spikes. This may be plugged on systems with pressure less than 3000 psi (207 bar).

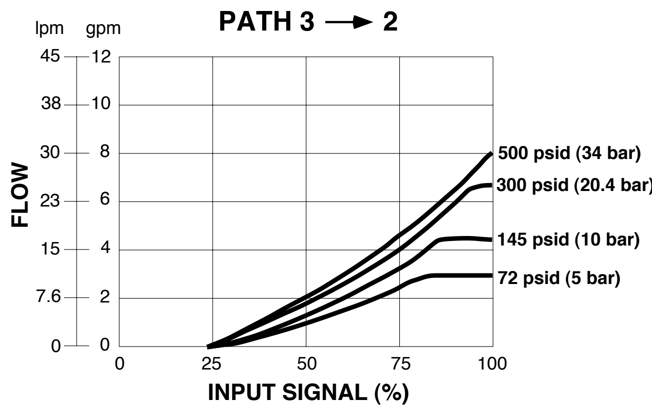
†NOTE: Response times are effected by pressure, viscosity and flow rate.

FLOW VS. CURRENT CURVES

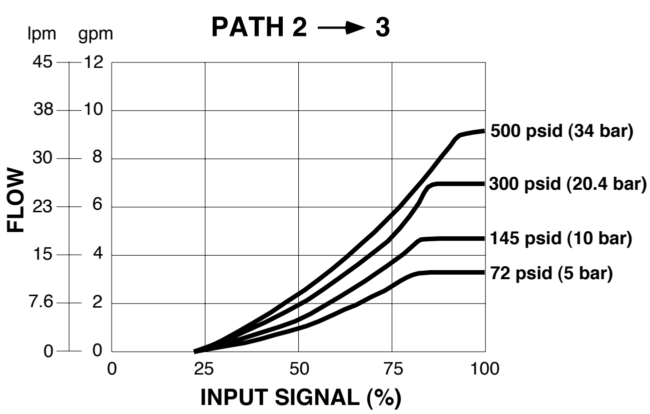
@ CONSTANT PRESSURE DROPS

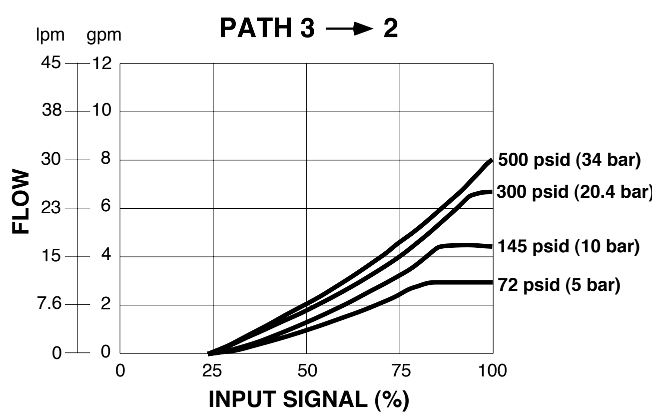
Code D16





Code D28

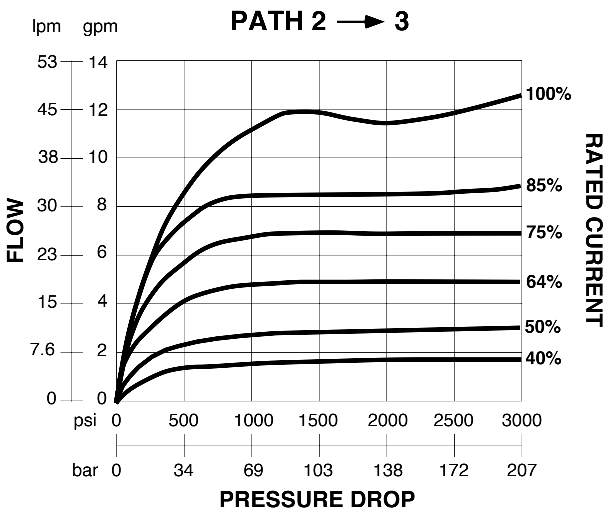


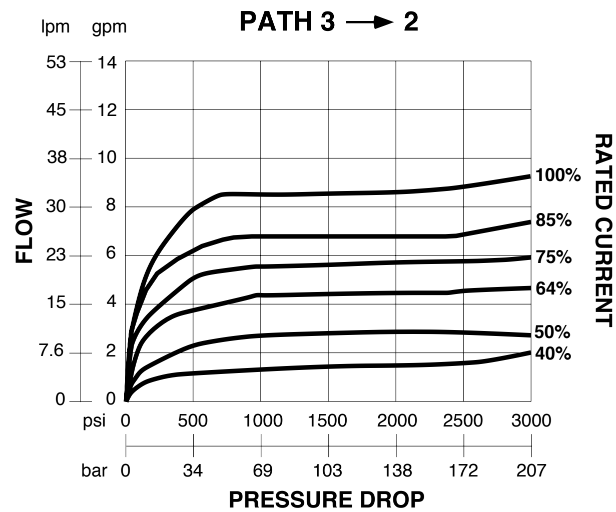


PRESSURE COMPENSATION CURVES

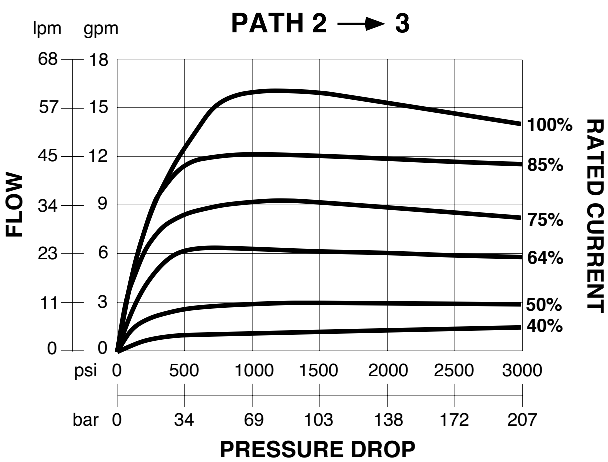
ISO VG 32 OIL @120° F. (49° C.)

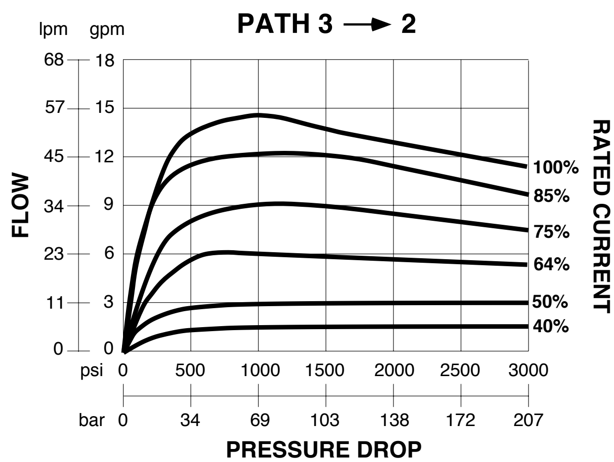
Code D16





Code D28

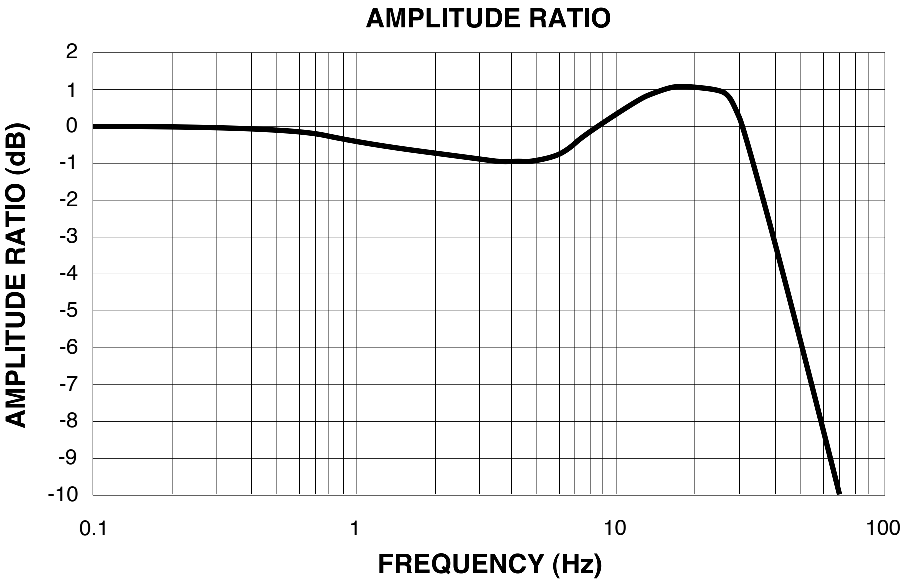


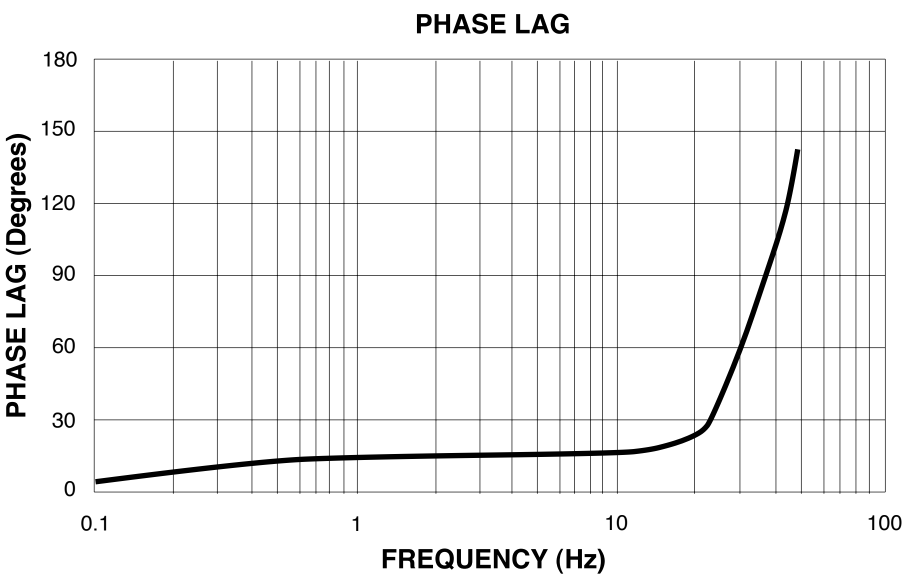


FREQUENCY RESPONSE CURVES

50% ± 25% INPUT SIGNAL @ 1000 psi (69 bar)

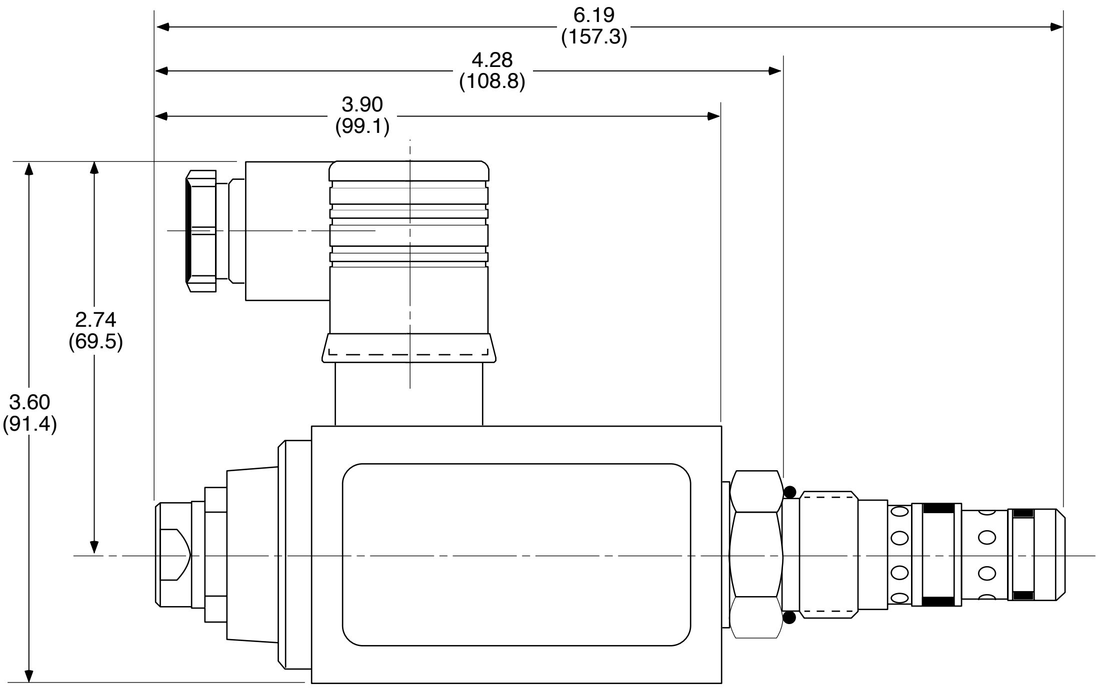
ISO VG 32 OIL @120° F. (49° C.)



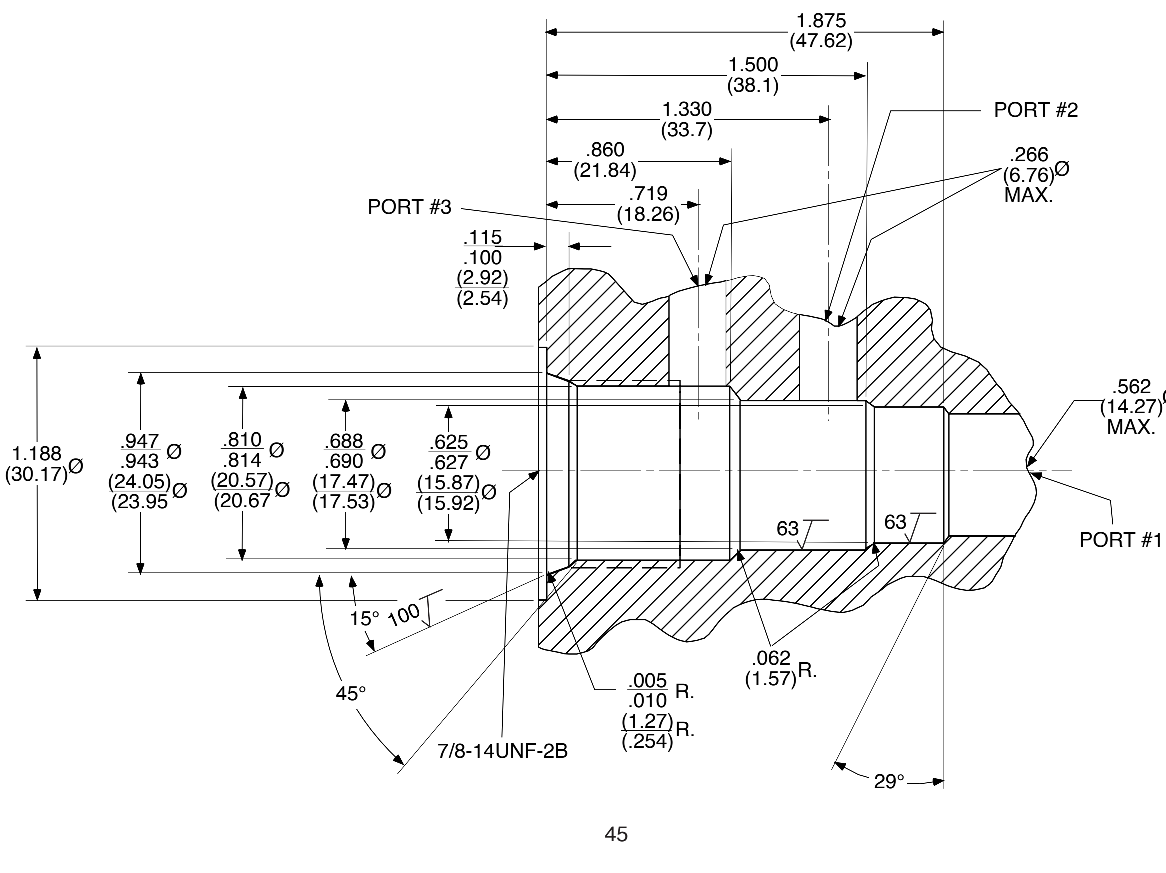


EF10C DIMENSIONS

Dimensions shown in: Inches (millimeters)

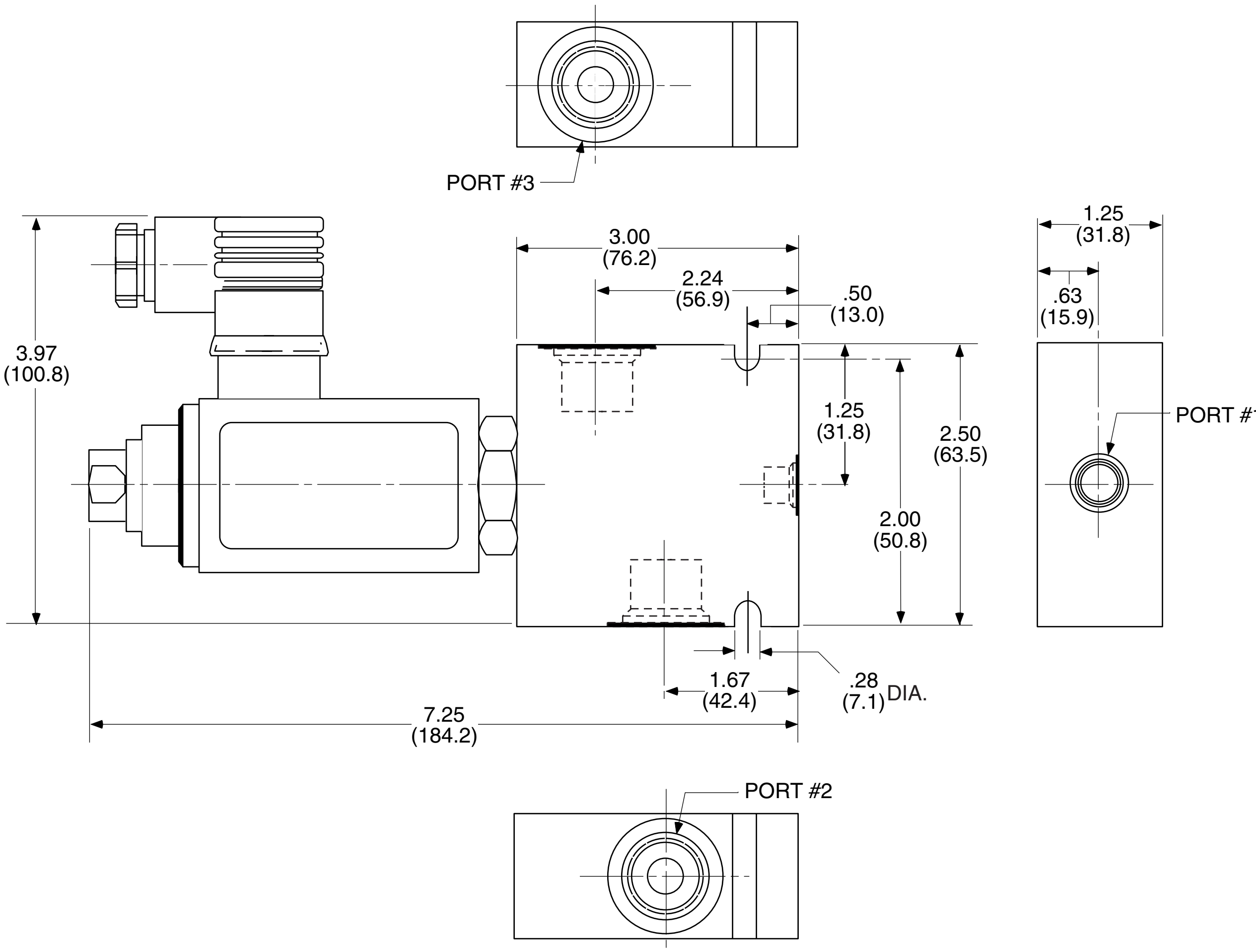


C10-3 CAVITY DIMENSIONS

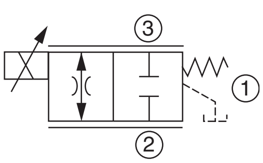


EF10L DIMENSIONS

Dimensions shown in: Inches (millimeters)



EF10C SCHEMATIC



ORDERING CODE INFORMATION

EF10 [SELECT ONE] – D [SELECT ONE] – G D [SELECT ONE] – [SELECT ONE] L – B (DESIGN LETTER)

VALVE TYPE

CODE	DESCRIPTION
C	CARTRIDGE ONLY
L	CARTRIDGE WITH LINE MOUNT BODY

FLOW

CODE	DESCRIPTION
16	16 LITERS 4.3 GPM
28	28 LITERS 7.5 GPM

PORT SIZE

CODE	DESCRIPTION
OMIT	CARTRIDGE ONLY
08	SAE-8 PORTS IN BODY SAE-6 DRAIN PORT
50	1/2" NPT PORTS IN BODY 1/4" NPT DRAIN PORT

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

FUNCTION

CODE
DIRECT OPERATED STANDARD

SEALS

CODE
VITON SEALS STANDARD

ELECTRICAL

CODE
DIN 43650 CONNECTOR STANDARD

TYPICAL ORDERING CODE:

EF10C-D16-GD-24L-B

EF12C

Proportional Cartridge Valves

DIRECT OPERATED FLOW CONTROL

CONTINENTAL HYDRAULICS

DESCRIPTION

The Continental Hydraulics EF12C is a direct operated, flow control cartridge valve that exhibits pressure compensation characteristics. This valve is available for use in existing or new applications using meter in, meter out, bleed-off priority/bypass control circuit configurations.

This cartridge valve design incorporates a single proportional solenoid acting directly on a spool via a drive pin and is opposed by an offset spring.

Without current applied to the solenoid, the offset spring will hold the valve spool in a blocked flow condition. Applying an electrical current to the solenoid will shift the spool against the offset spring and create an orifice between Ports 2 and 3. This orifice size is proportional to the applied solenoid current.

Continental Hydraulics' unique design offers the following:

- Direct operation
  - Fewer moving parts
  - No minimum pressures
  - Valve response times effected less due to varying viscosities
  - Less sensitive to contamination
- Mountings
  - C12-3 cartridge
  - In-line body
- Pressure compensator not required
- Pressure compensation
- Flow from port 2-3, or 3-2 (bi-directional flow)
- Standard C12-3 mounting cavity
- Full flow at full system pressure drop
- Minimal hysteresis
- Excellent linearity
- Multiple flow sizes to match system requirements
- Hardened spool and sleeve for long life
- Standard Viton seals
- Cartridge voltage interchangeable
- Low internal leakage
- Manual override pin

TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE		C12-3 Cavity In-Line Body	
FLOW CAPACITY @ 145 psi (10 bar) (Full Loop)	Code 40	10.5 gpm	39.7 lpm
	Code 60	15.8 gpm	59.8 lpm
MAXIMUM OPERATING PRESSURE	Ports 2 and 3	3500 psi	241 bar
	(Drain) Port 1 **	3000 psi	207 bar
TYPICAL RESPONSE TIME † (Nominal)	10 to 90% Spool Travel	30 ms	
	90 to 10% Spool Travel	60 ms	
	30 to 90% Spool Travel	25 ms	
	90 to 30% Spool Travel	35 ms	
SPOOL STROKE	Closed to open	1.20 in.	3.05 mm
HYSTERESIS	With Dither	< 5%	
THRESHOLD	With Dither	< 5%	
REPEATABILITY	With Dither	< 3%	
DEADBAND		16% nominal of spool travel	
VOLTAGE (Nominal)	Code 12	12 VDC	
	Code 24	24 VDC	
CURRENT (Maximum)	Code 12	2.2 Amp	
	Code 24	1.1 Amp	
WATTAGE (I^2 R) @ 76° F. (24° C.) (Continuous)	Code 12	19	
	Code 24	19	
COIL RESISTANCE @ 68° F. (20° C.)	Code 12	3.8 Ohms	
	Code 24	15.2 Ohms	
DUTY CYCLE		Continuous @ rated specifications	
FLUID VISCOSITY	Operating	80-350 SUS	
	Maximum	30-4000 SUS	
FLUID CLEANLINESS LEVEL		ISO 4406 Code 16/13 (SAE Class 4) or cleaner	
MOUNTING		Unrestricted	
WEIGHT (Cartridge Only)		2.7 lbs.	1.2 kg

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), inlet pressure @ 1000 psi (69 bar) using Continental Hydraulics ECM4 electronic controller.

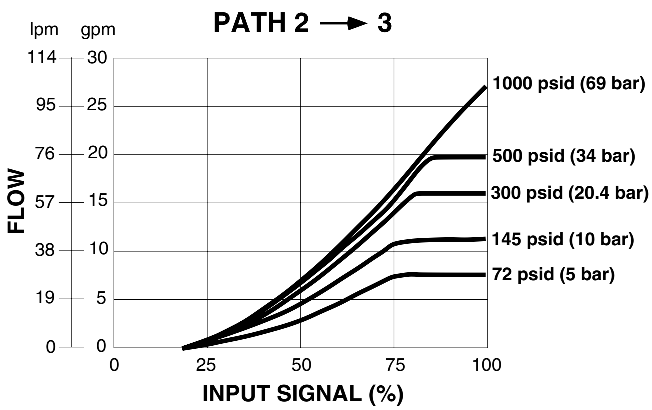
****NOTE:** Drain port must be used for pressures above 3000 psi (207 bar) including pressure spikes. This may be plugged on systems with pressure less than 3000 psi (207 bar).

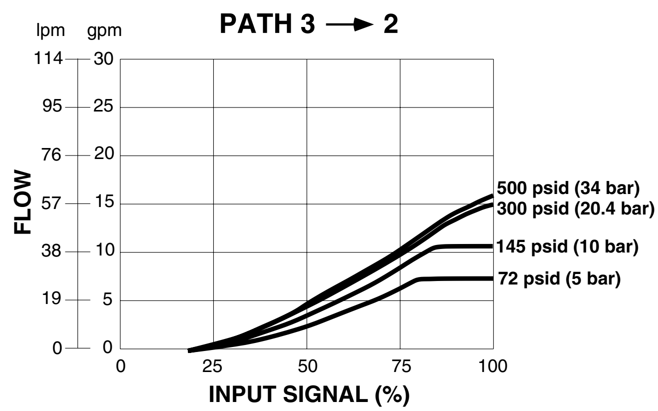
†NOTE: Response times are effected by pressure, viscosity and flow rate.

FLOW VS. CURRENT CURVES

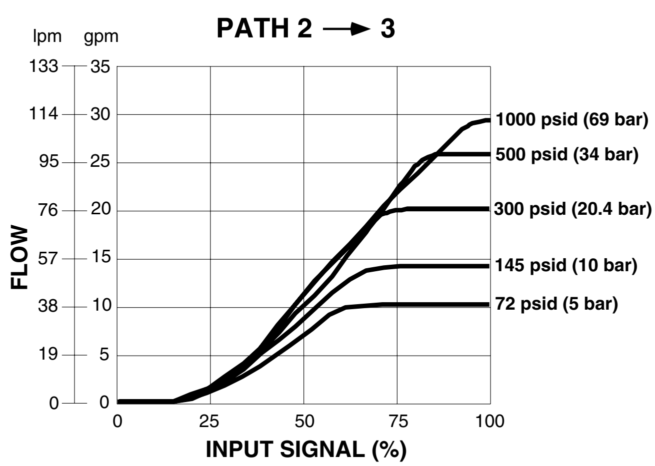
@ CONSTANT PRESSURE DROPS

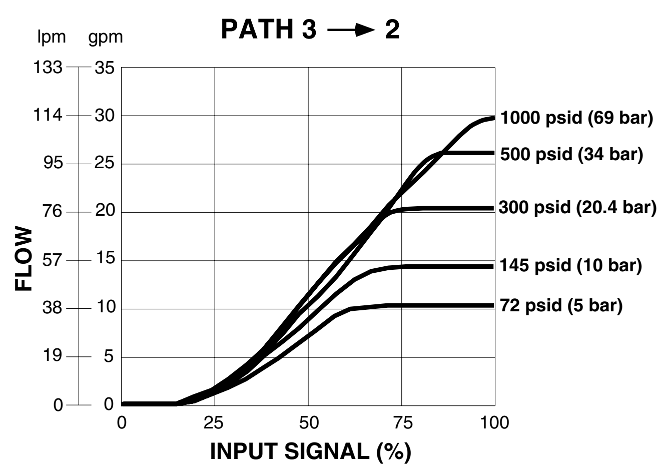
Code D40





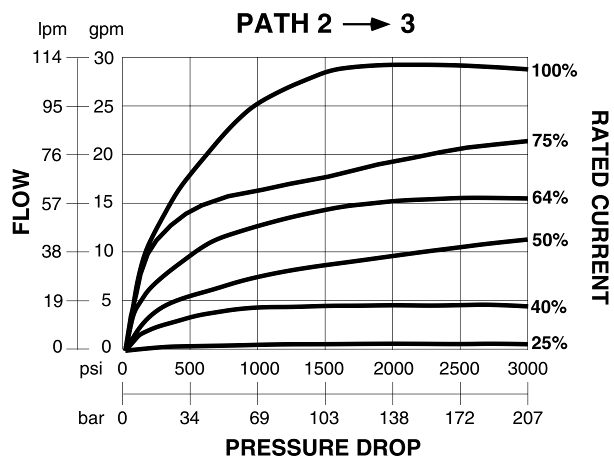
Code D60

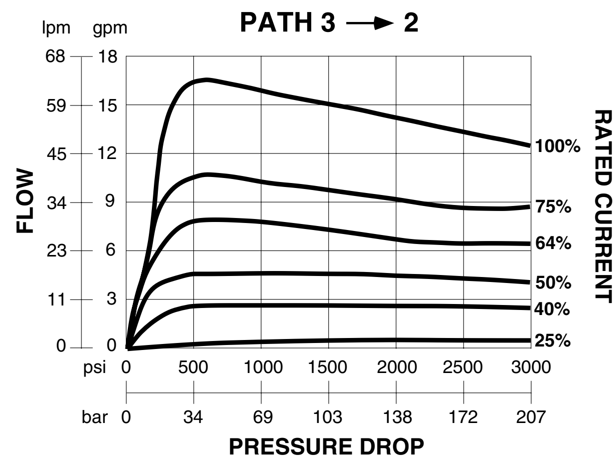




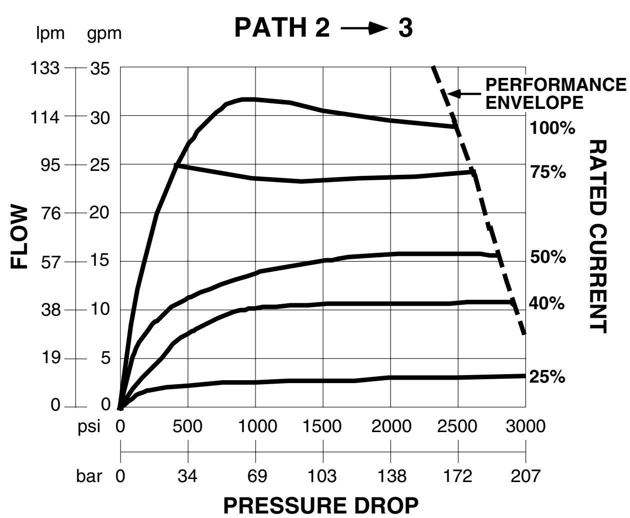
PRESSURE COMPENSATION CURVES
ISO VG 32 OIL @120° F. (49° C.)

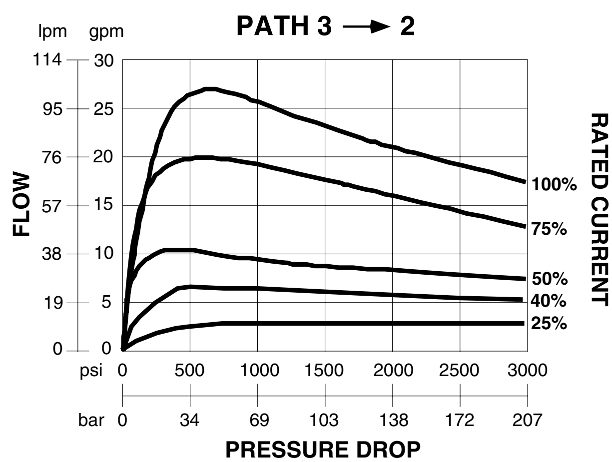
Code D40





Code D60

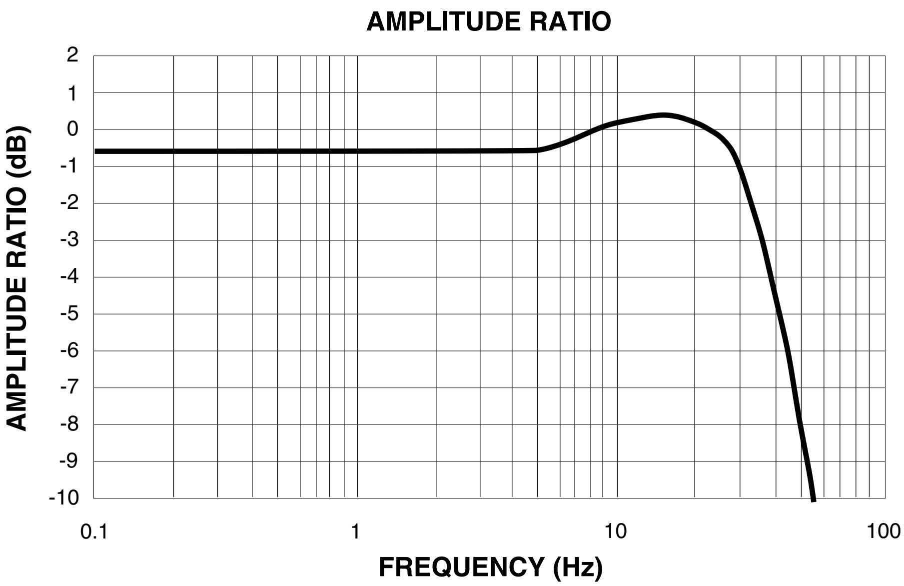


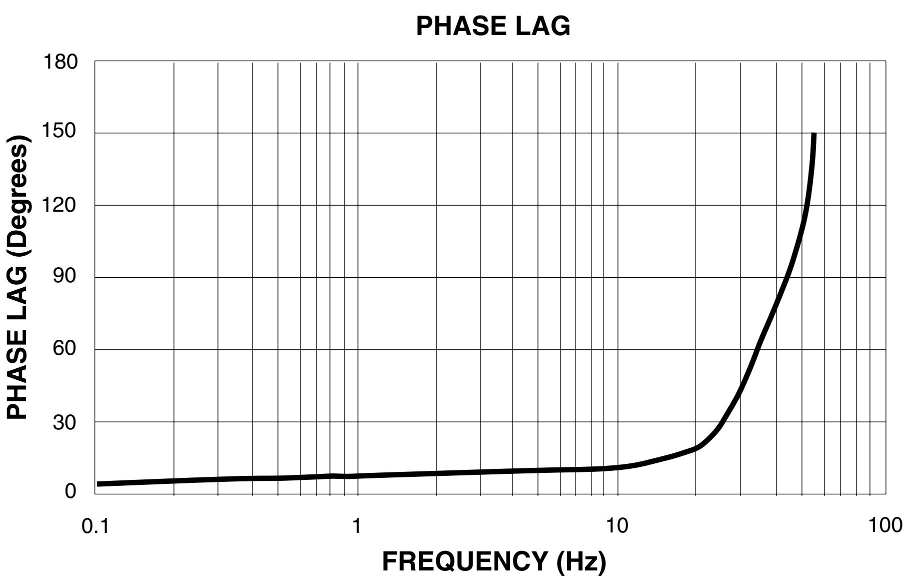


FREQUENCY RESPONSE CURVES

50% ± 25% INPUT SIGNAL @ 1000 psi (69 bar)

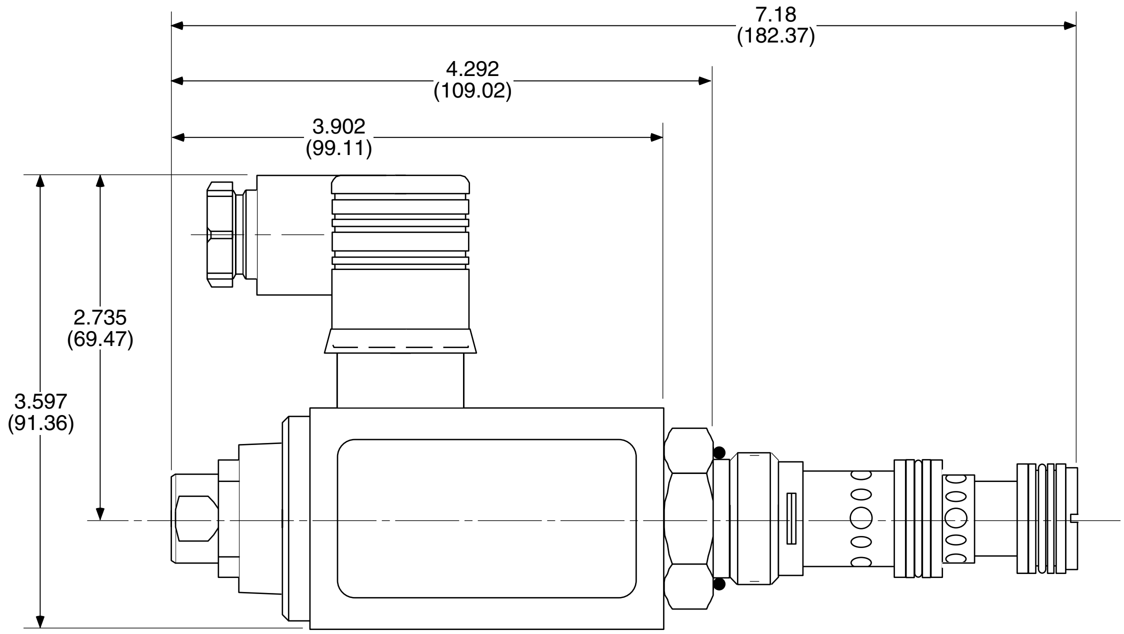
ISO VG 32 OIL @120° F. (49° C.)



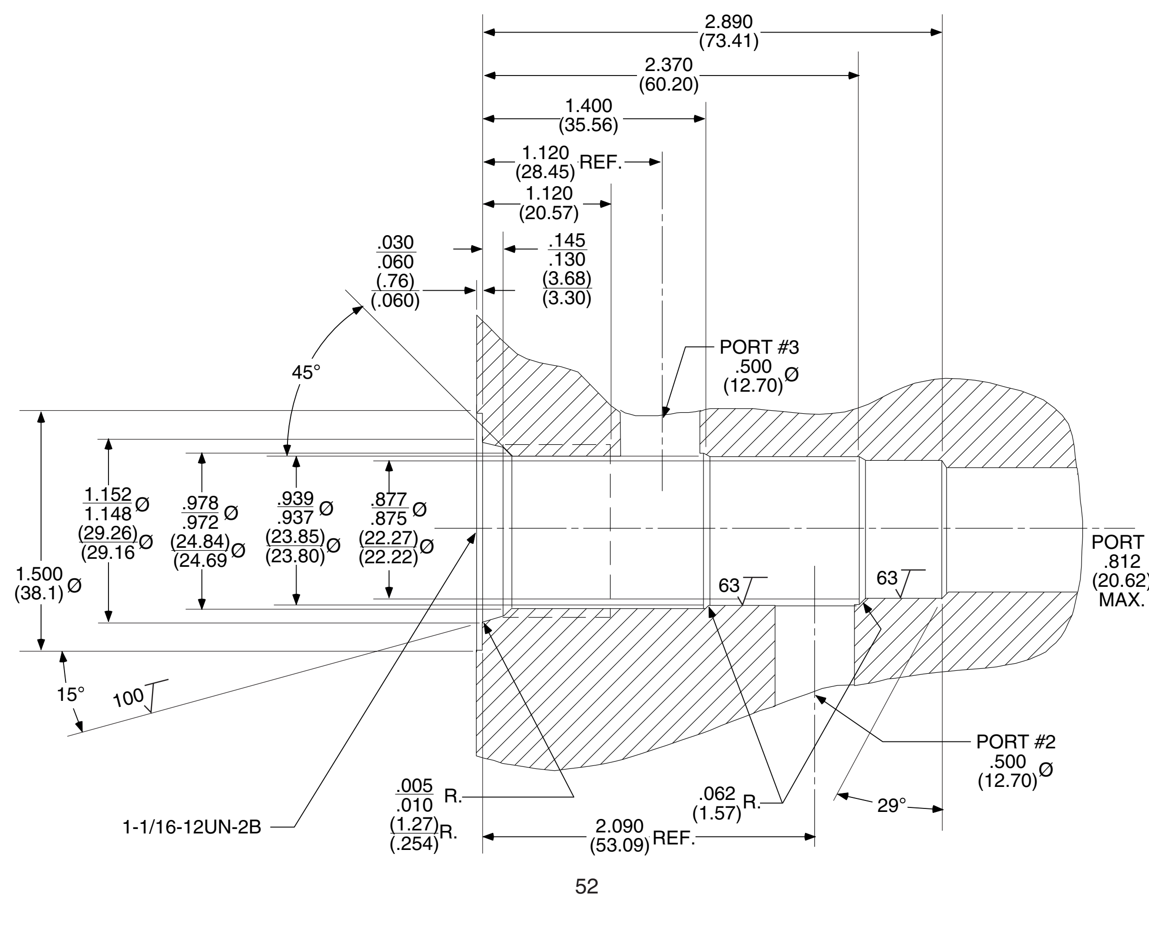


EF12C DIMENSIONS

Dimensions shown in: Inches (millimeters)

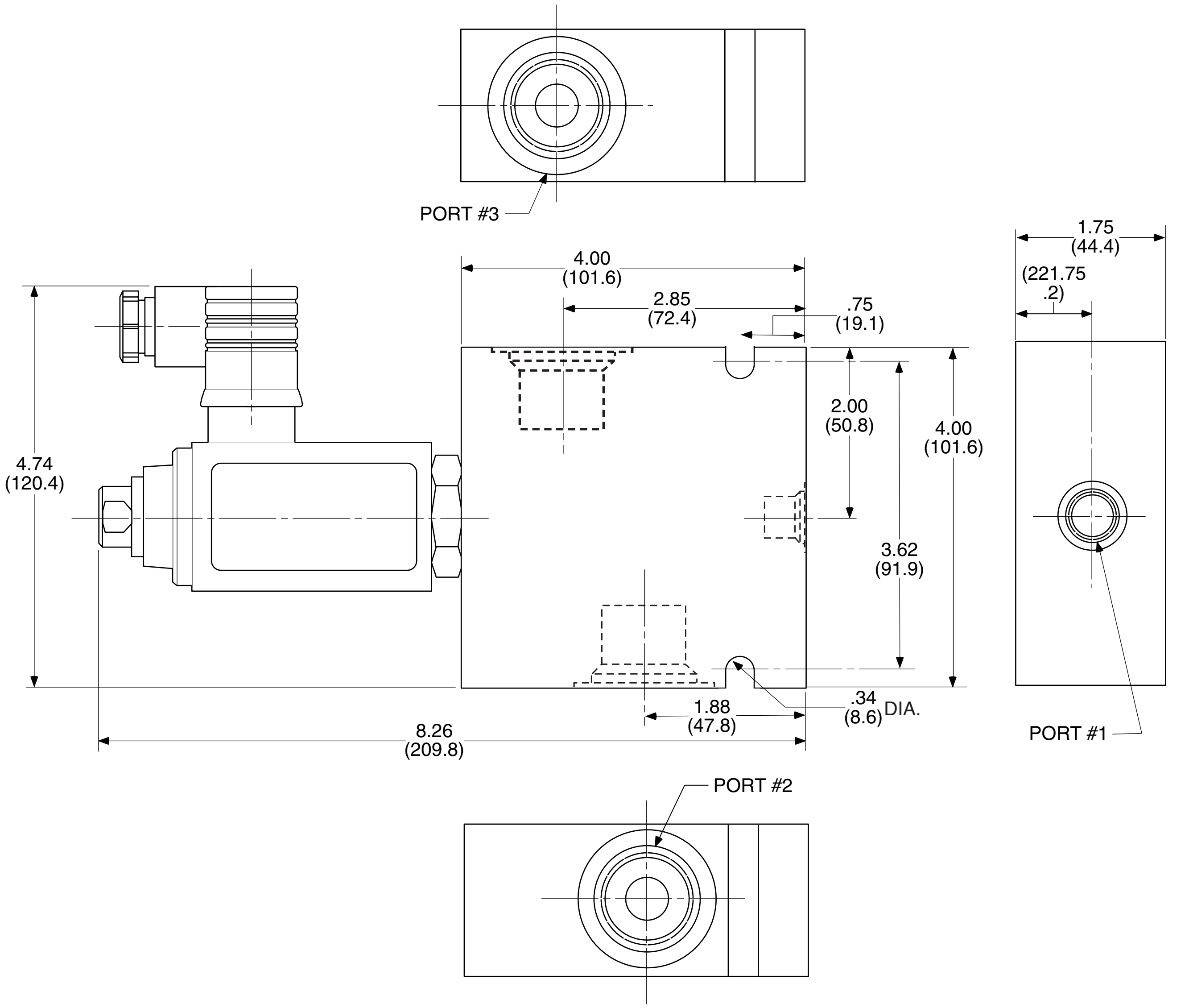


C12-3 CAVITY DIMENSIONS

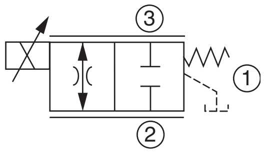


EF12L DIMENSIONS

Dimensions shown in: Inches (millimeters)



EF12C SCHEMATIC



CONTINENTAL HYDRAULICS

ORDERING CODE INFORMATION

EF12 [SELECT ONE] – D [SELECT ONE] – G D [SELECT ONE] – [SELECT ONE] L – B [DESIGN LETTER]

VALVE TYPE

CODE	DESCRIPTION
C	CARTRIDGE ONLY
L	CARTRIDGE WITH LINE MOUNT BODY

FLOW

CODE	DESCRIPTION
40	40 LITERS 10.5 GPM
60	60 LITERS 15.8 GPM

PORT SIZE

CODE	DESCRIPTION
OMIT	CARTRIDGE ONLY
12	SAE-12 PORTS IN BODY SAE-6 DRAIN PORT
75	3/4" NPT PORTS IN BODY 1/4" NPT DRAIN PORT

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

FUNCTION

CODE
DIRECT OPERATED STANDARD

SEALS

CODE
VITON SEALS STANDARD

ELECTRICAL

CODE
DIN 43650 CONNECTOR STANDARD

TYPICAL ORDERING CODE:

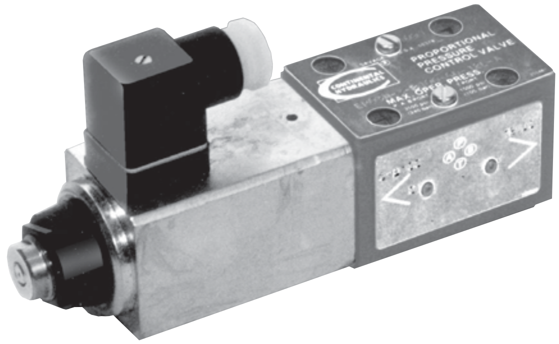
EF12C-D40-GD-24L-B

CONTINENTAL HYDRAULICS

EP03M-3

Pressure Control Valves

PRESSURE REDUCING/RELIEVING, SUBPLATE MOUNTED



DESCRIPTION

These proportional valves are direct operated pressure reducing valves. They can be used to control pressure in parts of a circuit. This valve incorporates a pressure control spool with a pressure sensing piston to sense downstream pressure.

The single solenoid version, code B, will allow fluid flow from P port to B port when an electrical signal is applied. If the signal is decreased to zero, P port will be blocked and B port opened to the tank port. The code A version will allow flow from P to A.

The double solenoid version, code C, will allow flow from P to A (or P to B) when the signal is applied to the proper solenoid. A and B ports are used alternately for pressure reduction in the respective port. P and T ports are common.

TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE		NFPA/T3.5.1M R2-2002 (D03) ISO/4401 SIZE 03	
MOUNTING POSITION		Unrestricted (Horizontal preferred)	
MAXIMUM OPERATING PRESSURE	P, A, B Ports T Port	3500 psi 400 psi	241 bar 28 bar
FLUID OPERATING VISCOSITY		80 - 350 SUS (0.3 - 75.5 Cs) Acceptable start-up 4000 SUS (863.0 Cs)	
HYSTERESIS	With Dither	4%	
THRESHOLD	Nominal w/Dither	1%	
REPEATABILITY	With Dither	3%	
VOLTAGE (Nominal)	Code 12 Code 24	12 VDC 24 VDC	
CURRENT (Maximum)	Code 12 Code 24	2.2 Amp 1.1 Amp	
WATTAGE (I^2 R) @ 68° F. (20° C.) (Continuous)	Code 12 Code 24	19 19	
COIL RESISTANCE @ 68° F. (20° C.)	Code 12 Code 24	3.8 Ohms 15.2 Ohms	
INTERNAL LEAKAGE @ 0 VDC	@ 1000 psi (69 bar) ΔP	8 $in.^3$/min. typical (131.1 ml/min.)	
FLUID TEMPERATURE RANGE		Max. 150° F. (65° C.) For safety, over 130° F. (54° C.) is not recommended	
WEIGHT	Code A or B Code C	4.1 lbs. 6.3 lbs.	1.9 kg 2.9 kg

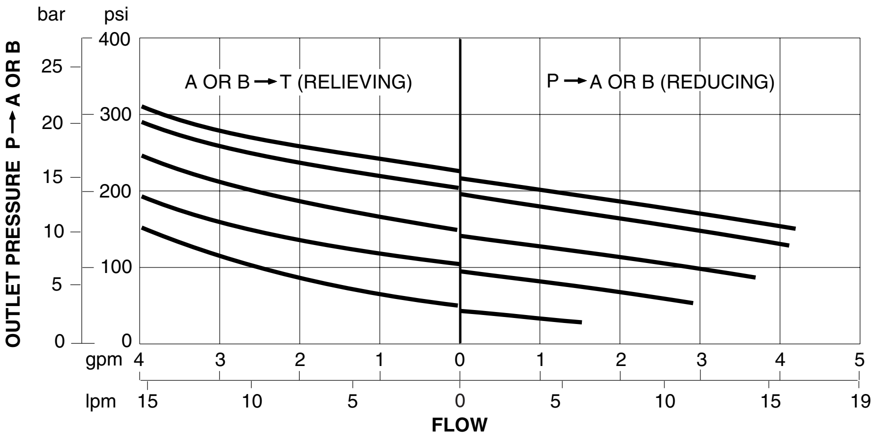
***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), using Continental Hydraulics ECM4 electronic controller.

PRESSURE VS. FLOW CURVES

NOTE: When the secondary pressure exceeds the reduced set pressure, flow reversal will occur and flow will take place from the controlled port to the tank port.

Code 15

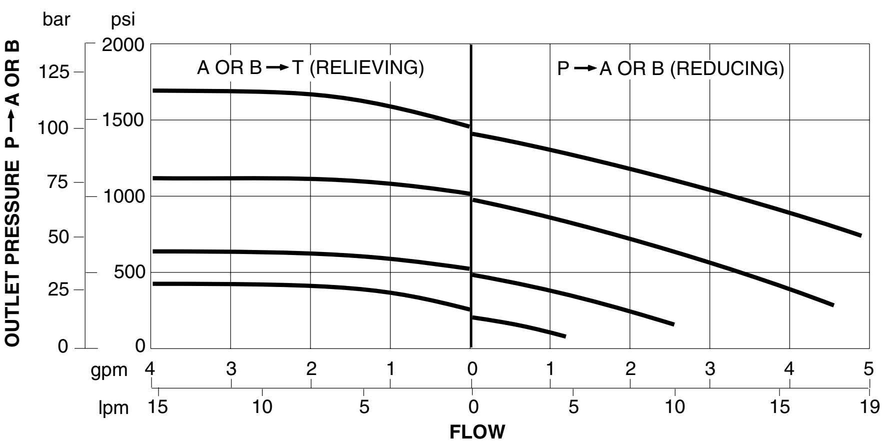
Control Pressure Range - 29 to 217 psi (2 to 15 bar)



Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), system pressure @ 1500 psi (103 bar) using Continental Hydraulics ECM4 electronic controller.

Code 100

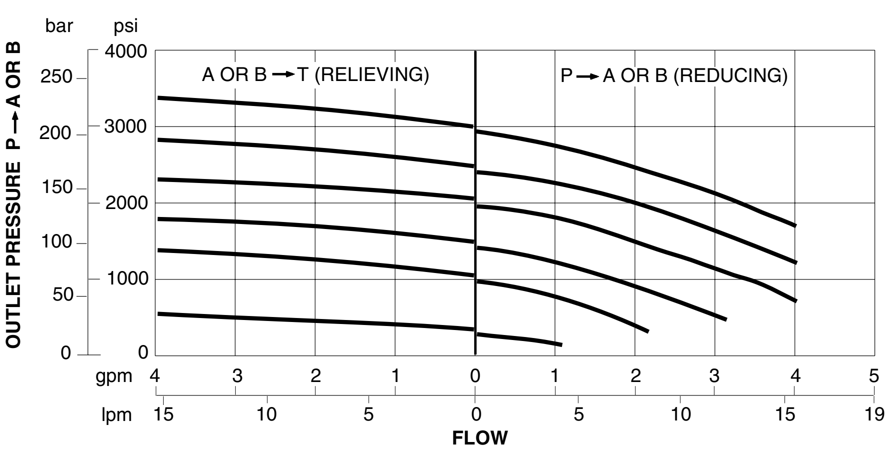
Control Pressure Range - 72 to 1450 psi (5 to 100 bar)



Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), system pressure @ 3000 psi (207 bar) using Continental Hydraulics ECM4 electronic controller.

Code 225

Control Pressure Range - 290 to 3265 psi (20 to 225 bar)

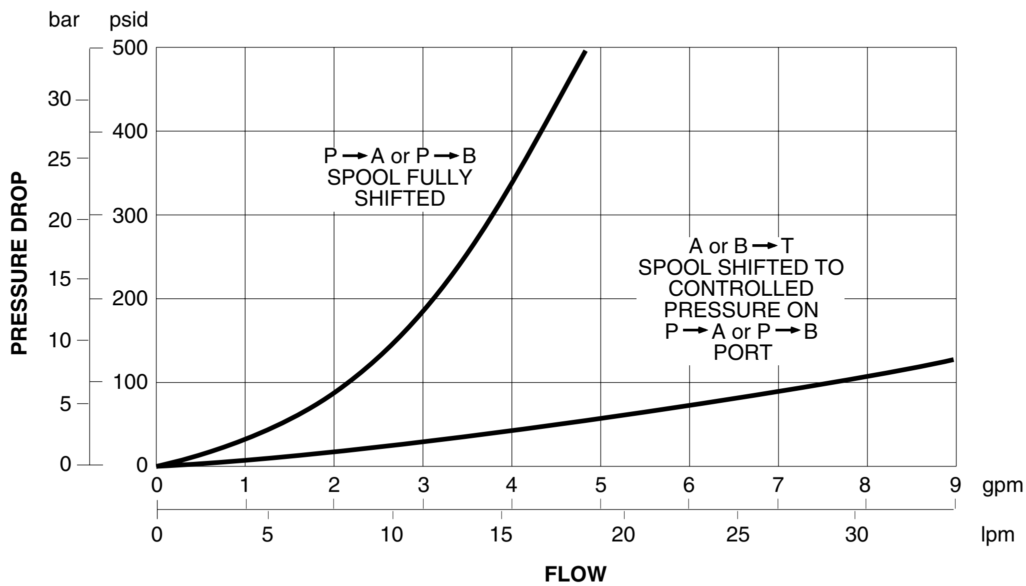


Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), system pressure @ 3300 psi (228 bar) using Continental Hydraulics ECM4 electronic controller.

PRESSURE DROP CURVE

SINGLE OR DOUBLE SOLENOID VALVE

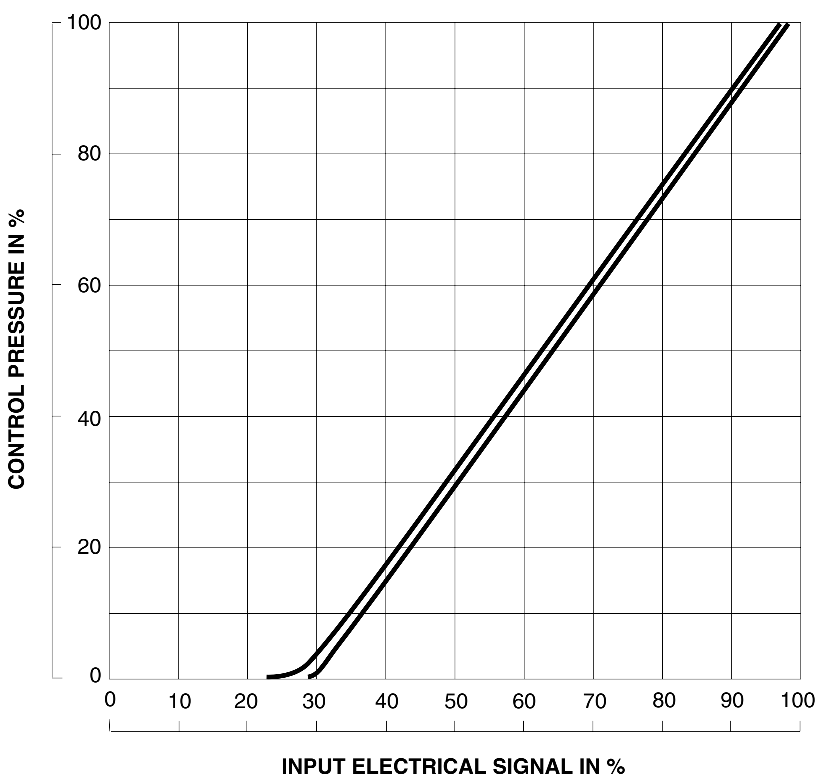
Fluid Viscosity: 100 SUS (20.6 Cs) @ 120° F. (49° C.)



CONTROL PRESSURE VS. INPUT SIGNAL CURVE

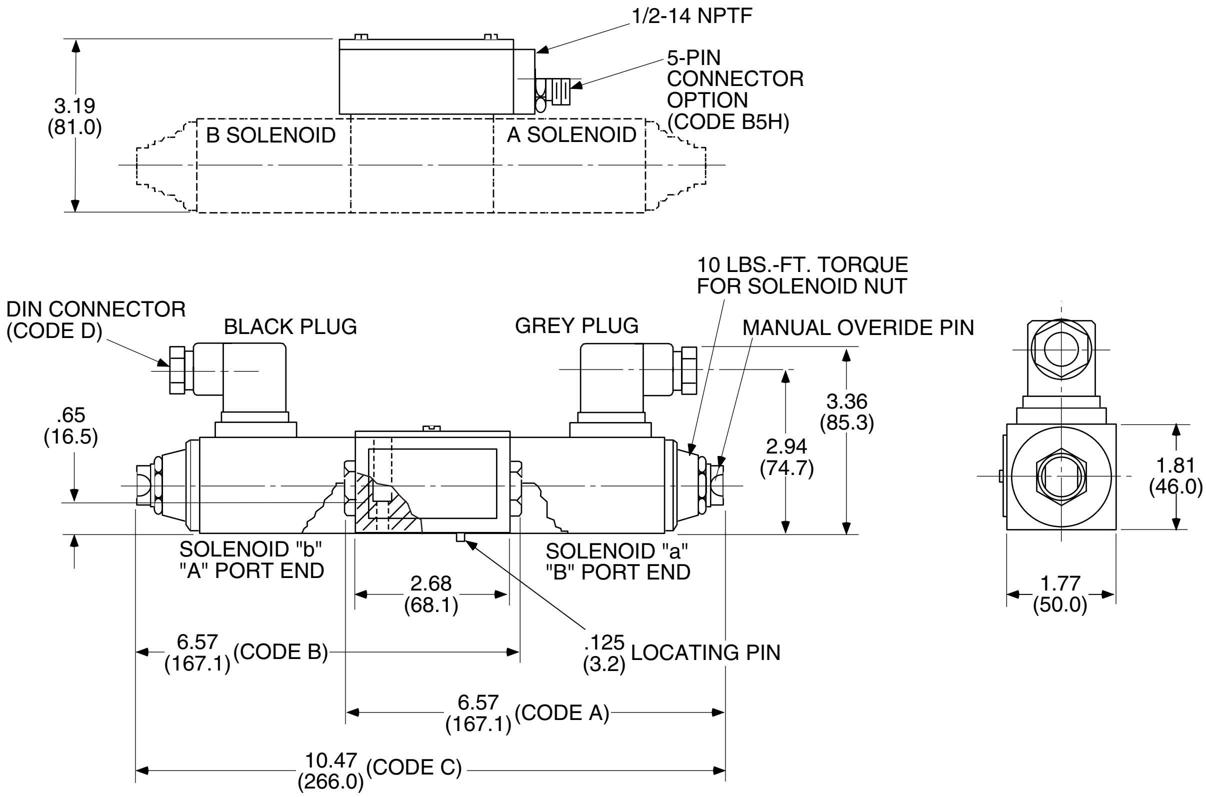
SINGLE OR DOUBLE SOLENOID VALVE

Fluid Viscosity: 100 SUS (20.6 Cs) @ 120° F. (49° C.)



EP03M-3 DIMENSIONS

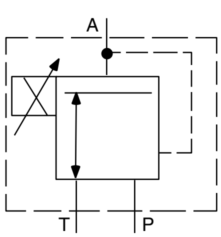
Dimensions shown in: Inches (millimeters)



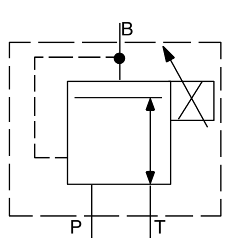
NOTES:
1. Electrical box may be rotated 180° (Codes B, BT, and B5H).
2. 5-pin disconnect meets NFPA recommende standard T3.5.29 R1 - 2003.
3. Two (2) lead wires for each solenoid 6 inches (152.4 mm) long (except Code D) and ground screw are provided by removing the top cover plate.
4. Four (4) mounting bolts are torqued to 10 - 12 lbs.-ft. (13.5 - 16.3 Nm).

EP03M-3 SCHEMATICS

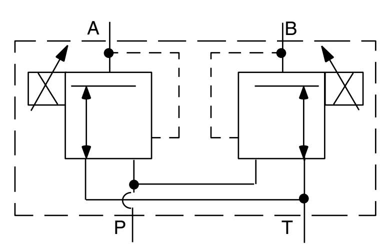
Code A



Code B



Code C



ORDERING CODE INFORMATION

EP03M - 3 - [SELECT ONE: FUNCTION] [SELECT ONE: PRESSURE RANGE] – G (SEALS) [SELECT IF REQ'D: ELECTRICAL OPTIONS] – [SELECT ONE: SOLENOID] L (SOLENOID MFG.) – B (DESIGN LETTER)

FUNCTION

CODE	DESCRIPTION
A	P, A & T PORTS (CONTROL PRESSURE ON “A” PORT) SINGLE SOLENOID
B	P, B & T PORTS (CONTROL PRESSURE ON “B” PORT) SINGLE SOLENOID
C	P to A OR B & T PORTS (CONTROL PRESSURE ON “A” or “B” PORT) DOUBLE SOLENOID

SEALS

CODE
VITON SEALS STANDARD

ELECTRICAL OPTIONS

CODE	DESCRIPTION
D	DIN 43650/ ISO 4400 (FORM A) CONNECTORS
B	LEAD WIRE W/ TOP ELECT. BOX WITHOUT TERMINAL POSTS
BT	LEAD WIRE W/ TOP ELECT. BOX WITH TERMINAL POSTS & GROUND
B5H	LEAD WIRE W/ TOP ELECT. BOX WITH 5-PIN MALE RECEPTACLE, FOR SINGLE OR DOUBLE SOLENOIDS

SOLENOID MFG.

CODE	DESCRIPTION
L	LISK

SOLENOID

CODE	VOLTAGE
12	12 VDC
24	24 VDC

PRESSURE RANGE

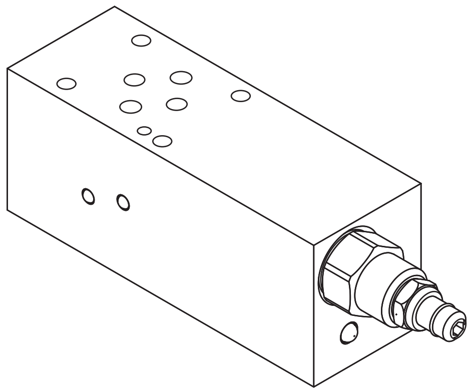
CODE	PRESSURE RANGE	MAXIMUM FLOW
15	2 - 15 bar (29 - 217 psi)	4.0 gpm (15 lpm)
100	5 - 100 bar (72 - 1450 psi)	4.0 gpm (15 lpm)
225	20 - 225 bar (290 - 3265 psi)	3.1 gpm (12 lpm)

TYPICAL ORDERING CODE:

EP03M-3-B15-GD-24L-B

CONTINENTAL HYDRAULICS

VALVES ACCESSORIES



TYPICAL PERFORMANCE SPECIFICATIONS*

MOUNTING SURFACE	NFPA/T3.5.1M R2-2002 (D03) ISO 4401 SIZE 03	
MAXIMUM OPERATING PRESSURE	3500 psi	241 bar
FLOW RATE	10 gpm	37.9 lpm
COMPENSATION PRESSURE ADJUSTMENT RANGE	60- 400 psi	4.1 - 27.6 bar
WEIGHT	1.95 lbs.	.88 kg

***NOTE:** Data taken with fluid temperature at 120°F. (49°C.) and viscosity at 100 SUS (20.6 Cs), using Continental Hydraulics ECM4 electronic controller.

DESCRIPTION

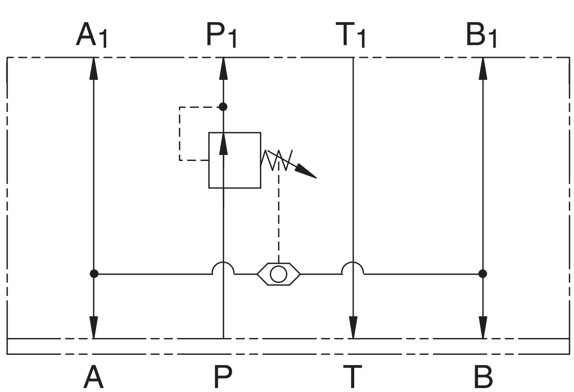
These pressure compensator valves are used to create a consistent pressure differential between the inlet and the outlet of an orifice. The most commonly used in Electro-hydraulic circuits are the **restrictive** and **by-pass** types. Care must be taken when appling these components for they naturally will have inconsistent pressure drops at various flow rates through a given valve. However, they will improve the system performance when widely changing loads are seen. See flow curve charts.

Continental Hydraulics offers adjustable pressure compensators to help match the valve to a circuit. To adjust this valve, it is recommended that the proportional valve be shifted to approximately 100% shift. Then, adjust the compensator to achieve the desired flow.

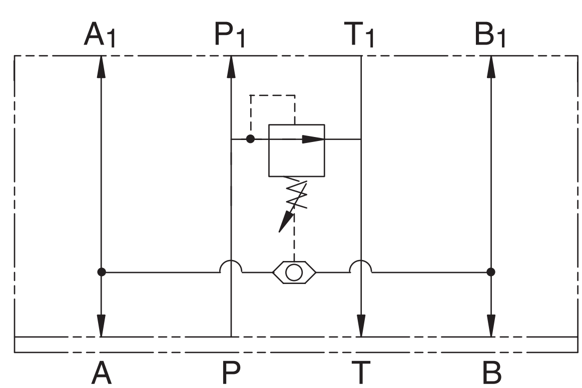
PLEASE NOTE: For other mounting sizes, consult the factory for availability.

SCHEMATICS

Restrictive

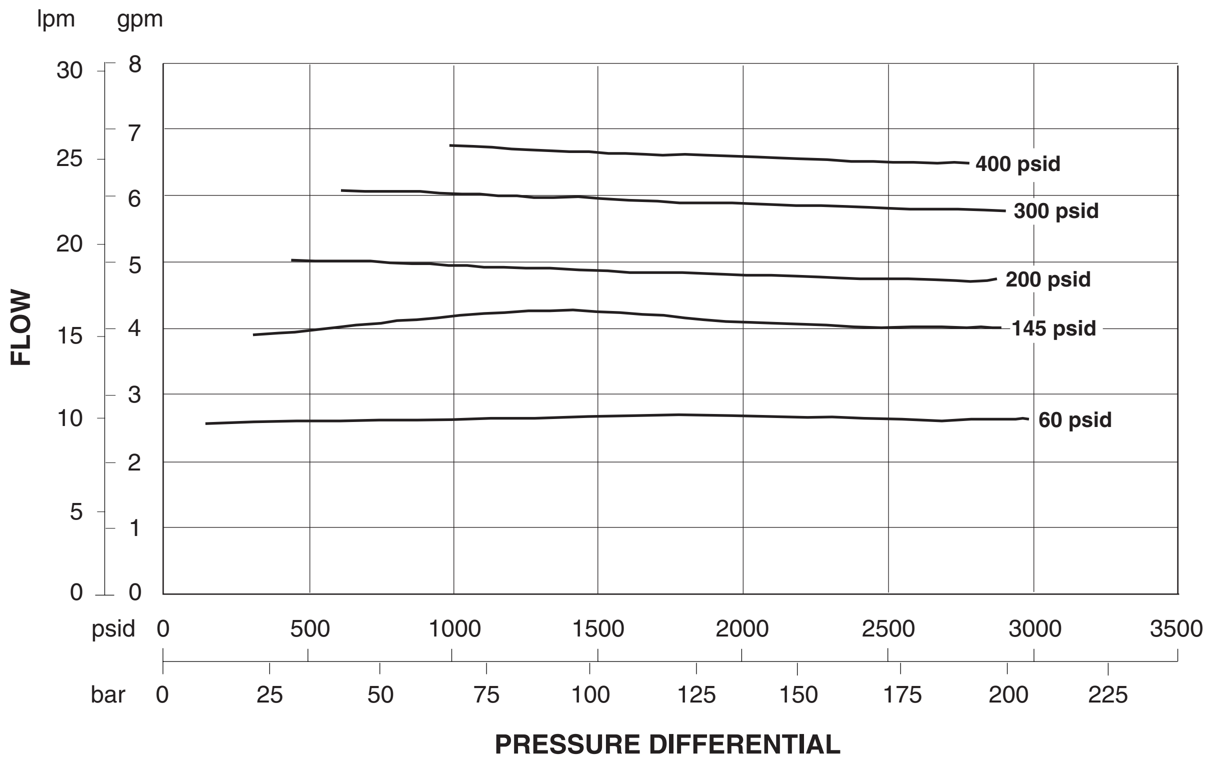


By-Pass



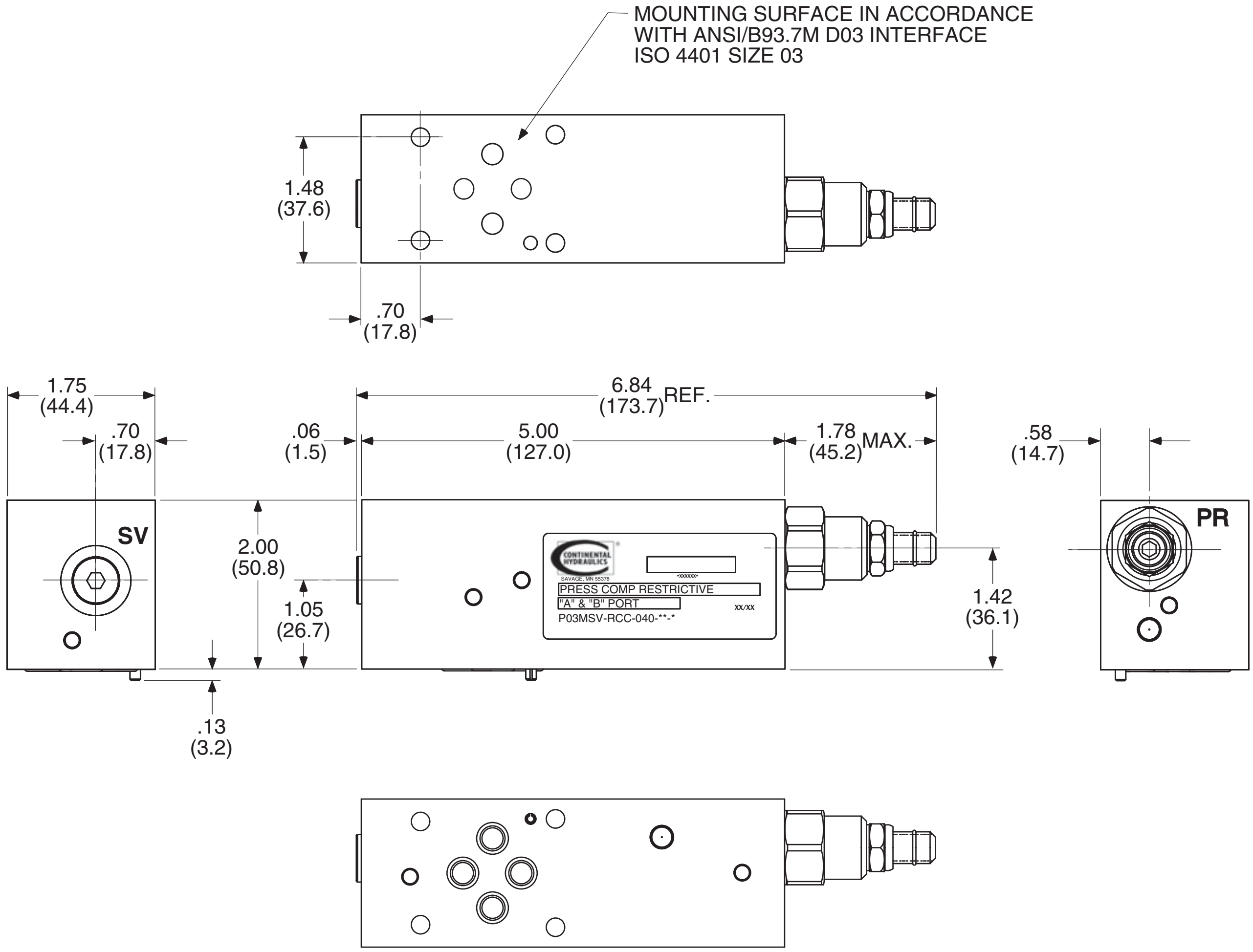
FLOW - PRESSURE DIFFERENTIAL CHARACTERISTICS

Used with VED03M-3AI-15-G-D-24L-A
Proportional Directional Valve at Full Current



PLEASE NOTE: For other mounting sizes, consult the factory for availability.

P03MSV-RCC DIMENSIONS



PLEASE NOTE: For other mounting sizes, consult the factory for availability.

ORDERING CODE INFORMATION

P03MSV - [SELECT ONE] [SELECT ONE] – [SELECT ONE] – [SELECT ONE] A – B (DESIGN LETTER)

FUNCTION

CODE	DESCRIPTION
RC	PRESSURE COMPENSATOR (RESTRICTIVE)
BC	PRESSURE COMPENSATOR (BY-PASS)

PORT

CODE	PORT
C	A and B

PRESSURE RANGE

CODE	PSI	BAR
040	60 - 400	4.1 - 27.5

SEALS

CODE
BUNA-N SEALS STANDARD

BODY MATERIAL

CODE	MATERIAL
A	ALUMINUM

PLEASE NOTE: For other mounting sizes, consult the factory for availability.

TYPICAL ORDERING CODE:

P03MSV-RCC-040-AA-B

ELECTRONIC CONTROL BOARDS

AVAILABLE IN SHADED AREAS ONLY

VALVE MODEL	ECMP-L1	ECM4-L1 (Single Solenoid Only)	ECM4-L2	ECM4-L4	ECM4-R2	ECM5-L2	ECM5-R2
VED03M w/o OB 1 or 2 SOLENOIDS	shaded	shaded	shaded	shaded	shaded	shaded	shaded
VED03M w/ OB 1 or 2 SOLENOIDS							
ED05M w/o LVDT 1 or 2 SOLENOIDS	shaded	shaded	shaded	shaded	shaded	shaded	shaded
ED05M w/3 WIRE LVDT 1 or 2 SOLENOIDS				shaded			
ED08M w/o LVDT 1 or 2 SOLENOIDS	shaded	shaded	shaded	shaded	shaded	shaded	shaded
ED08M w/3 WIRE LVDT 1 or 2 SOLENOIDS				shaded			
EF10C, EF12C	shaded	shaded	shaded	shaded	shaded	shaded	shaded
EP03M-3	shaded	shaded	shaded	shaded	shaded	shaded	shaded

ECMP-L1

Power Plug

PROPORTIONAL DIRECTIONAL CONTROL VALVE OPTION

GENERAL SPECIFICATIONS

SUPPLY VOLTAGE		11.5 VDC Min. 32.0 VDC Max.
SUPPLY CURRENT		45 mA Max. (No Load)
INPUT CONTROL SIGNAL	Voltage	0 - 10 VDC (500 k ohms)
	Current	0 - 20 mA (100 W ohms shunt resistor)
	Regulation ΔV	± 0.2% / V
	Regulation ΔT	± 0.1% / C°
	Ramp Time (Up/Down)	0.1 - 20 sec. Linear (± 0.1% / C°)
	PWM Frequency	95 - 225 Hz
	Output Leap to I Min.	@ 0.2 V or 0.4 mA (±15%)
TEMPERATURE RANGE		-13° F. to 185° F. -25° C. to 85° C.
OUTPUT CURRENT @ 25° C. (77° F.)	Continuous	3.0 A Max.
	Peak Pulsed (16 ms)	17.0 A Max.
	I Minimum (± 20%)	0 - 1.0 A Max.
	I Maximum (± 20%)	I Min. + 2.0 mA Max.

GENERAL DESCRIPTION

The Electronic Power Plug is a compact electronic circuit built into an environment-resistant miniaturized enclosure. The circuit features control of proportional solenoids and operators. Functions include minimum and maximum current limiting, control signals from 0 - 10 V or 0 - 20mA (with a step function at 0.2 volts or 0.4mA included for minimum current), a 0.10 - 20 second linear ramp up/ramp down adjustment and output current proportional to input command signal.

This unit incorporates the Form "A" DIN 43650/ISO 4400 connector male and female interface. The unit is mounted by use of a single mounting screw, DIN connector and two gaskets. Built to meet NEMA 4 environment standards, the Power Plug is made from engineered polymers for resistance to harsh chemicals and ingress of water or foreign substances. Adjustments are made on the top surface of the unit.

FUNCTION

Minimum Current and Maximum Current - These two adjustments will vary the minimum and maximum output current limits. The minimum current can be set between 0 -1.0 A for 3.0 A version. The maximum current can be set in the range between the minimum current setting and the minimum current setting plus 2.0 A. The minimum current must be set first as described below.

Minimum Current Adjustment - Set both minimum and maximum current controls maximum counterclockwise. Apply an input command signal of approximaiely 0.5 volts or 1.0 mA. Adjust the minimum current control for a minimum current or to a desired system response. Back up adjustment until system stops responding. Proceed to maximum current control.

Maximum Current Adjustment - Increase the input command signal to 10 volts or 20 mA. Adjust maximum current control for a maximum current limit or to a desired system response.

Note: To minimize any effect of supply voltage, load resistance or temperature variation, make setup adjustments when these parameters are at the midpoint of the expected operating range for a particlular installation. For example, if the expected operating temperature range is 20º C. to 60º C., make final setup adjustments when system is approximately 40º C. If the supply voltage has a tolerance of 22 to 32 volts, make adjustments when the supply voltage is approximately 27 VDC.

Ramp Up/Ramp Down - Adjust to desired ramp up/ramp down time (0.10 - 20 seconds). Ramp time is linear and is proportional to the step change in the control signal. For example,

0.2 - 10 VDC change in control signal gives maximum ramp of 20 seconds.

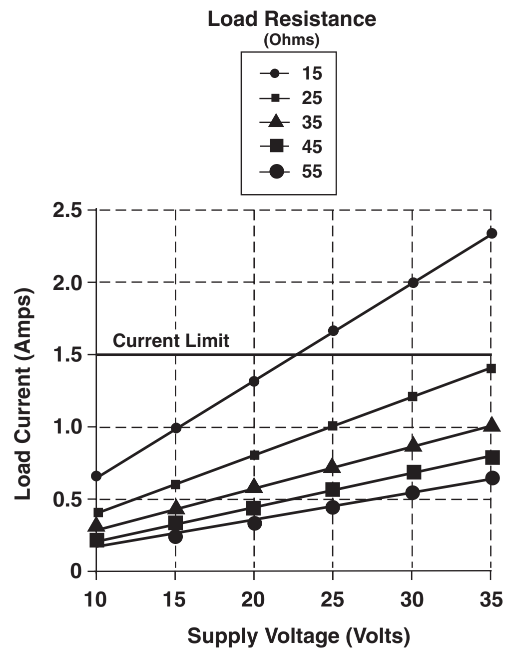
0.2 - 5 VDC change in control signal gives maximum ramp of 10 seconds.

PWM Frequency - The output is pulse-width modulated to control output current within the minimum and maximum current settings. The frequency of the modulation is continuously adjustable from 95 - 225 Hz (Standard. Other ranges available).

Output - The output is current regulated and will remain constant (within the limits specified under Technical Data on page 1) at the level set by the input command signal. Variations in supply voltage and load resistance have little effect as long as these values satisfy the equality stated above.

$$\text{Maximum Required Current} \leq \frac{\text{Min. Supply Voltage}}{\text{Max. Load Resistance}}$$

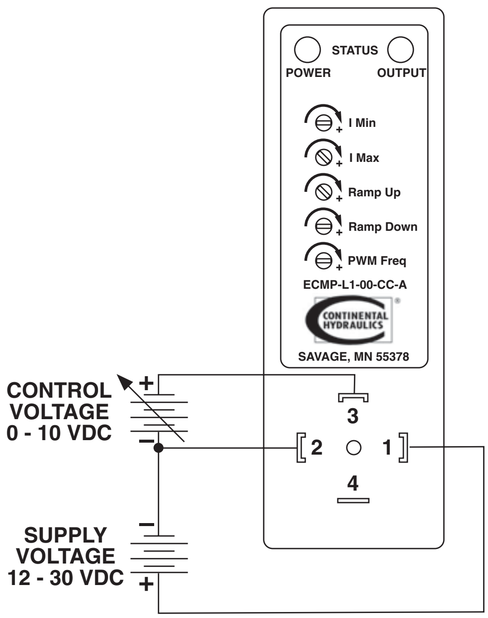
The graph below depicts Load Current vs. Supply Voltage for various load resistances. Use this graph to aid in determining supply voltage requirements versus load current for the resistance of the device being controlled. For example, if the required load current is 1 amp and the load resistance is 25 ohms, then the minimum required supply voltage is 25 volts. Alternately, if the load resistance is only 15 ohms, then the minimum required supply voltage is 15 volts. The load resistance line must fall within the area below the maximum required load current and to the left of the minimum supply voltage. In determining maximum resistance, changes due to temperature must be taken into consideration. The Power Plug will limit the output current to the 3.0 amp design limit.



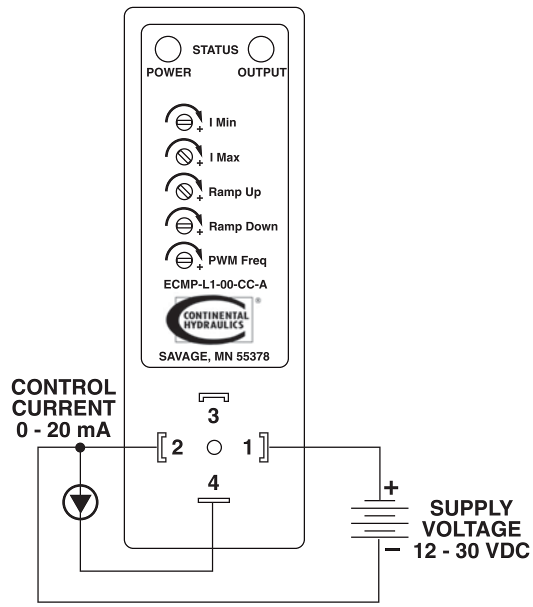
CONTINENTAL HYDRAULICS

ECMP-L1
Power Plug
PROPORTIONAL DIRECTIONAL CONTROL VALVE OPTION

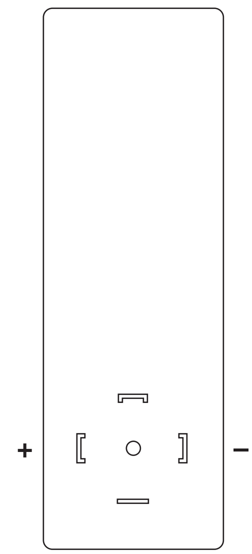
POWER PLUG CONNECTION DIAGRAMS



Voltage Control



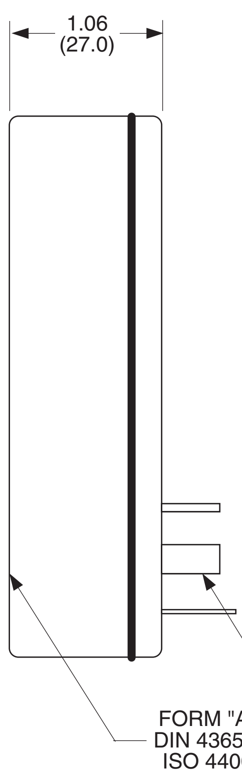
Current Control

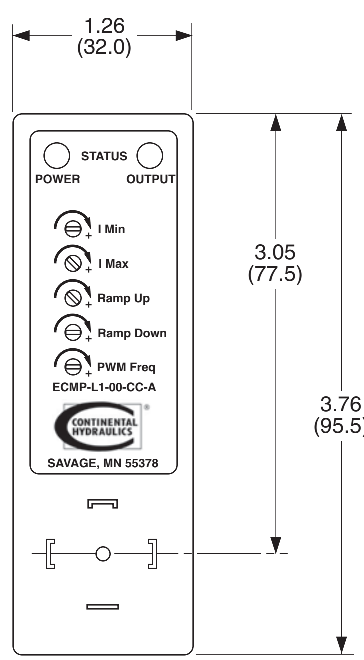


Bottom View

POWER PLUG DIMENSIONS

Dimensions shown in: Inches (millimeters)





ECMP-L1

Power Plug

PROPORTIONAL DIRECTIONAL CONTROL VALVE OPTION

CONTINENTAL HYDRAULICS

ORDERING CODE INFORMATION

DESIGN LETTER

ECMP - L1 - 0 0 – CC – A

OPTIONS

CODE	DESCRIPTION
0	NO CORD SET

MOUNTING

CODE	DESCRIPTION
0	CONTROL VOLTAGE AND CURRENT INPUT (NO REFERENCE VOLTAGE OUTPUT)

TYPICAL ORDERING CODE:

ECMP-L1-00-CC-A

ECM4-L1

Electronic Control Boards

LINEAR AMPLIFIER - SINGLE SOLENOID

GENERAL DESCRIPTION

The ECM4-L2 amplifier is a single channel amplifier for use in any system with a DC power supply. It is designed to be used with Continental Hydraulics' single or double solenoid proportional valves: EF10C, EF12C, VED03M, EP03M-3, ED05M and ED08M valves. The ECM4-L1 board is designed for applications where the LVDT spool feedback option is not required.

Coil temperature changes will not affect output current to the valve because it is a current control device. Also, it is current limited and protected against short circuits. An adjustable dither improves valve characteristics over the full range of the pulse width modulation (PWM) output.

This unit features a built-in DC to DC converter to provide reference voltages from DC input power ranging from 10 to 30 volts. A limited amount of regulated DC is available to power sensors and command controls.

The ECM4-L1 amplifier is packaged in a 3.94 inch (100.0 mm) by 4.6 inch (116.8 mm) printed circuit board. All connections are made through a terminal plug at one end. The board is designed to mount with stand-offs on a panel or in a single EURO card cage. All adjustments, operating lights and test points are located on the primary board.

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within three (3) feet (91.4 cm) of an exposed amplifier board. If outer loop feedback is used, consult the feedback device supplier for possible RF interference.

ADJUSTMENTS

NULL This adjustment is used to reduce or eliminate deadband. LEDs will indicate when the solenoid is being energized.

GAIN This adjustment is used to set maximum valve current when command is at maximum. This will result in full command resolution from off to maximum valve output.

RAMP This adjustment will vary the rate of increasing or decreasing the command signal. This will control acceleration and deceleration of the actuator.

CMD On-board command potentiometer for use during set-up.

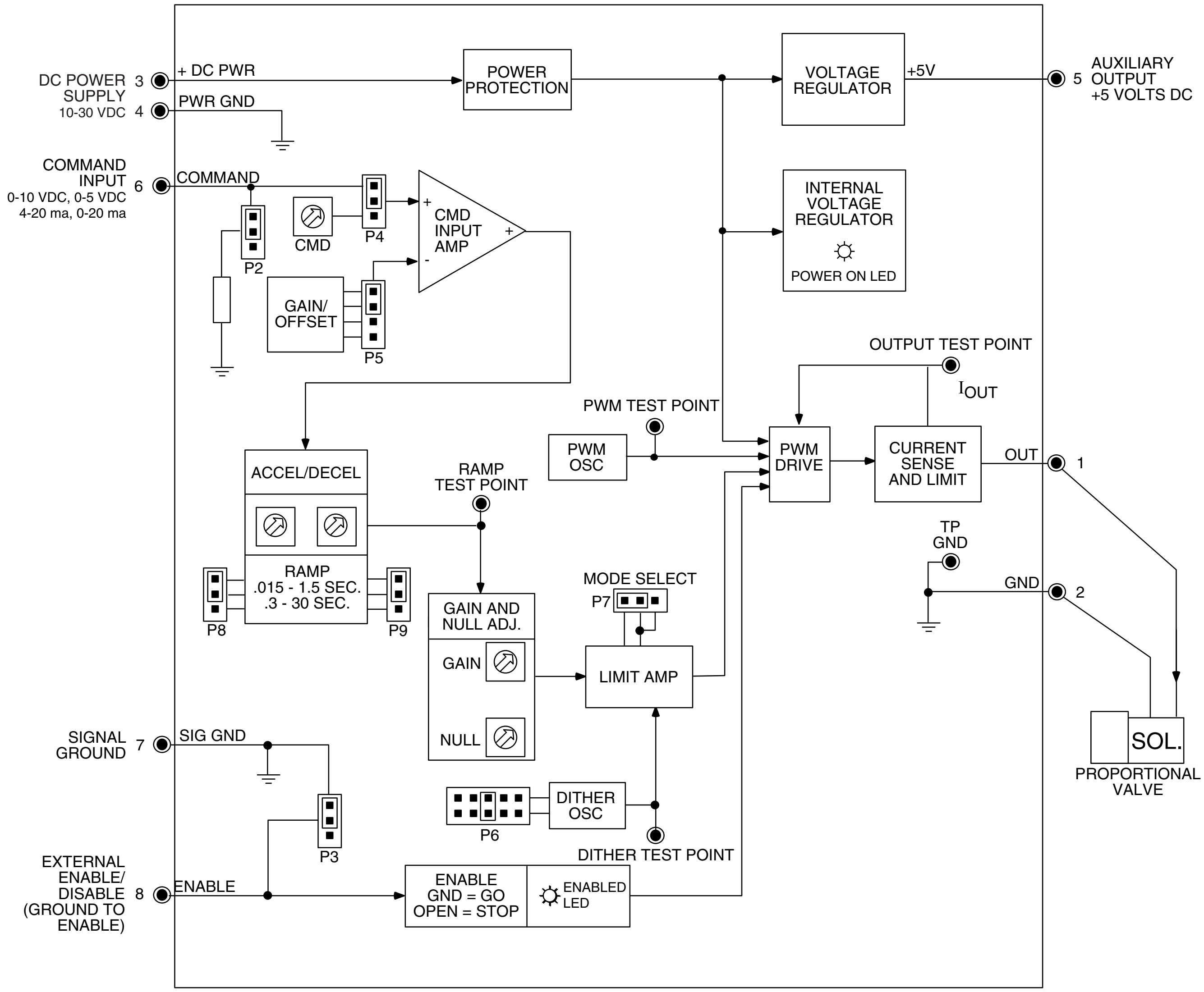
GENERAL SPECIFICATIONS

INPUT POWER	Voltage	10 to 30 VDC
	Current	3.1 Amp @ 12 VDC 1.6 Amp @ 24 VDC
	Power	41 Watts
	Overload Protection	Reverse Supply Protection Voltage Spike Protection
INPUT COMMAND	Type	Analog
	Voltage Analog DC	0 - 10 Volts, 0 - 5 Volts 4 - 20 mA, 0 - 20 mA
	Input Resistance	100 K nominal
TEMPERATURE RANGE		-40° F. to 176° F. -40° C. to 80° C.
AUXILIARY OUTPUT		5 Volts DC up to 100 mA
MOUNTING		Panel

CONTROL SPECIFICATIONS

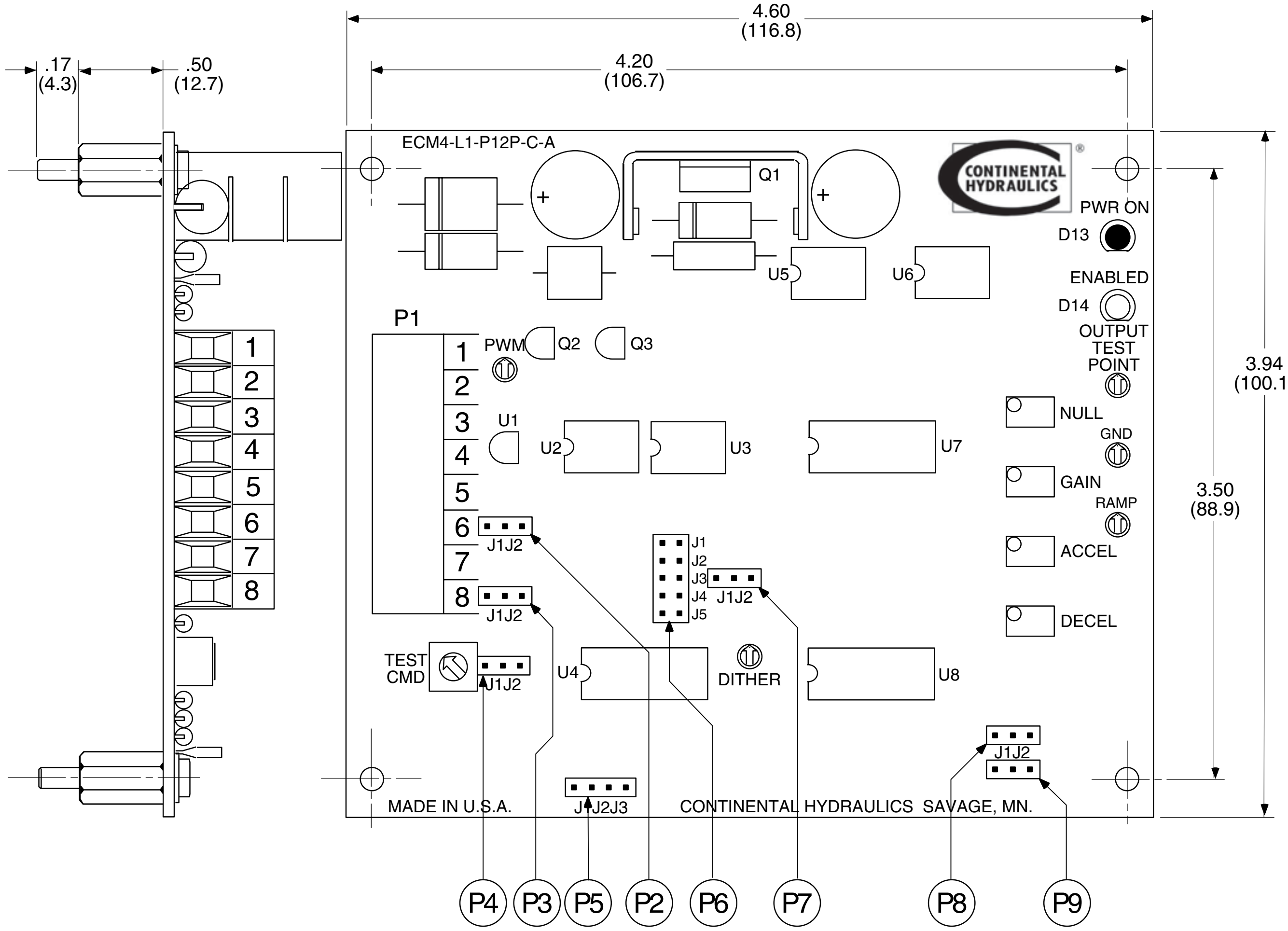
		STANDARD	ON-BOARD OPTION
OUTPUT POWER	Voltage	24 VDC	12 VDC
	Current	1.5 Amps Max.	3.0 Amps Max.
OUTPUT CONTROL	PWM Frequency	1400 Hz. Nominal	
	Dither	120 HZ.	60 - 360 Hz. 30 Hz. Steps
	Accel/Decel	.015 - 1.5 sec.	.30 - 30 sec.
	Command Offset	± 2 VDC	±10 VDC/None
	Enable	Jumper Selected	
	Disable		Jumper Selected
	Channels	Single	

FUNCTIONAL SCHEMATIC



ECM4-L1 DIMENSIONS

Dimensions shown in: Inches (millimeters)



TYPICAL ORDERING CODES:

ECM4-L1-P12P-C-A

CONTINENTAL HYDRAULICS

GENERAL DESCRIPTION

The ECM4-L2 amplifier is a dual channel amplifier for use in any system with a DC power supply. It is designed to be used with Continental Hydraulics' single or double solenoid proportional valves: ED03M, EP03M, ED05M and ED08M. The ECM4-L2 board is designed for applications where the LVDT spool feedback option is not required.

Coil temperature changes will not affect output current to the valve because it is a current control device. Also, it is current limited and protected against short circuits. Coil return wires may be separate or combined. A pre-set dither improves valve characteristics over the full range of pulse width modulation (PWM) output. This holds power loss to a minimum.

This unit features a built-in DC to DC converter to provide reference voltages from DC input power ranging from 10 to 30 volts. A limited amount of regulated DC is available to power sensors and command controls.

The ECM4-L2 amplifier is packaged in a 4 x 6.3-inch (100 x 160 mm) printed circuit board. All connections are made through a terminal plug at one end. The boards come in two forms.

Code "P" mounts with stand-offs on a panel. All adjustments, operating lights and test points are located on the primary board. This board may also be mounted in a single EURO card cage.

Code "E" mounts into a single EURO card cage. All adjustments, operating lights and test points are located on a face panel so that the board does not require removal from the cage for set-up adjustments.

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within three (3) feet (91.4 cm) of an exposed amplifier board. If outer loop feedback is used, consult the feedback device supplier for possible RF interference.

GENERAL SPECIFICATIONS

INPUT POWER	Voltage	10 to 30 VDC
	Current	3.4 Amp @ 12 VDC 1.7 Amp @ 24 VDC
	Power	41 Watts
	Overload Protection	Reverse Supply Protection Voltage Spike Protection
INPUT COMMAND	Type	Analog
	Voltage Analog DC	±10V, ±5V, 0 - +10V, -10V - 0 4 - 20 mA
	Input Resistance	100 K nominal
TEMPERATURE RANGE		-40° F. to 176° F. -40° C. to 80° C.
AUXILIARY OUTPUT		± 15 Volts DC @ 50 mA ± 10 Volts DC @ 10 mA
MOUNTING		Panel or Single Euro Card Cage

CONTROL SPECIFICATIONS

		STANDARD	ON-BOARD OPTION
OUTPUT POWER	Voltage	24 VDC	12 VDC
	Current	2.0 Amps Max.	3.0 Amps Max.
OUTPUT CONTROL	PWM Frequency	1400 Hz. Nominal	
	Dither	120 HZ.	0, 60, 180 Hz.
	Accel/Decel	30 - 3000 ms	.30 - 30 sec.
	Command Offset	± 2 VDC	±10 VDC/None
	Enable	Jumper Selected	
	Disable		Jumper Selected
	Channels	Dual	

ADJUSTMENTS

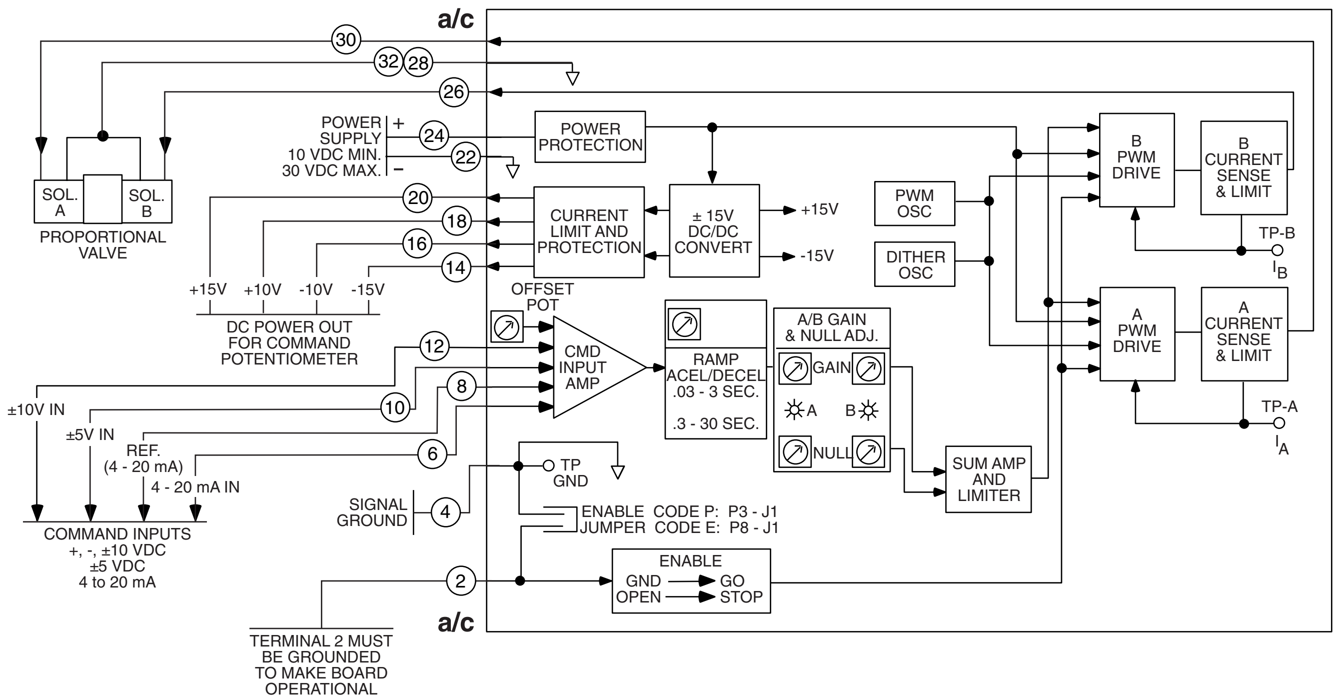
NULL This adjustment, one for each solenoid, is used to reduce or eliminate deadband. LEDs will indicate which solenoid is being energized.

GAIN This adjustment, one for each solenoid, is used to set maximum valve current when command is at maximum. This will result in full command resolution from off to maximum valve output.

RAMP This adjustment will vary the rate of increasing or decreasing the command signal. The controlled acceleration and deceleration for both forward and reverse will be the same for a specific ramp control setting.

OFFSET On-board command potentiometer for use during set-up. It can also be used as a fine center adjustment.

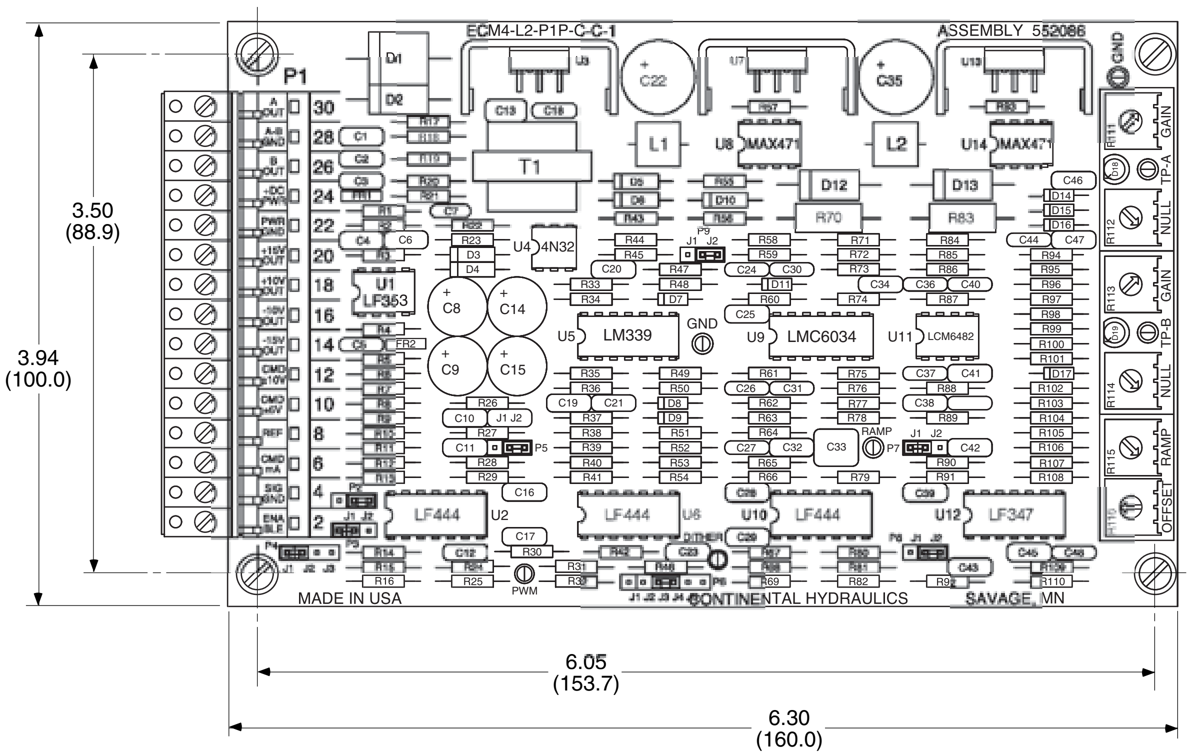
FUNCTIONAL SCHEMATIC



CONTINENTAL HYDRAULICS

ECM4-L2-P1P-C-C DIMENSIONS

Dimensions shown in: Inches (millimeters)

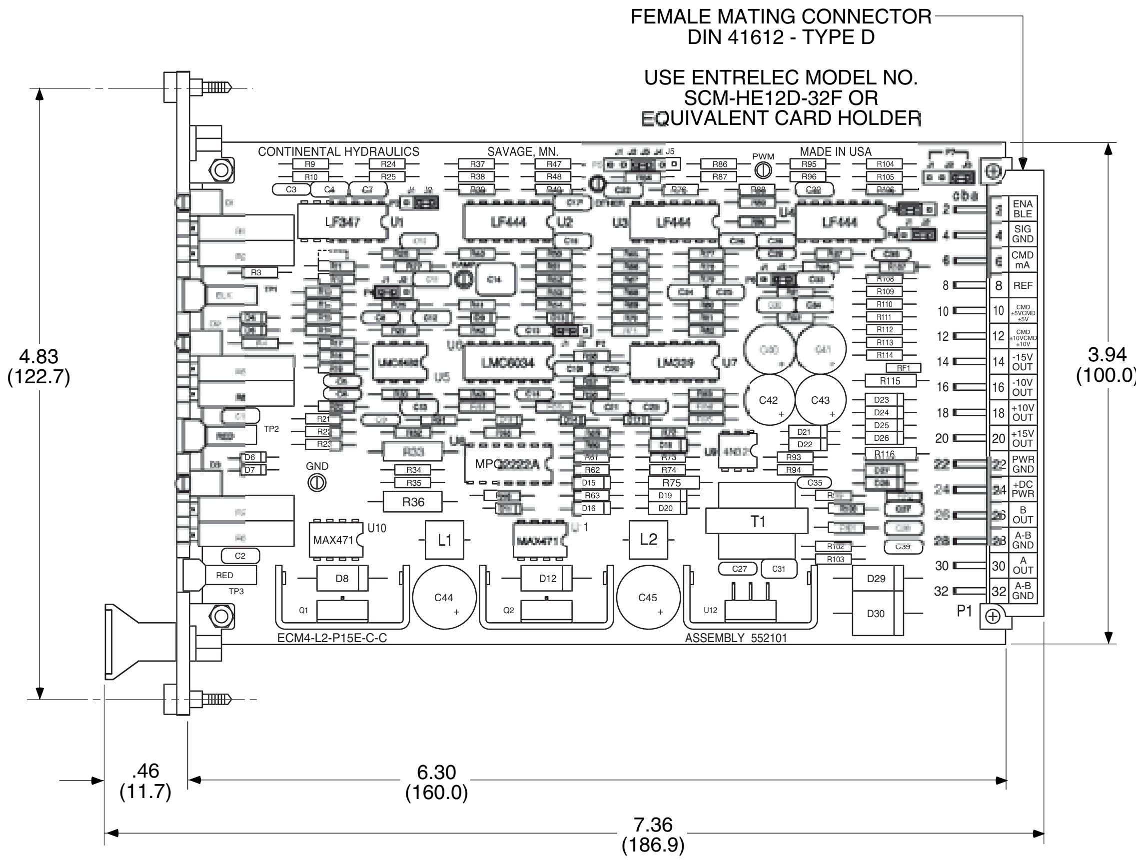


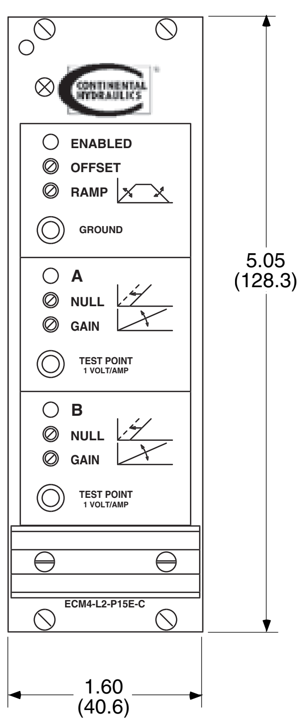
TYPICAL ORDERING CODE:

ECM4-L2-P1P-C-C

ECM4-L2-P15E-C-C DIMENSIONS

Dimensions shown in: Inches (millimeters)





TYPICAL ORDERING CODE:

ECM4-L2-P15E-C-C

ECM4-L4
Electronic Control Boards
LINEAR AMPLIFIER - DOUBLE SOLENOID

CONTINENTAL HYDRAULICS.

GENERAL DESCRIPTION

The ECM4-L4 is a dual channel amplifier for use in any system with a DC power supply that may vary widely. It is designed to be used with Continental Hydraulics' VED03M, EP03M-3, ED05M and ED08M single or double solenoid proportional valves. The valves may or may not include a 3-wire LVDT. Options are: outer loop position, velocity and pressure feedback.

It is a current control device with pulse width modulation (PWM): this means power loss is held to a minimum, even when output voltage varies.

Coil temperature changes will not affect output current to the valve because it is a current control device. Also, it is current limited and protected against short circuits. Coil return wires may be separate or combined. A pre-set dither improves valve characteristics over the full range of PWM output.

Command signals may be ±10 VDC bipolar, 0 to +5 VDC unipolar, or 4-20 ma current. For maximum performance, the amplifier is designed to work with an optional LVDT position feedback sensor.

This unit features a built-in DC to DC converter to provide reference voltages from DC input power ranging from 10 to 30 volts. A limited amount of regulated DC is available to power sensors and command controls.

In normal operation, the output ENABLE is connected to ground. The green OK LED will light. The board can be enabled internally with jumper P2-J1 or externally by grounding terminal P1-18. When the ground connection is broken, both outputs are disabled immediately and the yellow DISABLE LED will light. When the ground connection is returned, the selected output returns to the commanded value. Safety or panic stop designs should always include redundant shut-off controls.

The LVDT spool position feedback uses a 4-20 ma signal. Loss of feedback is sensed if the signal goes below 2 ma or above 25 ma. This will disable outputs and light the red LVDT FAULT LED.

The ECM4 amplifier is packaged in a 9.20 by 6.30 inch (160.0 by 233.0 mm) printed circuit board. All connections are made via a terminal strip at one end. The circuit board may be mounted with standoffs on a panel.

GENERAL SPECIFICATIONS

INPUT POWER	Voltage	10 to 30 VDC	
	Current	3.4 Amp @ 12 VDC 1.7 Amp @ 24 VDC	
	Power	41 Watts	
	Overload Protection	Reverse Supply Protection Voltage Spike Protection	
INPUT COMMAND	Type	Analog	
	Voltage Analog DC	±10V, ±5V, 0 to +10V, 0 to -10V 4 - 20 mA	
	Input Resistance	100 K nominal	
FEEDBACK	Position	4 to 20 mA - LVDT Optional	
OUTPUT POWER	Voltage	12 VDC	24 VDC
	Current	3.0 Amps Max.	2.0 Amps Max.
OUTPUT CONTROL	PWM Frequency	1400 Hz. Nominal	
	Dither	120 HZ	Optional 0, 60, 90, 150,180 Hz.
	Accel/Decel	15 - 1500 ms	.15 - 15 sec.
	Command	Dual	
TEMPERATURE RANGE		-40° F. to 176° F. -40° C. to 80° C.	
AUXILIARY OUTPUT		± 15 Volts DC @ 50 mA ± 10 Volts DC @ 10 mA	
TERMINAL BLOCK		Terminal block - 18 pin, PC Mtd., .20 centers (Phoenix Header #MSTBA 1.5/18-G-5.08)	
		Connector- 18 pin, Right Angle Plug-In (Phoenix Terminal Block #MSTB 1.5/18-ST-5.08)	
MOUNTING		Panel	

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within three (3) feet (91.4 cm) of an exposed amplifier board. If outer loop feedback is used, consult the feedback device supplier for possible RF interference.

ADJUSTMENTS

NULL This adjustment, one for each solenoid, is used to reduce or eliminate deadband. LEDs will indicate which solenoid is being energized.

GAIN This adjustment, one for each solenoid, is used to set maximum valve current when command is at maximum. This will result in full command resolution from off to maximum valve output.

RAMP ACCEL. Limits the acceleration rate at which the valve opens in either direction.

RAMP DECEL. Limits the deceleration rate at which the valve closes in either direction.

RAMP RATE Each ramp control adjusts over a range of .015 to 1.5 seconds for 0 to 100% step input. Optional range is .15 to 15 seconds.

LVDT CENTER This adjustment is used to center the LVDT output to a mechanically centered spool. This adjustment must be made with the solenoid wire disconnected from the valve.

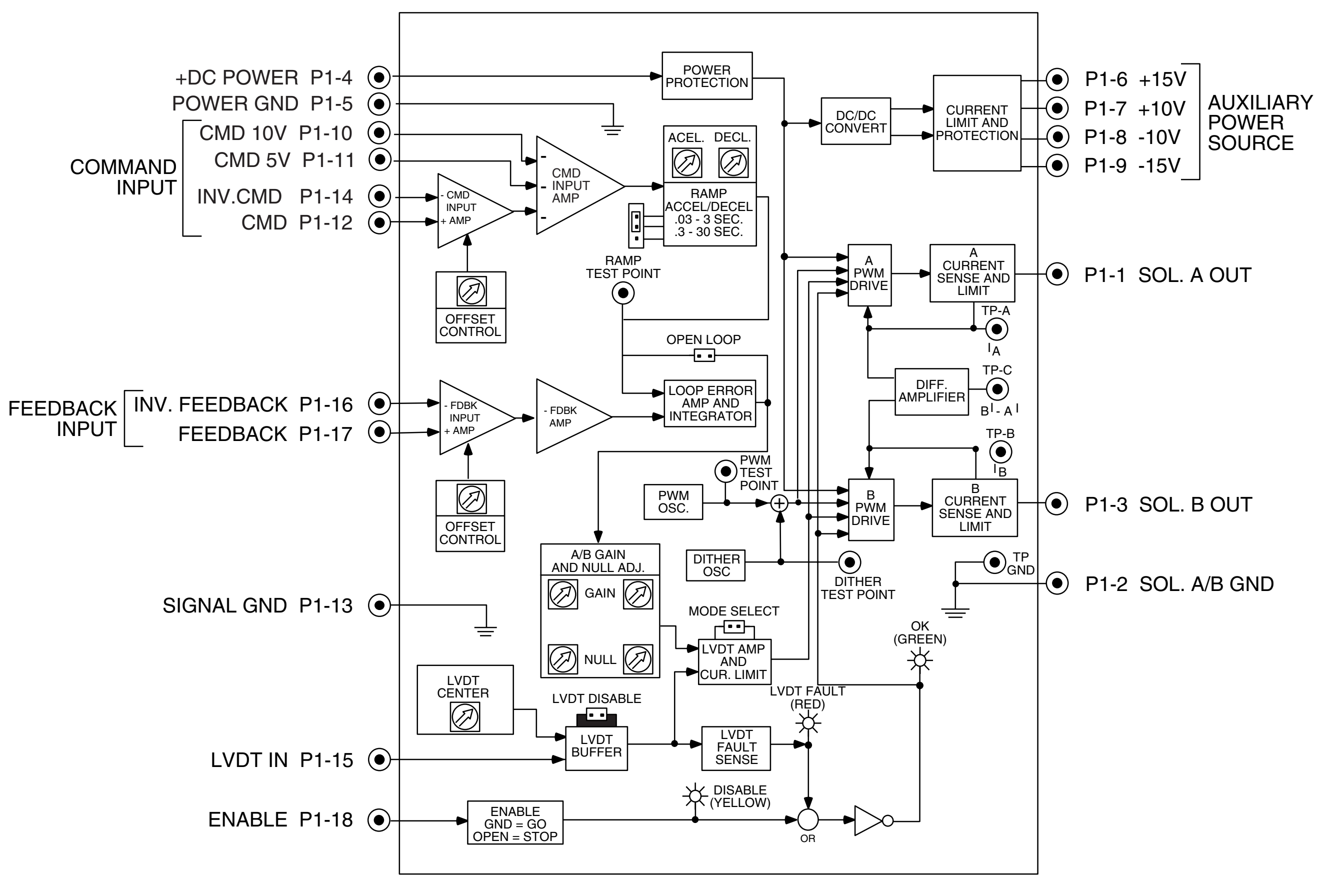
COMMAND OFFSET This adjustment is used to compensate for offsets in the command signal. This control may also be used to generate commands for setup or troubleshooting purposes.

COMMAND OFFSET SENSITIVITY ± 1 Volt. Optional: ±10 Volts.

FEEDBACK OFFSET This adjustment is used to compensate for offsets in the feedback signal.

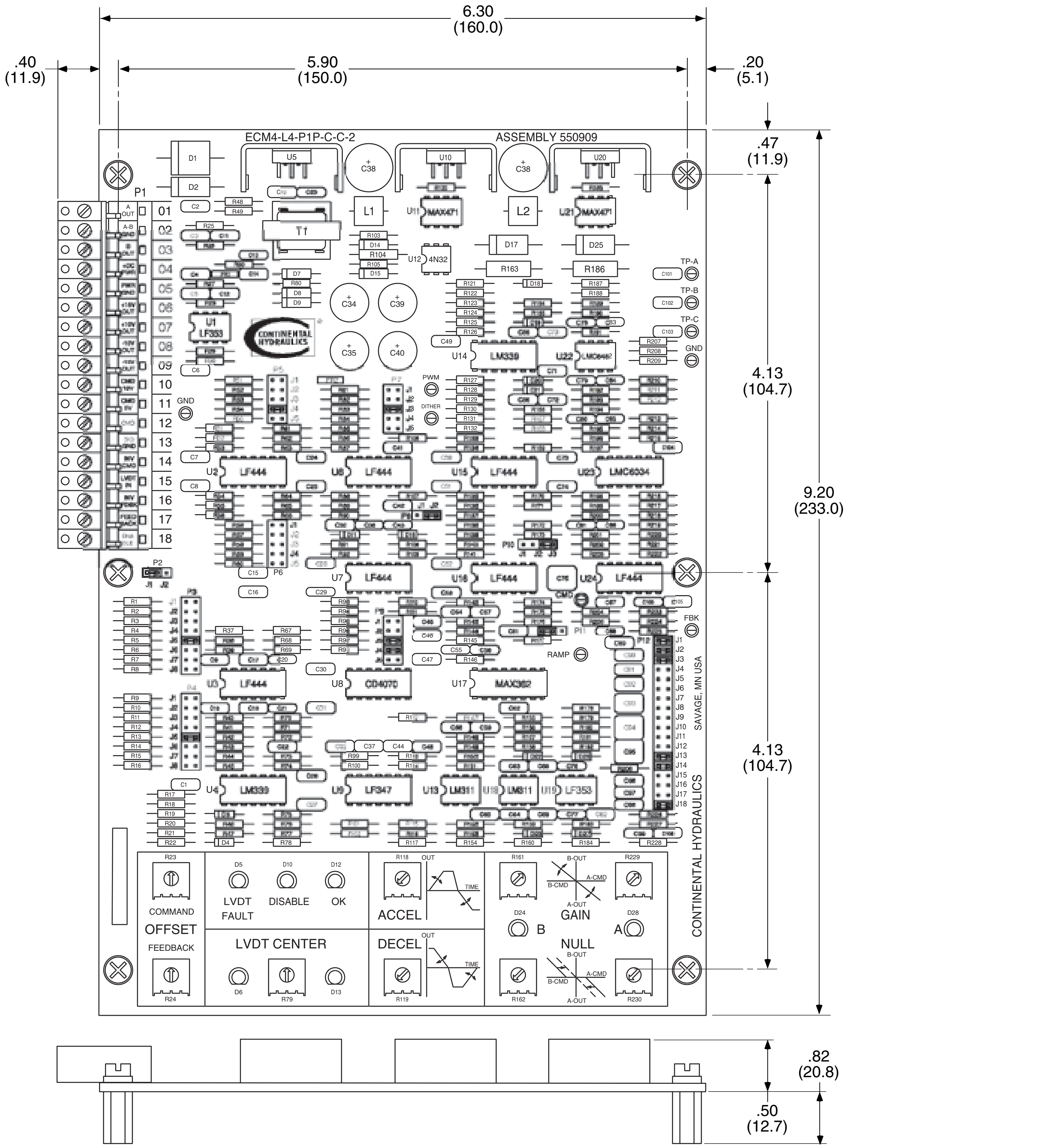
FEEDBACK OFFSET SENSITIVITY ± 1 Volt. Optional: ±10 Volts.

FUNCTIONAL SCHEMATIC



ECM4-L4-P1P-C-C DIMENSIONS

Dimensions shown in: Inches (millimeters)



TYPICAL ORDERING CODE:

ECM4-L4-P1P-C-C

GENERAL DESCRIPTION

The ECM4-R2 amplifier is a dual channel amplifier for use in any system with a 24-volt DC power supply. It provides motion control (time and speed) to Continental Hydraulics' single or double solenoid proportional valves. There are four adjustable (additive) speed settings, two ramp controls (acceleration and deceleration) for each direction of flow, and eight LED's indicating which program input is selected.

To reduce the effects of temperature changes on the valve solenoid, the output current is regulated so it is proportional to the speed setting. The supply voltage is efficiently converted to output current by using pulse width modulation. Maximum current of each output is limited by the gain control setting and is protected against short circuits by internal power management in the output drives.

The ECM4-R2 is packaged in a 3.94 by 6.30 inch (100.0 by 160.0 mm) Euro card printed circuit board. All connections are made via a Form D 32-pin Euro connector at one end. The circuit board may be inserted into a Euro card cage or individual Euro card holder. All displays, test jacks, and adjustments are accessible on the display panel.

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within three (3) feet (91.4 cm) of an exposed amplifier board.

ADJUSTMENTS

GAIN This adjustment, one for each solenoid, is used to set maximum valve current when command is at maximum. This will result in full command resolution from off to maximum valve output.

RAMP ACCEL. Controls the acceleration rate at which the valve opens in either direction. Adjustable from .03 to 30 seconds with three (3) selectable ranges.

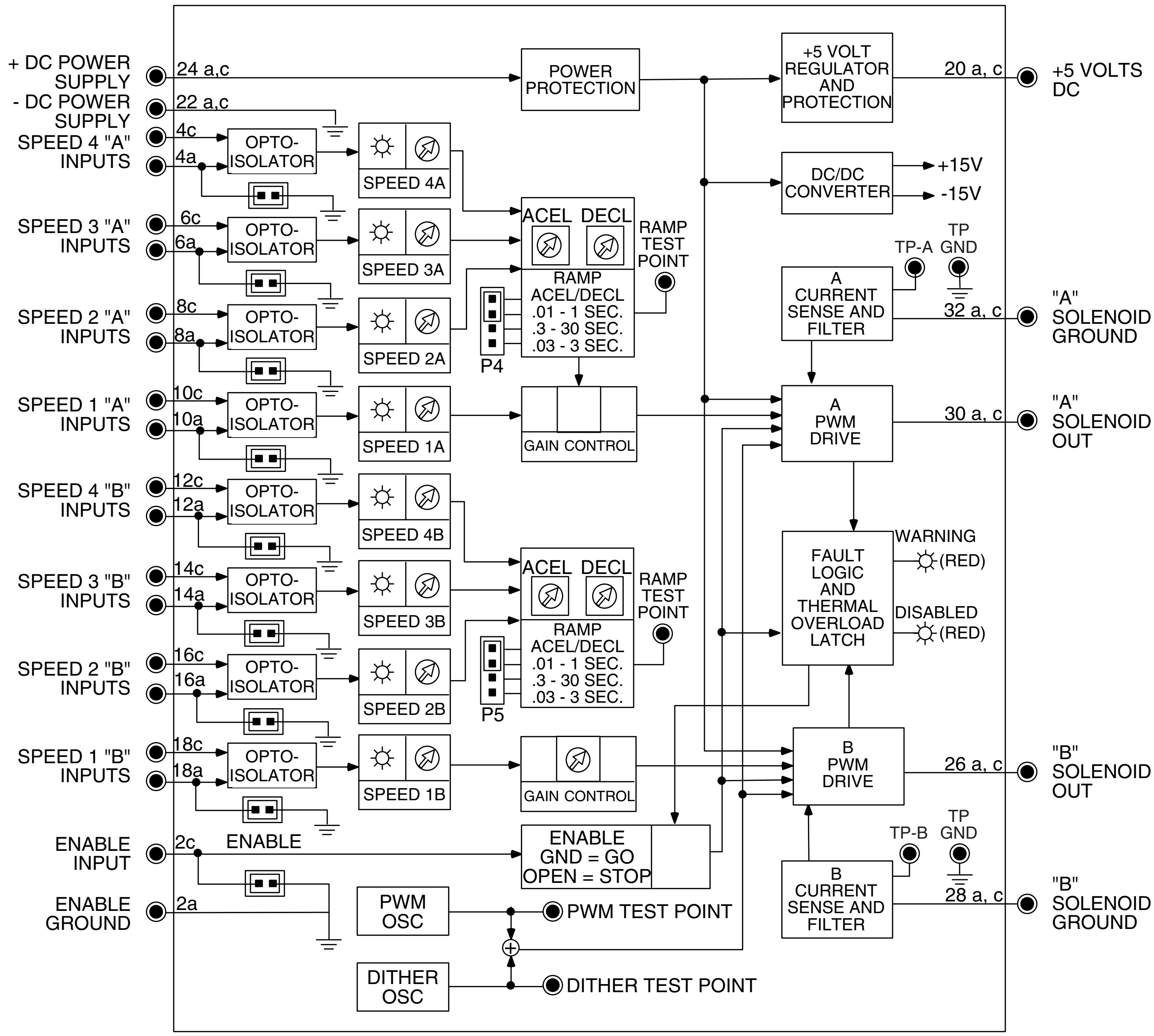
RAMP DECEL. Controls the deceleration rate at which the valve closes in either direction. Adjustable from .03 to 30 seconds with three (3) selectable ranges.

GENERAL SPECIFICATIONS

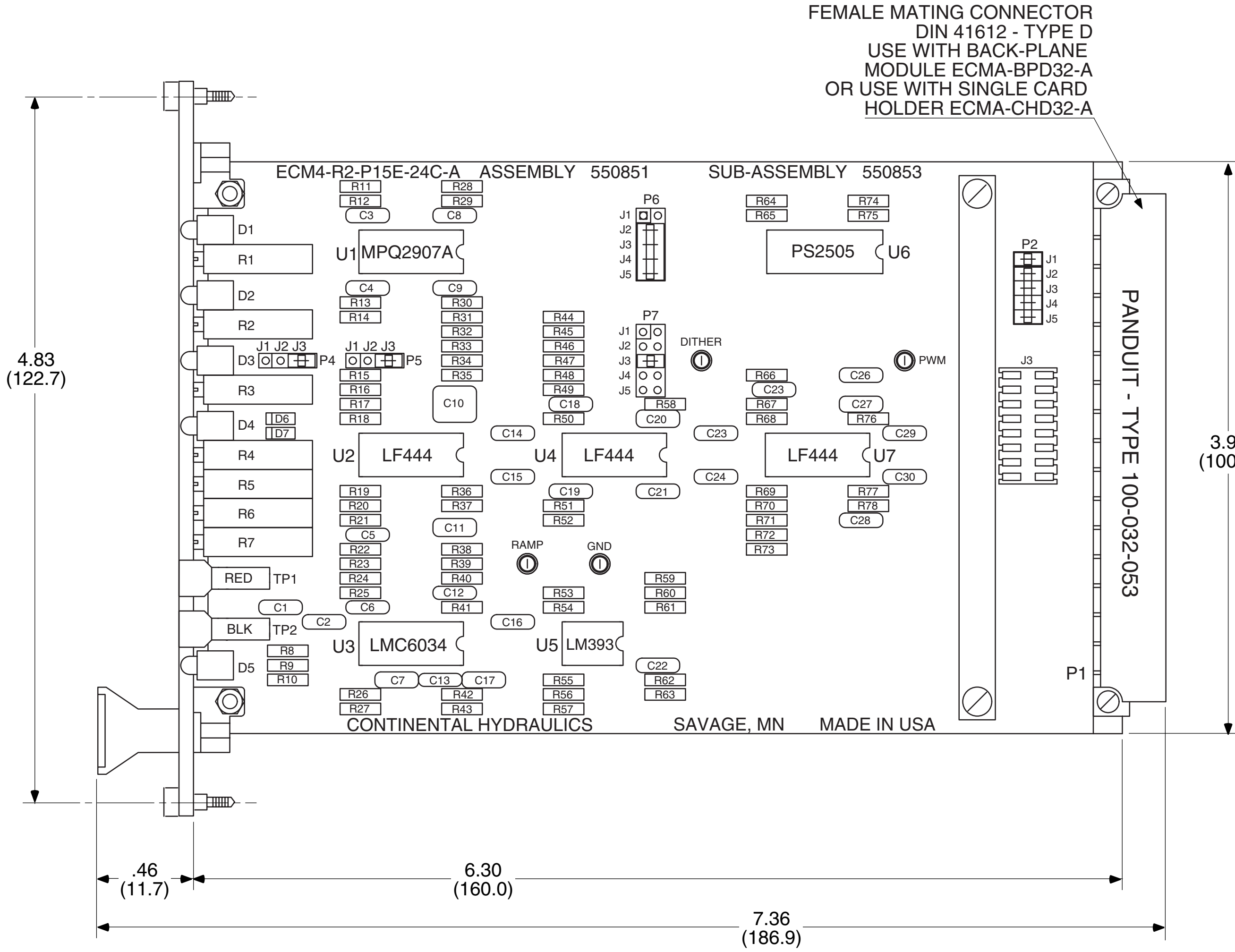
INPUT POWER	Voltage	24 to 30 VDC	
	Current	1.7 Amp @ 24 VDC	
	Power	41 Watts	
	Overload Protection	Reverse Supply Protection Voltage Spike Protection	
INPUT COMMAND	Type	Discrete Signal	
	Voltage	3 to 15 Volts DC	
	Input Resistance	100 K nominal	
OUTPUT POWER	Voltage	24 VDC	
	Current	1.5 Amps	
OUTPUT CONTROL	PWM Frequency	1400 Hz.	
	Dither	120 HZ	Optional 0, 60, 90, 150,180 Hz.
	Accel/Decel	30 - 3000 ms	Optional .3 - 30 sec. .01 - 1 sec.
	Channels	Dual	
TEMPERATURE RANGE		-40° F. to 176° F. -40° C. to 80° C.	
AUXILIARY OUTPUT		± 5 Volts DC @ 500 mA	
MOUNTING		Panel or Single Euro Card Cage	

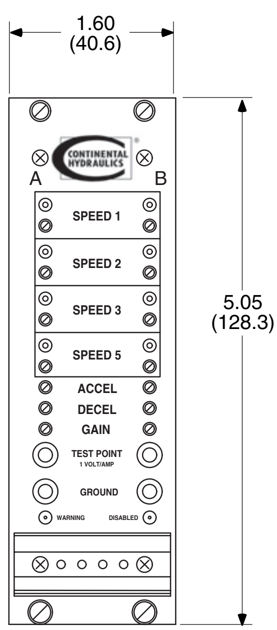
SPEED This adjustment, four (4) for each channel, is used to set desired speed. Speeds 1, 2 and 3 can each be adjusted for up to 50% output. Speed 4 can each be adjusted for up to 100% output. If more than one speed is selected, the adjustments are additive. Speed 1 bypasses the ramp control to ensure rapid and consistant stops for actuator positioning. The speed select inputs use optoisolators which can allow total isolation from the rest of the board. The speed select inputs are compatible with various interfaces, such as TTL logic or 4 - 20 mA current loops with external shunt resistors. A minimum of 1.3 mA is required to select the input.

FUNCTIONAL SCHEMATIC



ECM4-R2-P15E-24C-A DIMENSIONS





Dimensions shown in: Inches (millimeters)

TYPICAL ORDERING CODE:

ECM4-R2-P15E-24C-A

ECM4-L4

Electronic Control Boards

DUAL CHANNEL AMPLIFIER

ORDERING CODE INFORMATION

ECM4 - [SELECT ONE] – [SELECT ONE] [SELECT IF REQ'D] – [SELECT ONE] – C – [DESIGN LETTER]

CONTROL (select one)

CODE	DESCRIPTION
L1	LINEAR AMPLIFIER SINGLE SOLENOID
L2	LINEAR AMPLIFIER DOUBLE SOLENOID
L4	LINEAR AMPLIFIER SINGLE SOLENOID 3 WIRE LVDT WITH RAMP & FEEDBACK CAPABILITY
R2	RAMP AMPLIFIER DOUBLE SOLENOID

OPTIONS (select one)

CODE	DESCRIPTION
P12	12 TURN POTENTIOMETER CODE P MOUNTING (L1 ONLY)
P1	SINGLE TURN POTENTIOMETER CODE P MOUNTING (L2, L4 ONLY)
P15	15 TURN POTENTIOMETER CODE E MOUNTING (L2, R2 ONLY)

MOUNTING (select if req'd)

CODE	DESCRIPTION
E	SINGLE EURO CARD W/ FACE MOUNTED ADJUSTMENTS (L2, R2 ONLY)
P	SINGLE EURO CARD SIZE FOR PANEL MOUNTING (L1, L2 ONLY)
P	DOUBLE EURO CARD SIZE FOR PANEL OR EURO CARD (L4 ONLY)

SOLENOID VOLTAGE (select one)

CODE	DESCRIPTION
OMIT	12/24 VOLT DC (L1, L2, L4 ONLY)
24	24 VOLT DC (R2 ONLY)

MANUFACTURER

CODE	DESCRIPTION
C	CONTINENTAL HYDRAULICS

TYPICAL ORDERING CODES:

ECM4-L1-P12P-C-A
ECM4-L2-P1P-C-C
ECM4-L2-P15E-C-C
ECM4-L4-P1P-C-C
ECM4-R2-P15E-C-A

GENERAL DESCRIPTION

This dual channel, linear amplifier with built-in power supply is designed for use with Continental Hydraulics' single or double solenoid proportional 4-way valves without LVDT.

It is a current control device with pulse width modulation (PWM) for minimum power loss when varying the output voltage. A pre-set dither improves valve characteristics over the full range of PWM output.

On-board controls include two null adjustments, two gain adjustments and one accel/decel ramp control adjustment. Two LEDs indicate which channel is being energized.

For POSITION feedback control, it is recommended that a valve with LVDT be used with a ECM4-L4 amplifier. For velocity feedback control, use the ECM4-L4 amplifier.

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within ten (10) feet (304.8 cm) of an exposed amplifier board or its wiring to Command stations and valve.

ADJUSTMENTS

NULL This adjustment (one for each solenoid) reduces or eliminates deadband. LEDs indicate which solenoid is being energized.

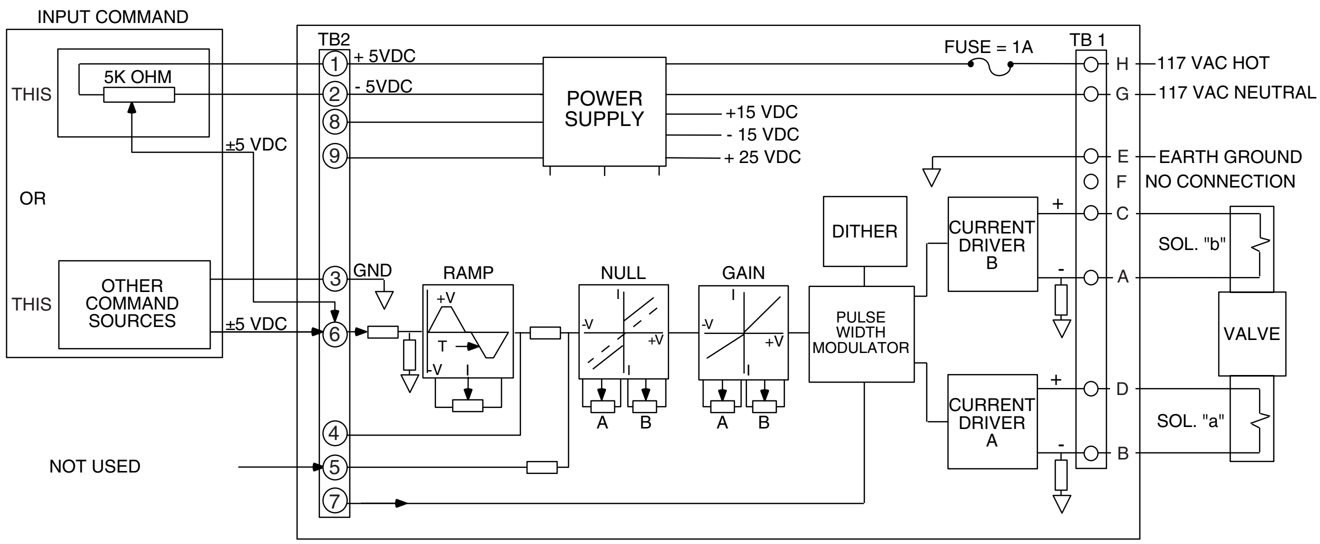
GAIN This adjustment (one for each solenoid) sets maximum valve current when command is at maximum. This results in full command resolution from off to maximum valve output.

RAMP This adjustment varies the rate of increasing or decreasing the command signal. Controlled acceleration and deceleration (for both forward and reverse) will be the same for a specific ramp control setting. Range is 30 ms to 3 seconds.

GENERAL SPECIFICATIONS

INPUT POWER		Voltage	117 VAC 60 Hz
		Overload Protection	1.0 Amp
INPUT COMMAND		Type	Analog
	Voltage	A Port	0 to -5 VDC
		B Port	0 to +5 VDC
		Potentiometer Resistance	5 K Ohms
		Input Resistance	100 K Ohms
OUTPUT CONTROL		Voltage	0 to 24 VDC PWM
		Current	1.5 Amps Max.
		PWM Frequency	1400 Hz.
		Dither	120 HZ Fixed Amplitude
		Accel/Decel	30 - 3000 ms
		Channels	Dual
TEMPERATURE RANGE			32° F. to 140° F. 0° C. to 60° C.
MOUNTING			Panel

FUNCTIONAL SCHEMATIC

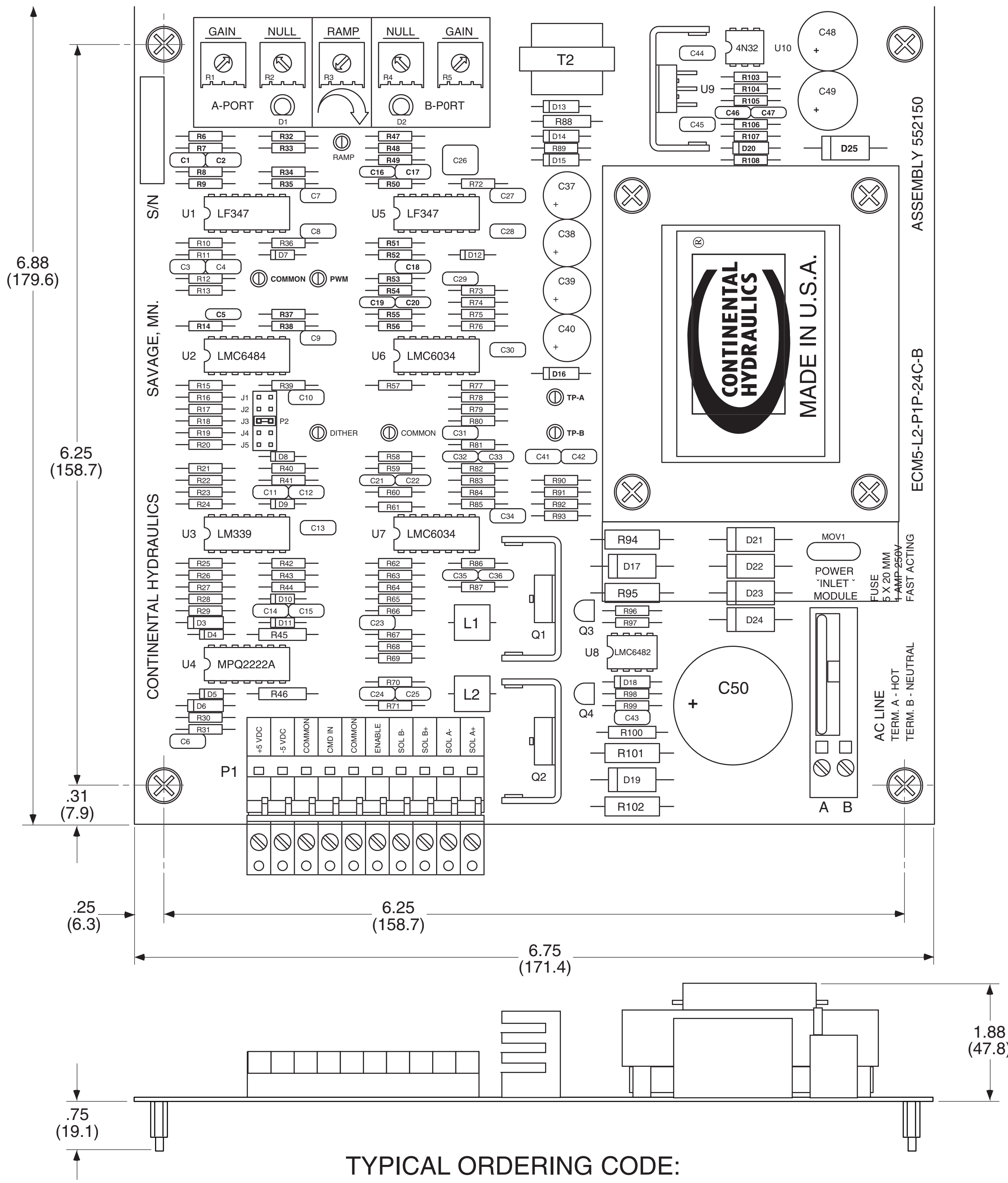


Use of Defeat Terminal #7 of ECM5-L2

If terminal 7 is connected to terminal 3, the output to the proportional valve will instantly go to zero (0). Opening the connection will instantly return the output to the level at which the command is set.

ECM5-L2-P1P-24C-B DIMENSIONS

Dimensions shown in: Inches (millimeters)



TYPICAL ORDERING CODE:

ECM5-L2-P1P-24C-B

CONTINENTAL HYDRAULICS

GENERAL DESCRIPTION

This dual channel amplifier with built-in power supply provides motion control (time and speed) to Continental Hydraulics' single or double solenoid proportional 4-way valves without LVDT. Six (6) on-board potentiometers are used to adjust three (3) speed levels in each direction. There are also four (4) potentiometers to adjust acceleration and deceleration rates in each direction.

It is a current control device with pulse width modulation (PWM) for minimum power loss when varying the output voltage. A pre-set dither improves valve characteristics over the full range of PWM output.

CAUTION: Do not use radio transmitters or similar devices that emit radio frequency (RF) signals within ten (10) feet (304.8 cm) of an exposed amplifier board or its wiring to Command stations and valve.

ADJUSTMENTS

There are three speed controls for each direction. Each control has an adjustment range of approximately 10 to 90% of the maximum solenoid output, depending on the span adjustment setting.

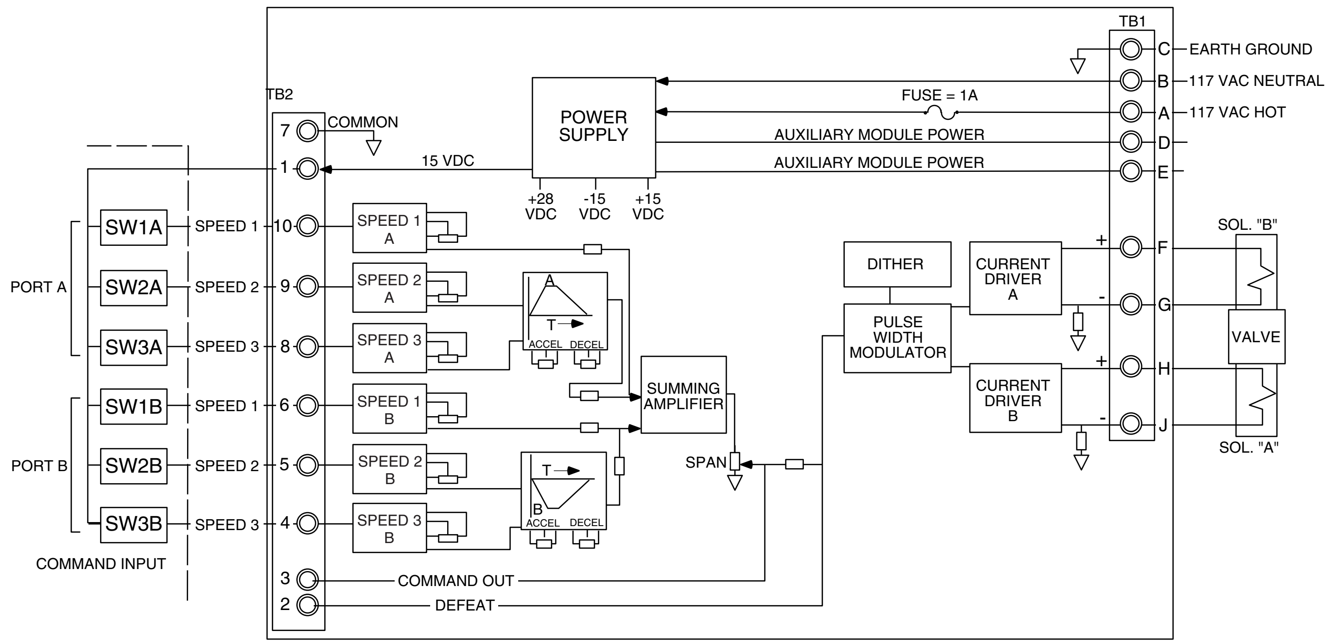
Speed No. 1 (Command 6 or 10) is fast on/off as standard (no acceleration or deceleration). If acceleration/deceleration of speed No. 1 is desired, alternate positions to R44 (Port "A") and R52 (Port "B") are provided and marked on the board.

Speeds do not have to be activated in numerical order. Settings are additive so that more than three speeds can be achieved by sequencing the switching order.

GENERAL SPECIFICATIONS

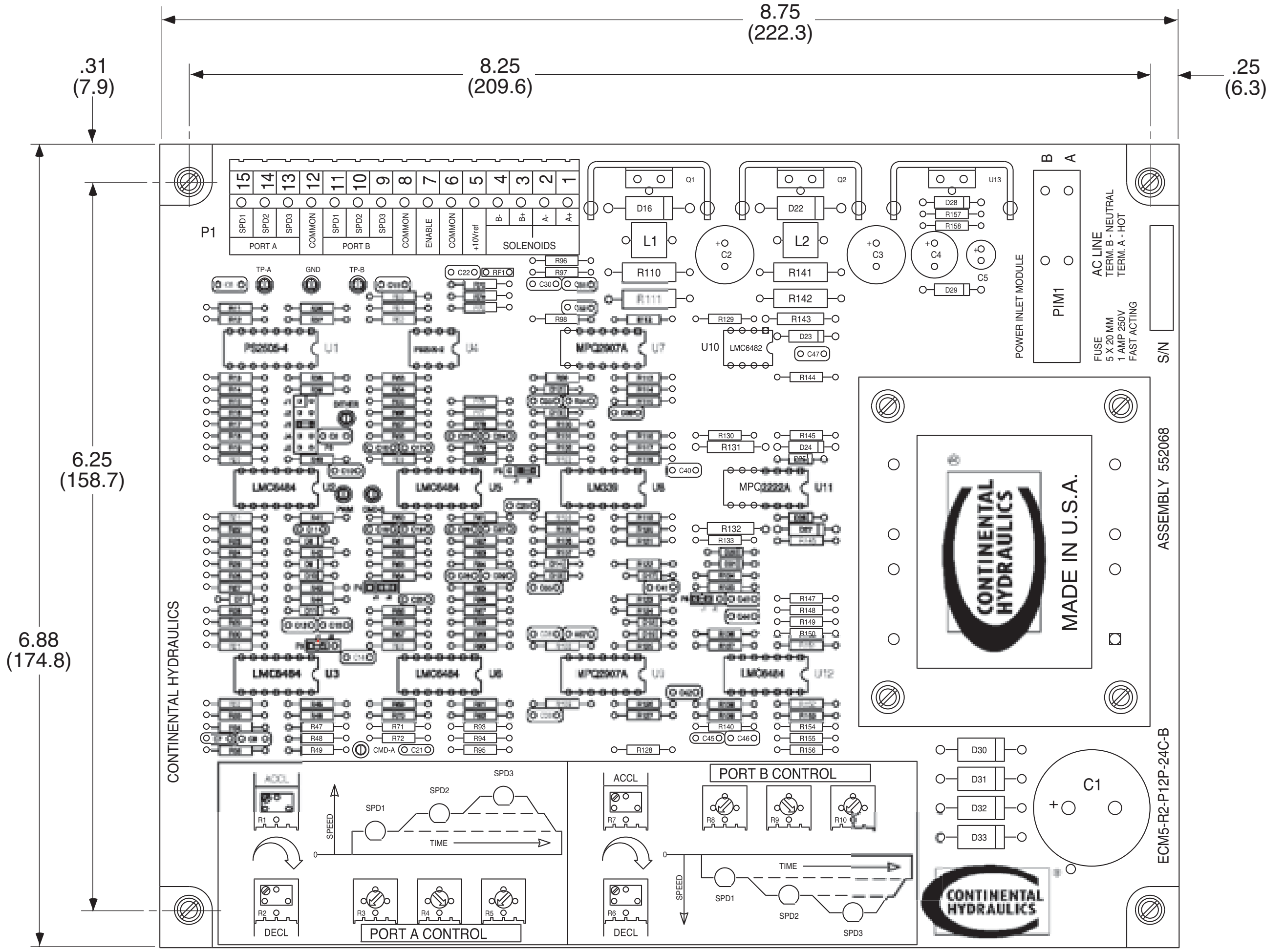
INPUT POWER	Voltage	117 VAC 60 Hz
	Overload Protection	1.0 Amp
INPUT COMMAND	Type	Discrete Signal
	Voltage	2 to 15 VDC
	Input Resistance	100 K Ohms
OUTPUT CONTROL	Voltage	0 to 24 VDC PWM
	Current	1.5 Amps
	PWM Frequency	1400 Hz.
	Dither	120 HZ Fixed Amplitude
	Channels	Dual
	Ramp Adjustments	.03 to 3 sec. .01 to 1 sec. (optional)
TEMPERATURE RANGE		32° F. to 155° F. 0° C. to 68° C.
MOUNTING		Panel

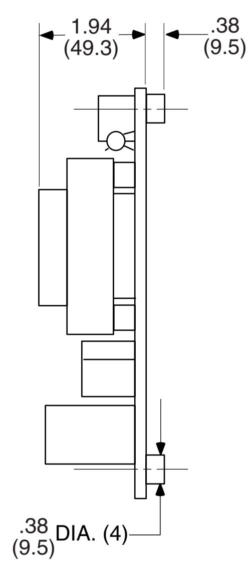
FUNCTIONAL SCHEMATIC



ECM5-R2-P12P-24C-B DIMENSIONS

Dimensions shown in: Inches (millimeters)





TYPICAL ORDERING CODE:

ECM5-R2-P12P-24C-B

ORDERING CODE INFORMATION

ECM5 - [SELECT ONE] – [SELECT ONE] – 24 – C – B (DESIGN LETTER)

CONTROL

CODE	DESCRIPTION
L2	LINEAR AMPLIFIER DOUBLE SOLENOID
R2	RAMP AMPLIFIER DOUBLE SOLENOID

OPTIONS

CODE	DESCRIPTION
P1P	SINGLE TURN POTENTIOMETER (L2 ONLY)
P12P	12 TURN RAMP, SINGLE TURN SPEED POTENTIOMETERS (R2 ONLY)

SOLENOID VOLTAGE

CODE	DESCRIPTION
24	24 VOLT DC

MANUFACTURER

CODE	DESCRIPTION
C	CONTINENTAL HYDRAULICS

TYPICAL ORDERING CODES:

ECM5-L2-P1P-24C-B

ECM5-R2-P12P-24C-B

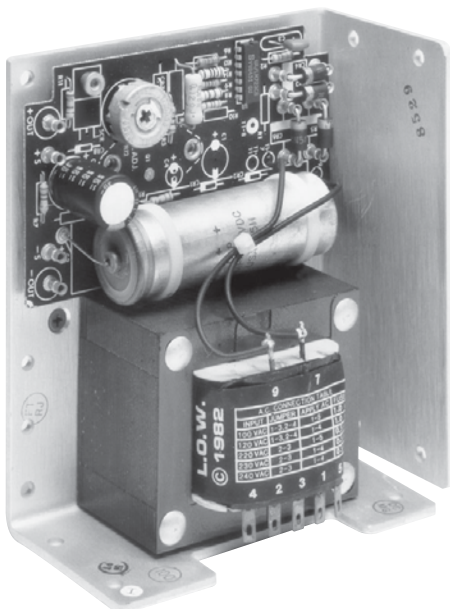
CONTINENTAL HYDRAULICS

CONTROL BOARD ACCESSORIES

ECMA-P-24C

Electronic Control Boards

24 VOLT POWER SUPPLY



GENERAL DESCRIPTION

Features:

- Remote sense-most outputs
- ±0.5% regulation
- Industry standard size
- Foldback current limit
- Full-rated to 122° F. (50° C.)
- UL recognized
- CSA certified
- Chassis notches for AC input

Remote Sense

Remote sense terminals may be used to compensate for output line losses and to provide for remote point of regulation. Figure 1 shows the proper termination for a power supply with remote sensing.

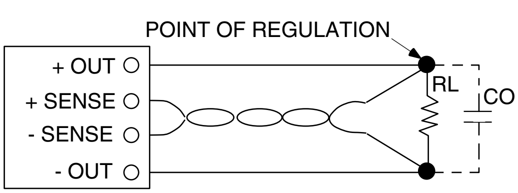


Figure 1.

Load lines must be sized to prevent an excessive voltage drop from the output to the load. Since the point of regulation is at the load, the power supply must compensate for line losses. Excessive load line losses may affect current limiting, AC line dropout point and OVP margin (if applicable).

Leads should be sized to drop no more than 5.5 V - the less the better. Using a twisted pair or shielded pair for the sense lines is recommended for noise immunity. In problem applications, using a small AC decoupling capacitor (.1 to 10 Fd) across the sense terminals is highly recommended. In some applications there may be a tendency for the power supply to oscillate due to additional phase shift caused by series resistance and inductance in the load leads.

GENERAL SPECIFICATIONS

AC INPUT	See AC Connection and Fusing Chart on next page.
DC OUTPUT	24 VDC, 2.4 Amps
LINE REGULATION	±.05% for a 10% change
LOAD REGULATION	±.05% for a 50% change
OUTPUT RIPPLE*	.02% PK-PK
TRANSIENT RESPONSE	50μ seconds for 50% load change
SHORT CIRCUIT & OVERLOAD PROTECTION	Automatic current limit/foldback
REMOTE SENSING	Provided on all models, 3 Amps and above, open sense lead protection built-in
STABILITY	±.05% for 24 hours of warm-up
TEMPERATURE RATING	32° to 122° F. (0° to 50° C.) full rated, derated linearly to 40% @ 158° F. (70° C.)
TEMPERATURE COEFFICIENT	±.01% / °C. maximum
EFFICIENCY	24 V unit: 60%
VIBRATION	Per Mil-Std-810B, Method 514, Procedure 1, Curve AB (to 50 Hz)
SHOCK	Per Mil-Std-810B, Method 516, Procedure 5
REMOTE PROGRAMMING	Capabilities included on remote sense models

Continued Next Page...

Continued From Previous Page

Adding a capacitor Co will reduce output impedance and provide stability. The recommended value of Co is 100 Fd per ampere or 50 Fd per foot and can be the sum of the distributed decoupling capacitors found in most systems.

POWER SUPPLY has open sense lead protection toprotect the load from an overvoltage condition if the sense leads are removed. There is no need to strap the sense terminals to the output terminals in the local sense mode.

EMI/RFI

These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet requirements without additional noise filtering. Consult the factory for special applications.

Grounding

Grounding considerations when designing a power distribution system are often overlooked but can havea significant impact on overall system performance. A single point system ground should be employed where possible to eliminate ground loops and improve regulation.

Figure 2 shows an improved connection system in which regulation is maintained at all three loads because wire losses are not cumulative.

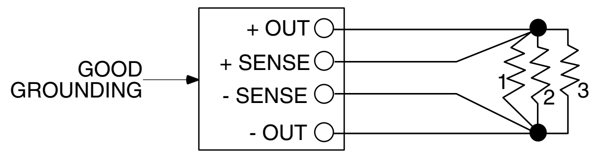


Figure 2.

Figure 3 shows a simple but undesirable connection scheme. Regulation at loads 1 and 2 becomes progressively worse due to voltage drops in the finite wire resistance between loads.

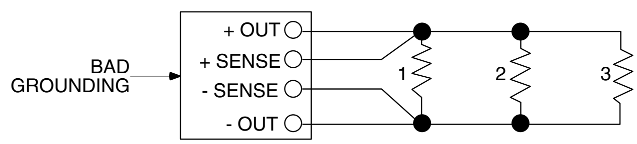
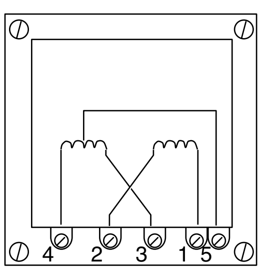


Figure 3.

AC Connection and Fusing



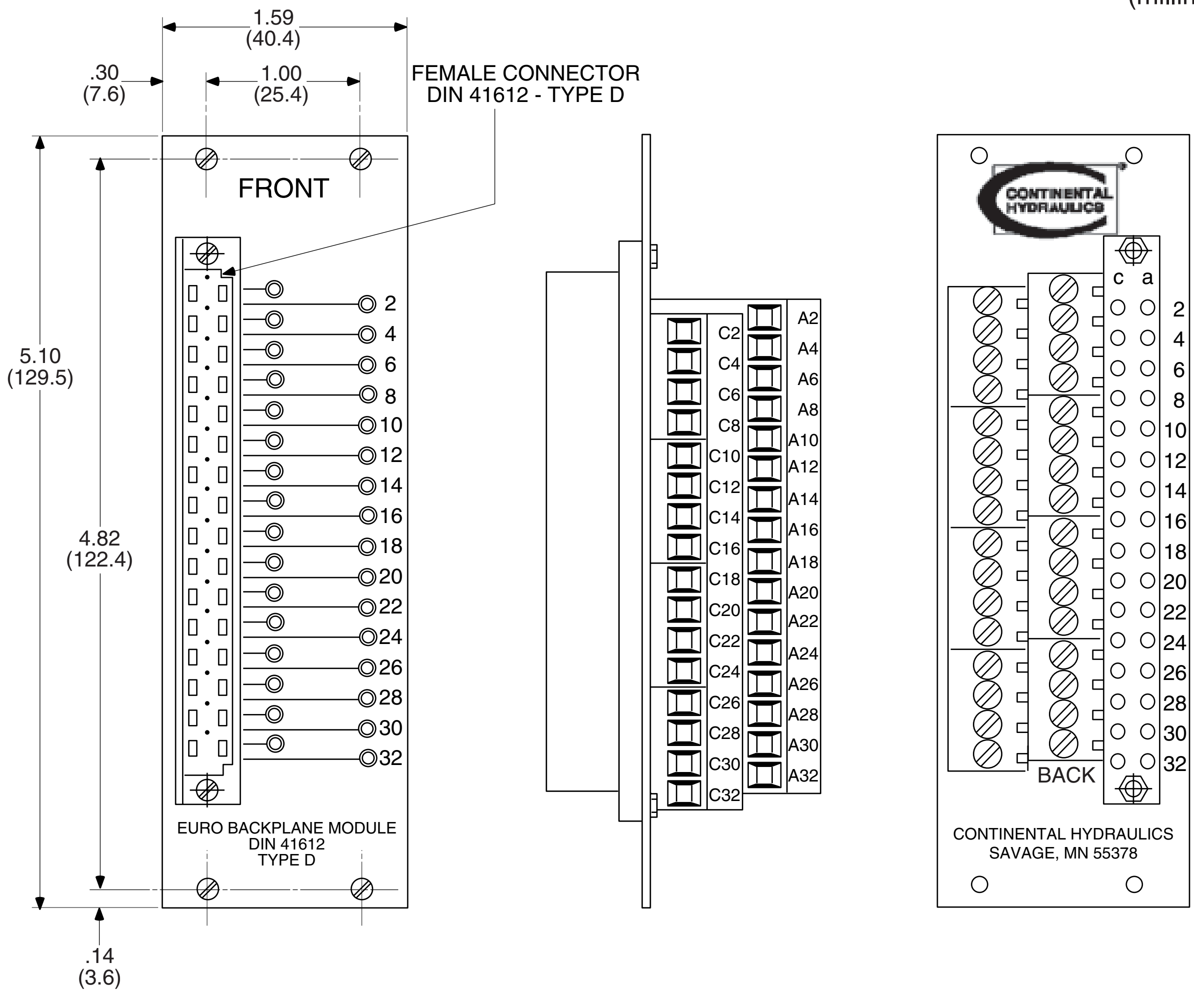
AC CONNECTION TABLE			
INPUT	**JUMPER**	**APPLY AC**	**FUSE**
100 VAC	1 - 3 2 - 4	1 - 5	1.0 A
120 VAC	1 - 3 2 - 4	1 - 4	1.0 A
220 VAC	2 - 3	1 - 5	0.5 A
230 VAC	2 - 3	1 - 4	0.5 A
240 VAC	2 - 3	1 - 4	0.5 A

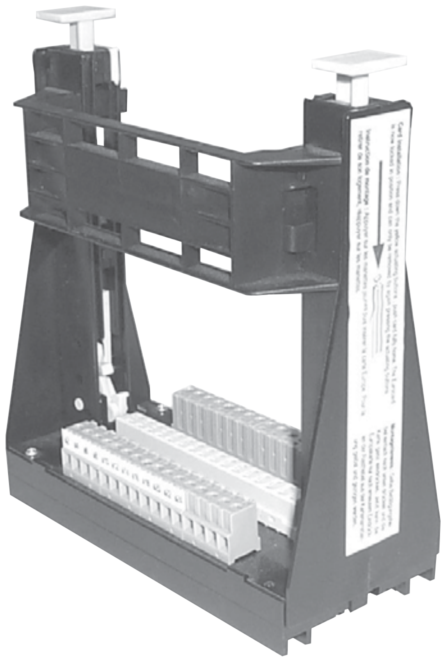
FEATURES

- Works with all ECM4 Euro style amplifiers.
- Use with card racks in single or multiple board applications.
- Matches standard Eurocard rack dimensions.
- Foldback current limit
- Screw terminal wire attachment - no soldering.

ECMA-BPD32 DIMENSIONS

Dimensions shown in: Inches (millimeters)



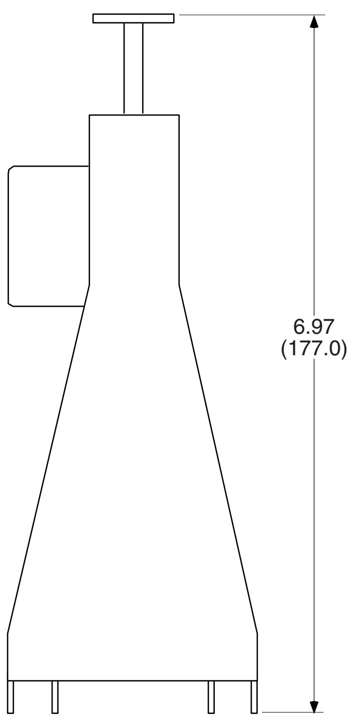


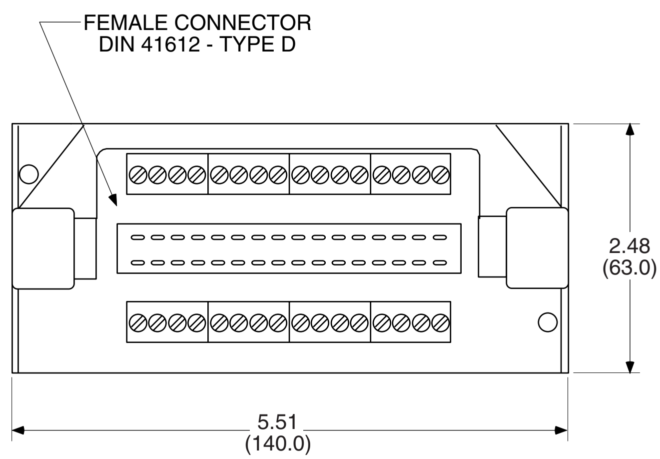
FEATURES

- Works with all ECM4 Euro style amplifiers.
- Compatible with 100 by 160 mm (3.94” by 6.30”) cards.
- Screw terminal wire attachment - no soldering.
- Cards are retained with mechanical locks.

ECMA-CHD32 DIMENSIONS

Dimensions shown in: Inches (millimeters)





ORDERING CODE INFORMATION

	SELECT ONE		DESIGN LETTER
ECMA -	[ ]	—	A

OPTIONS

CODE	DESCRIPTION
P-24C	POWER SUPPLY 24 VOLT - DC
BPD32	BACK PLANE CONNECTOR 32 PIN - "D" SERIES DIN - 41612
CHD32	CARD HOLDER 32 PIN - "D" SERIES DIN - 41612

TYPICAL ORDERING CODES:

ECMA-P-24C-A
ECMA-BPD32-A
ECMA-CHD32-A

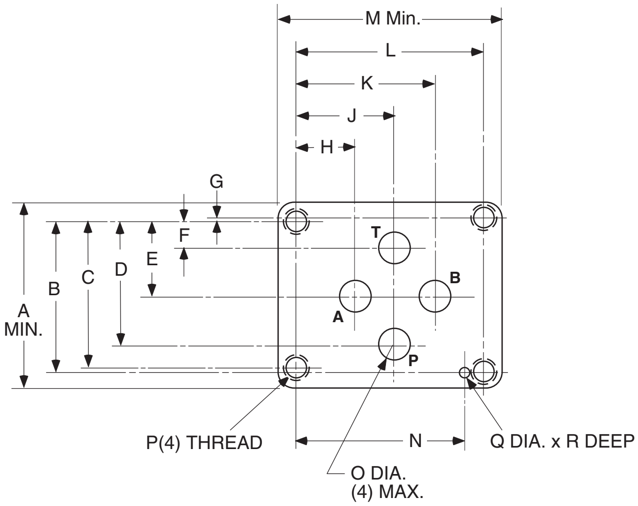
MISCELLANEOUS

DIMENSIONS: Mounting surfaces must be flat within 0.1 mm per 100 mm (.0004 in. per 4.00 in.) and N8 (63AA) finish.

NOTES: A = Cylinder Port B = Cylinder Port T = Tank Port
P = Pressure Port X = Pilot Port Y = Drain Port

D03 MOUNTING SURFACE

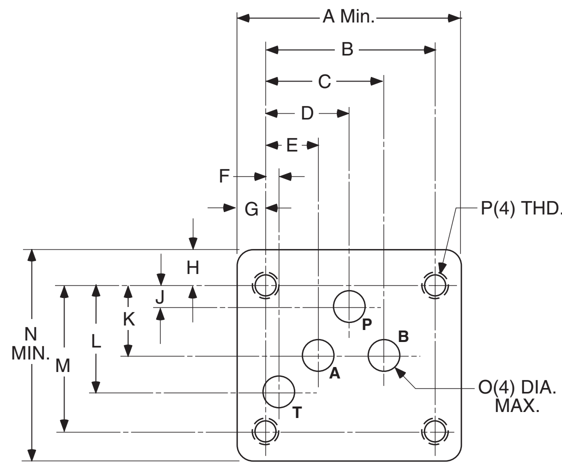
Conforms to NFPA/T3.5.1 R2 - 2002, ISO/DIS 4401 SIZE 03



	INCH	mm		INCH	mm		INCH	mm
A	1.70	43.2	**G**	0.03	0.8	**N**	1.30	33.0
B	1.25	31.8	**H**	0.50	12.7	**O**	0.25	6.3
C	1.22	31.0	**J**	0.85	21.6	**P**	10-24UNC-2B	
D	1.02	25.9	**K**	1.19	30.2	**Q**	0.16	4.1
E	0.61	15.5	**L**	1.59	40.4	**R**	0.16	4.1
F	0.20	5.1	**M**	2.00	50.8			

D05 MOUNTING SURFACE

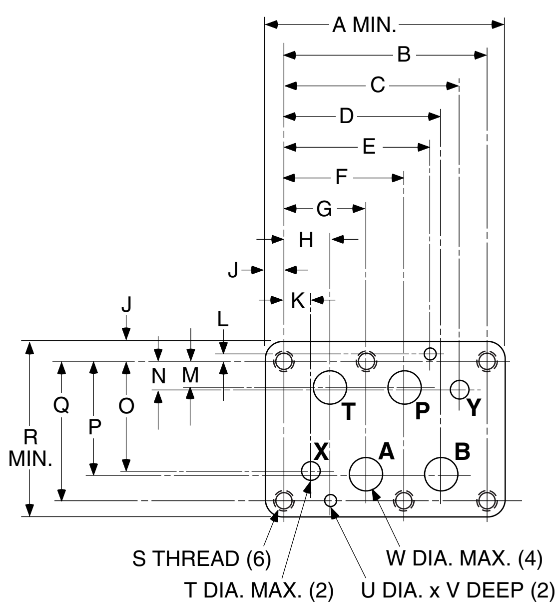
Conforms to NFPA/T3.5.1 R2 - 2002, ISO/DIS 4401 SIZE 05



	INCH	mm		INCH	mm		INCH	mm
A	2.84	72.1	**F**	0.13	3.3	**L**	1.28	32.5
B	2.13	54.0	**G**	0.36	9.1	**M**	1.81	46.0
C	1.47	37.3	**H**	0.44	11.2	**N**	2.28	57.9
D	1.06	26.9	**J**	0.25	6.3	**O**	0.44	11.2
E	0.66	16.8	**K**	0.84	21.3	**P**	1/4-20 UNC	

D08 MOUNTING SURFACE

Conforms to NFPA/T3.5.1 R2 - 2002, ISO/DIS 4401 SIZE 08



	INCH	mm		INCH	mm		INCH	mm
A	6.00	154.4	**J**	0.44	11.2	**R**	4.57	116.1
B	5.13	130.3	**K**	0.69	17.5	**S**	1/2-13 UNC	
C	4.44	112.8	**L**	0.19	4.8	**T**	0.44	11.2
D	3.97	100.8	**M**	0.69	17.5	**U**	0.28	7.1
E	3.72	94.5	**N**	0.75	19.0	**V**	0.38	9.7
F	3.03	77.0	**O**	2.88	73.2	**W**	0.92	23.4
G	2.09	53.1	**P**	2.93	74.4			
H	1.16	29.5	**Q**	3.63	92.2			

TERMINOLOGY

Backlash. The free play between interacting mechanical parts such as a lead screw. Occurs when motion is reversed.

Compliance. The springiness of an object. Amount of displacement per unit of force.

Deadband. The amount the spool must travel from the center condition to the point that flow starts. Caused by the overlap of the spool lands to the valve body lands.

Dither. Used to reduce the effects of friction of the spool to the body. A small amount of oscillating power added to the output power going to the valve coil. This signals rate and/or amplitude is adjustable so the effect will keep the spool in motion, but will not affect the output from the valve.

Flow Gain. Relationship of control flow to input current, typically expressed as GPM/ma.

Frequency Response. The measurement of how the output responds to an oscillating input signal of varying frequency with fixed amplitude. Measured in terms of decibels and/or phase lag. Decibels (dB) is given at the –3dB point (the point at which the output is approximately 70% of the commanded output). Phase lag is given at the –90° point. Phase shift as compared to the input signal (the output is at 100% shift when the command is at 0%).

Gain (Current maximum). Sets *maximum* amperage to the solenoid. Used to set the maximum flow or pressure from the valve to the system. Do not adjust past the maximum the system can supply or the system may not respond as desired if long ramp times are used.

Hysteresis. The difference in the input current to produce the same output when going from center to full shift and back to center. Typically measured at 50% signal in both directions.

Inertia. The property of an object that resists change in motion. The inertia of an object is dependent on the mass and shape. Simply put, an object at rest tends to stay at rest; an object in motion tends to stay in motion.

Internal Leakage. There are two sources of internal leakage. The first is the leakage between the main body and spool and the second is pilot flow (some proportional and servo components require a small pilot flow through a hydraulic amplifier known as "quiescent flow").

Linearity. The maximum deviation of the control flow from the best straight line of flow gain, expressed as a percent of rated current.

Null Bias (Current minimum). Sets *minimum* amperage to the solenoid. Used for deadband reduction, or will set a minimum flow or pressure. Always adjust null before adjusting gain.

Pressure Compensator. Devices used to create a consistent pressure differential between the inlet and the outlet of an orifice. The most commonly used in electro-hydraulic circuits are the *restrictive* and *by-pass* types. Care must be taken when applying these components since they naturally will have inconsistent pressure drops at various flow rates through a given valve. However, they will improve the system performance when widely changing loads are seen.

Pressure Drop. In order to have flow, there must be differential in pressure between two points. It will also require some amount of force (pressure) to push the fluid through an orifice. A pressure drop, unlike in standard hydraulic systems, is a "good thing" and is required. Pressure drops create stiffness in the system, stiffness = controllability. Although pressure drop results in wasted energy through heat, it is the cost of getting in control.

Pressure Gain. A measure of the change in control port pressures as the input current is varied about the zero flow point.

Pulse Width Modulation (PWM). An effective method of controlling electrical power without creating heat. PWM is the amount or percent of time that power is ON for one cycle. If power is on for 25% and off for 75% of a cycle of a 12 volt supply, the average amount would be 3 volts. The frequency must be significantly higher than the valve response.

Ramp Accel. Limits the rate an *increasing command* can open or increase the valve output.

Ramp Decel. Limits the rate a *decreasing command* can close or decrease the valve output.

Repeatability. The ability to repeatedly return to the same output for the same input from the same direction.

Resolution. The smallest amount of input that results in a change in output.

Step Response. The amount of time it takes a spool to shift for a stepped input signal.

Symmetry. The degree of equality between the flow gain of one direction and that of the reversed direction.

Threshold. The minimum change in reverse output with the reversal of input signal. Percent of command change required to show a change in output.

CONCEPTS

How Does a Direct Acting Proportional Flow Control Valve Work

There are three components or items that are required. First, a spool and body assembly that are designed to gradually open or close a flow path (metering notches or orifice) as it is moved along its distance of travel. The second component is a proportional solenoid and spring arrangement that will position the spool to a point, where the electromagnetic force developed by the current applied to the coil is balanced by the resistive force pushing back from the spring. The third component that makes the proportional valve work is the amplifier card. An amplifier card is the component that will convert a low power electrical command signal into a higher power controlled current to run the solenoid.

System and Valve Sizing

In order to correctly “size” a valve for a given application, you MUST know the application. Start with the load itself and ask the following questions:

- What is the load? Is the load an over running (flywheel) type, restrictive type (always pushing back) or both in the movement?
- How many hertz or frequency response is required to do the work?
- What amount of time is available to make the move?
- How fast is the step response of the valve being considered?
- What are the pump flow and pump response time?
- How accurately must the load maintain (plus or minus what % of force, rpm, position)?
- What force is required to move the load in the time allotted? *Force required to move the load = load mass + force due to acceleration + load friction + external force + seal friction*

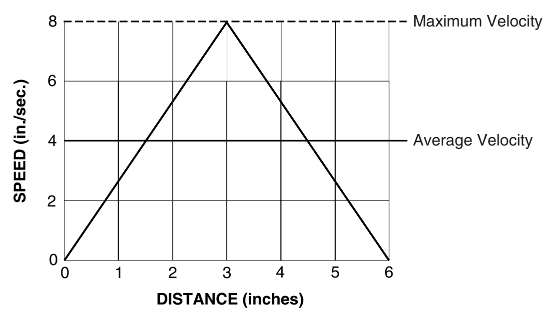
Example: To determine the correct system components, review this typical cylinder application that helps to show the relationships of time, mass, cylinder size and flow rates.

- Cylinder has a 2 inch (50.8 mm) bore, 1 inch (25.4 mm) rod and 6 inch (152.4 mm) stroke.
- Load is 5000 lbs. (2268 kg) in the extend mode; 1000 lbs.(453.6 kg) in the retract mode.
- Cycle time is 1.5 seconds in both the extend and retract mode.
- The load is a vertical elevator type lift where a second operation will remove the load off the platen.
- A smooth acceleration and deceleration is desired on the extend stroke.

Based on the above information, it will be assumed that a counterbalance valve will be used to prevent the cylinder from free falling during the retract mode. A uniform acceleration and deceleration motion profile will be used.

Typical Formula and Calculations Required

1. Cylinder area for extend for a 2 inch bore = (2 x 2) x .7854 = 3.14 sq. in.
2. Cylinder effective area for retract a 1 inch rod = 3.14 - [(1 x 1) x .7854] = 2.36 sq. in.
3. Average (extend mode) velocity for a uniform acceleration and deceleration means that one-half the time of the extend cycle will be acceleration and half deceleration or .750 seconds. Therefore, the maximum velocity = distance/time or 6 inches/.750 seconds = 8 in./sec.



4. System peak flow can now be calculated using the peak velocity of the cylinder and the extend area. Peak flow in gpm = (Vm x area x 60)/231 or (8 x 3.14 x 60)/231 = 6.53 gpm peak flow.
5. Acceleration is then velocity maximum/time or 8 in. per sec/.750 sec. = 10.67 in./sec.^{2}.
6. The force of acceleration = load mass x acceleration (mass is weight/gravity) or (5000/386.4) x 10.67 = 138 pounds.
7. Total force pressure = force of acceleration + load/extend area = (138 + 5000)/3.14 = 1640 psi.
8. System pressure = total force pressure required at the cylinder + valve pressure drop (see performance curve of valve being used) + line loss + seal friction = 1640 + 195 (estimated) + 100 + 165 = 2100 psi estimated system pressure.

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CONCEPTS (Continued...)

To show how time, flow or cylinder size affect each other in the above example:

- Change the 1.5 second time to 1 second results in 9.8 gpm and an additional 50 psi.
- Drop the peak flow available to 3.5 gpm results in an increase of pressure at the cylinder as the load will need to be accelerated to its peak speed quicker. This may result in damage to the product being moved if the g forces are too great.
- Change the cylinder size will change both the flow rates and pressures required.

Spool Selection
Selecting the correct spool is critical for best control in any application. A valve sized incorrectly can be the difference between correct consistent operation and poor overall control. Continental Hydraulics offers not only a wide variety of flow rates, but also offers a variety of metering functions. These metering functions are designed to match the load, actuator and circuit characteristics for the best possible control.

When selecting a spool for given application, it is recommended that the spool's rated flow be as closely matched to the maximum flow required. Size the spool for approximately a 200 - 300 pressure drop across the valve (see flow curve charts) for best overall performance. This pressure drop and/or back pressure provide system stiffness that is required for optimum control.

The metering characteristics of the spool will be based on the load characteristics an/or circuit design. Spool metering options available are combination metering, meter-in, meter-out, 2:1 ratio, 1.3:1 ratio and position control.

The flow control range of a valve should be kept within a 20:1 ratio for the best results. Do not expect to have one valve control 0.5 gpm and 50 gpm accurately at either condition.

Due to external factors like high oil or ambient temperature, coil power losses may affect the maximum output from the valve used. In situations where high temperatures may come into play, size the valve so the maximum flow is achieved prior to the maximum rated current of the coil is used.

Pressure Drop and Flow Relationships
It must be understood that *all proportional and servo control valves are orifices*. With that stated, the relationship between pressure drop (the difference between the inlet pressure and the outlet pressure) is expressed by general formula for flow through an orifice: $Q = K(A)\sqrt{\Delta P}$

Q = Flow
K = Orifice Constant
A = Area
ΔP = Pressure Drop

An example of this would be a valve rated for passing 10 gpm (37.8 lpm) at a pressure drop of 100 psi (6.9 bar) will pass about 14 gpm (53.0 lpm) at a pressure drop of 200 psi (13.8 bar). As you see if the load required pressure changes or drops by 100 psi (6.9 bar), the flow will automatically change by 40%. Care must be taken to watch how the load being controlled may change. If wide swings are possible, other components may be required to compensate for the effect.

Open Loop Control Systems
The system responds to a command input signal to vary the output accordingly, but there will not be any corrections made to the output based on what is happening at the load.

Closed Loop Control Systems
The system responds to the command input as in the open loop system, but the output will be corrected via a comparison of the command input signal to a negative feedback signal coming from a source at the load.

An example of open and closed loops would be a car going from a flat surface to an incline without adjusting the gas pedal (command input source). This is open loop. In closed loop, adding cruise control (feedback input signal) will adjust the system output closing the loop for the desired control. A true closed loop control system will sense the system output and automatically correct any difference between the desired system reaction and the actual system reaction.

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CONCEPTS (Continued...)

Closed loop systems for hydraulic applications can be defined by three methods. Each required a certain type of logic to achieve the best performance.

- Position Control
- Velocity Control
- Force or Pressure Control

The basic concept of *position control* is to move to a point and stop. This requires a logic system that will in essence have a command source (analog) of one polarity and value, and a feedback source that will be the same in value but opposite in polarity. Once in position, the two signals will cancel each other providing the control valve a zero or off command, and the valve will close. Digital systems will typically be commanded to a position of X pulses, and once the system has counted out the correct number of pulses, it will send an off signal to the control valve.

The concept of *velocity control* is to set an actuator speed and hold it constant. Unlike position control where the valve must close to hold position when the loop error (position error) is zero, the valve in velocity control must hold open when the loop error (velocity error) is zero to maintain desired velocity. The error, between the feedback and command, is summed with the command resulting in an open valve. When the velocity error goes to zero, the output to the valve holds steady. Any further errors in velocity will adjust output up or down to correct the loop.

Force or pressure control is similar to velocity control. In pressure control, the valve must remain energized (open) when the loop error (pressure error) is zero to maintain desired pressure. The error, between the feedback and command, is summed with the command resulting in an energized valve. When the pressure error goes to zero, the output to the valve holds steady. Any further errors in pressure will adjust output up or down to correct the loop.

These systems will also require other mathematical calculations to help gain speed and accuracy. These calculations are done in the “P I D” loop closure part of the control circuit.

- P Proportional
- I Integration
- D Derivative

“PID” example: You need to move your vehicle from point A to point B, down the road with several curves using only ”P” and “I”. On the first run, drive the course using only the rear view mirror. You will not travel as fast (Proportional) towards the destination as by the time you see the road has curved (Phase Lag), you will need to correct your course. As you move along (Time), the curve will cause you to turn the wheel more as you note that you are further off target (your brain multiples the error by the time involved (Integration). At some point you will have over compensated and you will go off target with the opposite error, and the process will start over again. You solve this by slowing down (Proportional) so the effectiveness of the corrections (Integration) are more substantial; or add a side view (a little Derivative) so the corrections can be made quicker; or add a forward view (a lot of Derivative) that will anticipate the corrections based on your eyes seeing the change allowing to start the corrections quicker as they come up.

- **Proportional Term** - (moderate frequencies). As the proportional term is increased, the effectiveness of Integration is lowered and the effectiveness of Derivative will come into effect later.
- **Integraton Term** - (low frequencies, adds phase lag). The primary benefit is the reduction of steady state error.
- **Derivative Term** - (high frequencies, adds phase lead). Helps improve responsiveness and stability.

Adjusting “PID”

The adjustment procedure is to reduce the “I” and”D” term values to minimum so the “P” term value can be set with little or no effect from the “I” and “D” terms. Increase the “P” term until the system instability occurs. Set the “P” term about 30% less than that point. Next, raise the “I” term until the system is about to go unstable, then increase “D” term to improve system stability. Repeat increasing “I” and then “D” as needed.

Rule of Thumb - Always select a feedback device that measures what you want to measure! An example of this would be to use a load cell on the cylinder rather than a pressure transducer. A pressure transducer is a device that does not take into account seal friction, mechanical friction, etc. that will be subtracted from the actual force that is being exerted.

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CONTINENTAL HYDRAULICS

CONCEPTS (Continued...)

Formulas and Reference Material

- Current is measured in Amps (A)
- Voltage is measured in Volts (V)
- Resistance is measured in Ohms (O)
- Inductance is measured in Henries (H)
- Capacitance is measured in Farads (F)

Ohm's Law: Voltage = Current x Resistance for DC

$$V = I \times R$$

Power: Power (Watts) = Current x Voltage

$$W = I \times V$$

Flow through an orifice: $Q = K\ (A) \sqrt{\Delta P}$ (see Pressure Drop and Flow Relationships)

Force due to Acceleration: The force to overcome the combination of several load and inertia components can become a large factor in high speed applications. The following information and mathematical formulas will be required to calculate the overall requirements.Force required = load mass + acceleration + external force + seal friction.

- Load mass (in pounds) can be total weight or a percentage (%) of total weight as dictated by angle of incline and/or coefficient of friction.
- Acceleration Force = load mass x acceleration
    - Load Mass = [mass/386.4 (gravity)]
    - Acceleration = [Max. velocity (in./sec.)/time to move (sec.)].
- External Force: Any changes made to the load due to external sources (example would be an addition or subtraction of weight due to a box coming on or off a conveyor).
- Seal Friction: Use 10% of maximum force.

Basic Formulas

Formula for:	Word Formula:	Letter Formula:
Fluid Pressure (in pounds per square inch)	Flow Rate = $\frac{\text{Force (pounds)}}{\text{Unit Area (sq. inches)}}$	$P = \frac{F}{A}$ or $psig = \frac{F}{A}$
Fluid Flow Rate (in gallons per minute)	Flow Rate = $\frac{\text{Volume (gallons)}}{\text{Unit Time (minute)}}$	$Q = \frac{V}{T}$
Fluid Power (in horsepower)	Horsepower = $\frac{\text{Pressure x Flow}}{1714}$	$HP = \frac{P (Q)}{1714}$
Velocity through Piping (in feet per second)	Velocity = $\frac{\text{0.3208 x Flow Rate thru I.D. (gpm)}}{\text{Internal Area (sq. Inches)}}$	$V = \frac{.3208 (Q)}{A}$
Compressibility of Oil (in additional required oil to reach pressure)	Volume = $\frac{\text{Press. x Volume Oil Under Press.}}{\text{250,000 (approx.)}}$	$VA = \frac{P (V)}{250,000}$ (See Note 1 Below)
Compressibility of a Fluid	Compressiblity = $\frac{1}{\text{Bulk Modulus of Fluid}}$	$CB = \frac{1}{BM}$ (See Note 2 Below)
Specific Gravity of a Fluid	Specific Gravity = $\frac{\text{Weight of 1 Cu. Ft. of Fluid}}{\text{Weight of 1 Cu. Ft. of Water}}$	$SG = \frac{W}{62.4283}$
Viscosity to Centistokes (For 32 SUS to 100 SUS)	Centistokes = 0.2253 x SUS - $\frac{194.4}{\text{SUS}}$	$Cs = 0.2253 (SUS) - \frac{194.4}{SUS}$
(For 100 SUS to 240 SUS)	Centistokes = 0.2193 x SUS - $\frac{134.6}{\text{SUS}}$	$Cs = 0.2193 (SUS) - \frac{134.6}{SUS}$
(For 240 SUS and greater) (SUS to Cs)	Centistokes = $\frac{\text{SUS}}{4.635}$	$Cs = \frac{SUS}{4.635}$

Note 1: Use 0.3208333 for greater accuracy. **Note 2:** Approximately .5 % per 1000 psig.

Pump Formulas

Formula for:	Word Formula:	Letter Formula:
Pump Outlet Flow (in gallons per minute)	Flow = $\frac{\text{rpm x Pump Displacement (cu. in./rev)}}{231}$	$Q = \frac{n (d)}{231}$
Pump Input Power (in horsepower required)	Horsepower = $\frac{\text{Flow Rate (gpm) x Press. (psi)}}{\text{1714 x Efficiency (Overall)}}$	$HPIN = \frac{Q (P)}{1714 (Eff.)}$
Pump Efficiency (overall in percent)	Efficiency Overall (%) = $\frac{\text{Output Horsepower}}{\text{Input Horsepower}}$ x 100	$EFF._{OV} = \frac{HP_{OUT}}{HP_{IN}} \times 100$
	Efficiency (%) = Volumetric Eff. x Mechanical Eff.	$EFF._{OV} = Eff._{VOL} \times Eff._{MECH}$
Pump Efficiency volumetric in percent)	Vol. Eff. (%) = $\frac{\text{Actual Flow Rate Output (gpm)}}{\text{Theoretical Flow Rate Output (gpm)}}$	$EFF._{VOL} = \frac{Q_{ACT}}{Q_{THEO}} \times 100$
Pump Efficiency (mechanical in percent)	Mech. Eff. (%) = $\frac{\text{Theoretical Torque to Drive}}{\text{Actual Torque to Drive}}$ x 100	$EFF._{MECH} = \frac{T_{THEO}}{T_{ACT}} \times 100$
Pump Life (B_{10} bearing life)	Bearing Life =Rated Hrs. x $\left(\frac{\text{Rated RPM}}{\text{New RPM}} \times \frac{\text{Rated PSI}}{\text{New PSI}}\right)^3$	B_{10} = Rated Hrs x $\left(\frac{RPM_R}{RPM_N} \times \frac{PSI_R}{PSI_N}\right)^3$

One **British Thermal Unit (BTU)** is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. One horsepower = 2545 BTU/hr.

Thermal Formulas

Formula for:	Word Formula:	Letter Formula:
Reservoir Cooling Capacity (based on adequate air circulation)	Heat (BTU/hr.) = 2 x Temperature Difference Between Reservoir Walls & Air (F°) x Area of Reservoir (sq. in.)	BTU/hr. = 2.0 x Δ F° x A
Heat in Hydraulic Oil (approx.) (due to system inefficiency (SG = 0.89 - 0.92)	Heat (BTU/hr.) = Flow Rate (gpm) x 210 x Temperature Difference (F°)	BTU/hr. = Q x 210 x Δ F°
Heat in Fresh Water (approx.)	Heat (BTU/hr.) = Flow Rate (gpm) x 500 x Temperature Difference (F°)	BTU/hr. = Q x 500 x Δ F°
Heat in Hydraulic System Due to Unused Flow/Pressure	Heat (BTU/hr.) = Flow Rate (gpm) x 1.485 x Pressure Drop (psig)	BTU/hr. = Q x 1.485 x psig

Actuator Formulas

Formula for:	Word Formula:	Letter Formula:
Cylinder Area (in square inches)	Area = π x Radius^2 (inches)	$A = 3.14 (r^2)$
	Area = $\frac{\pi}{4}$ x Diameter^2 (inches)	$A = \frac{3.14}{4} (D^2)$ or $A = 0.785 (D^2)$
Cylinder Force (in pounds, push or pull)	Force = Pressure (psig) x Net Area (sq. in.)	F = psig x A or F = P (A)
Cylinder Velocity or Speed (in feet per second)	Velocity = $\frac{\text{231 x Flow Rate (gpm)}}{\text{12 x 60 x Net Area (sq. in.)}}$	$V = \frac{231 (Q)}{720 (A)}$ $V = \frac{0.3208 (Q)}{A}$ (See Note 1 Below)
Cylinder Volume Capacity (in gallons of fluid)	Volume = $\frac{\pi \text{ x Radius}^2 \text{ (inches) x Stroke (inches)}}{231}$	$V = \frac{3.14 (S)}{231}$ S = length of stroke
	Volume = $\frac{\text{Net Area (sq.in.) x Stroke (inches)}}{231}$	$V = \frac{A (S)}{231}$ S = length of stroke
Cylinder Flow Rate (in gallons per minute)	Flow Rate = $\frac{\text{12 x 60 x Vel. (ft./sec.) x Net Area (sq. in.)}}{231}$	$Q = \frac{720 (V)(A)}{231}$ $Q = 3.117 (V)(A)$ (See Note 2 Below)
Fluid Motor Torque (in inch-pounds)	Torque = $\frac{\text{Pressure (psig) x Motor Displacement (cu. in.)}}{2\pi}$	$T = \frac{psig (d)}{2 (\pi)}$ $T = \frac{P (d)}{2 (3.14)}$
	Torque = $\frac{\text{Horsepower x 63025}}{\text{rpm}}$	$T = \frac{63025 (HP)}{n}$
	Torque = $\frac{\text{Flow rate (gpm) x Pressure (psig) x 36.77}}{\text{rpm}}$	$T = \frac{Q (psig) (36.77)}{n}$ $T = \frac{Q (P) (36.77)}{n}$ (See Note 3 Below)
Fluid Motor Torque/100 psig (in inch-pounds)	Torque/100 psig = $\frac{\text{Motor Displacement (cu. in./rev.)}}{0.0628}$	T/100 psig = $\frac{d}{0.0628}$
Fluid Motor Speed (in revolutions per minute)	Speed = $\frac{\text{231 x Flow Rate (gpm)}}{\text{Motor Displacement (cu. in./rev.)}}$	$n = \frac{231 (Q)}{d}$
Fluid Motor Power (in horsepower output)	Horsepower = $\frac{\text{Torque Output (inch-pounds)}}{63025}$	$HP = \frac{T (n)}{63025}$

Note 1: Use 0.3208333 for greater accuracy. **Note 2:** Use 3.116883117 for greater accuracy. **Note 3:** Use 36.77071 for greater accuracy.

About Continental Hydraulics

Continental Hydraulics grew from the need for highly reliable fluid power components. Because existing hydraulic components couldn t meet the performance and reliability standards of DoAll saws, Continental Machines began to manufacture pumps, valves and power units. As the reputation for these components spread, so did the demand. Continental Hydraulics Division was formed in 1962 to design, manufacture and sell reliable hydraulic components around the world.

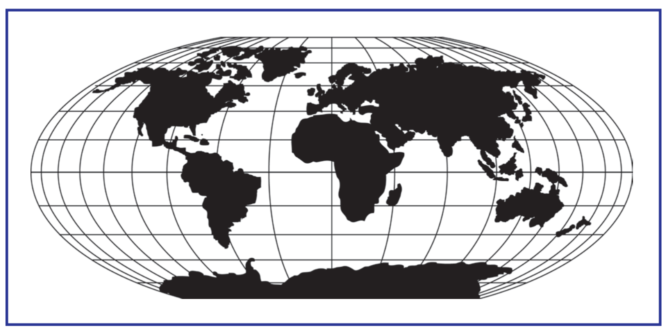
Today, whenever reliable, precise hydraulic power is required, Continental Hydraulics products meet the need. They re found in applications as diverse as machine tools, plastic molding machines, marine auxiliary power controls and deck handling equipment, heavy construction, oil field and farm equipment and foundry mold handling equipment.

Continental products are born in an extensive research and design facility. Every product - every new design undergoes extensive laboratory evaluation. Then field testing insures that the product or design meets or exceeds high standards for performance and service life.

Reliability also comes from our modern automated production facilities. Sophisticated in-process quality control and 100% product testing maintain our rigid quality standards in each and every product.

Continental Hydraulics Distributors are located in every major industrial region in North America, and throughout the world.. They provide assistance in selecting components and developing systems. They also provide a readily available supply of products, parts, after-sale service and training. If you have special design requirements, Continental Hydraulics Regional Managers can recommend special products to meet your specific design or performance criteria.

We believe that Continental Hydraulics products are the finest you can buy. We encourage you to ask your Continental Distributor for a list of references in your area. Check our reputation for performance, reliability, delivery and service. Find out why people who buy Continental stay with Continental.



Why settle for close enough when you need hydraulics?

Continental Hydraulics offers a complete line of products to meet your need for reliable, precise fluid power. Turn to Continental for vane and piston pumps, a full line of control valves, integrated hydraulic circuits, and hydraulic power units.

Continental's products are used in diverse applications such as plastic molding machinery, machine tools, pulp and paper machines, marine auxiliary power controls and deck handling equipment, and masonry product production equipment.

Distributors who know how to help — Anyone can say, "Here's our catalog, take your pick." Continental Distributors work with you to find out what you need, and with our engineers to make sure you get it.

Service and support — To provide maximum service and assistance, Continental Hydraulics maintains a strong distribution network, with representatives throughout North America and around the world. The average Continental Distributor has been with us for 15 years. He's got repair and replacement parts, and the skill to solve your hydraulics problem.

Our Distributors work hand-in-hand with our Engineers to select components and build systems that will meet your toughest specifications. And they'll suggest creative solutions that can help save money or enhance performance.

Whether you need a complete hydraulic power supply or a single directional control valve, come to Continental.

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