

Technical Catalog

# Solenoid Directional Valves DG-S9 Series with Spool Position Monitoring Function



## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

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### Revision History

| Date     | Revision content   | Version |
|----------|--|---------|
| JUN 2019 | Initial release  | 001     |
| APR 2021 | Monitoring instructions, spare parts and ordering instructions were added. | 002     |
| OCT 2021 | Monitoring instructions were revised; D7/M7 option was removed.            | 003     |
| AUG 2023 | Format upgrade & document No. update                                       | 004     |
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## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

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## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

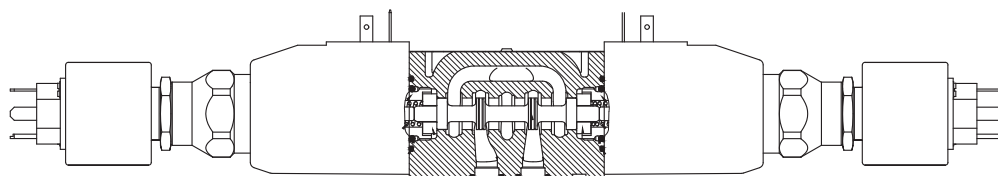
### Overview

#### Typical Applications

This catalog introduces the Solenoid Directional Valve DG-S9 Series with spool position monitoring function. This series are used in the working conditions requiring real-time monitoring of spool position with strict reliability requirements for solenoid directional valves spools, and are widely used in industries with high requirements for safety operation such as machine tools, hydropower, metallurgy, mining, ships and ports. This series of valves are equipped with non-contact electromagnetic induction proximity switches. After the spool reaches the monitoring position, the switch signal is triggered, and the spool status is fed back to the upper computer for processing, thus improving the safety level of the equipment. Typical applications include hydraulic presses, injection molding machines, bottle blowing machines, hydraulic hoists, ship locks, etc.

#### Principle

DG-S9 series solenoid directional valves are designed based on the standard solenoid directional valves with the addition of inductive proximity switch. After the spool reaches the monitoring position, the inductive proximity switch is triggered, and the switch signal is generated. The typical section layout is as follows:



According to different wiring modes, the switch signal of the inductive proximity switch can be monitored by two signal states, namely, normally closed (Pin 2) or normally open (Pin 4). The normally closed or normally open signal is output to the upper computer through the DIN plug or M12 plug configured by users as the signal source for safety monitoring.

DG-S9 series solenoid directional valves can accurately monitor the working position of the solenoid directional valve spool. According to different installation positions of sensors and adjustment positions of switching points, different combinations of monitoring positions can be achieved. See the section of model code and monitoring instructions for detailed description. [Note: In order to ensure safety and reliability, the main valve spool is directly monitored without monitoring the pilot valve spool in the double-stage directional valve.]

### S9 Characteristics

#### DG-S9 Characteristics

- The position of the solenoid directional valve spool can be monitored directly without intermediate steps such as guide rods
- No mechanical contact, long service life
- High precision, good repeatability
- No dynamic seal, high reliability
- Optional normally closed/normally open output signal; various combinations are available, with multiple combinations of end position monitoring and center position monitoring
- Integrated inductive proximity switch with polarity protection, short-circuit protection, overload protection and surge protection
- IP65/IP67
- CE EN61000-6-2/4 EMC compatibility

### Technical Data

#### Hydraulic Valve Parameters

| Features                | DG4V3  | DG4V5 | DG5V7 | DG5V8 |
|-------------------------|--|-------|-------|-------|
| Max. pressure P/A/B bar | 350  | 315   | 350   |       |
| Max. pressure T bar     | 210  |       |       |       |
| Max. flow rate L/min    | 80   | 120   | 300   | 700   |
| Oil temperature °C      | -20 °C ~ +70 °C  |       |       |       |
| IP rating               | IP65 (DIN plug fitted correctly)<br>IP67 (M12 plug fitted correctly) |       |       |       |
| EMC compatibility       | EN61000-6-2/4  |       |       |       |

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Technical Data

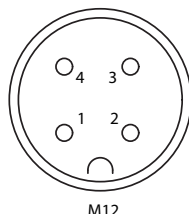
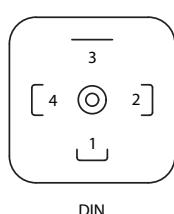
#### Sensor Parameters

| Features                          | Technical parameters |             |
|-----------------------------------|----------------------|-------------|
| Supply voltage                    | V                    | DC 24 ± 20% |
| Voltage drop                      | V                    | ≤2.5        |
| No-load current                   | mA                   | ≤40         |
| Load capacity                     | mA                   | ≤400        |
| Allowable residual voltage        | V                    | ≤1          |
| Repeatability precision (@ +25°C) | mm                   | ≤0.02       |
| Hysteresis loop (@ +25°C)         | mm                   | ≤0.05       |
| Thermal drift (0~+80°C)           | mm                   | ≤±0.15      |

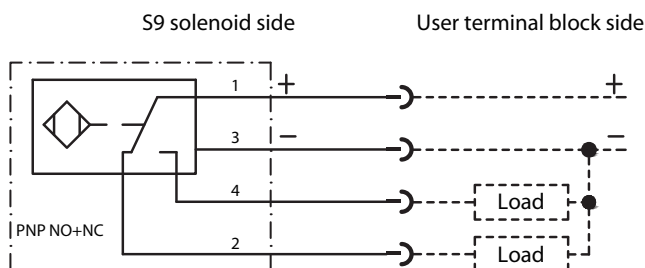
### Wiring Instructions

#### Sensor Wiring

DG-S9 solenoid directional valve inductive switch can be connected as normally open or normally closed. If the corresponding electrical plug is needed, it should be ordered separately (please refer to the Accessory Information on the order number of the electrical plug).



1. Power supply +
2. Output: Normally closed contact
3. Power supply -
4. Output: Normally open contact



#### Wiring Notes

In order to protect the user's electrical cabinet, the valve base plate, solenoid and cable shielding should be connected to a grounding point. In any case, valves and cables should be kept as far away as possible from any electromagnetic radiation source as possible, such as heavy-current cables, relays and certain types of portable radio transmitters. In a worse environment, additional shielding may be needed to avoid interference.

For M12 plug, IP67 can only be achieved if the wires with plugs and cables fused together are configured. If the mode of plugs and cables being welded on site is used and the plug and cable connections are not performed with special protection treatment, only IP54 can be achieved.

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Model Code

#### DG4 Single-stage Valve Model Code

| 1    | 2 | 3    | 4    | 5 | 6 | 7  | 8 | 9 | 10 | 11 | 12 | 13 | 14     |
|------|---|------|------|---|---|----|---|---|----|----|----|----|--------|
| DG4V | * | (*)* | *(L) |   | M | S9 | * | * | U  | H  | *  | ** | EN *** |

#### 1 Valve type

|             |   |
|-------------|---|
| <b>DG4V</b> | Base plate mounted directional control valve, solenoid controlled |
|-------------|---|

#### 2 Mounting interface and maximum port pressure

|          |               |   |
|----------|---------------|---|
| <b>3</b> | CETOP 3 /NG6  | Port pressure of port P, A, and B Max. 350bar |
| <b>5</b> | CETOP 5 /NG10 | Port pressure of port P, A, and B Max. 315bar |

#### 3 Spool type

|             |                                       |
|-------------|---------------------------------------|
| <b>(*)*</b> | See page 9 for valve function diagram |
|-------------|---------------------------------------|

#### 4 Spool spring arrangement

|           |                                 |
|-----------|---------------------------------|
| <b>A</b>  | Spring offset, end-to-end       |
| <b>AL</b> | Same as "A" but left hand build |
| <b>B</b>  | Spring offset, end to center    |
| <b>BL</b> | Same as "B" but left hand build |
| <b>C</b>  | Spring centered                 |
| <b>N</b>  | No-spring detented              |

#### 5 Manual override option

|  |                                     |
|--|-------------------------------------|
|  | Plain override on solenoid end only |
|--|-------------------------------------|

#### 6 Marking symbols

|          |                                 |
|----------|---------------------------------|
| <b>M</b> | Electrical features and options |
|----------|---------------------------------|

#### 7 Spool position indicator switch

|           |   |
|-----------|---|
| <b>S9</b> | With spool position monitoring function |
|-----------|---|

#### 8 Sensor connector type

|          |                                |
|----------|--------------------------------|
| <b>D</b> | DIN 43650 (recommended option) |
| <b>M</b> | M12                            |

#### 9 Monitoring position

|          |   |  |
|----------|---|--|
| <b>0</b> | De-energized position *                         | * Suitable for single solenoid valve.<br>The sensor is located opposite the solenoid |
| <b>1</b> | Energized position *                            |  |
| <b>2</b> | Energized position a and energized position b Δ | Δ Suitable for double solenoid valve   |
| <b>3</b> | Energized position a Δ                          |  |
| <b>4</b> | Energized position b Δ                          |  |
| <b>5</b> | De-energized position □                         | □ Suitable for single solenoid valve.<br>The sensor is located on the solenoid side  |
| <b>6</b> | Energized position □                            |  |

#### 10 Coil type

|          |   |
|----------|---|
| <b>U</b> | ISO 4400 (DIN 43650), mounting base, without plug |
|----------|---|

#### 11 Coil voltage rating

|          |        |
|----------|--------|
| <b>H</b> | 24V DC |
| <b>G</b> | 12V DC |

#### 12 Port T pressure value

|          |         |
|----------|---------|
| <b>7</b> | 210 bar |
|----------|---------|

#### 13 Design number

|           |               |
|-----------|---------------|
| <b>6*</b> | CETOP 3 /NG6  |
| <b>2*</b> | CETOP 5 /NG10 |

#### 14 Special improvements

|               |                         |
|---------------|-------------------------|
| <b>EN ***</b> | Omitted if not required |
|---------------|-------------------------|

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Model Code

#### DG5 Double-stage Valve Model Code

| 1   | 2    | 3 | 4   | 5  | 6    | 7  | 8 | 9   |
|-----|------|---|-----|----|------|----|---|-----|
| **- | DG5V | * | (R) | ** | *(L) | S9 | * | *** |

#### 1 Seals

|              |                                       |
|--------------|---------------------------------------|
| <b>Blank</b> | Anti-wear hydraulic fluid (L-HM)      |
| <b>F3</b>    | Same as above or phospholipid (L-HFD) |
| <b>F6</b>    | Water glycol (L-HFC)                  |

#### 2 Directional pilot valve

|             |   |
|-------------|---|
| <b>DG5V</b> | Subplate mounted, hydraulic two-stage<br>Port pressure max. 350 bar@ P, A, B, X, 210 bar@T, Y |
|-------------|---|

#### 3 Valve size

|           |                                       |
|-----------|---------------------------------------|
| <b>7</b>  | Valve specification CETOP 7, NFPA D07 |
| <b>8H</b> | Valve specification CETOP 8, NFPA D08 |

#### 4 Pressure reducer module

|          |  |
|----------|--|
| <b>R</b> | With reducer (can be omitted when pilot pressure is less than 210 bar) |
|----------|--|

#### 5 Spool type

|            |  |
|------------|--|
| <b>0</b>   | Open center position (all ports)                                 |
| <b>2</b>   | Closed center position (all ports)                               |
| <b>3</b>   | Closed center position (P and B closed) A through T              |
| <b>6</b>   | Closed center position (P port closed) A and B through T         |
| <b>7</b>   | Open center position (P to A and B) T closed                     |
| <b>8</b>   | Bypass center position (P to T)                                  |
| <b>31</b>  | Closed center position (P and B closed) B through T              |
| <b>33</b>  | Closed center position, B and A throttle and through T           |
| <b>52</b>  | Closed center position (all ports), differential by solenoid "A" |
| <b>521</b> | Closed center position (all ports), differential by solenoid "B" |

#### 6 Spool spring arrangement

|           |                                 |
|-----------|---------------------------------|
| <b>A</b>  | Spring offset, end-to-end       |
| <b>AL</b> | Same as "A" but left hand build |
| <b>B</b>  | Spring offset, end to center    |
| <b>BL</b> | Same as "B" but left hand build |
| <b>C</b>  | Spring centered                 |
| <b>N</b>  | No-spring detented              |

#### 7 Spool position indicator switch

|           |   |
|-----------|---|
| <b>S9</b> | With spool position monitoring function |
|-----------|---|

#### 8 Sensor connector type

|          |                                |
|----------|--------------------------------|
| <b>D</b> | DIN 43650 (recommended option) |
| <b>M</b> | M12                            |

#### 9 Main stage spool monitoring positions

|            |  |
|------------|--|
| <b>PCA</b> | Single sensor, located on the A side of the main valve port, monitoring the reversing position on the b side   |
| <b>PCB</b> | Single sensor, located on the B side of the main valve port, monitoring the reversing position on the a side   |
| <b>PDC</b> | Double sensors, monitoring that the spool is in the c center position  |
| <b>PDB</b> | Double sensors, monitoring that the spool is at the a-side reversing position of the b-side reversing position |

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Model Code

#### DG5 Double-stage Valve Model Code

|  | 10  | 11  | 12  | 13  | 14 | 15    | 16 | 17 | 18 | 19     |
|--|-----|-----|-----|-----|----|-------|----|----|----|--------|
|  | (E) | (T) | (K) | (*) | M  | ***** | ** | *  | ** | EN *** |

#### 10 External pilot oil supply

|              |                           |
|--------------|---------------------------|
| <b>Blank</b> | Internal pilot oil supply |
| <b>E</b>     | External pilot oil supply |

#### 11 Internal pilot drain

|              |                      |
|--------------|----------------------|
| <b>Blank</b> | External pilot drain |
| <b>T</b>     | Internal pilot drain |

#### 12 Minimum pilot pressure generator ("P" port option)

|              |                           |
|--------------|---------------------------|
| <b>Blank</b> | No generator              |
| <b>K</b>     | 0.35 bar opening pressure |

#### 13 Manual override option (no override on non-solenoid side of single solenoid valve)

|              |  |
|--------------|--|
| <b>Blank</b> | Manual override on solenoid side only            |
| <b>H</b>     | Waterproof manual operator on solenoid side only |
| <b>Z</b>     | No manual override on both ends                  |

#### 14 Electrical marking symbols

|          |                                  |
|----------|----------------------------------|
| <b>M</b> | Pilot valve features and options |
|----------|----------------------------------|

#### 15 Coil form

|             |   |
|-------------|---|
| <b>U</b>    | ISO 4400 (DIN 43650), mounting base, without plug         |
| <b>KUP5</b> | Integrated Deutsch plug                                   |
| <b>FW</b>   | 1/2" NPT threaded terminal box                            |
| <b>FTWL</b> | Lighted 1/2" NPT threaded terminal box and terminal block |

#### 16 Coil voltage rating (see standard catalog E-VLVI-CC002-E for further parameters)

|           |                           |
|-----------|---------------------------|
| <b>B</b>  | 110V AC 50Hz/120V AC 60Hz |
| <b>D</b>  | 220V AC 50Hz/240V AC 60Hz |
| <b>DS</b> | 28V DC                    |
| <b>G</b>  | 12V DC                    |
| <b>H</b>  | 24V DC                    |

#### 17 Port T pressure value

|          |         |
|----------|---------|
| <b>7</b> | 210 bar |
|----------|---------|

#### 18 Design number

|           |               |
|-----------|---------------|
| <b>5*</b> | CETOP 7 /NG16 |
| <b>1*</b> | CETOP 8 /NG25 |

#### 19 Special improvements

|               |                         |
|---------------|-------------------------|
| <b>EN ***</b> | Omitted if not required |
|---------------|-------------------------|

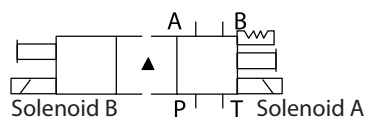


# Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

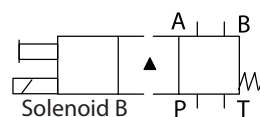
## Model Code

### Solenoid Standard

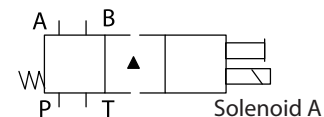
Double solenoid valve, two-position, with positioning



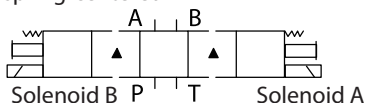
Single solenoid valve, solenoid at port A



Single solenoid valve, solenoid at port B



Double solenoid valve with spring-centered



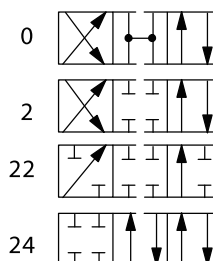
▲ Transient state only

### Valve Function Diagram

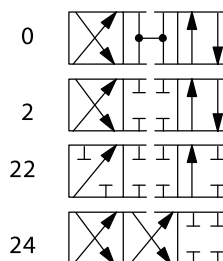
DG 4V-3(S)-\*N



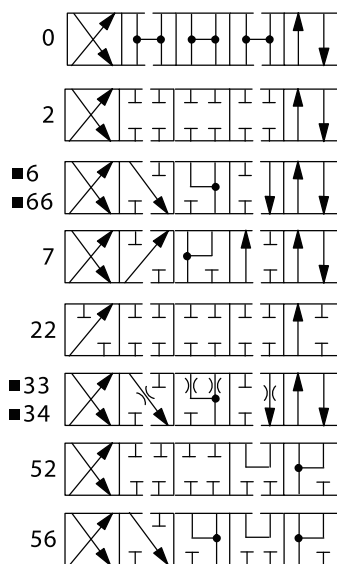
DG 4V-3(S)-\*A



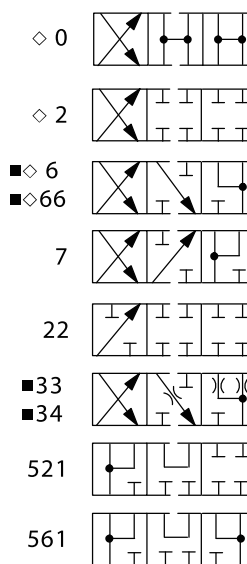
DG 4V-3(S)-\*AL



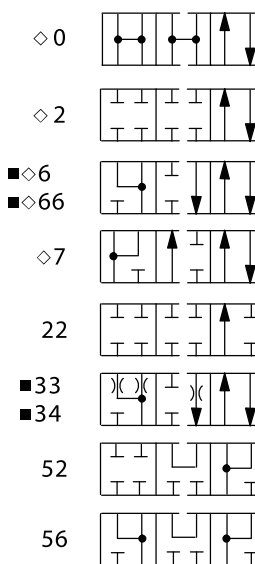
DG 4V-3(S)-\*C



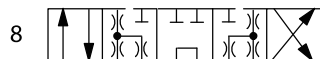
DG 4V-3(S)-\*B/F



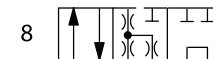
DG 4V-3(S)-\*BL/FL



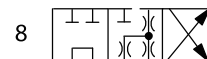
DG 4V-3(S)-8C



DG 4V-3(S)-8BL



DG 4V-3(S)-8B



# Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

## Monitoring Instructions

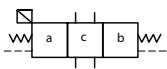
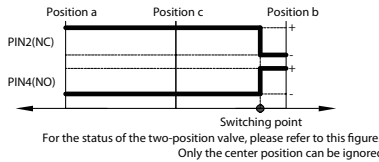
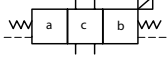
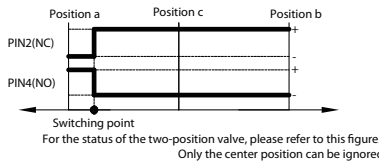

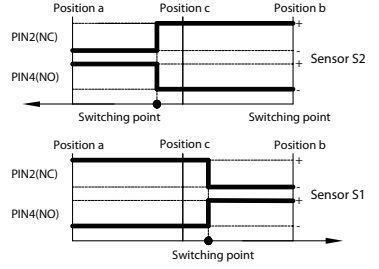

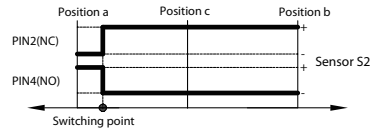
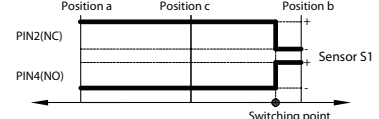
### DG4 Single-stage Valve Monitoring Instructions

| Monitoring position code | Proximity switch mounting position | Monitoring position                | Signal schematic diagram |
|--------------------------|------------------------------------|------------------------------------|--------------------------|
| 0                        |                                    | Position b (de-energized position) |                          |
| 1                        |                                    | Position a (energized position)    |                          |
| 2                        |                                    | Position b (energized position)    |                          |
|                          |                                    | Position a (energized position)    |                          |
| 3                        |                                    | Position a (energized position)    |                          |
| 4                        |                                    | Position b (energized position)    |                          |
| 5                        |                                    | Position b (de-energized position) |                          |
| 6                        |                                    | Position a (energized position)    |                          |

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Monitoring Instructions

#### DG5 Double-stage Valve Monitoring Instructions

| Monitoring position code | Proximity switch mounting position  | Monitoring position                | Signal schematic diagram  |
|--------------------------|---|------------------------------------|---|
| PCA                      |    | Position b (energized position)    |    |
| PCB                      |    | Position a (energized position)    |    |
| PDC                      |    | Position c (de-energized position) |   |
| PDB                      |  | Position a (energized position)    |  |
|                          |   | Position b (energized position)    |  |

#### Example

For DG4V-5-0A-M-S9D0-U-H7-20, the proximity switch is mounted opposite the solenoid (see the mounting position of the proximity switch), and the factory adjusted switching point is close to position b (see signal diagram), so that whether the spool is in position b can be reliably monitored.

Working process: When PIN1 and PIN3 of the proximity switch are powered on and the solenoid is not energized, the spool is in position b (de-energized position). At this time, PIN2 of the proximity switch remains in the closed (+) state, and PIN4 remains in the open (-) state; energize the solenoid. When the solenoid is charged, the spool starts to move from the de-energized position (see the direction of the arrow in the signal diagram). When the spool moves to the switching point, PIN2 switches from closed to open and PIN4 switches from open to closed, and the output signal is reversed, indicating that the spool has left the target monitoring position. When the solenoid is de-energized, the spool returns to position b, PIN2 returns to the closed state again, and PIN4 returns to the open state again.

#### Warning

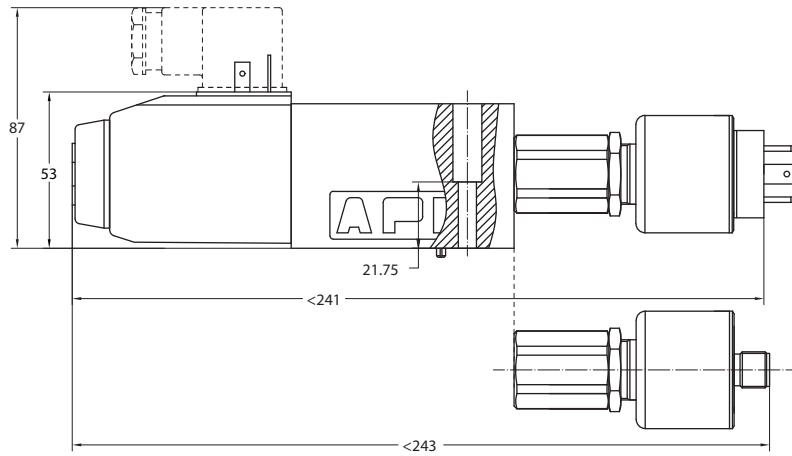
**Users are not allowed to adjust or replace the position monitoring components themselves. If necessary, please contact Danfoss technical service personnel.**

## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

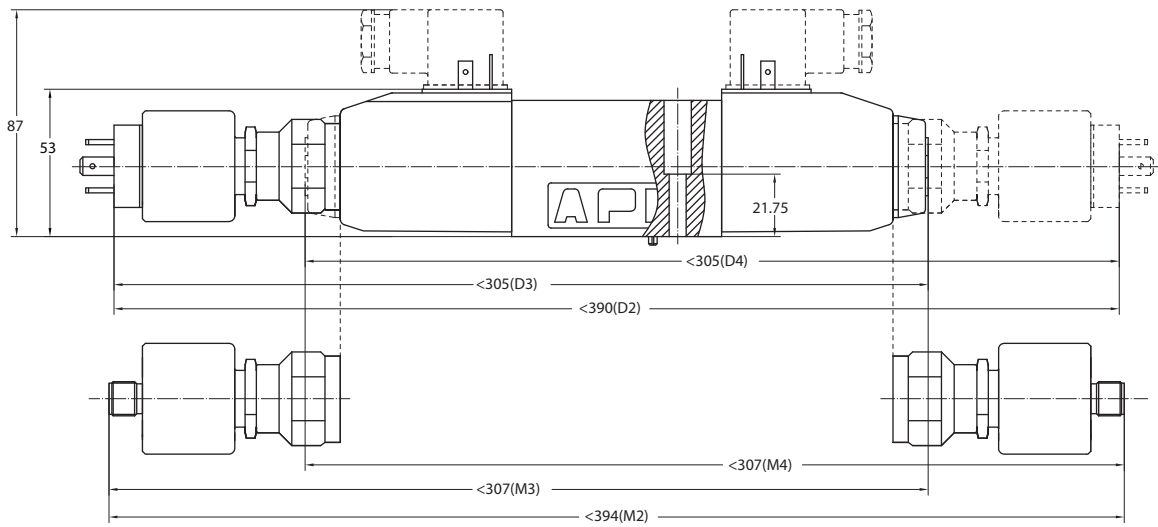
### Dimensions

#### DG4V3 Single-stage Valve (mm)

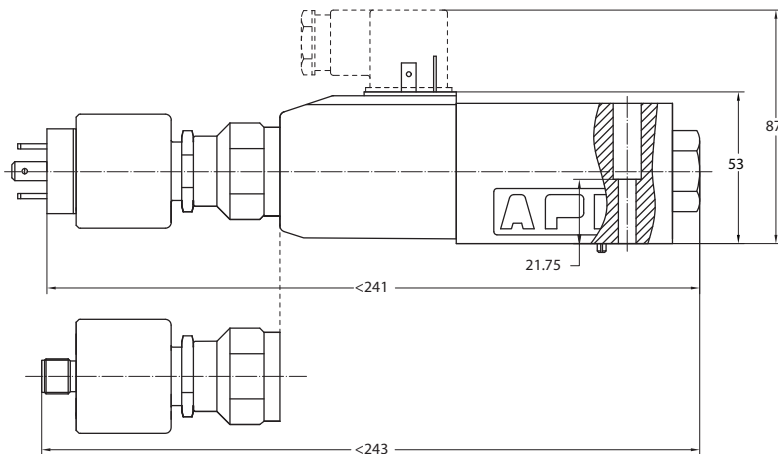
S9 \*0/1



S9 \*2/3/4



S9 \*5/6

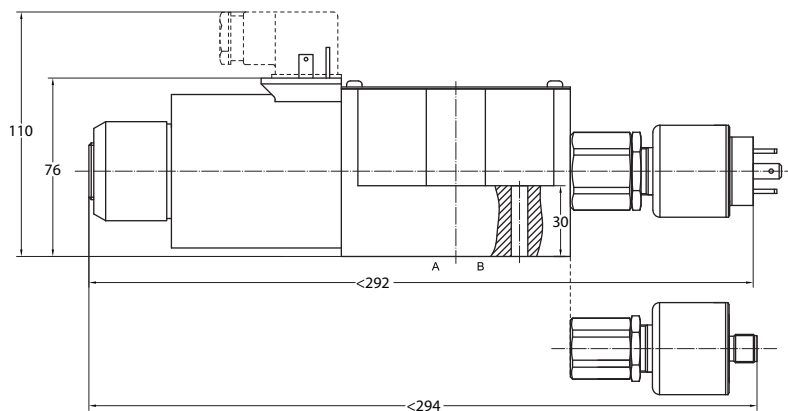


# Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

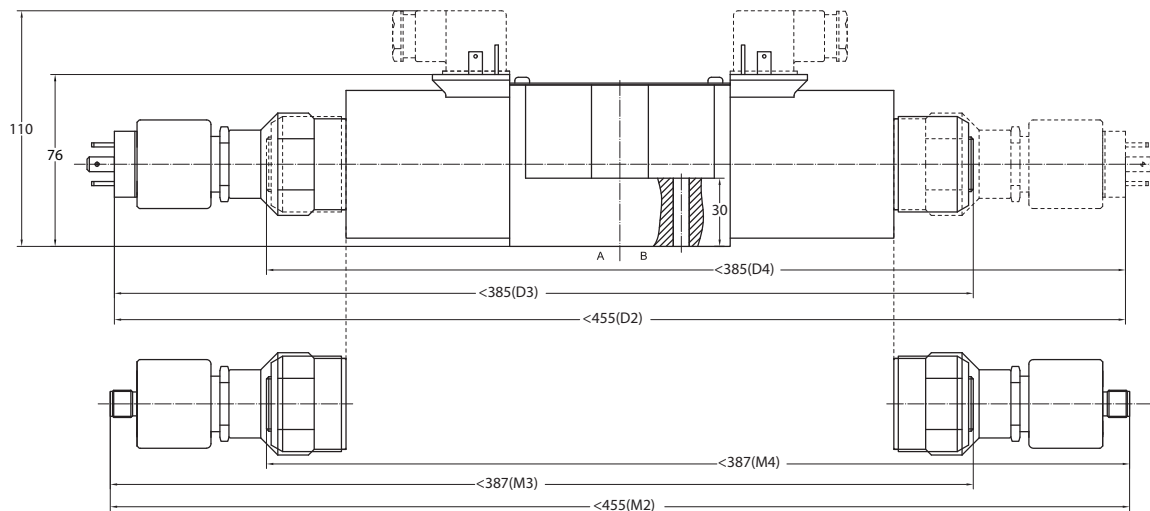
## Dimensions

### DG4V5 Single-stage Valve (mm)

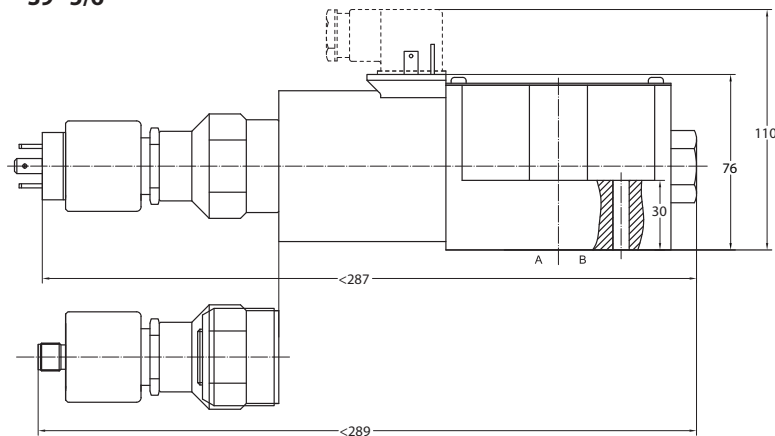
S9 \*0/1



S9 \*2/3/4



S9 \*5/6

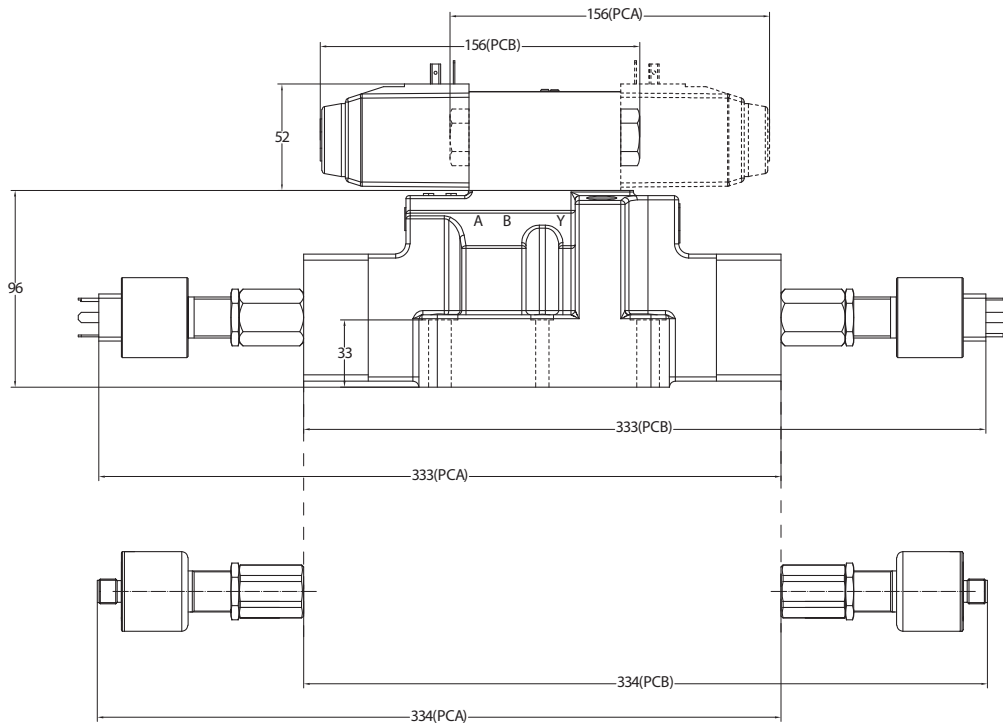


## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

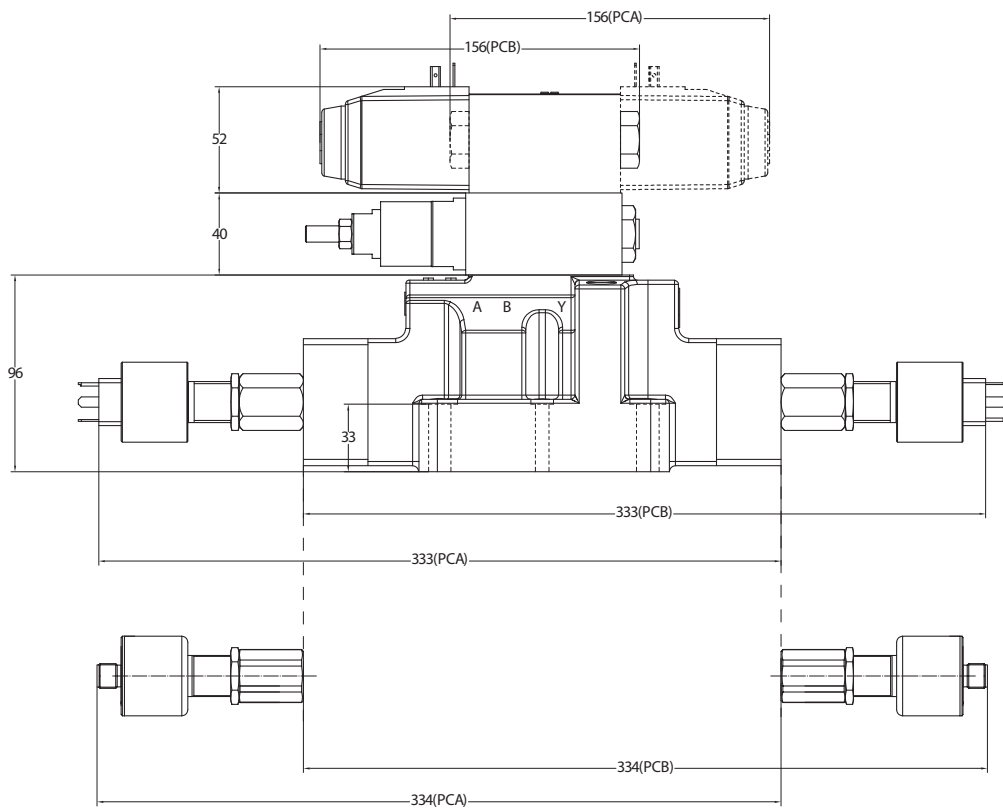
### Dimensions

#### DG5V7 Double-stage Valve (mm)

##### PCA/PCB



##### PCA/PCB with pressure reducer

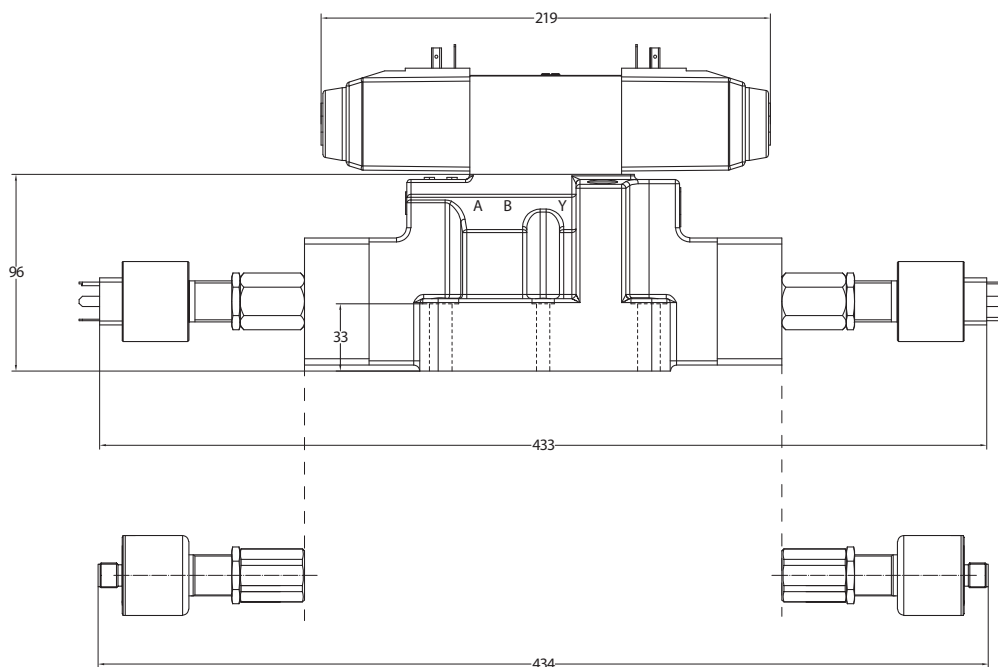


# Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

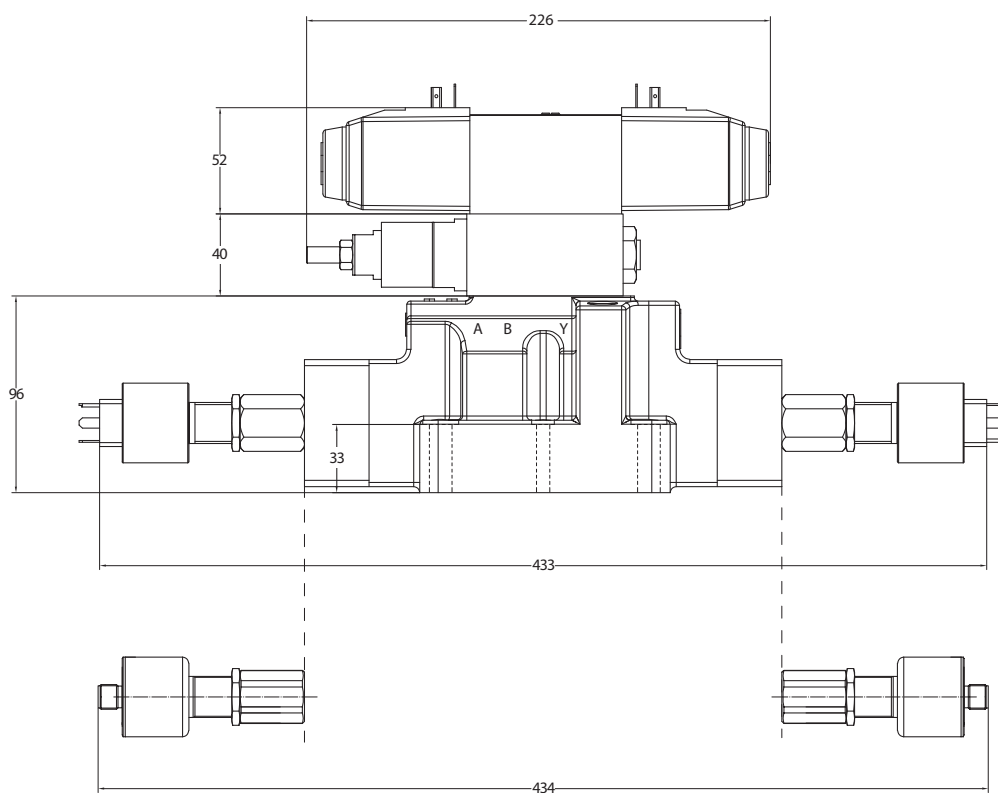
## Dimensions

### DG5V7 Double-stage Valve (mm)

#### PDB/PDC



#### PDB/PDC with pressure reducer

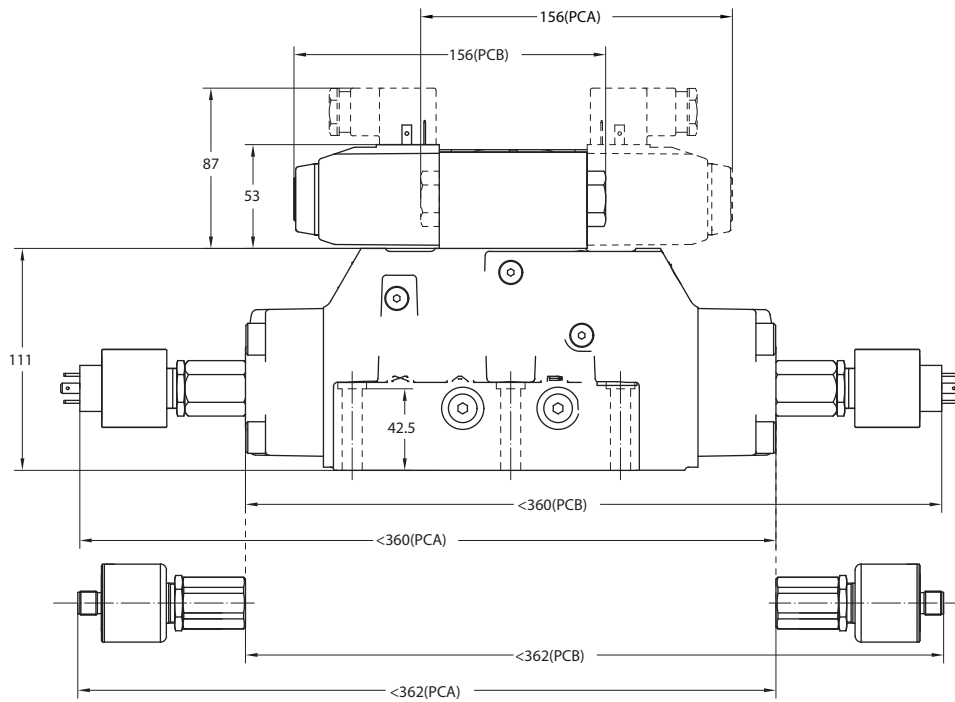


## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

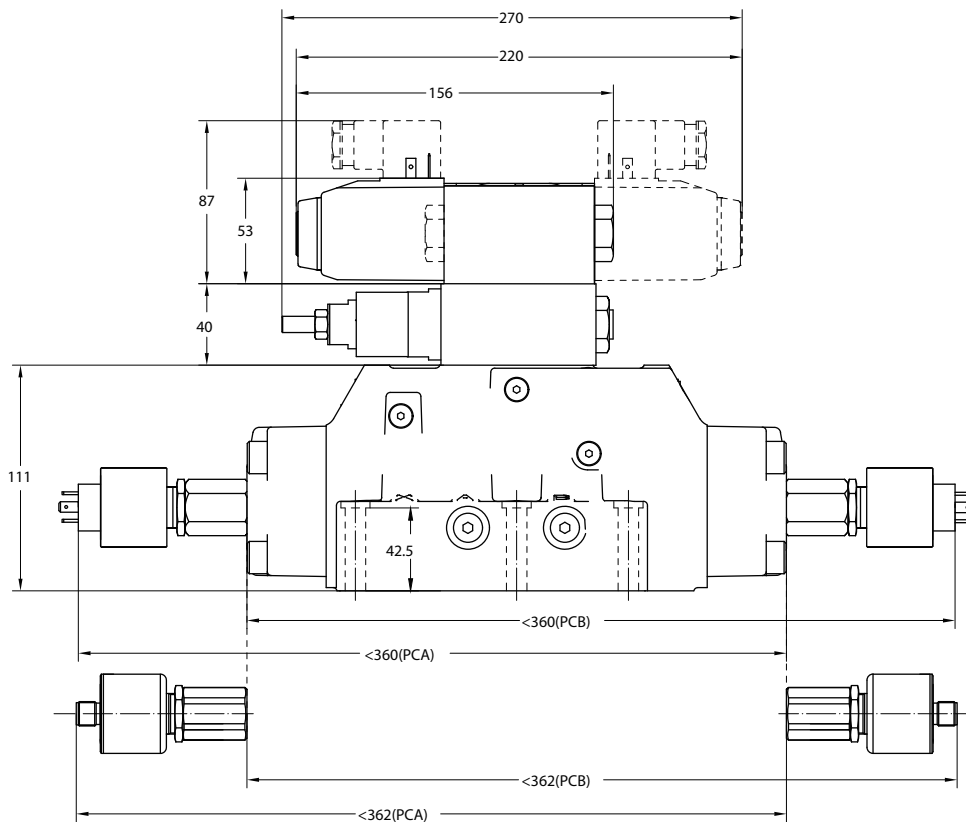
### Dimensions

#### DG5V8 Double-stage Valve (mm)

##### PCA/PCB



##### PCA/PCB with pressure reducer



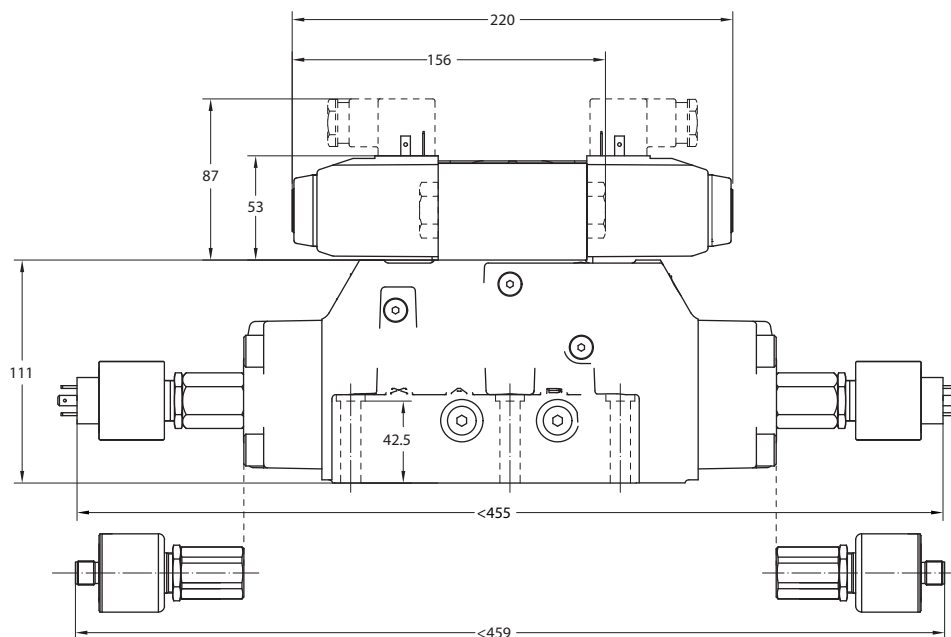


## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

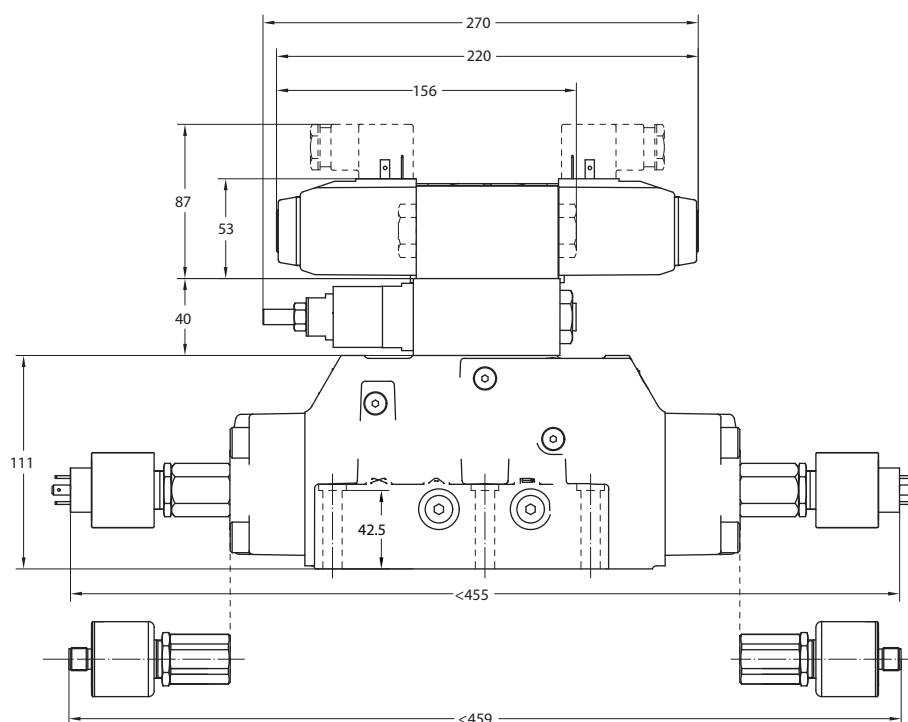
### Dimensions

#### DG5V8 Double-stage Valve (mm)

PDB/PDC



#### PDB/PDC with pressure reducer



## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Accessories

#### Seals

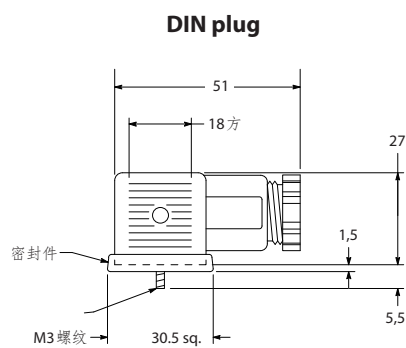
| Valve type | Seal material | PTAB port      |              | XY port        |              |
|------------|---------------|----------------|--------------|----------------|--------------|
|            |               | Specifications | Order number | Specifications | Order number |
| DG4V3      | Blank (FKM)   | 9.25x1.78      | 262332       | —              | —            |
| DG4V5      | Blank (FKM)   | 12.42X1.78     | 262334       | —              | —            |
| DG5V7      | Blank/F6(NBR) | 21.89x2.62     | 170255       | 9.19x2.62      | 154007       |
|            | F3(FKM)       | 21.89x2.62     | 252357       | 9.19x2.62      | 262349       |
| DG5V8      | Blank/F6(NBR) | 26.57X3.53     | 200140       | 18.64X3.53     | 118202       |
|            | F3(FKM)       | 26.57X3.53     | 02-324910    | 18.64X3.53     | 02-321195    |

#### Bolt and Torque

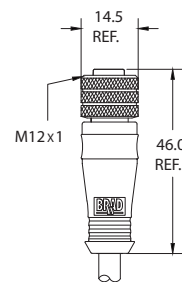
| Valve type | Mounting bolts |         |
|------------|----------------|---------|
|            | Size           | Torque  |
| DG4V3      | M5             | 5~7     |
| DG4V5      | M6             | 9-14    |
| DG5V7      | M10            | 49-59   |
|            | M6             | 9-14    |
| DG5V8      | M12            | 103-127 |

#### Electrical Plug

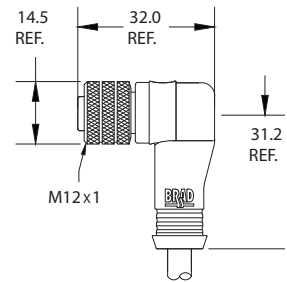
| Plug type               | Order number   | Description            |
|-------------------------|----------------|------------------------|
| DIN plug                | C18309N21      | 4PIN DIN43650 PLUG     |
| M12 plug straight type  | 804000W03M020W | 4Pin female M12 2M     |
| M12 plug 90° angle type | 804001W03M020W | 4Pin female M12 90D 2M |



**M12 plug straight type**



**M12 plug 90° angle type**



## Solenoid Directional Valve DG-S9 Series with Spool Position Monitoring Function

### Accessories

#### Approximate Weight

| Single-stage valve | DG4V3 (kg) | DG4V5 (kg) |
|--------------------|------------|------------|
| S9*0/1/5/6         | 1.8        | 4.6        |
| S9*2               | 2.6        | 6.4        |
| S9*3/4             | 2.4        | 6.2        |

| Two-stage valve | DG5V7 (kg) | DG5V8 (kg) |
|-----------------|------------|------------|
| PCA/PCB         | 9.5        | 14.0       |
| PDB/PDC         | 10.3       | 14.6       |

### Ordering Information

#### Common Part Numbers

| Order number | Description                     |
|--------------|---------------------------------|
| 6034983-001  | DG4V-3-0A-M-S9D0-U-H7-60        |
| 6040519-001  | DG4V3-0B-M-S9D0-U-H7--60        |
| 6040517-001  | DG4V-3-0C-M-S9D2-U-H7-60        |
| 6041049-001  | DG4V-3-2AL-M-S9D0-U-H7-60       |
| 6036288-001  | DG4V-3-2AL-M-S9D1-U-H7-60       |
| 6039298-001  | DG4V-3-2AL-M-S9D6-U-H7-60       |
| 6034984-001  | DG4V-3-2A-M-S9D0-U-H7-60        |
| 6035082-001  | DG4V-3-2A-M-S9D1-U-H7-60        |
| 6045272-001  | DG4V-3-2A-M-S9D6-U-H7-60        |
| 6040524-001  | DG4V-3-2BL-M-S9D1-U-H7-60       |
| 6040617-001  | DG4V-3-2B-M-S9D1-U-H7-60        |
| 6040516-001  | DG4V-3-2C-M-S9D2-U-H7-60        |
| 6040506-001  | DG4V-3-6C-M-S9D2-U-H7-60        |
| 6044882-001  | DG4V-5-0CJ-M-S9D2-U-H7-20       |
| 6034981-001  | DG4V-5-2AJ-M-S9D0-U-H7-20       |
| 6035080-001  | DG4V5-2AJ-M-S9D1-U-H7-20        |
| 6036289-001  | DG4V5-2ALJ-M-S9D0-U-H7-20       |
| 6035079-001  | DG4V-5-2A-M-S9D1-U-H7-20        |
| 6045181-001  | DG4V5-2BJ-M-S9D0-U-H7-20        |
| 6046408-001  | DG4V-5-2CJ-M-S9D2-U-H7-20       |
| 6045666-001  | DG4V-5-52CJ-M-S9D2-U-H7-20      |
| 6040860-001  | DG4V-5-6CJ-M-S9D2-U-H7-20       |
| 6046038-001  | DG5V-8H-6C-S9-D-PDB-T-M-U-H7-10 |

#### Products we offer:

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- Hydrostatic pumps
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