4/3-way servo solenoid directional control valves with electrical position feedback (Lvdt DC/DC) (ruggedized design)

Type 4WRL10...25

Sizes (NG) 10, 16, 25
Unit series 3X
Maximum working pressure P, A, B 350 bar
Nominal flow rate 55...370 l/min (∆p 10 bar)

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Features

- Pilot operated 4/3-way servo solenoid directional control valves NG10 to NG25
- Pilot valve NG6, with control piston and sleeve in servo quality and sturdy design, actuated on one side, 4/4 fail-safe position when switched off
- Position transducer (Lvdt DC/DC) with metal cap
- Main stage in servo quality with position feedback
- Flow characteristic
  - M = Progressive with fine metering notch
  - P = Non-linear curve
  - L = Linear
- For subplate attachment, mounting hole configuration NG10 to ISO 4401-05-05-0-05, NG16 to ISO 4401-07-07-0-05 and NG25 to ISO 4401-08-08-0-05
- Subplates as per Technical Data Sheet, NG10 RE 45055, NG16 RE 45057 and NG25 RE 45059 (order separately)
- Plug-in connectors to DIN 43563-AM6, see Technical Data Sheet RE 08008 (order separately)
- External trigger electronics (order separately)
  - Electric amplifier for standard curves “M” and “L”
  - Electric amplifier for non-linear curve “P”

For information regarding the available spare parts see: www.boschrexroth.com/spc
Ordering data

**4WRL** | **-3X/G24** | **K0/M 750**

For external trigger electronics = no desig.

NG10 = 10
NG16 = 16
NG25 = 25

Control spool symbols

4/3-way version

\[
\begin{array}{ccc}
A & B & P \\
\hline
0 & b & \text{V, V1}
\end{array}
\]

With symbol V1:
P → A: \( q_v \)
B → T: \( q_v/2 \)
P → B: \( q_v/2 \)
A → T: \( q_v \)

1) \( Q_N \): Flow characteristic “M” or “L”
2) \( Q_N \): Flow characteristic “P”

M = 750 = Ruggedized design

NG10 = NBR seals, suitable for mineral oils (HL, HLP) to DIN 51524

K0 = Electrical connection

K0 = without plug-in connector,
with plug to DIN 43563-AM6
Order plug-in connector separately

Control oil inlet “x”
control oil outlet “y”

No designation = “x” = external, “y” = external
E = “x” = internal, “y” = external
ET = “x” = internal, “y” = internal
T = “x” = external, “y” = internal

Power supply of trigger electronics

G24 = 24 V DC
3X = Unit series 30 to 39
(installation and connection dimensions unchanged)

Flow characteristic

M = Progressive with linear fine metering
P = Non-linear curve \(^2\), linear (kink at 40%)
L = Linear

Nominal flow rate

at 10 bar valve pressure difference
(5 bar per metering notch)

**NG10**

<table>
<thead>
<tr>
<th>Flow (l/min)</th>
<th>( Q_N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>85</td>
<td>85</td>
</tr>
</tbody>
</table>

**NG16**

<table>
<thead>
<tr>
<th>Flow (l/min)</th>
<th>( Q_N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

**NG25**

<table>
<thead>
<tr>
<th>Flow (l/min)</th>
<th>( Q_N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>370</td>
<td>370</td>
</tr>
</tbody>
</table>
## Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>M: Progressive with fine metering</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>P: Non-linear, linear (40%)</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>L: Linear</td>
</tr>
</tbody>
</table>

### Accessories, not included in delivery

<table>
<thead>
<tr>
<th>Fastening bolts</th>
<th>Specification</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NG10</td>
<td>4 x ISO 4762-M6 x 40-10.9-N67F82170</td>
<td>2 910 151 209</td>
</tr>
<tr>
<td>NG16</td>
<td>2 x ISO 4762-M6 x 45-10.9-N67F82170</td>
<td>2 910 151 211</td>
</tr>
<tr>
<td>NG25</td>
<td>4 x ISO 4762-M10 x 50-10.9-N67F82170</td>
<td>2 910 151 301</td>
</tr>
<tr>
<td>NG25</td>
<td>6 x ISO 4762-M12 x 60-10.9-N67F82170</td>
<td>2 910 151 354</td>
</tr>
<tr>
<td>VT-VRRA1-527-20/V0/2STV</td>
<td>see RE 30045</td>
<td>0 811 405 063</td>
</tr>
<tr>
<td>VT-VRRA1-527-20/V0/K40-AGC-2STV</td>
<td>see RE 30043</td>
<td>0 811 405 068</td>
</tr>
</tbody>
</table>

Plug-in connector not included in delivery, also see RE 08008

### Testing and service equipment

- Test box type VT-PE-TB2, see RE 30064
- Test adapter type VT-PA-3, see RE 30070
Function, sectional diagram

Construction
The valve consists of two main assemblies:
– Pilot valve (1) with control spool and sleeve, return springs, control solenoid and inductive position transducer
– Main stage (2) with centering springs and position feedback

Functional description
When the control solenoid is not actuated, the control spool is held by springs in the fail-safe position, and the main stage spool remains in spring-centered mid position at 1...6% of the stroke in the direction P-B/A-T. In the on-board electronics, the pre-defined setpoint is compared with the actual value for the position of the main stage control spool. In the event of an error signal, the control solenoid is actuated, and the pilot spool is moved as the magnetic force changes. The flow released through the control cross-sections causes the main control spool to move. The stroke/control cross-section of the main control spool is controlled proportionately to the setpoint. If the input setpoint is 0 V, the electronics move the main stage control spool to mid position. The control oil is conveyed to the pilot valve either internally via port P or externally via port X. The oil returns to the tank internally via port T or externally via port Y.

Power failure
In the event of a power failure or an open circuit, the on-board electronics cut off the electricity to the control solenoid and the pilot spool moves to the “fail-safe” position, relieving the control oil chambers of the main stage. The main stage control spool is held by springs in mid position.
Control oil supply

The pilot valve can be supplied both via ports X and Y (externally) and via the main flow channels P and T.

### NG10, 25

**Type...–3X...**

**Type...–3X...E...**

**Type...–3X...ET...**

**Type...–3X...T...**

**No designation**

- **E** = “x” = internal  “y” = external
- **ET** = “x” = internal  “y” = internal
- **T** = “x” = external  “y” = internal

### Important

Hydraulic symbols are largely derived from the symbols of the switching valves. 4/3-way servo solenoid directional control valves (pilot operated) do not have a closed mid position when switched off! They only perform their function in an active, closed control loop, even if the pilot valve features a fail-safe 4th position.

See technical data for details on “switch-off behavior”.

**Symbol in detail**

*(external control oil inlet and outlet)*
## Technical data

### General

<table>
<thead>
<tr>
<th>Construction</th>
<th>Spool type valve, pilot operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuation</td>
<td>Servo solenoid directional control valve NG6, with position controller for pilot valve and main stage, external electric amplifier</td>
</tr>
<tr>
<td>Type of mounting</td>
<td>Subplate, mounting hole configuration NG10...25 to ISO 4401-...</td>
</tr>
<tr>
<td>Installation position</td>
<td>Optional</td>
</tr>
<tr>
<td>Ambient temperature range °C</td>
<td>-20...+60</td>
</tr>
<tr>
<td>Weight kg</td>
<td>NG10 8.6</td>
</tr>
<tr>
<td>Vibration resistance, test condition</td>
<td>Max. 40 g, shaken in 3 dimensions (24 h)</td>
</tr>
</tbody>
</table>

### Hydraulic (measured with HLP 46, \( \theta_{oil} = 40 ^\circ C \pm 5 ^\circ C \))

<table>
<thead>
<tr>
<th>Pressure fluid</th>
<th>Hydraulic oil to DIN 51524...535, other fluids after prior consultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity range</td>
<td>recommended mm(^2)/s 20...100 max. permitted mm(^2)/s 10...800</td>
</tr>
<tr>
<td>Pressure fluid temperature range °C</td>
<td>-20...+70</td>
</tr>
<tr>
<td>Maximum permissible degree of contamination of pressure fluid</td>
<td>Class 18/16/13 (^1)</td>
</tr>
<tr>
<td>Purity class to ISO 4406 (c)</td>
<td>See symbol</td>
</tr>
</tbody>
</table>

### Flow direction

<table>
<thead>
<tr>
<th>Nominal flow at ( \Delta p = 5 ) bar per notch (^4)</th>
<th>l/min</th>
<th>NG10</th>
<th>NG16</th>
<th>NG25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. working pressure Ports P, A, B bar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. pressure Ports T, X, Y bar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. control oil pressure in “pilot stage” bar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Q_{max} ) l/min</td>
<td>170</td>
<td>450</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>( Q_{N} ) pilot valve l/min</td>
<td>4</td>
<td>12</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Leakage of pilot valve at 100 bar cm(^3)/min</td>
<td>&lt;180</td>
<td>&lt;300</td>
<td>&lt;500</td>
<td></td>
</tr>
<tr>
<td>Leakage of main stage at 100 bar cm(^3)/min</td>
<td>&lt;400</td>
<td>&lt;600</td>
<td>&lt;1000</td>
<td></td>
</tr>
</tbody>
</table>

### Static/Dynamic

<table>
<thead>
<tr>
<th>Hysteresis</th>
<th>%</th>
<th>&lt; 0.1 scarcely measurable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing tolerance for ( Q_{max} ) %</td>
<td>≤ 10</td>
<td></td>
</tr>
<tr>
<td>Response time for signal change (at X = 100 bar) 0...100 %</td>
<td>0...100 %</td>
<td>0...10 %</td>
</tr>
<tr>
<td>Response time for signal change (at X = 10 bar) 0...100 %</td>
<td>0...100 %</td>
<td>0...10 %</td>
</tr>
<tr>
<td>Switch-off behavior After electrical switch-off: pilot valve in “fail-safe”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main stage moves to spring-centered “mid position”: 1...6 % P-B/A-T</td>
<td>1...6 % P-B/A-T</td>
<td></td>
</tr>
<tr>
<td>Thermal drift Zero point displacement &lt;1 % at ( \Delta T = 40 ^\circ C )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero adjustment Adjustable ±5 % via valve amplifier</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) The purity classes stated for the components must be complied with in hydraulic systems. Effective filtration prevents problems and also extends the service life of components. For a selection of filters, see Technical Data Sheets RE 50070, RE 50076 and RE 50081.

\(^2\) Characteristic curve: P (non-linear).

\(^3\) Characteristic curve: M or L

\(^4\) Flow rate at a different \( \Delta p \), \( Q_x = Q_{nom} \cdot \sqrt{\Delta p_x / 5} \)
Technical data

**Electrical**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclic duration factor %</td>
<td>100 ED</td>
</tr>
<tr>
<td>Power supply</td>
<td>24 V DC nom (external electric amplifier)</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP 65 to DIN 40050, plug-in connector 1 834 482 024 correctly fitted</td>
</tr>
<tr>
<td>Solenoid and position transducer connector</td>
<td>To DIN 43563-AM6 (plug-in connector 1 834 482 024) Pg16 For pin assignment, see block diagram on pages 8 and 9</td>
</tr>
<tr>
<td>Max. solenoid current A</td>
<td>2.7</td>
</tr>
<tr>
<td>Coil resistance $R_{20}$ Ω</td>
<td>2.5</td>
</tr>
<tr>
<td>Max. power consumption at 100% load and operating temperature VA</td>
<td>40</td>
</tr>
<tr>
<td>Position transducer DC/DC technology</td>
<td>Supply: +15 V/35 mA -15 V/25 mA Signal: 0±10 V ($R_L \geq 10 , k\Omega$)</td>
</tr>
</tbody>
</table>

All characteristics only in connection with valve amplifier 0 811 405 063

**Important**

Pilot operated 4/3-way servo solenoid directional control valves only perform their function in an active closed control loop and do not have a “fail-safe” position when switched off. For this reason, many applications require the use of “external check valves”, which must be taken into account during the On/Off switching sequence.
Valve with external trigger electronics (standard linear curve: M, L)

Block diagram/pin assignment

Versions of trigger electronics
- With non-linear curve and surface area compensation, see RE 30043
- With integrated \( \nu/Q \) controller, see RE 30058
Valve with external trigger electronics (non-linear curve: P)

Block diagram/pin assignment

Versions of trigger electronics
- With standard linear curve, see RE 30045
- With integrated \( p/Q \) controller, see RE 30058
**Characteristic curves** (measured with HLP 46, \( \theta_{oil} = 40 \, ^{\circ}\mathrm{C} \pm 5 \, ^{\circ}\mathrm{C} \))

Flow rate – signal function \( Q = f (U_E) \)

Flow characteristic M

Flow characteristic P

Flow characteristic L

Pressure gain
**Characteristic curves** (measured with HLP 46, $\theta_{\text{oil}} = 40 \, ^\circ\text{C} \pm 5 \, ^\circ\text{C})

**Bode diagram**

**NG10**

[Amplitude vs. Phase diagram for NG10 with $P_s = 100$ bar]

**NG16**

[Amplitude vs. Phase diagram for NG16 with $P_s = 100$ bar]

**NG25**

[Amplitude vs. Phase diagram for NG25 with $P_s = 100$ bar]
Unit dimensions NG10 (nominal dimensions in mm)

1 Pilot valve
2 O-ring 9.25 x 1.78 (ports P, A, B, T)
3 Main valve
4 Inductive position transducer (main valve)
5 Nameplate
6 O-ring 12 x 2 (ports P, A, B, T, T1)
7 O-ring 10 x 2 (ports X, Y)
8 Machined valve contact surface, mounting hole configuration according to ISO 4401-05-05-0-05
Deviates from standard:
Ports P, A, B, T, T1 Ø10.5 mm
Minimum thread depth: Ferrous metal 1.5 x Ø
Non-ferrous 2 x Ø

Subplates, see Technical Data Sheet RE 45055

Valve fastening bolts (order separately)
The following valve fastening bolts are recommended:
4 cheese-head bolts ISO 4762-M6x40-10.9-N67F82170
(galvanized in accordance with Bosch standard N67F82170)
Tightening torque $M_a = 11 \pm 3$ Nm
Material no. 2910151209
Unit dimensions NG16 (nominal dimensions in mm)

1 Pilot valve
2 O-ring 9.25 x 1.78 (ports P, A, B, T)
3 Main valve
4 Inductive position transducer (main valve)
5 Nameplate
6 O-ring 23 x 2.5 (ports P, A, B, T)
7 O-ring 9 x 2 (ports X, Y)

8 Machined valve contact surface, mounting hole configuration according to ISO 4401-07-07-0-05
Deviates from standard:
Ports P, A, B, T Ø 20 mm
Minimum thread depth: Ferrous metal 1.5 x Ø
Non-ferrous 2 x Ø

Subplates, see Technical Data Sheet RE 45057

Valve fastening bolts (order separately)
The following valve fastening bolts are recommended:
2 cheese-head bolts ISO 4762-M6x45-10.9-N67F821 70
(galvanized in accordance with Bosch standard N67F821 70)
Tightening torque $M_A = 11+3$ Nm
Material no. 2910151211

4 cheese-head bolts ISO 4762-M10x50-10.9-N67F821 70
(galvanized in accordance with Bosch standard N67F821 70)
Tightening torque $M_A = 50+10$ Nm
Material no. 2910151301
Unit dimensions NG25 (nominal dimensions in mm)

1 Pilot valve
2 O-ring 9.25 x 1.78 (ports P, A, B, T)
3 Main valve
4 Inductive position transducer (main valve)
5 Nameplate
6 O-ring 28 x 3 (ports P, A, B, T)
7 O-ring 15 x 2.5 (ports X, Y)

8 Machined valve contact surface, mounting hole configuration according to ISO 4401-08-08-0-05
Deviates from standard:
NG25: Ports P, A, B, T Ø 25 mm
Minimum thread depth: Ferrous metal 1.5 x Ø
Non-ferrous 2 x Ø

Subplates, see Technical Data Sheet RE 45059
Valve fastening bolts (order separately)
The following valve fastening bolts are recommended:
6 cheese-head bolts ISO 4762-M12x60-10.9-N67F821 70
(galvanized in accordance with Bosch standard N67F821 70)
Tightening torque $M_a = 90+30$ Nm
Material no. 2910151354
Notes