

EATON

Vickers

Pilot Operated Directional Valves

Catalog

DG3V-5, 10 Series, Pilot Operated

DG5V-5, 10/20 Series, Solenoid Controlled, Pilot Operated

ISO 4401-05-05-0-94

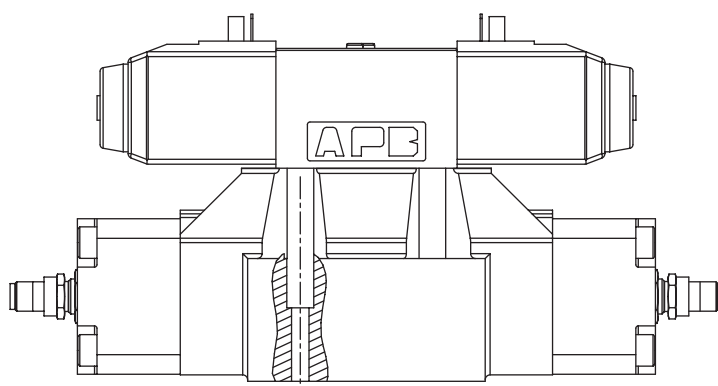
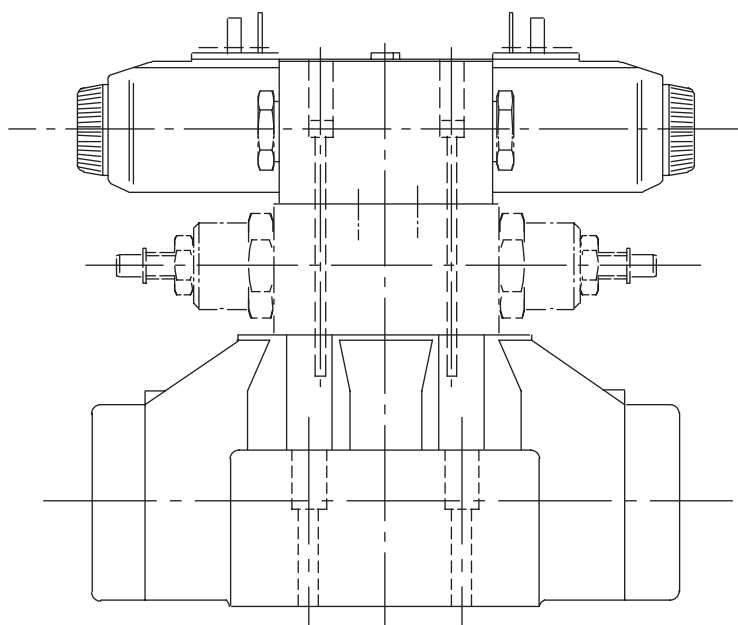


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DG5V-5 10/20 Series, Solenoid Controlled Pilot Operated Directional Valves

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Introduction

Basic Characteristics

Max. operating pressure
315 bar (4567 psi)

Max. flow at max. pressure
160 L/min (42 USgpm)

General Description

These valves are used for controlling the starting, stopping and direction of fluid flow.

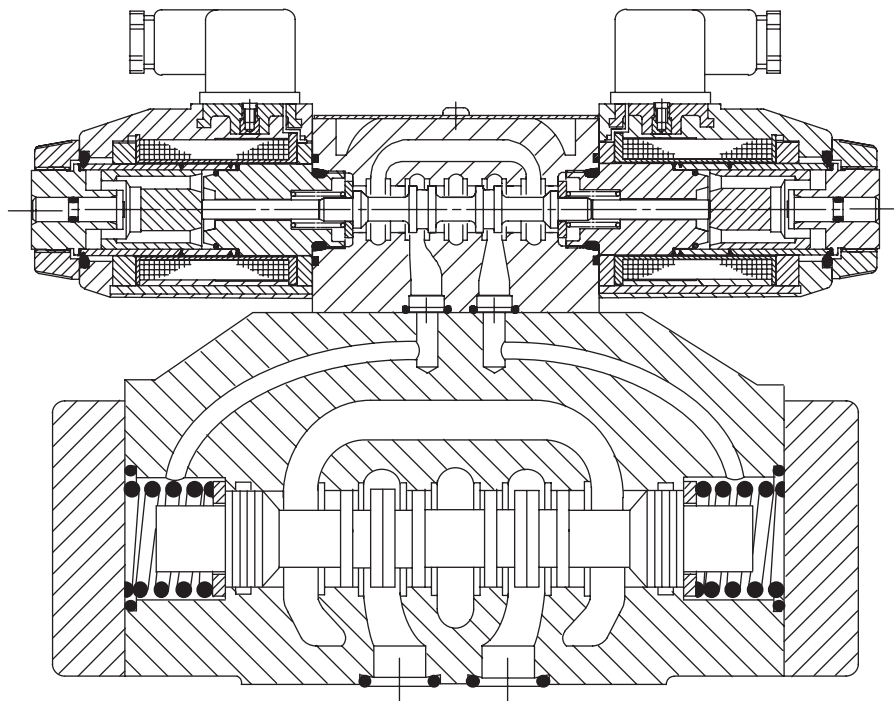
Two types of control are available:

- Hydraulic pilot pressure (DG3V-5 models)
- Integrally-mounted solenoid operated pilot valves (DG5V-5 models) comprising spring-offset, spring-centered and detented versions. Pilot pressure and drain can be independently configured for internal or external connection.
- **Optional mainstage spool position monitoring switch (CE marked)**

All spool types have been designed to provide good low-shock, fast-response characteristics which can be enhanced by an optional pilot choke module to control the speed of travel of the main spool.

Typical Section

DG5V-5-2C



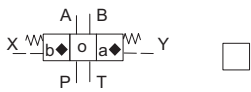
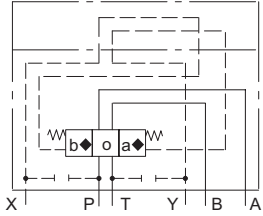
Functional Symbols

DG3V-5 Pilot Operated Models

Comprehensive and simplified symbols.

Spring Centered, DG3V-5-**-C

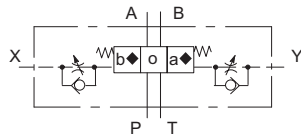
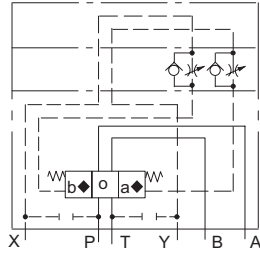
Spool types: All



◆ "a" and "b" interchanged for spool type 8

DG3V-5-**-C Models with Pilot Choke Module

Obtained by specifying "2" at Model Code position 4



Symbols on Nameplates

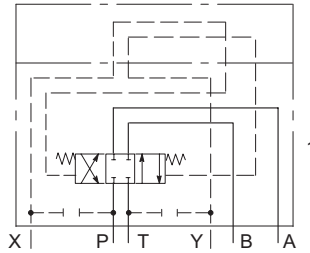
Typical illustrations for:

Control elements (i.e. solenoid pilot valve, choke module, cover plate) used with size 5 main stage valves are standard Vickers units complete with their individual nameplates including model code and symbols. The main stage carries the model code of the 2-stage valve and the functional symbol of the main stage spool.

Referring to the examples, nameplates are located as follows:

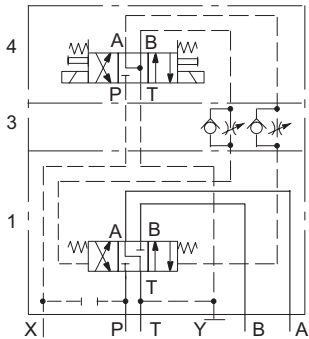
1. On main stage (DG3V-5/DG5V-5)
2. On cover plate (DG3V-5)
3. On pilot choke module (DG5V-5)
4. On pilot stage valve (DG5V-5)

DG3V-5-2C



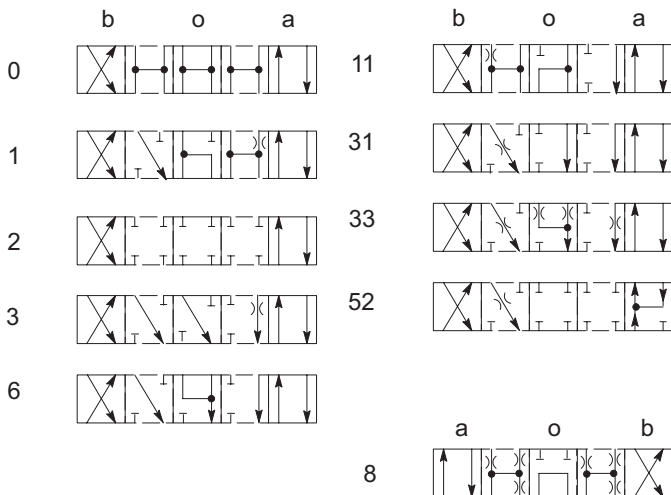
Note that for clarity pilot lines (dotted lines in illustrations) are omitted from the main-stage nameplate.

DG5V-5-3C-2-E-T



Spool Types

Shown in 3-position form, plus 2 transients.



Notes:

1. In the detailed and simplified symbols on the previous pages, the transient positions are omitted for simplicity.
2. In certain 2-position valves, the "o" position becomes an additional transient, i.e. in DG5V-5-**-A(L) and DG5V-5-**-N valves.

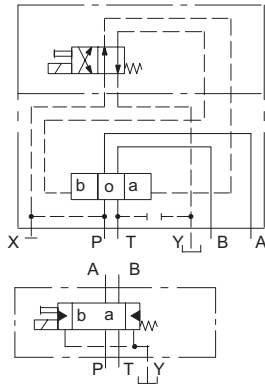
Functional Symbols

DG5V-5, Solenoid Controlled, Pilot Operated Models

Comprehensive and simplified symbols shown configured for external pilot supply and internal drain

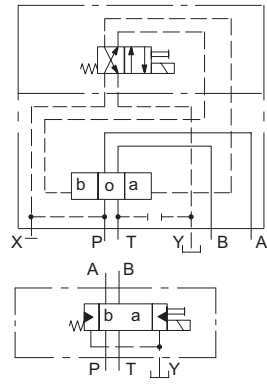
Spring Offset, End-to-End, DG5V-5**A

Spool types: 0, 2, 6, 52



Spring Offset, End-to-End, Opposite Hand, DG5V-5**AL

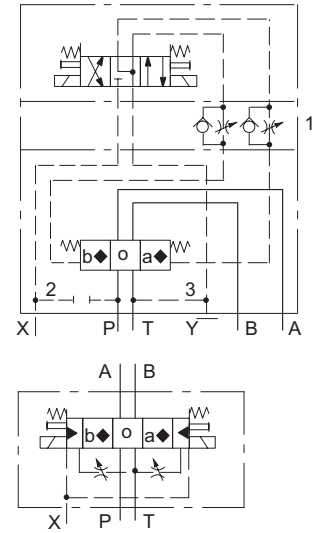
Spool types: 0, 2, 6, 52



DG5V-5 Options

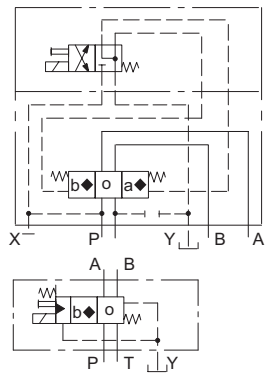
The following are shown in a DG5V-5**C example:

1. Pilot choke module
2. External pilot connection
3. Internal drain



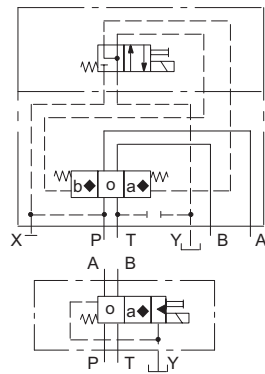
Spring Offset, End-to-Center

Models Spool types
 DG5V-5**B 0, 2, 52
 DG5V-5**BL 8



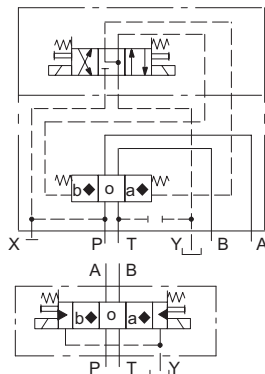
Spring Offset, End-to-Center, Opposite Hand

Models Spool types
 DG5V-5**B 8
 DG5V-5**BL 0, 2, 52



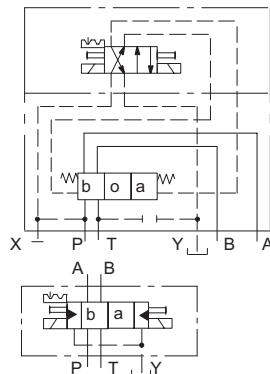
Spring Centered, DG5V-5**C

Spool types: All



Detented, DG5V-5**N

Spool types: 0, 2, 6, 52



Model Codes

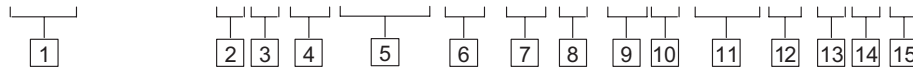
For pilot operated valves:

(F3-)DG3V-5-** C (-2)-1*



For solenoid controlled, pilot operated valves:

(F3-)DG5V-5-** ** (-2) (- P**) (-E)(-T)(*)-(V)M-***** (L)-* -* -**



1 Special Seals for Phosphate Esters

Omit for standard seals (see "Hydraulic Fluids" section)

2 Spool Type

See "Functional Symbols" section on pages 3-4.

3 Spool Spring Arrangement

For DG3V-5

C - Hydraulic pilot-operated, 3-position, spring-centered

For DG5V-5▲

A - Single solenoid, spring-offset to position "a"; energize solenoid for position "b"

AL - Single solenoid, spring-offset to position "b"; energize solenoid for position "a"

B - Single solenoid, spring-offset to center position "o"; energize solenoid for position "b"

BL - Single solenoid, spring-offset to center position "o"; energize solenoid for position "a"

C - Double solenoid, spring-centered; energize solenoid for position "a" or "b"

N - Double solenoid; energize solenoid for position "a" or "b"; detent-held in last selected position ■

▲ All main-stage assemblies are spring-centered. The conditions described depend on the availability of pilot pressure in excess of 4.5 bar (65 psi) to move the spool against these springs. This is particularly important when using external pilot pressure supply.

■ Subject to availability of pilot pressure.

4 Spool Shift Control

2 - Pilot choke adjustment for both directions of spool travel

Omit if not required

5 Main Stage Spool Monitoring Switch

(Omit if not required.)

PCA - Center sensing switch on "A" port end

PCB - Center sensing switch on "B" port end

PDA - Double offset sensing switch on "A" port end

PDB - Double offset sensing switch on "B" port end

PCD - Center sensing switch on "A" port end and double offset sensing switch on "B" port end

PPA - Offset sensing proximity switch "A" port end

PPB - Offset sensing proximity switch "B" port end

PPD - Offset sensing proximity switch both ends

* The spool position monitoring switch shown on this technical document is CE marked and certified and complies to European Standard EN 61000-6-4: 2001 (Emissions) for Class A and European Standard EN 61000-6-2: 2001 (Immunity).

■

6 Pilot Pressure Supply

E - Valve configured for external pilot supply to port "X"

Omit for internal pilot supply (port "X" must be blanked off, e.g. at the valve mounting face, when using internal pilot supply)

7 Pilot Drain Arrangement◆

T - Valve configured for internal pilot valve drain (port "Y" must be blanked off, e.g. at the valve mounting face, when using internal drain)

Omit for external drain from port "Y".

◆ See 13 for pressure limits.

8 Pilot Valve Manual Override Option

No Symbol = Plain override(s) on solenoid end(s) only.

H▼ - Water-resistant override(s) on solenoid end(s)

Z - No override at either end

▼ See catalog 2015 for details

8 Solenoid Identity Method

V - Solenoid "A" at port "A" end of pilot valve body and/or solenoid "B" at port "B" end of pilot valve body, independent of main-stage port locations and spool type.

9 Solenoid Identity Method (continued)

Omit (except as noted below) for US ANSI B93.7 standard requiring solenoid "A" energization to connect main ports P and A and/or solenoid "B" energization to connect P and B, independent of solenoid location.

Note: The "V" code is always used for valves with type "8" spool as the solenoid identity is the same for both methods of identification.

10 Start of Electrical Features

M - Start of electrical features codings

11 Solenoid Type/Connection(s)

U - ISO 4400 (DIN 43650) mounting■

FJ - M20 thread junction box

FTJ - M20 thread junction box and terminal strip

FW - 1/2 NPT thread junction box

FTW - 1/2 NPT thread junction box and terminal strip

FPA3W - Junction box with 3-pin male connector ▲ to NFPA T3.5.29-1980 for single-solenoid valves

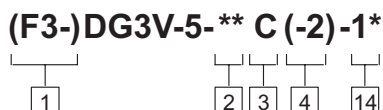
FPA5W - Junction box with 5-pin male connector ▲ to NFPA T3.5.29-1980 for single or double-solenoid valves

■ Some female plug connector options available separately from Vickers Systems (see "Plugs for ISO 4400" on page A.16).

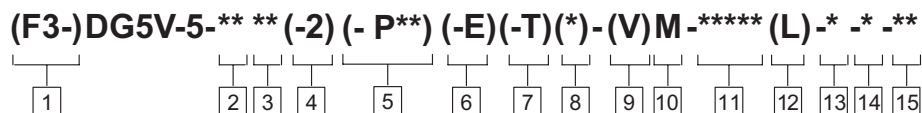
▲ Female connector to be supplied by user.

Model Codes

For pilot operated valves:



For solenoid controlled, pilot operated valves:



12 Indicator Lights

L - Lights fitted

No Symbol - Lights not fitted

For U-code coils use plug with integral light, see page XX.

13 Coil Rating

See "Operating Data" on page XX for further information.

A - 110V AC 50 Hz

B - 110V AC 50 Hz/◆
120V AC 60 Hz

C - 220V AC 50 Hz

D - 220V AC 50 Hz/◆
240V AC 60 Hz

G - 12V DC

H - 24V DC

◆ For 60 Hz or dual frequency.

14 Port T or Y Maximum Pressure†

5 - 100 bar (1450 psi), for DC solenoids only

6 - 160 bar (2300 psi), for AC solenoids only

† This pressure rating (determined by the pilot valve drain port) is applicable to:

1. Port T when using internal drain ("T" at position 6)

2. Port Y when using external drain (no symbol at position 6)

15 Design Number, 10 and 20 Series

Subject to change. Installation dimensions unaltered for design numbers 10 to 19 and 20 to 29 inclusive.

10 - DG5V-5 with AC solenoids DG3V-5

20 - DG5V-5 with DC solenoids

Features in brackets are optional; all other features must be specified when ordering.

For DG5V solenoid-controlled models, other features/options on the DG4V-3/3S 60-design pilot valve may be made available as applicable and subject to quantity required. See appropriate catalog for details:

- 2015 for AC voltages: DG4V-3 (high performance) models
- 2168 for DC voltages: DG4V-3S (standard performance) models

Operating Data

Based on petroleum oil at
36 cSt (168 SUS) and at
50 C (122 F).

MAXIMUM PRESSURES:

DG3V-5 valves; ports:	
All Ports	315 bar (4567 psi)
DG5V-5 valves, externally drained; ports:	
P, A, B, T and X	315 bar (4567 psi)
Y	315 bar (4567 psi)
with AC solenoids	160 bar (2300 psi)
with DC solenoids	210 bar (3045 psi)
DG5V-5 valves, internally drained; ports:	
P, A, B, X and Y	315 bar (4567 psi)
T	315 bar (4567 psi)
with AC solenoids	160 bar (2300 psi)
with DC solenoids	210 bar (3045 psi)

Maximum Flow 160 L/min (42 USgpm)

Minimum Pilot Pressure See "Control Data"

For all data related to the DG4V-3/3S 60-design pilot valve,
refer to appropriate catalog:

2015 for AC voltages: DG4V-3 models
2168 for DC voltages: DG4V-3S models

TEMPERATURE LIMITS

Minimum ambient	-20°C (-4°F)
Maximum ambient	As for fluids
DG3V-5 models	As for fluids
DG5V-5 models	As for fluids
With AC dual frequency coils:	
At 50 Hz and 107% voltage	40°C (104°F)
At 50 Hz and 110% voltage	30°C (86°F)
At 60 Hz and 107% voltage	50°C (122°F)
At 60 Hz and 110% voltage	40°C (104°F)
With AC single frequency (50 Hz) coils:	
At 50 Hz and 110% voltage	40°C (104°F)
With DC coils at 110% voltage	70°C (158°F)

Fluid Temperature Limits

	Petroleum Oil	Watercontaining
Min.	-20 C (-4 F)	+10 C (+50 F)
Max.*	+80 C (+176 F)	+54 C (+130 F)

* To obtain optimum service life from both fluid and hydraulic system, 65 C (150 F) is the recommended maximum fluid temperature, except for water-containing fluids. For synthetic fluids consult fluid manufacturer or Vickers where limits are outside those for petroleum oil.

Solenoid Identification (refers to installation drawing, page XX)

For model code variants:

Position 3, spool spring arrangement

Position 8, solenoid identity method

MODEL	SPOOL TYPES	SOLENOID IDENTITY MAIN PORT A END	SOLENOID IDENTITY MAIN PORT B END
DG5V-5-*A/B(-2)(-E)(-T)(-**-M	All except "8"	-	B
DG5V-5-*A/B(-2)(-E)(-T)(-**-VM	All except "8" "8" only	- B	A -
DG5V-5-*AL/BL(-2)(-E)(-T)(-**-M	All except "8"	A	-
DG5V-5-*AL/BL(-2)(-E)(-T)(-**-VM	All except "8" "8" only	B -	- A
DG5V-5-*C/N(-2)(-E)(-T)(-**-M	All except "8"	A	B
DG5V-5-*C/N(-2)(-E)(-T)(-**-VM	All spools	B	A

Performance Data

Pilot Pressures

Differential pressure, i.e. pilot pressure at port P (or port X) minus pilot drain pressure at port T (or port Y).

Maximum

315 bar (4567 psi)

Minimum (for max. flow):

For spool types 0, 1, 8♦, 11
4,5 bar (65 psi)

For spool type 6

8 bar (116 psi)

For spool types 2, 3, 31, 33, 52

10 bar (145 psi)

All main stages are spring-centered. Selection of spool offset positions "a" or "b" requires pilot pressure equal to or in excess of the above minimums to move the spool against the spring force. This is particularly important when using external pilot pressure supply.

♦ When using a type 8 spool with the valve configured for internal pilot supply, flow through the valve should be at least 80 L/min (21 USgpm) to generate 4,5 bar (65 psi) pressure drop when the spool is in the center position (flow P to T).

DG5V-5-***N

The spool of the pilot valve of this model is detent-held in its last selected position, and the spool will remain ▲ in this position after the solenoid has been de-energized.

The main stage is spring-centered and requires at least minimum pilot pressure to hold the spool in its offset ("detent-held") position. When pilot pressure falls below the recommended minimum, the main-stage spool will move to position "o" under the action of the centering springs. The system designer should ensure that under these conditions the flow condition at center position "o" is appropriate for the application.

▲ See comment in "Mounting Attitude".

Pilot Choke Module

This allows the velocity of the main-stage spool to be controlled, thereby reducing transient shock conditions. For best results a constant, low pilot pressure is recommended.

Hydraulic Fluids

These valves are suitable for use with hydraulic oils, water-in-oil emulsions and water glycols.

The extreme operating range is from 500 to 13 cSt (2270 to 70 SUS) but the recommended running range is 54 to 13 cSt (245 to 70 SUS).

Contamination Control Requirements

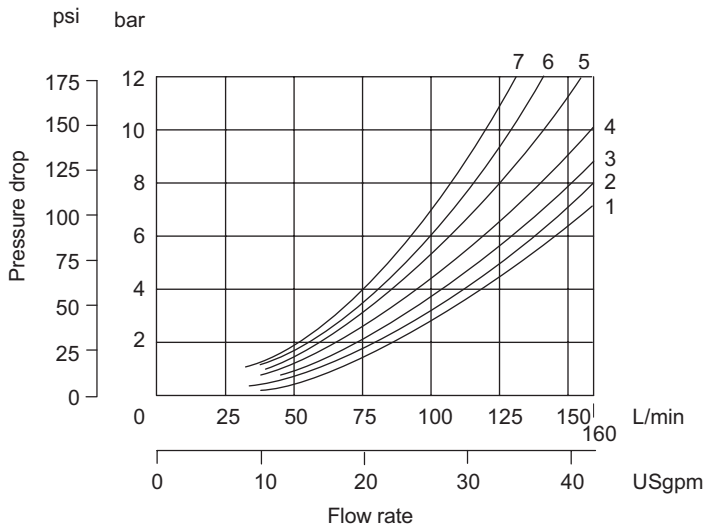
Recommendations on contamination control methods and the selection of products to control fluid condition are included in Vickers publication 9132 or 561, "Vickers Guide to Systemic Contamination Control". The book also includes information on the Vickers concept of "ProActive Maintenance".

The following recommendations are based on ISO cleanliness levels at 2µm, 5µm and 15µm. For products in this catalog the recommended levels are:

Up to 210 bar (3000 psi)
20/18/15

Above 210 bar (3000 psi)
19/17/14

Based on petroleum oil at 36 cSt (168 SUS) and at 50 C (122 F).



SPOOL TYPE	FOR POSITIONS "A" OR "B"				FOR POSITION "O" :		
	P → A	B → T	P → B	A → T	A → T	B → T	P → T
0	4	4	1	4	1	3	5
1	1	4	1	4	3	-	6
2	1	2	1	5	-	-	-
3	2	3	1	4	5	-	-
6	1	2	1	3	-	-	-
8	4	2	2	6	-	-	7
11	4	1	3	4	-	7	5
31	3	3	3	4	-	4	-
33	2	2	3	4	-	-	-
52	2	3	3	5	-	-	-

Installation Dimensions

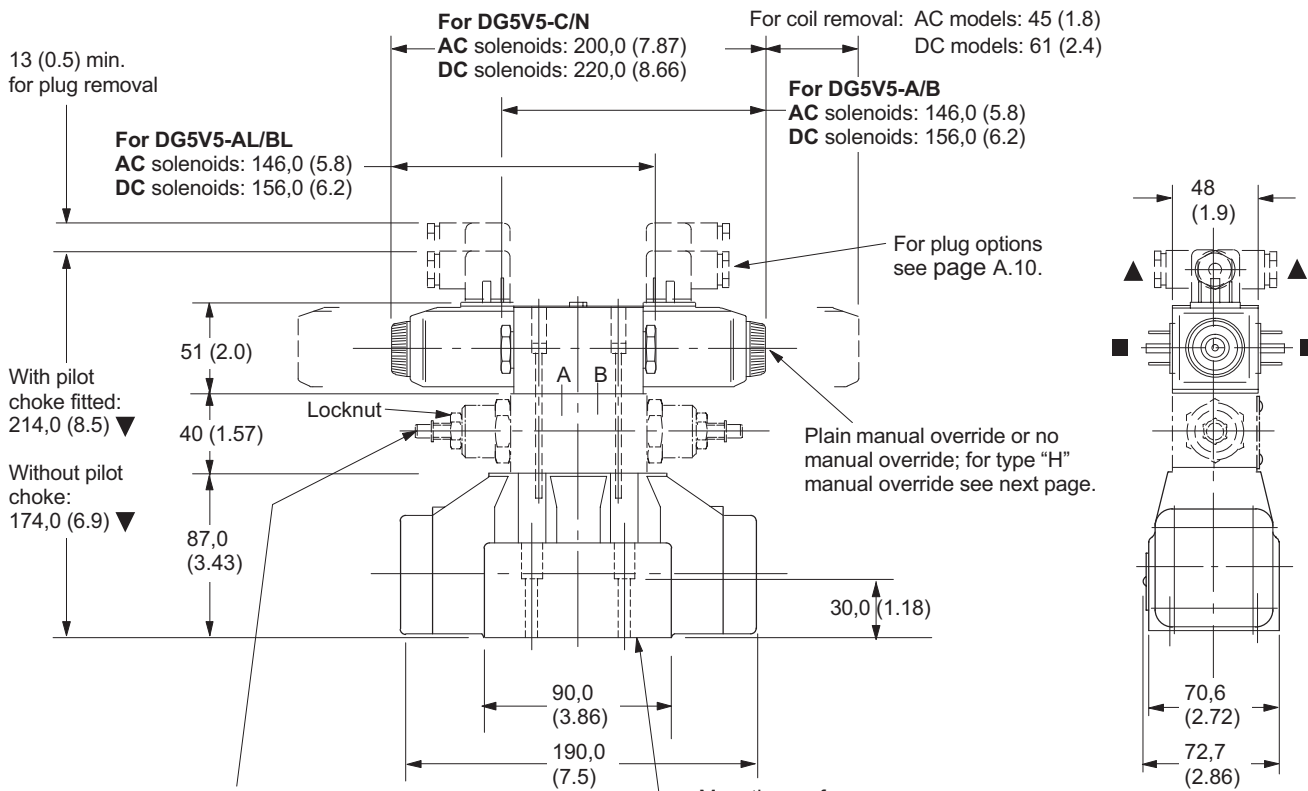
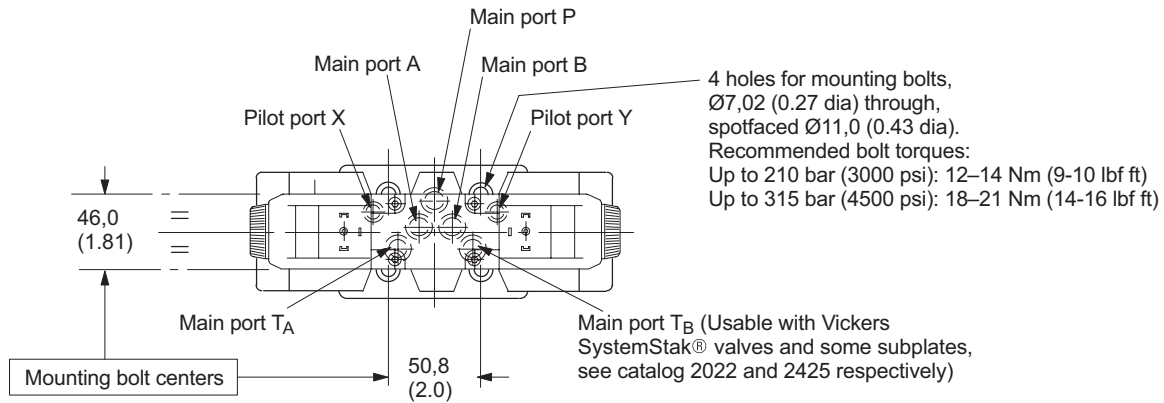
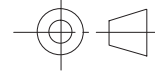
Millimeters (inches)

Solenoid Controlled Models with ISO 4400 (DIN 43650) Electrical Connections and Optional Pilot Choke

DG5V5-5-**(L)(-2)(-E)(-T)(-*)(-V)M-U example

For solenoid identification see previous page.

3rd angle
projection



Pilot choke adjusters fitted when Model Code **4** = 2.
To adjust, turn locknut counter-clockwise, then turn screw clockwise to slow down rate of spool travel, or counter-clockwise to increase the rate.
Re-tighten locknut to 25-30 Nm (18-22 lbf ft).

- ▼ May vary according to plug source.
- Alternative plug positions by loosening knurled nut counter-clockwise, turning coil and re-tightening nut.

- ▲ Cable entry can be positioned at 90° either way from position shown, by re-assembling the contact holder into the appropriate position inside the plug connector housing.

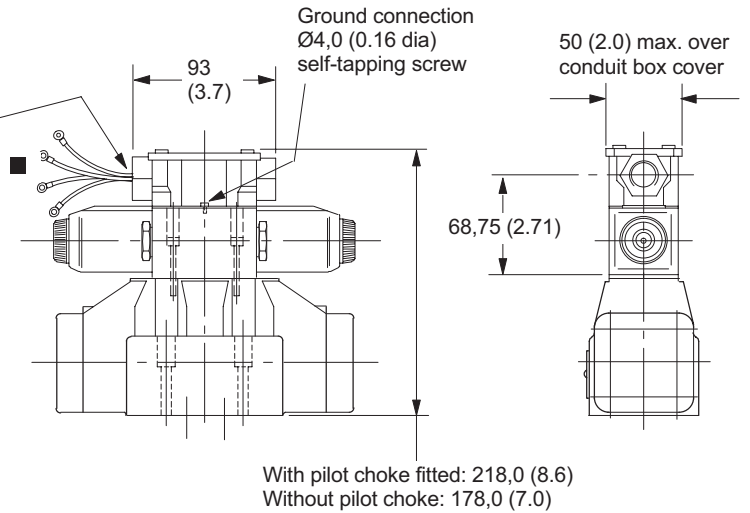
Optional Features

Solenoid Controlled Models with Junction Box having Optional Terminal Strip and Indicator Lights

DG5V-5-***(L)(-2)(-E)(-T)(-*)-(V)M-F****(L) example

For solenoid identification see page A.7.
Available also with other options shown on previous and following pages.

M20-6H x 1,5 thread for F(T)J options, or 1/2" NPT for F(T)W options, at both ends. Closure plug fitted at one end.
For other options see [10](#) & [11](#) in "Model Code" on page A.5 and under "NFPA Connector---" and "Terminal Strip and Lights", on pages A.10 and A.11.



■ Ref. "Model Code" [10](#):
Codes "FJ" and "FW":

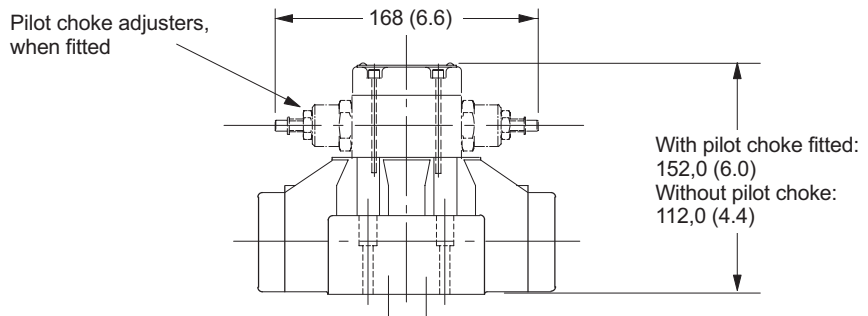
2 lead wires for each solenoid, approx. 150 (6.0) long.
M3 (#6) terminals provided for customer connection.

Codes "FTJ" and "FTW":

Valve supplied with lead wires connected into terminal strip suitable for M3 (#6) terminals provided for customer connection.

Pilot Operated Models with Optional Pilot Choke

DG3V-5-** C(-2) example



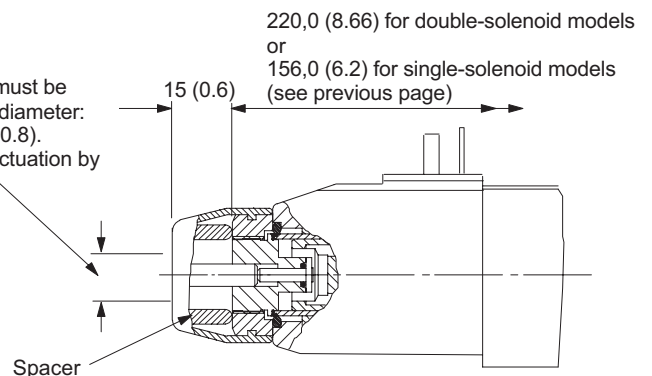
Water-Resistant Manual Override

DG5V-5---M-*****(L)-H valves

Application:

General use where finger operation is required (standard manual overrides can only be operated by using a small tool).

Manual actuation must be applied within this diameter: approximately 20 (0.8). Spacer prevents actuation by larger device.

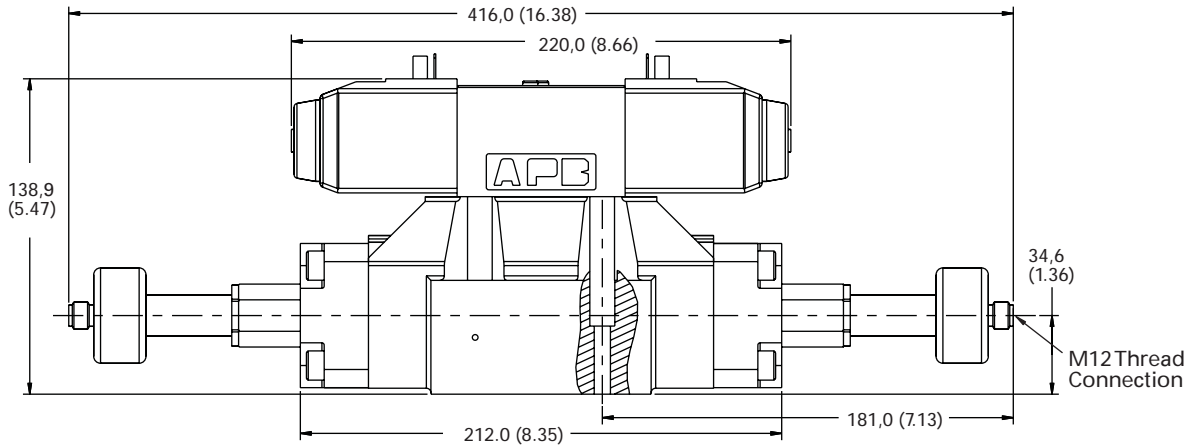


Note: "H" feature is not field convertible from other models; specify with order.

Electrical Information

DG5V-5 with Main Stage Spool Monitoring Switch "PCA", "PCB", "PDA", "PDB" or "PCD" Models (LVDT style)

Millimeters (inches)

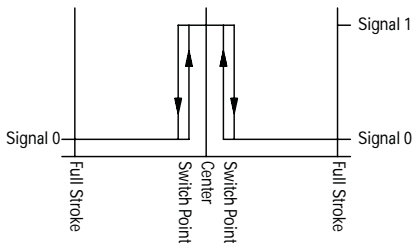


SPECIFICATIONS

SUPPLY VOLTAGE	24VDC +/- 20%
(FULL WAVE BRIDGE WITH CAPACITOR)	
REVERSE POLARITY PROTECTION	MAX. 300 V INSTALLED
RIPPLE VOLTAGE	10%
CURRENT CONSUMPTION	40 mA APPROX
OUTPUTS	NC CONTACT POSITIVE
OUTPUT VOLTAGE	(NO SHORT CIRCUIT PROTECTION)
SIGNAL L	INPUT - 2.5 V
SIGNAL O	< 1.8 V
OUTPUT CURRENT	< 400 mA AT INPUT + 20%
ENVIRONMENTAL PROTECTION	IP65 (WITH MOUNTED PLUG)
OPERATING TEMP RANGE	0° C TO +85° C
WIRE CROSS-SECTIONAL AREA	4 X 0.5mm ²
TENSILE STRENGTH OF TRANSMIT CONDUIT p dyn.	315 bar
CE DECLARATION OF CONFORMITY NO.	00 02 002 9 93

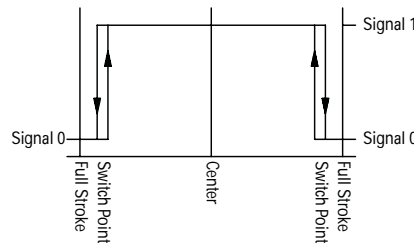
ATTENTION: EMC ONLY ENSURED WHEN USING SCREENED CABLES AND SCREENED PLUG CASING!

TYPICAL "PCA/PCB" OUTPUT
(FOR SENSING CENTER POSITION)



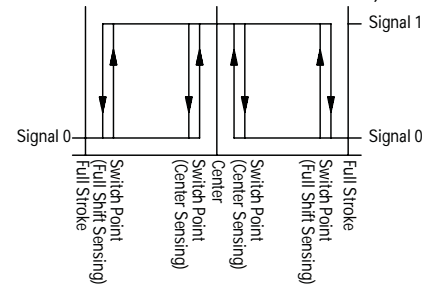
Signal 0 = Voltage at pin 2/4 < 1.8V
Signal 1 = Voltage at pin 2/4 > (Vs - 2.5V)

TYPICAL "PDA/PDB" OUTPUT
(FOR FULL SHIFT SENSING)



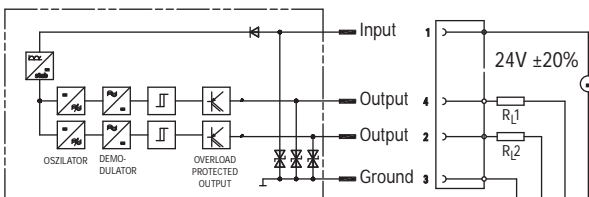
Signal 0 = Voltage at pin 2/4 < 1.8V
Signal 1 = Voltage at pin 2/4 > (Vs - 2.5V)

TYPICAL "PCD" OUTPUT
(FOR CENTER SENSING 'A' PORT END,
FULL SHIFT SENSING 'B' PORT END)



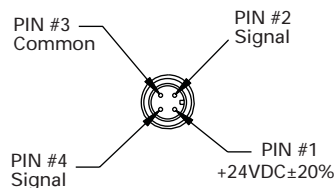
Signal 0 = Voltage at pin 2/4 < 1.8V
Signal 1 = Voltage at pin 2/4 > (Vs - 2.5V)

Electrical Schematic and Mating Connector Detail



R₁, R₂ = e.g. Coil Resistance of the switch relay >= 60 OHMS

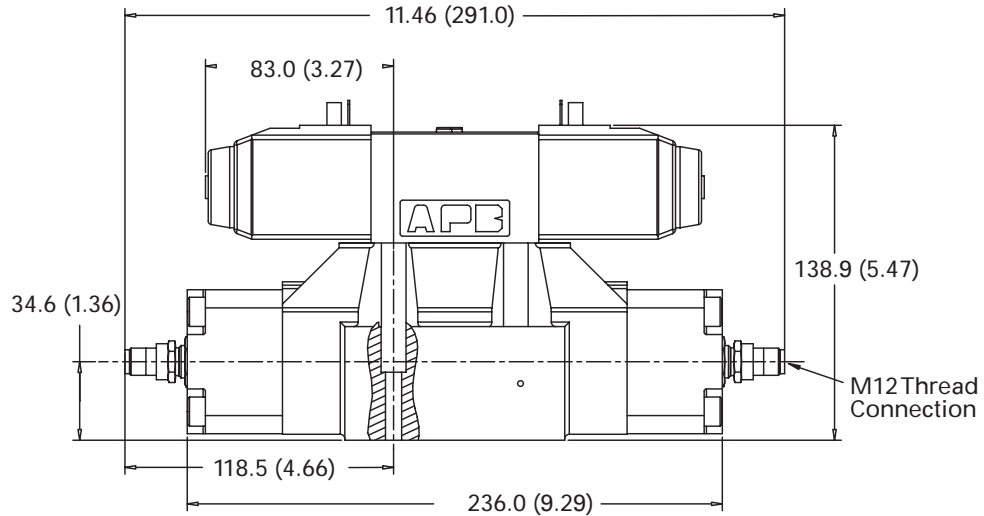
Connector Detail



Electrical Information

DG5V-5 with Main Stage Spool Monitoring Switch "PPA", "PPB", "PPD" Models (Proximity Switch)

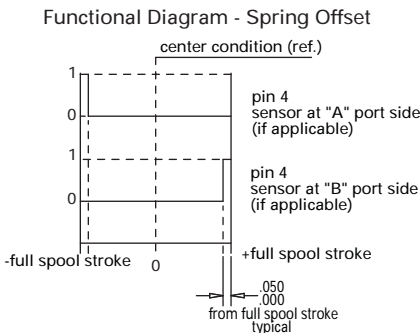
Millimeters (inches)



SPECIFICATIONS

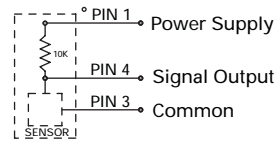
Supply Voltage (Vs)	10 to 30 Vdc
Supply Current (Is)	8 mA at 24 Vdc (plus load current)
Supply Over-voltage Rating:	35 Vdc continuous
Supply Reverse Polarity Rating	-35 Vdc (with no shorts)
Short Circuit Tolerance:	Continuous short between any two pins
High Potential Test, Pin to Case:	300 Vdc
Electromagnetic Compatibility:	ISO 7637 Parts 0 and I worst case and Immunity to Radiated Electromagnetic Fields, 10 KHZ to 1 GHZ per SAE J1113/25 Sep 95
Pins to Case Resistance	50 Megohms
Load Dump Tolerance:	80 Vdc Peak, 400 ms Decay, with 1.5 Ohm Source Impedance
Switching Frequency:	0 to 3K Hz
Output:	Open collector PNP sourcing, normally open
Sensing Distance "d":	.050" ±.010"
Hysteresis:	.010" Max.
Sense Target:	Ferromagnetic steel, minimum dimensions are .75" x .75" x .05" thick
Rise/Fall Time:	6.5/1.5 microsec R1=820 Ohm, C1=20 pF @ 8Vdc
Output Leakage Current	10µa Max.
Output Voltage High:	+Vs - 2.2 Vdc minimum
Output Load Current:	200 mA Max.
Operating Pressure:	5000 psi rating per NFPA T2.6.1 7500 psi Max.
Connector/Cable to withstand 5lb force strain	
Assembly to be capable of 15lb/ft Min. torque applied to locknut	
Operating Temperature:	-40° to 230°F
Humidity:	0 to 100%

Electrical information shown is for offset sensing, Proximity Switch "PPA", "PPB" or "PPD" Models

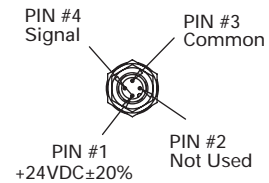


0=voltage at pin 4 0.5V min.
1=voltage at pin 4 (Input-2.2V) min.

Output Circuit Wiring Instructions



Connector Detail



Electrical Information

Plugs for ISO 4400 (DIN 43650) Type Coil Connection

For valves with type "U" coils

The cable entry on these plugs can be repositioned at 90° intervals by reassembly of the contact holder relative to the plug housing.

The cable entry is Pg.11, for cable Ø 6-10 mm (0.24 to 0.39 dia).

Order separately by part number.

PLUGS WITHOUT INDICATOR LIGHTS

Part no.	Color	Use on solenoid coil
710775	Black	Sol. B
710776	Gray	Sol. A

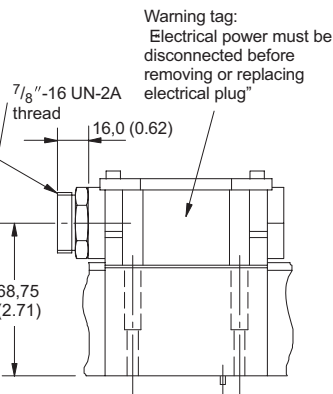
PLUGS WITH INDICATOR LIGHTS

Voltage	Part no. Gray (sol. A)	Part no. Black (sol. B)
12-24V	977467	977466
100-125V	977469	977468
200-240V	977471	977470

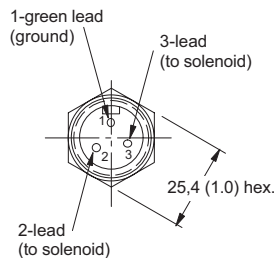
NFPA Connector T3.5.29-1980

DG5V-5-***---FPA3W(L) and DG5V-5-***---FPA5W(L) models

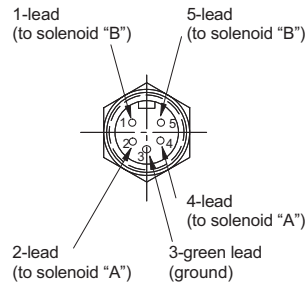
The receptacle is a standard three or five-pole connector with shortened leads and terminals added. The five-pole plug has four leads 101,6 mm (4.0) long and one of 177,8 mm (7.0) length. All wires have US Underwriters Laboratory-recognized non-solder insulated eyelet terminals. The green wire is used for the ground (earth) connection (No. 8-size screw furnished). Valves are supplied prewired.



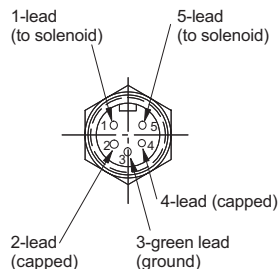
3-pin connector
When fitted in single-solenoid valves, e.g:
DG5V-5-*A(L)(-**-)(V)M-FPA3W(L)
DG5V-5-*B(L)(-**-)(V)M-FPA3W(L)



5-pin connector
When fitted in double-solenoid valves, e.g:
DG5V-5-*C(-**-)(V)M-FPA5W(L)
DG5V-5-*N(-**-)(V)M-FPA5W(L)



5-pin connector
When fitted in single-solenoid valves, e.g:
DG5V-5-*A(L)(-**-)(V)M-FPA5W(L)
DG5V-5-*B(L)(-**-)(V)M-FPA5W(L)



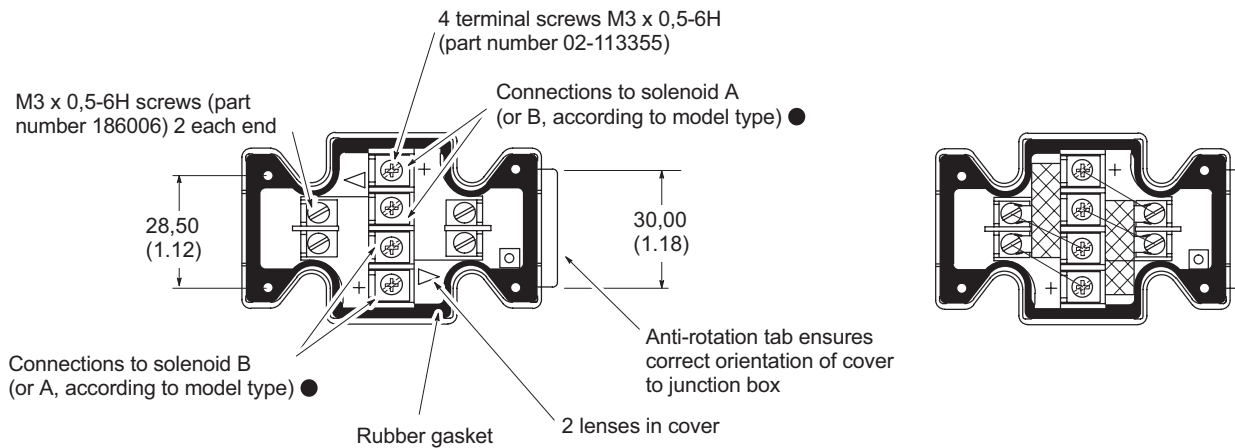
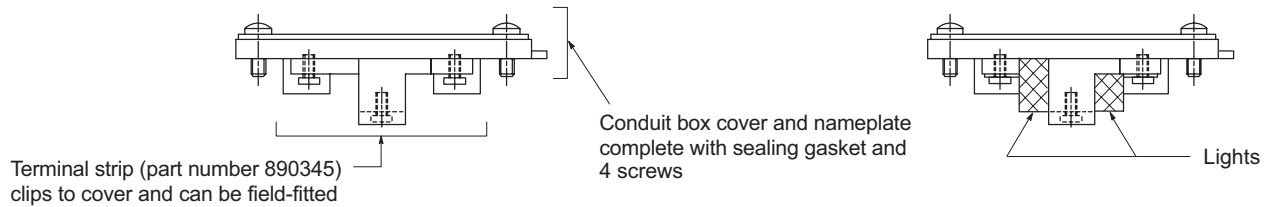
Electrical Information

Terminal Strip and Light Options

When fitted in solenoid controlled valves DG5V-5-**(L)---F****(L).

DG5V-5-**(L)---F*****

DG5V-5-**(L)---F****L*



- 1. For DC coils the +ve lead(s) must be connected to the terminal(s) marked +. When using 3-wire incoming leads to double solenoid valves (i.e. common neutral) the inner pair of terminals must be linked.
- 2. For correct light indication of energized solenoid ensure that solenoid leads are correctly connected: light terminals are common with each outer pair of solenoid terminals according to the side with + mark.

Mounting Attitude

Unrestricted except for no-spring detented model DG5V-5-**N, which may be affected by severe vibration or shock, especially if a solenoid is not energized.

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