4/3-way servo solenoid directional control valves, pilot operated, with electrical position feedback (Lvdt DC/DC ±10V)

Type 4WRL 10...35, symbols V/V1

Sizes (NG) 10, 16, 25, 27, 35
Unit series 3X
Maximum working pressure P, A, B 350 bar (NG27: 280 bar)
Nominal flow rate 55...1000 l/min (∆p = 10 bar)

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Features

- Pilot operated 4/3-way servo solenoid directional control valves NG10 to NG35
- Pilot valve NG6, with control piston and sleeve in servo quality, actuated on one side, 4/4 fail-safe position when switched off
- Control solenoid with electrical position feedback and electronics for position transducer (Lvdt DC/DC)
- 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, NG25/27 to ISO 4401-08-08-0-05 and NG35 to ISO 4401-10-09-0-05
- Subplates as per Technical Data Sheet, NG10 RE 45055, NG16 RE 45057, NG25/27 RE 45059 and NG35 RE 45060 (order separately)
- Plug-in connectors to DIN 43560-AM2
  Solenoid 2P+PE/M16 x 1.5, position transducer 4P/Pg7 included in delivery, see Technical Data Sheet RE 08008
- External trigger electronics (order separately)
  - Electric amplifier for standard curve “M” and “L”
  - Electric amplifier for non-linear curve “P”

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

<table>
<thead>
<tr>
<th>4WRL</th>
<th>3X/G24</th>
<th>Z4/M *</th>
</tr>
</thead>
</table>

For external trigger electronics = no desig.

- NG10 = 10
- NG16 = 16
- NG25 = 25
- NG27 = 27
- NG35 = 35

Control spool symbols

4/3-way version

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

With symbol V1:

- \( P \rightarrow A: q_v \)
- \( B \rightarrow T: q_v/2 \)
- \( P \rightarrow B: q_v/2 \)
- \( A \rightarrow T: q_v \)

Nominal flow rate

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

- NG10
  - 55 l/min
  - 70 l/min
  - 85 l/min
- NG16
  - 100 l/min
  - 120 l/min
  - 150 l/min
  - 200 l/min
- NG25
  - 300 l/min
  - 370 l/min
- NG27
  - 430 l/min
  - 1000 l/min
- NG35
  - 700 l/min

Further information in plain text

- M = NBR seals, suitable for mineral oils (HL, HLP) to DIN 51524
- Z4 = Electrical connection with plug-in connector, with plug to DIN 43560-AM2
  - Plug-in connector included in delivery
- E = Control oil inlet “x” control oil return “y”
  - no desig. = “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, linear (kink at 40%)
- L = Linear

1) NG27 is a high-flow version of NG25, ports P, A, B and T have \( \phi \) 32 mm in the main stage. Contrary to standard ISO 4401-08-08-0-05, ports P, A, B and T may be drilled to max. \( \phi \) 30 mm in the control block. These valves therefore offer higher flow rates \( Q_A : Q_B \)

2) NG35 is a high-flow version of NG32, ports P, A, B and T have \( \phi \) 50 mm in the main stage. Contrary to standard ISO 4401-10-09-0-05, ports P, A, B and T may be drilled to max. \( \phi \) 48 mm in the control block. These valves therefore offer higher flow rates \( Q_A : Q_B \)

3) \( Q_N \): Flow characteristic “P”
4) \( Q_N \): Flow characteristic “M” or “L”
### Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>M: Progressive with fine metering</th>
<th>P: Non-linear, linear (40%)</th>
<th>L: Linear</th>
</tr>
</thead>
</table>

### Accessories, not included in delivery

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<th>Accessories</th>
<th>Specifications</th>
<th>Code</th>
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</thead>
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<tr>
<td>Valve fastening bolts</td>
<td>NG10: 4 x ISO 4762-M6 x 40-10.9-N67F82170</td>
<td>2 910 151 209</td>
</tr>
<tr>
<td></td>
<td>NG16: 2 x ISO 4762-M6 x 45-10.9-N67F82170</td>
<td>2 910 151 211</td>
</tr>
<tr>
<td></td>
<td>4 x ISO 4762-M10 x 50-10.9-N67F82170</td>
<td>2 910 151 301</td>
</tr>
<tr>
<td></td>
<td>NG25/27: 6 x ISO 4762-M12 x 60-10.9-N67F82170</td>
<td>2 910 151 354</td>
</tr>
<tr>
<td></td>
<td>NG35: 6 x ISO 4762-M20 x 90-10.9-N67F82170</td>
<td>2 910 151 532</td>
</tr>
<tr>
<td></td>
<td>VT-VRRA1-527-20/V0/2STV, see RE 30045</td>
<td>0 811 405 063</td>
</tr>
<tr>
<td></td>
<td>VT-VRRA1-527-20/V0/K40-AGC-2STV, see RE 30043</td>
<td>0 811 405 068</td>
</tr>
<tr>
<td></td>
<td>2P+PE (M16 x 1.5) and 4P (Pg7) included in delivery, also see RE 08008</td>
<td></td>
</tr>
</tbody>
</table>

### Testing and service equipment

- Test box type VT-PE-TB2, see RE 30064
- Test adapter type VT-PA-3, see RE 30070
**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, 27, 35**

**Symbol in detail**
(external control oil inlet and outlet)

**Main valve**

**Pilot valve**

**Type...–3X...**

**Type...–3X...E...**

**Type...–3X...ET...**

**Type...–3X...T...**

<table>
<thead>
<tr>
<th>No designation</th>
<th>“x” = external</th>
<th>“y” = external</th>
</tr>
</thead>
<tbody>
<tr>
<td>E =</td>
<td>“x” = internal</td>
<td>“y” = external</td>
</tr>
<tr>
<td>ET =</td>
<td>“x” = internal</td>
<td>“y” = internal</td>
</tr>
<tr>
<td>T =</td>
<td>“x” = external</td>
<td>“y” = internal</td>
</tr>
</tbody>
</table>

**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”.

<table>
<thead>
<tr>
<th>NG16</th>
<th></th>
</tr>
</thead>
</table>
## Technical data

### General

<table>
<thead>
<tr>
<th>Construction</th>
<th>Spool type valve, pilot operated</th>
</tr>
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<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...35 to ISO 4401-...</td>
</tr>
<tr>
<td>Installation position</td>
<td>Optional</td>
</tr>
<tr>
<td>Ambient temperature range °C</td>
<td>–20...+50</td>
</tr>
<tr>
<td>Weight kg</td>
<td>NG10 8.35  NG16 10  NG25 18  NG27 18  NG35 80</td>
</tr>
<tr>
<td>Vibration resistance, test condition</td>
<td>Max. 25 g, shaken in 3 dimensions (24 h)</td>
</tr>
</tbody>
</table>

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

<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 mm(^2)/s</td>
<td>recommended 20...100 max. permitted 10...800</td>
</tr>
<tr>
<td>Pressure fluid temperature range °C</td>
<td>–20...+80</td>
</tr>
<tr>
<td>Maximum permissible degree of contamination of pressure fluid purity class to ISO 4406 (c)</td>
<td>Class 18/16/13 1)</td>
</tr>
</tbody>
</table>

### Flow direction

<table>
<thead>
<tr>
<th>Flow direction</th>
<th>See symbol</th>
</tr>
</thead>
</table>

### Nominal flow at \( \Delta p = 5 \text{ bar per notch} \)\(^2)\)

<table>
<thead>
<tr>
<th></th>
<th>NG10</th>
<th>NG16</th>
<th>NG25</th>
<th>NG27</th>
<th>NG35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. working pressure</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>280</td>
<td>350</td>
</tr>
<tr>
<td>Ports P, A, B External control oil inlet bar</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ports P, A, B Internal control oil inlet bar</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ports T, X, Y bar</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. control oil pressure in &quot;pilot stage&quot; bar</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Q_{\text{max}} ) l/min</td>
<td>170</td>
<td>450</td>
<td>900</td>
<td>1000</td>
<td>3500</td>
</tr>
<tr>
<td>( Q_N ) pilot valve l/min</td>
<td>4</td>
<td>12</td>
<td>24</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>Leakage of pilot valve at 100 bar cm(^3)/min</td>
<td>&lt;180 &lt;300 &lt;500 &lt;500 &lt;900</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leakage of main stage at 100 bar cm(^3)/min</td>
<td>&lt;400 &lt;600 &lt;1000 &lt;1000 &lt;6000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Static/Dynamic

<table>
<thead>
<tr>
<th>Hysteresis %</th>
<th>&lt;0.1, scarcely measurable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing tolerance for ( Q_{\text{max}} ) %</td>
<td>≤10</td>
</tr>
<tr>
<td>Response time for signal change (at ( X = 100 \text{ bar} )) 0...100 %</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Response time for signal change (at ( X = 10 \text{ bar} )) 0...100 %</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switch-off behavior</th>
<th>After electrical switch-off: pilot valve in fail-safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal drift</td>
<td>Zero point displacement &lt;1 % at ( \Delta T = 40 ^\circ \text{C} )</td>
</tr>
<tr>
<td>Zero adjustment</td>
<td>Adjustable ±5 % via valve amplifier</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) Flow rate at a different \( \Delta p \) \( Q_x = Q_{\text{nom}} \sqrt{\frac{\Delta p_x}{5}} \)
Technical data

**Electrical**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<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</td>
</tr>
<tr>
<td>Solenoid connector</td>
<td>Connector DIN 43560/ISO 4400 M16x1.5 (2P+PE)</td>
</tr>
<tr>
<td>Position transducer connector</td>
<td>Connector Pg7 (4P)</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>
</tbody>
</table>

**Position transducer**

<table>
<thead>
<tr>
<th>Technology</th>
<th>DC/DC technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply:</td>
<td>±15 V/35 mA, –15 V/25 mA</td>
</tr>
<tr>
<td>Signal:</td>
<td>0…±10 V ($R_L ≥ 10 kΩ$)</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 \( p/Q \) controller, see RE 30058
Valve with external trigger electronics (non-linear curve: P)

Block diagram/pin assignment

- Safety logics
- Potentiometer supply
- Control zero
- Enabling
- Error
- Signal inputs
- Zero adjustment
- Differential amplifier
- 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, $\theta_{\text{oil}} = 40 \, ^\circ\text{C} \pm 5 \, ^\circ\text{C})$

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

Flow characteristic M

Flow characteristic P

Flow characteristic L

Pressure gain

![Diagram of characteristic curves](image-url)
**Characteristic curves** (measured with HLP 46, $\theta_{\text{oil}} = 40 ^\circ\text{C} \pm 5 ^\circ\text{C})

**Bode diagram**

**NG10**

- $P_s = 100$ bar
- $\frac{A}{B}$ dB
- $\varphi$

- Amplitude
- Phase

**NG16**

- $P_s = 100$ bar
- $\frac{A}{B}$ dB
- $\varphi$

- Amplitude
- Phase

**NG25/27**

- $P_s = 100$ bar
- $\frac{A}{B}$ dB
- $\varphi$

- Amplitude
- Phase

**NG35**

- $P_s = 100$ bar
- $\frac{A}{B}$ dB
- $\varphi$

- Amplitude
- Phase
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 4401-05-05-05

Deviates from standard:
- Ports P, A, B, T, T1 Ø 10.5 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 N67F821 70)

Tightening torque $M_a = 11+3$ 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 $M_A = 11.5 + 3$ 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

Required surface quality of mating component

$R_{\text{max}} = 0.01 / 100$
**Unit dimensions NG25/27** (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 (ports P, A, B, T)
   - NG25: 28 x 3
   - NG27: 34.6 x 2.62
7. O-ring 15 x 2.5 (ports X, Y)

---

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
- NG27: Ports P, A, B, T Ø 32 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 NG25 $M_A = 90 + 30$ Nm,
   - NG27 $M_A = 90 + 15$ Nm

Material no. **2910151354**
Unit dimensions NG35 (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 53.57 x 3.53 (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 4401-10-09-0-05
   Deviates from standard:
   Ports P, A, B, T Ø 48 mm
   Minimum thread depth: Ferrous metal 1.5 x Ø
   Non-ferrous 2 x Ø

Subplates, see Technical Data Sheet RE 45060

Valve fastening bolts (order separately)
The following valve fastening bolts are recommended:
6 cheese-head bolts ISO 4762-M20x90-10.9-N67F82170
   (galvanized in accordance with Bosch standard N67F82170)
   Tightening torque $M = 450+110$ Nm
Material no. 2910151532