Soft Shift Directional Control Valve
DG4S4-01-60-S*** Design
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Introduction

The DG4S4-01-60-S*** directional control is a solenoid operated, 4-way, soft-shift valve having a unique five-chamber design.

The spool end land configuration isolates the core tube volume from the valve’s tank cavity. This volume is displaced through an orifice in each solenoid armature to increase the shift and dropout periods.

System shock is greatly reduced by metering the flow across the special spool land as well as spool modulation produced by the armature orifice.

The valve terminal box contains a bridge rectifier, allowing alternating current to be applied directly to the valve. Therefore, the solenoid winding senses only direct current, eliminating the “in-rush” characteristic of a standard AC solenoid.

Features & Benefits

- Low cost alternative to pilot-operated and proportional valves.
- Mounts interchangeable with any NFPA D05, CETOP 5, ISO 05 valve.
- Conventional direct-solenoid operated valve design with contoured spool and controlled solenoid shift speed.
- Available in single or double solenoid configurations.
- Wet armature solenoids for quieter operation and long life with no dynamic seals to leak.
- Rectifier is housed in the terminal junction box and is protected from moisture and dirt.
- Coil has plug-in construction and is held on by a nut enabling quick coil voltage interchange or service, without breaking into the hydraulic envelope.
- DC solenoid prevents coil burnout during controlled rate of solenoid shift. Conventional alternating input current is converted to direct current through a rectifier located in the terminal box. For example: 110-120 50/60V AC and 220-240 50/60V AC are converted to 105V DC and 214V DC, respectively.
- A larger diameter spool combined with five-chamber body core passages results in lower pressure drop.
- Milled metering notches on the spool enable precise control of flow rate change as the spool is shifted.
- Four-land spool permits manufacturing of a consistently rounder spool for better balance in the bore and lower spool wear and less leakage.
- Five-chamber body design isolates the tank passages from the core tube so that pressure spikes or surges are not transmitted to the solenoid core tube.
- NFPA fatigue pressure rated at 250 bar (3600 psi)
- Easily interchangeable orifice plugs allow for fine tuning of valve shift time to each application.
- Solenoid indicator lights are available.
**General Information**

### Basic Characteristics

**Max. pressure ports P, A & B:**
- Up to 250 bar (3600 psi) depending on fluid

**Max. pressure port T:**
- 70 bar (1000 psi)

**Max. flow rates:**
- Up to 75 l/min (20 USgpm) depending on spool

**Operating temp.:**
- 20° to 82° C (70° to 180° F)

**Fluid viscosity:**
- 14-54 cSt (75-250 SUS)

### Seals & Fluid Cleanliness

Fluorocarbon seals are standard and are suitable for use with phosphate ester type fluids or its blends, water glycol, water–in–oil emulsion fluids and petroleum oil. Refer to 694 for hydraulic fluid and temperature recommendations.

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials and additives for protection against wear of components, elevated viscosity and inclusion of air.


### Mounting Interface

ISO 4401-05  
CETOP 5  
NFPA D05

### Operating Principles

- **Spool notches**
  - Spools with contoured or notched lands are used to provide maximum control of flow rate change as the spool is shifted.

- **D.C. solenoid**
  - D.C. solenoids prevent coil burnout during controlled rate of solenoid shift.

- **Metering orifice**
  - Spool shift speed is controlled by a metering orifice in the solenoid. Three orifice sizes are available to meet your application.

- **Rectifier**
  - Conventional alternating current (120/60 or 110/50) input is converted to D.C. through a rectifier located in the terminal box.
# Model Code

(F3) - DG4S4 (L) W - 01 ** - (U**) - * - *** - 60 - (LH) - S ***

## Seals
- Blank – Standard seals
- F3 – Special seals

## Valve Type
- D – Directional control valve
- G – Manifold or subplate mounted
- 4 – Solenoid operated
- S – Sliding spool
- 4 – 4-way flow direction

## Electrical Accessories
- Blank – For “U” type connectors
- W – Terminal box
- LW – Terminal box with lights

## Interface
- 01 – ISO-4401-AC-05-4-A, NFPA D05, CETOP 5

## Spool Types
- A models – 0, 2, 9
- B models – 0, 2, 6, 8
- C models – 0, 2, 6, 8

## Spool/Spring Arrangement
- A – Spring offset, P to A
- B – Spring centered, solenoid “a” removed
- C – Spring centered, three position

## Wet Armature Solenoid(s)
(non-serviceable core tubes)
- Blank – Plug-in coils
- U – DIN 43650 coil(s)* without electrical plug (non-rectified)
- U1 – Connector fitted (DC only)
- U6 – Connector fitted w/ lights (DC only)
- U11 – Connector fitted w/ rectifier & lights (AC only)
- U12 – Connector fitted w/rectifier

## Coil Identification Letter(s)
(See “Solenoids” below)

## Soft Shift Orifice
- Blank – Standard (.047)**
- .062 – .062 inch
- .078 – .078 inch

## Design Number
- Subject to change.
- Installation dimensions remain as shown for designs 60 through 69.

## Left-hand Assembly
- Omit for right-hand assembly with solenoid “a” removed.

## Special Soft Shift Solenoids
- S491 – Standard valve
- S528 – Canadian Standards Assoc. CSA certification

## Solenoids

<table>
<thead>
<tr>
<th>Solenoid Identification Letter</th>
<th>Solenoid Voltage Rating</th>
<th>Holding Amps (rms)</th>
<th>Holding Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>120 VAC 60Hz Rectified</td>
<td>0.38</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>110 VAC 50Hz 105 VDC</td>
<td>0.35</td>
<td>35</td>
</tr>
<tr>
<td>BD</td>
<td>240 VAC 60 Hz Rectified</td>
<td>0.19</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>220 VAC 50 Hz 214 V DC</td>
<td>0.17</td>
<td>35</td>
</tr>
<tr>
<td>G</td>
<td>12V DC non-rectified</td>
<td>—</td>
<td>42</td>
</tr>
<tr>
<td>H</td>
<td>24 V DC non-rectified</td>
<td>—</td>
<td>42</td>
</tr>
</tbody>
</table>

* Note that the U type coils are non-rectified and require a connector with rectifier when using AC current.
A non-rectified connector must be used when supplying DC current.

** Not recommended for type 8 spool when operating at maximum flow and pressure.
**Operating Data**

### Functional Symbols

<table>
<thead>
<tr>
<th>Standard Spool Types</th>
<th>Graphic Symbol Center Condition</th>
<th>&quot;A&quot; Models ▲ Spring Offset</th>
<th>&quot;B&quot; Models ▲ Spring Centered</th>
<th>&quot;C&quot; Models Spring Centered</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

▲ Standard (right hand) build shown. “A” solenoid omitted.

**Note**

When solenoid “a” is energized, flow is “P” to “A”. When solenoid “b” is energized, flow is “P” to “B”. This is in accordance with the ANSI–B93.9 Standard.

<table>
<thead>
<tr>
<th>Note</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solenoid designations “a” and “b” are identified on the diagram plate on the side of the valve.</td>
</tr>
</tbody>
</table>

### Solenoid Energizing

Spring centered and spring offset valves will be spring positioned unless the solenoid is energized continuously.

**NOTE**

Any sliding spool valve, if held shifted under pressure for long periods, may stick and not spring return, due to slitting. Therefore, it is recommended that the valve be cycled periodically to prevent this from occurring.

### Bleeding Procedure

Apply a minimum of 3.4 bar (50 psi) tank pressure. Shift either solenoid “a” or “b”. Loosen manual actuators in solenoid ends until air is evacuated. Tighten manual actuators. No further bleeding should be required.

To fully utilize the features of the soft shift solenoid, the core tubes must remain full of oil. The tank line must be plumbed so that the tank port is always flooded with oil. Addition of a back pressure check valve may be required to prevent bleed down.

### Response Time

Response times are increased over that of a standard solenoid. These times are influenced by flow, pressure, applied solenoid voltage, oil and ambient temperatures. Response times can be fine tuned to the application by orifices that are changeable via the manual actuator in the solenoid end.

The DG4S4-01**-60-S*** valve comes with a .047 inch diameter orifice as standard. A .062 and a .078 inch orifices are also available.

Response times shown below were established with a system pressure of 250 bar (3600 psi), flow of 38 l/min (10 USgpm), solenoid voltage at 100% of rating and 38° C (110° F) oil temperature.

The given response times were measured from the point of energization/de-energization to the point of first indication of inlet pressure change.

Response up to full system pressure is dependent on the system’s compressed volume and can vary with each application.

### Orifice & Tool Kit

For fine tuning shift performance, orifices must be ordered separately. The following kit comes with:

- Two (2) .047, .062 and .078 inch diameter orifices.
- One (1) Installation tool.
- One (1) 5/32” hex key.
- One (1) 3/32” hex key.

Order #02–119131
Response Time / Orifice Changing Procedure

**Response Time**

<table>
<thead>
<tr>
<th>Model</th>
<th>Valve type</th>
<th>Spool type</th>
<th>Spool response (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shift Orifice dia. (in.) Return Orifice dia. (in.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>047 062 078</td>
</tr>
<tr>
<td>A</td>
<td>Spring offset</td>
<td>2</td>
<td>110 100 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>150 100 90</td>
</tr>
<tr>
<td>C/B</td>
<td>Spring centered</td>
<td>0</td>
<td>150 100 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>160 110 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>190 120 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>200 140 100</td>
</tr>
</tbody>
</table>

**Orifice Changing Procedure**

**WARNING**

Before breaking a circuit connection make certain that power is OFF and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure. Plug all removed units and cap all lines to prevent the entry of dirt into the system.

1. Using a $\frac{5}{32}$" hex key, remove manual actuator plug and spring from the end of solenoid (Tightening torque 6.2-7.3 Nm 55–65 lbf. in.)

2. Insert extraction tool (878495) into solenoid via the manual actuator opening. Rotate tool until aligned and push into slot in armature.

3. Using $\frac{1}{2}$" wrench and tool to prevent the armature from rotating, insert $\frac{3}{32}$" hex key down the center of tool and remove orifice plug.

4. Replace by the same method, tightening orifice snug to ensure bottoming of threads. Smaller orifices increase response times. Larger orifices decrease response times. The .047 in. dia. orifice is standard in the valve.

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**Orifice & tool kit 02-119131**

For fine tuning shift performance, orifices must be ordered separately. The kit includes (2) each of .047, .062, & .078 in. dia. orifices, (1) installation tool, (1) $\frac{5}{32}$" hex key and (1) $\frac{3}{32}$" hex key.
Performance Data

Pressure Drops

The pressure drop curves give approximate pressure drop ($\Delta P$) when passing 21 cSt (100 SUS) fluid (having .865 specific gravity) through the indicated flow path.

For any other viscosity, the pressure drop ($\Delta P$) will change as follows:

<table>
<thead>
<tr>
<th>Viscosity cSt (SUS)</th>
<th>14 (75)</th>
<th>32 (150)</th>
<th>43 (200)</th>
<th>54 (250)</th>
<th>65 (300)</th>
<th>76 (350)</th>
<th>87 (400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of $\Delta P$ (Approx)</td>
<td>91</td>
<td>111</td>
<td>119</td>
<td>126</td>
<td>132</td>
<td>137</td>
<td>141</td>
</tr>
</tbody>
</table>

For any other specific gravity ($G_1$), the pressure drop ($\Delta P_1$) will be approximately: $\Delta P_1 = \Delta P (G_1/G)$

Pressure Drop Curves

<table>
<thead>
<tr>
<th>Spool type</th>
<th>Curve numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0C/B</td>
<td>3 3 3 3 3 5</td>
</tr>
<tr>
<td>2C/B</td>
<td>1 1 1 2 -</td>
</tr>
<tr>
<td>6C/B</td>
<td>3 5 3 5 -</td>
</tr>
<tr>
<td>8C/B</td>
<td>4 1 4 2 6</td>
</tr>
<tr>
<td>0A</td>
<td>1 1 1 1 -</td>
</tr>
<tr>
<td>2A</td>
<td>1 1 1 1 -</td>
</tr>
<tr>
<td>9A</td>
<td>1 1 1 1 -</td>
</tr>
</tbody>
</table>
Performance Data

Maximum Flow Data

Maximum recommended flow data is for 90% nominal voltage in a 4-way circuit with cylinder ports either looped or blocked and containing 2.5 liter (.66 USgpm) compressed volume. Performance may vary when certain spools are used in 3-way circuits.

Maximum flow chart reference

<table>
<thead>
<tr>
<th>Model</th>
<th>Spool type</th>
<th>Curve number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>B/C</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>3*</td>
</tr>
</tbody>
</table>

* .047 orifice not recommended at maximum flow curve.
Installation Dimensions

Spring offset
Spring centered
Millimeters (inches)

4 valve mounting holes for socket head cap screws - 
\( \frac{1}{4} \) - 20 x 1 \( \frac{1}{2} \) or M6x40 metric
(torque 12-15 N.m., 110-130 in. lb.)
Installation Dimensions

Spring centered
Millimeters (inches)

Clearance required to remove coil

Clearance required to remove core tube

Clearance required to remove knob

1/2 NPTF for conduit connection (terminal box can be rotated 180°)

4 valve mounting holes for socket head cap screws - 1/4 - 20 x 1 1/2 or M6x40 metric (torque 12-15 N.m., 110-130 in. lb.)
Installation Dimensions

DIN 43650 Connector

Millimeters (inches)

This interface is used for connecting electrical receptacles conforming to DIN std 43650.

▲ Plug connector
(Order separately)
(ISO4400/DIN 43650)

(Coils not rectified)
12 and 24V DC only

Cable diameter range . . . Ø6—10 mm (0.24—0.40)
Wire section range . . . . 0.5—1.5 mm² (0.0008—0.0023 in²)
Terminals . . . . . . . . . . Screw type
Type of protection . . . . IEC144 class IP65, when plugs are fitted correctly to
the valves with the interface seals (supplied with plugs)
in place.

Connector can be positioned at 90° intervals on valve by re-assembling contact
holder into appropriate position inside connector housing.

Connectors with and without indicator lights are available (order separately):

<table>
<thead>
<tr>
<th>Receptacle</th>
<th>Input Voltage (AC or DC)</th>
<th>Part Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1 Coils without lights</td>
<td>All DC voltages</td>
<td>710776</td>
</tr>
<tr>
<td>U6 Coils with lights</td>
<td>12-24</td>
<td>977467</td>
</tr>
<tr>
<td></td>
<td>100-125</td>
<td>977469</td>
</tr>
<tr>
<td></td>
<td>200-240</td>
<td>977471</td>
</tr>
<tr>
<td>U11 Rectified coils with lights</td>
<td>12V AC</td>
<td>02-141358*</td>
</tr>
<tr>
<td></td>
<td>24V AC</td>
<td>02-141359*</td>
</tr>
<tr>
<td></td>
<td>110/120V AC</td>
<td>02-141360*</td>
</tr>
<tr>
<td></td>
<td>220/240V AC</td>
<td>02-141361*</td>
</tr>
<tr>
<td>U12 Rectified coils without</td>
<td>All AC voltages</td>
<td>02-141357</td>
</tr>
<tr>
<td>lights</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Clear/translucent colored

12 and 24V DC only (Coils not rectified)
The DG4S4-01-60-S*** series valve is a solenoid operated directional control valve using special solenoids, a unique spool configuration and a rectifier package.

Rated supply voltage is 120V AC/60 Hz. The rectifier package is enclosed within the terminal box and is protected against electrical surges with a M.O.V.
DGVM*-5 Subplate

Model Code

DG V M * - 5 * SP ** 10 ***

1 Valve Type
DG - Directional control valve

2 Pressure Rating
V - 345 bar (5000 psi)

3 Subplate
M - Subplate

4 Ports
Blank - Back ports
E - Side ports

5 Valve Size
5 - CETOP 5

6 Pipe Thread Size
Blank - 1/4 NPTF/BSP
X - 3/8 NPTF/BSP
Y - 1/2 NPTF/BSP
Z - 3/4 NPTF/BSP

7 Subplate Options
None provided

8 Design Number
10 - Design

9 Connection/Mounting
Blank - NPTF Thread connection
T** - SAE straight thread connection with .250-20 UNC-2B inch thread mounting.
T10 - .8750-14 UNF-2B conn.
T12 - 1.0625-12 UN-2B conn.
C** - SAE straight thread connection with M6 x 1.8 metric thread
C10 - .8750-14 UNF-2B conn.
C12 - 1.0625-12 UN-2B conn.

Ordering Information

Valves, subplates, connectors, and bolt kits must be ordered as separate items.
Example:
One (1)
DG4S4-012C-BB-60-S491 valve
One (1)
DGVM5-5-10-SP-T10 subplate
One (1)
BKDG01633 bolt kit

Torque Specifications

Maximum recommended mounting bolt torque is 13 N.m. (115 lb. in.).
Mounting Surface & Subplate Dimensions

Millimeters (inches)

4 — subplate mounting holes for socket head cap screws 5/8 or M10 metric.

Pilot port “X” 1/4 NPTF or 5/16–18 SAE plug if internally piloted.

When a subplate is not used, a machined pad corresponding to the shaded area must be provided.

18 SAE plug if internally piloted

1/4 NPTF

Drain port “Y” 1/4 NPTF or 9/16–18 SAE plug if internally drained

Approximate weight: Standard subplates 2.7 kgs. (6 lbs.)

Bolt kits*
Includes (4) directional valve mounting bolts.

<table>
<thead>
<tr>
<th>Model codes</th>
<th>Sizes</th>
<th>Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>BKDG01-633</td>
<td>1/4 x 20 x 1 1/2</td>
<td>Inch</td>
</tr>
<tr>
<td>BK855993M</td>
<td>M6 x 1.0P x 40</td>
<td>Metric</td>
</tr>
</tbody>
</table>

* Bolt kits are ordered separately.

NOTE: Metric grade 10.9 (SAE grade 8) mounting bolts required.