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

Type 4WRL 10...35, symbols E./W.

Sizes (NG) 10, 16, 25, 27, 35
Unit series 3X
Maximum working pressure P, A, B 350 bar (NG27: 280 bar)
Nominal flow rate 80...1100 l/min ($\Delta p = 10$ bar)

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Features

- Pilot operated 4/3-way servo solenoid directional control valves NG10 to NG35, with approx. 20% overlap
- 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 with position feedback
- Spool with linear travel, with anti-rotation element
- Flow characteristic
  - S = Progressive
  - NG16, 25 and 27 with load tap C1/C2
- 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 without ramps
  - Electric amplifier with ramps and dead-band compensation

For information regarding the available spare parts see: [www.boschrexroth.com/spc](http://www.boschrexroth.com/spc)
Ordering data

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

For external trigger electronics = no desig.

NG10 = 10
NG16 = 16
NG25 = 25
NG27 1) = 27
NG35 2) = 35

Control spool symbols = E, E1

- A B
  - P : T
    = E (Z), E1 (Z)
  - C1 / C2
    = W, W1

With symbol E1, E1(Z), E4, W1, W1(Z), W4:

- A B
  - P : T
    = W (Z), W1 (Z)

With load tap C1/C2 (NG16, 25, 27) = Z

Further information in plain text

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

Electrical connection

Z4 = with plug-in connector, with plug to DIN 43560-AM2, Plug-in connector included in delivery

Control oil inlet “x”

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

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

NG10
80 = 80 l/min

NG16
110 = 110 l/min
180 = 180 l/min

NG25
350 = 350 l/min

NG27
430 = 430 l/min 1)

NG35
1100 = 1100 l/min 2)

1) NG27 is a high-flow version of NG25, ports P, A, B and T have Ø 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. Ø 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 Ø 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. Ø 48 mm in the control block. These valves therefore offer higher flow rates $Q_A : Q_B$
## Accessories, not included in delivery

<table>
<thead>
<tr>
<th>Fastening bolts</th>
<th>NG10</th>
<th>4 x ISO 4762-M6 x 40-10.9-N67F821 70</th>
<th>2 910 151 209</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NG16</td>
<td>2 x ISO 4762-M6 x 45-10.9-N67F821 70</td>
<td>2 910 151 211</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 x ISO 4762-M10 x 50-10.9-N67F821 70</td>
<td>2 910 151 301</td>
</tr>
<tr>
<td></td>
<td>NG25/27</td>
<td>6 x ISO 4762-M12 x 60-10.9-N67F821 70</td>
<td>2 910 151 354</td>
</tr>
<tr>
<td></td>
<td>NG35</td>
<td>6 x ISO 4762-M20 x 90-10.9-N67F821 70</td>
<td>2 910 151 532</td>
</tr>
<tr>
<td>VT-1</td>
<td>VT-VRRA1-527-20/V0/2STV, see RE 30045</td>
<td>0 811 405 063</td>
<td></td>
</tr>
<tr>
<td>VT-2</td>
<td>VT-VRRA1-527-20/V0/RTS-2STV, see RE 30044</td>
<td>0 811 405 073</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

## 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.

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. If the input setpoint is 0 V, the main stage control spool is spring-centered in overlapped 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 spring-centered 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

Type...~3X...

Type...~3X...E...

Type...~3X...ET...

Type...~3X...T...

No designation =  “x” = external  “y” = external
E =  “x” = internal  “y” = external
ET =  “x” = internal  “y” = internal
T =  “x” = external  “y” = internal
# Technical data

## General

<table>
<thead>
<tr>
<th>Construction</th>
<th>Spool type valve, pilot operated</th>
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<tr>
<td>Actuation</td>
<td>Servo solenoid directional control valve NG6, with position controller for pilot valve and main stage, external electric amplifier</td>
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<td>Type of mounting</td>
<td>Subplate, mounting hole configuration NG10...35 to ISO 4401-...</td>
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<tr>
<td>Installation position</td>
<td>Optional</td>
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<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>

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

| Pressure fluid | Hydraulic oil to DIN 51524...535, other fluids after prior consultation |
| Viscosity range recommended mm²/s | 20...100 |
| max. permitted mm²/s | 10...800 |
| Pressure fluid temperature range °C | –20...+80 |
| Maximum permissible degree of contamination of pressure fluid | Class 18/16/13 ¹) |
| Purity class to ISO 4406 (c) | See symbol |
| Flow direction | See symbol |
| Nominal flow at \( \Delta p = 5 \, \text{bar per notch} \) l/min | NG10 80  NG16 180  NG25 350  NG27 430  NG35 1100 |
| Max. working pressure Ports P, A, B (external control oil inlet) bar | 350 350 350 280 350 |
| Ports P, A, B, X bar | 280 |
| Ports T, Y bar | 250 |
| Min. control oil pressure in “pilot stage” bar | 8 |
| \( \dot{Q}_{\text{max}} \) l/min | 170 450 900 1000 3000 |
| \( \dot{Q}_{\text{pilot valve (inlet)}} \) l/min | 2 4 12 12 40 |
| \( \Delta p = 35 \, \text{bar} \) | <150 <180 <350 <500 <1100 |
| Leakage of pilot valve at X = 100 bar cm³/min | <0.25 <0.4 <0.6 <0.6 <1.1 |
| Leakage of main stage control spool symbols “E” at P = 100 bar l/min | See symbol |

## Static/Dynamic

| Overlap in mid position | \( \approx 18...22\% \) of spool stroke, electrically adjustable for \( I'_{D-E} \pm 0.5 \, \text{V} \) with 0 811 404 073 |
| Spool stroke, main stage ± mm | 4 7 10 10 12.5 |
| Control oil volume of main stage 100% cm³ | 1.1 4.3 11.3 11.3 41.5 |
| Control oil requirement 0...100%, (at X = 100 bar) l/min | 2.2 4.7 11.7 11.7 15.6 |
| Hysteresis % | <0.1 scarcely measurable |
| Manufacturing tolerance | See flow curves, adjustable with 0 811 404 073 |
| Response time for 0...100%, (at X = 100 bar) ms | <40 <80 <80 <80 <130 |
| Response time for 0...100%, (at X = 10 bar) ms | <150 <250 <250 <250 <500 |
| Switch-off behavior | After electrical switch-off (pilot valve in fail-safe) Main stage moves to spring-centered overlapped mid position |
| Thermal drift | <1 % at \( \Delta T = 40 \, ^\circ C \) |

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 \( \Delta p \) \( Q = Q_{\text{nom}} \cdot \sqrt{\frac{\Delta p}{5}} \)
Technical data

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<td>Power supply</td>
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<td>Degree of protection</td>
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<td>Solenoid connector</td>
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<td>Position transducer connector</td>
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<tr>
<td>Max. solenoid current</td>
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<tr>
<td>Coil resistance $R_{20}$</td>
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<tr>
<td>Max. power consumption at 100% load and operating temperature</td>
</tr>
</tbody>
</table>
| Position transducer DC/DC technology | Supply: +15 V/35 mA  
                      -15 V/25 mA  | Signal: 0...±10 V ($R_L \geq 10 \text{kΩ}$) |

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

Important
Pilot operated 4/3-way servo solenoid directional control valves with positive overlap function in open or closed-loop-controlled axes and have approx. 20% overlap when switched off. This condition does not constitute an active fail-safe position. 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: without ramps, overlap compensation)

Block diagram/pin assignment

Versions of trigger electronics
- With ramps and overlap compensation, see RE 30044
Valve with external trigger electronics (standard: with ramps, overlap compensation)

Block diagram/pin assignment

Versions of trigger electronics
- With standard linear curve,
  see RE 30045
**Characteristic curves** (measured with HLP 46, $\theta_{\text{oil}} = 40 \degree C \pm 5 \degree C$)

Flow rate – signal function

$Q = f(U_E)$

Symbol $E(Z)$, $W(Z)$ ($Q_A : Q_B = 1 : 1$)

Symbol $E1(Z)$, $W1(Z)$ ($Q_A : Q_B = 2 : 1$)

Control spool with asymmetric metering notches

Control spools with asymmetric metering notches are available in a ratio of 2:1 for the purpose of adaptation to differential cylinders.

Flow in mid position, “leakage oil pressure relief”

With symbol “E”, leakage oil in the two work chambers A and B of the control piston gives rise to a build-up of pressure in A or B, which then causes a connecting cylinder to drift out of position. In many cases, the “W” symbol is a better solution. With a setpoint of “0”, the control piston moves into the overlapped mid position. In this mid position, pressure is then relieved from ports A and B with $1\% + 0.5\% Q_A$ to T. This also supports the function of external check valves.

Control spools in a differential circuit

In order to produce differential circuits, valve spools with a 4th position are available. It is sufficient to install a non-return valve in the consumer lines.

In addition, a control spool (symbol) with internal B-P connection is employed for certain branch-oriented solutions. However, we recommend that you consult the BRH Application Center with regard to these special symbols, as a simulation or knowledge of this type of system is usually required.
**Characteristic curves** (measured with HLP 46, \( \theta_{\text{oil}} = 40 \, ^\circ\text{C} \pm 5 \, ^\circ\text{C} \))

**Load tap C1/C2**

To compensate for fluctuations in the load or supply pressure, 4/3-way servo solenoid directional control valves are combined with pressure compensators. The load is tapped via a shuttle valve for the NG10 and 35, and via two additional ports C1 and C2 for the NG16, 25 and 27 ("4WRL" and "4WRLE" only).

The pressure compensator therefore always receives the correct pressure signal even in the event of negative load. When using pressure compensators, an external control oil supply should always be selected.
Characteristic curves (measured with HLP 46, $\theta_{oil} = 40^\circ C \pm 5^\circ C$)

Response time (at $X = 100$ bar)

**NG10**

**NG16**

**NG25/27**

**NG35**
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 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 according with Bosch standard N67F82170)
Tightening torque $M_a = 11 \pm 3$ Nm
Material no. 2910151209

Required surface quality of mating component:

$R_{max} = 4$

$0.01/100$
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, C1, C2)

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 $T_A = 11 \pm 3$ 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 $T_A = 50 \pm 10$ Nm
Material no. 2910151301
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, C1, C2)

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
   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 $M_A = 90\pm15$ 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-N67F821 70
   (galvanized in accordance with Bosch standard N67F821 70)
   Tightening torque $M_A = 450 \times 110$ Nm

Material no. 2910151532