Special Features

- robust industrial design
- valve is made up of a first and second stage, as per the Rexroth modular system
- valve connection dimensions to A 10 DIN 24 340
- mode of feedback optional
- sealed torque motor running in air reduces sticking due to contamination
- available in explosionproof and flameproof form
- The filter element in the first stage can be easily removed and serviced. The filter chamber is in sections, so particles of dirt cannot enter the oil system. Service can generally be carried out on site.
- Interchangeable control sleeve

Variations

- 3 optional valve feedback systems
- 8 nominal flow ratings
- 3 different coil ratings
- explosionproof
- flameproof
- internal or external pilot supply
- internal or external pilot drain
- plug or cable connection
- 4 standard spool overlaps
**Examples of Application**

**Fig. 1:** barometric or mechanical servo valve feedback for controlling rotary or angular movement.

![Diagram of Fig. 1](image1)

Servo amplifier VT-1600 with accessories

**Fig. 2:** barometric or mechanical servo valve feedback for controlling linear movement.

![Diagram of Fig. 2](image2)

Servo amplifier VT-1600 with accessories

**Fig. 3:** barometric or mechanical servo valve feedback for regulating pressure

![Diagram of Fig. 3](image3)

Servo amplifier VT-1600 with accessories

**Fig. 4:** electrical servo valve feedback for control element or quantity: as shown in figs. 1, 2 or 3

![Diagram of Fig. 4](image4)

Servo amplifier VT-1610 with accessories

**Description of Function, Section**

Servo valves type 4 WS 2E.10 are electrically operated, 2 stage 4 way flow servo valves with connection dimensions to A10 DIN 24 340. Servo valves are generally used in closed circuit for controlling position, force and speed.

They comprise:
- the pilot control (first stage) with control motor (1) energised by continuous solenoid and a hydraulic amplifier (2) designed as a jet flapper plate valve.
- the second stage with horizontal spool valve in 4 way design for flow control and feedback according to the feedback system.

This means that when the moments are unequal, caused by a change in the electrical input signal, the flapper plate (6) is moved from centre position between the two regulating jets. This creates a pressure differential, which affects both ends of the control spool. The effect of the pressure differential causes the control spool (5) to change its position. This change in position continues until the torques are in equilibrium again and the pressure differential is zero. The stroke of the control spool (5) and thus the flow of the 4 way servo valves is proportional to the electrical input signal.

**Pilot Control**

The pilot control is an electrically operated pressure servo valve which operates according to the principle of a jet flapper plate valve.

The electrical control current brings the solenoid system out of balance and thus deflects the flapper plate (6) between the two regulating jets (7). The flapper plate's change in position causes an alteration in the jet opening and thus a variable pressure drop to move the control spool.

**Second stage, mechanical feedback**

\[ Q = \text{proportional to } z_1 \text{ (mA)} \]

The control spool (5) is connected to the control motor (1) of the first stage almost without tolerance play by means of the mechanical feedback (3). The type of feedback used here operates because the torque of the control motor (1) is related to the feedback spring (3).
Electrical feedback of second stage

Q = proportional to input signal value (volts)

The control spool (5) is coupled to the inductive linear transducer (10) by means of the core (11). The position of the core (11) causes a voltage, the actual value, in the inductive linear transducer coils fed with AC current.

When the input value and the actual value are compared, the error is evaluated electronically and is fed as a signal to the first stage of the valve. This signal deflects the flapper plate (6) between the two regulating jets (7) and a pressure differential is created between the control chambers (8) and (9).

The control spool (5) with the core (11) of the inductive linear transducer (10) fixed to it is moved until the input value agrees with the actual value.

In this spool position, the pressure in control chambers (8) and (9) is equalised and the control spool is held in the regulating position.

There is a pilot opening to regulate flow, due to the position of the control spool (5) to the control sleeve (12). This opening is proportional to the nominal value, as is the spool stroke and the flow volume.

The electrical amplification in the electronic control is set to suit the closed loop control and the valve.

Barometric feedback of the second stage

Q = proportional to z₁ (mA)

When the coils are de-energised, there is pressure balance at the control spool (5), which is held in neutral position by the regulating springs (4).

The flapper plate is deflected by an electrical input signal, thus causing a pressure drop between the two control chambers (8) and (9).

This pushes the control spool until a force balance is reached — resulting from the pressure difference between the control chambers (8) and (9) of the control spool (5) on one side and the spring and flow force on the opposite side.

Since the regulating springs (4) show a linear characteristic, the stroke of the control spool (5) and thus the flow of the directional servo valve is proportional to the electrical input signal.
### Ordering Code

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 WS 2 E</td>
<td>mechanical feedback = M</td>
</tr>
<tr>
<td>10 -30/</td>
<td>electrical feedback = E</td>
</tr>
<tr>
<td>B</td>
<td>barometric feedback = B</td>
</tr>
<tr>
<td>11</td>
<td>Further details to be stated in text</td>
</tr>
<tr>
<td>10</td>
<td>no design. = std. model</td>
</tr>
<tr>
<td>R</td>
<td>additional controls (built in redundancy)</td>
</tr>
<tr>
<td>N4</td>
<td>emergency hand operation</td>
</tr>
<tr>
<td>30</td>
<td>Series 30 (30–39 installation and connection dimensions remain the same)</td>
</tr>
<tr>
<td>2</td>
<td>Nominal flow 2 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>5</td>
<td>Nominal flow 5 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>10</td>
<td>Nominal flow 10 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>20</td>
<td>Nominal flow 20 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>30</td>
<td>Nominal flow 30 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>45</td>
<td>Nominal flow 45 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>60</td>
<td>Nominal flow 60 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>75</td>
<td>Nominal flow 75 l/min at pₚ = 70 bar</td>
</tr>
<tr>
<td>1</td>
<td>Coil no. 1 (5 mA/500 Ohm per coil)</td>
</tr>
<tr>
<td>2</td>
<td>Coil no. 2 (30 mA/40 Ohm per coil)</td>
</tr>
<tr>
<td>3</td>
<td>Coil no. 3 (7.5 mA/200 Ohm per coil)</td>
</tr>
<tr>
<td>5</td>
<td>Standard model = no design.</td>
</tr>
<tr>
<td>1</td>
<td>Explosionproof (Ex) s G5</td>
</tr>
<tr>
<td>4</td>
<td>Flameproof (Sch) s</td>
</tr>
<tr>
<td>6</td>
<td>External pilot supply, external pilot drain= -</td>
</tr>
<tr>
<td>7</td>
<td>Internal pilot supply, external pilot drain= E</td>
</tr>
<tr>
<td>8</td>
<td>External pilot supply, internal pilot drain= T</td>
</tr>
<tr>
<td>9</td>
<td>Internal pilot supply, internal pilot drain= ET</td>
</tr>
<tr>
<td>10 -315 bar</td>
<td>(with mechanical feedback) = 315</td>
</tr>
<tr>
<td>40</td>
<td>10 to 40 bar input pressure to first</td>
</tr>
<tr>
<td>70</td>
<td>40 to 70 bar and with barometric</td>
</tr>
<tr>
<td>140</td>
<td>70 to 140 bar stage with barometric</td>
</tr>
<tr>
<td>210</td>
<td>140 to 210 bar and with electrical feedback</td>
</tr>
<tr>
<td>315</td>
<td>210 to 315 bar stage with barometric</td>
</tr>
<tr>
<td>315</td>
<td>210 to 315 bar and with electrical feedback</td>
</tr>
</tbody>
</table>

### Model Code Explanations

#### Feedback Systems

**Criteria for Different Applications**

**Mechanical Feedback (standard)**
- Automatic spool centering if control current fails
- Pressure change permissible
- Only one pressure rating necessary for pilot control
- High degree of positioning accuracy, reproducibility, good dynamic characteristics
- Especially suitable for frequently changing operating conditions

**Electrical Feedback**
- Change of pressure within the pressure range possible
- Very high degree of positioning accuracy, reproducibility, good dynamic characteristics
- For the most accurate requirements of control technology
- Valve regulating circuit with variable amplification
- Additional electronics
- Disturbance variables have little influence on valve
- Redundant control possible
- External control oil possible e.g. for fine filtration or holding pressure of first stage constant
- Simple exchange of the pilot control

**Barometric Feedback**
- Automatic spool centering if pressure or electronics fail
- Constant pilot pressure is recommended
- External pilot oil feed possible, e.g. for fine filtration or holding pressure of first stage constant
- Simple exchange of pilot control section
- Redundant control possible

#### Nominal Flow Q₀

The flow in l/min at nominal current $i_{N}$ and total valve pressure drop $p_{v} = 70$ bar is shown as nominal flow. Flow tolerance is $\pm 10\%$. The valve pressure drop $p_{v} = 70$ bar is important only as an average, as flow quantity can also change with a change in load pressure. The relevant values can be seen from the flow — load function. The most economic use of power is achieved at $p_{v} \approx P/3$. Servo valves with non linear curves are available on request. A special specification is necessary for this.
Explanation of Ordering Code

3 Coil

a) Coil no. 2 with 30 mA/40 Ohm per coil should be used as standard. Electronic units VT-1600/VT-1610 were designed for this.
b) Coil no. 3 must be used for the DC input signal for electrical measuring and regulating equipment to DIN 19 230 with 4–20 mA. The connections in the mating plug must be wired in a differential circuit. The valve is in neutral position at control current 12 mA per coil, at zero current or if the electronics should fail. This type of coil can also be used for amplifiers with an output of ±7.5 mA per coil.
c) An amplifier with output current of ±5 mA per coil is required for coil no. 1.

4 Insulation

a) The standard model is built with insulation IP 65 to DIN 40 050.
b) (Ex) s G5
   Special insulation type (Ex) s G5 to VDE 0171 is certified for coil sizes 1, 2 and 3. A servo valve with model code “EX” is therefore suitable for use in conditions where there is danger of explosion from flammable substances within ignition classifications G1 to G5. This model is not permissible where there is electrical feedback.
c) Special insulation type (Sch) s VDE 0170 is certified for coil sizes 1, 2 and 3 for servo valves with “F” in the model code. This is not permissible where there is electrical feedback.

5 Control Oil Designation Letter

In special applications, an external control is advantageous. The DIN subplate does not provide a connection for this, but a subplate can be fitted between the first and second stages on valves with electrical and barometric feedback.
a) Servo valves type 4 WS 2 EM 10.. are available only with internal oil supply and drain.
b) With types 4 WS 2 EE 10.. and 4 WS 2 EB 10.. it is possible to choose between the variations shown in the model codes.

6 Input pressure to the first stage

a) For the standard model with mechanical feedback use the 315 bar pressure range.
b) For electrical or barometric feedback the correct pressure stage should be chosen, i.e. the pilot pressure (internal port P, external-port X) should correspond to the pressure stage.
c) The pilot pressure in valves with electrical feedback, should preferably be the same as the system pressure. It may however be different, but the valve characteristics will change. For pressures below 40 bar it is preferable that pressures at ports P and X be the same.
d) For valves with barometric feedback the pressure at port X may not exceed the maximum pressure shown on the nameplate.
   Should the system pressure be less than the average of the maximum and minimum pressures of the pressure stage (e.g. pressure stage 140 → pressure 70 to 140 → average 105 bar) then the flow through the valve will be reduced.
   Higher pressures (up to max. pressure) will give higher flows.
e) Varying pilot pressure during operation, will mean reduced control over the machine movement. Pilot pressure should therefore be held constant.

7 Electrical Connection

The basic model “K8” is supplied only with the relevant socket without mating plug. If the mating plug is required, code “Z8” should be stated. Code “C” is used where the cable connection required (2 metres long) standard also for insulations “Ex” and “F”.

8 Spool Overlap

Spool overlap is based on a nominal spool stroke of ±0.8 mm. The overlaps A, B, C and D, are standard.

Main Applications:
Spool overlap: A
Suitable for speed control circuits.
Advantage: lower neutral position flow than spool “D”.
Spool overlap: B
Suitable for position and power control circuits.
Advantage: Higher damping, however, higher flow in neutral position than spool “D”
Spool overlap: C
Suitable for controls and speed regulation circuits without flow in neutral.
Spool overlap: D (Standard)
Universal overlap suitable for speed, positioning and power regulation circuits.

9 Seal Material

Stability must always be checked, as the reaction of the different fluid temperature to the seal material varies. “V” must be used for valve application at temperatures 90–150 °C.

10 This space remains blank unless the accessory is required.

a) In the case of redundant controls, the function is explained under ‘unit dimensions’.
b) Mechanical hand emergency can be used only with barometric feedback.

11 Details in Text

Special models should be specified here. This will be checked at the factory and a designation number will be allocated.
### Technical Data
(measured at \( v = 36 \text{ mm}^2/\text{s} \) [cSt] and \( t = 50 \degree\text{C} \))

#### General

<table>
<thead>
<tr>
<th>Feedback system</th>
<th>mechanical (standard)</th>
<th>electric</th>
<th>barometric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting position</td>
<td>As required, providing that sufficient pilot pressure is available at start up. Should the pressure be insufficient, the spool may remain in an intermediate position. Because of this, the P port may be connected to a service port and pressure build up delayed.</td>
<td>Remedied by means of shut-off devices in the service lines</td>
<td>As the spool is spring centred, no problem will occur in the pressure build up</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>( -55 ... +90 \degree\text{C} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid temperature</td>
<td>( +10 ... +90 \degree\text{C} ) with seal type &quot;V&quot; = ( +10 ... +150 ) preferably ( +50 \pm 5 ) (ideal)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Hydraulic

| Hysteresis (with optimum dither) (%) | \( \leq 2,5 \) | \( \leq 0,5 \) | \( \leq 5 \) for press. stages 40 & 70 \( \leq 3,5 \) for press. stages 140,210,315 |
| Sensitivity of response (%)         | \( \leq 0,5 \) | \( \leq 0,2 \) | \( \leq 1,0 \) |
| Reversal current (%)                | \( \leq 1,0 \) | \( \leq 0,2 \) | \( \leq 2,0 \) |
| Flow symmetry deviation (%)         | \( \leq 5 \)   | \( \leq 5 \)   | \( \leq 5 \)   |

| Pressure amplification for:         |           |           |            |
| spool overlap A                     | 30 ... 60% P at 1% \( z_{iN} \) |           |            |
| spool overlap B                     | 20 ... 60% P at 1% \( z_{iN} \) |           |            |
| spool overlap C                     | 10 ... 30% P at 1% \( z_{iN} \) |           |            |
| spool overlap D                     | 40 ... 80% P at 1% \( z_{iN} \) |           |            |

| Return line pressure (bar) | Port A, B, P, X | 10 ... 315 | 10 ... 315 | observe pressure ranges |
| Return pressure (bar)      | Port T, Y      | \( \leq 4,5 \) | pressure peaks \( < 100 \) | (return line pressure reduces the flow) |

| Hydraulic medium            | HLP mineral oils | water glycol | phosphat ester (HFD) |

| Filtration                  | Pressure filter without bypass valve, if possible directly in front of the servo valve |
| pilot fluid                 | Class 4 - 5 NAS 1638 |
| main fluid                  | Class 7 - NAS 1638 |
| recommendation: basic       | Class 4 - 5 NAS 1638 |

| Nominal flow \( \pm 10\% \) (l/min) at \( p_v = 70 \text{bar} \) | 2 - 5 - 10 - 20 - 30 - 45 - 60 - 75 |

| Zero flow (l/min) 1st stage (oil of pilot control) | \( \approx 0,8 \sqrt{\frac{P}{70}} \) | \( \approx 0,8 \) |
| Zero flow for overlap A (l/min) (control and leakage oil 2nd stage) | \( \approx \sqrt{\frac{P}{70}}(0,8 + 0,01 \cdot Q_N) \) | \( \approx 0,8 + \sqrt{\frac{P}{70}} \cdot 0,01 \cdot Q_N \) |
| Zero flow for overlap B (l/min) | \( \approx \sqrt{\frac{P}{70}}(0,8 + 0,04 \cdot Q_N) \) | \( \approx 0,8 + \sqrt{\frac{P}{70}} \cdot 0,04 \cdot Q_N \) |
| Zero flow for overlap C (l/min) | \( \approx \sqrt{\frac{P}{70}}(0,8 + 0,005 \cdot Q_N) \) | \( \approx 0,8 + \sqrt{\frac{P}{70}} \cdot 0,005 \cdot Q_N \) |
| Zero flow for overlap D (l/min) | \( \approx \sqrt{\frac{P}{70}}(0,8 + 0,02 \cdot Q_N) \) | \( \approx 0,8 + \sqrt{\frac{P}{70}} \cdot 0,02 \cdot Q_N \) |
Technical Data (measured at $v = 36 \text{ mm}^2 / \text{s [cSt]}$ and $t = 50^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Electrical (pilot control)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co&lt;sub&gt;il&lt;/sub&gt; Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal current per coil</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance per coil</td>
<td>$\Omega$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inductance per coil at 50 Hz and 100% $z_{IN}$ input amplitude</td>
<td>mH</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>70</td>
<td>350</td>
</tr>
<tr>
<td>Feedback system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical (standard)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barometric</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zero balance current (%): $< 5$, long term $< 8$

Zero offset based on zero point adjusted valve for change of:

- Fluid temperature (%): $< 2/20^\circ \text{C}$
- Ambient temperature (%): $< 2/20^\circ \text{C}$
- System pressure (%): $< 2$ in range $0.8 \ldots 1.2 \cdot P$
- Return pressure (%): $< 2$ in range $0 \ldots 0.1 \cdot P$

Recommended dither signal (%): $\pm 110\%$ nominal current at $100 \ldots 250 \text{ Hz}$

Electrical (inductive positional transducer)

<table>
<thead>
<tr>
<th>Electrical measuring system</th>
<th>differential transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spool nominal stroke (mm)</td>
<td>$\pm 0.8$</td>
</tr>
<tr>
<td>Sensitivity at 2 kHz and 50 k$\Omega$ load (mV/V/mm)</td>
<td>50</td>
</tr>
<tr>
<td>Resolution (mm)</td>
<td>$&lt; 0.002$</td>
</tr>
<tr>
<td>Linearity deviation related to the spool nominal stroke (%)</td>
<td>$&lt; \pm 0.5$</td>
</tr>
<tr>
<td>Feed voltage ($V_{eff}$)</td>
<td>1 ... 5</td>
</tr>
<tr>
<td>Carrier frequency (kHz)</td>
<td>2 ... 10</td>
</tr>
<tr>
<td>Coil resistance yellow/grey ($\Omega$)</td>
<td>110</td>
</tr>
<tr>
<td>Inductance (mH)</td>
<td>$\approx 50$</td>
</tr>
</tbody>
</table>

For applications outside the above parameters, please consult us.

Performance Curves (measured at $v = 36 \text{ mm}^2 / \text{s [cSt]}$ and $t = 50^\circ \text{C}$)

Tolerance field of flow/signal function

Saturation conditions must be considered with flows $\geq 60 \text{ l/min}$
Performance Curves (measured at $\nu = 36 \text{ mm}^2/\text{s \, [cSt]}$ and $t = 50 \degree \text{C}$)

Flow/load function for all feedback systems (tolerance ±10%)

$$Q = Q_N \sqrt{\frac{p_v}{70}}$$

Nominal flow $Q$ (l/min)

Valve pressure drop $p_v$ (bar)

Typical frequency reference curves for servo valve with mechanical feedback

Frequency related to operating pressure

$\phi = 0^\circ$

$\phi = -90^\circ$

Operating pressure $p$ (bar)

Frequency $f$ (Hz)

--- $Q_N$: 45 – 75 l/min, $z_{iN}$
--- $Q_N$: <= 30 l/min, $z_{iN}$
--- $Q_N$: 45 – 75 l/min, 25% $z_{iN}$
--- $Q_N$: <= 30 l/min, 25% $z_{iN}$
Typical frequency reference curves for servo valves with electrical feedback

Typical frequency curves for servo valves with barometric feedback and QN < 30 l/min

Typical frequency curves for servo valves with barometric feedback and QN = 45–75 l/min

Performance Curves (measured at \( v = 36 \text{ mm}^2/\text{s} \) [cSt] and \( t = 50 {}^{\circ} \text{C} \))

A(dB) vs Frequency f (Hz) and \( \phi \) (°)

- \( Q_N: 45 - 75 \text{ l/min, } z_i N \)
- \( Q_N: \leq 30 \text{ l/min, } z_i N \)
- \( Q_N: 45 - 75 \text{ l/min, 25\% } z_i N \)
- \( Q_N: \leq 30 \text{ l/min, 25\% } z_i N \)

Frequency related to operating pressure

fo (-90°)
fo reference curve

<table>
<thead>
<tr>
<th>Operating pressure p (bar)</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Pressure ratings:
- 40 bar
- 70 bar
- 140 bar
- 210 bar
- 315 bar

Frequency f (Hz) vs A(dB) and \( \phi \) (°)
**Electrical connections**

### Pilot control (1st stage)

**Plug connection**
- Blue
- Green
- Red
- Yellow

**Cable connection**
- White
- Red
- Brown
- Blue
- Yellow
- Green

The electrical connection can be either in parallel, series or differential circuit. For safety reasons, we recommend parallel circuit.

Parallel circuit: mating plug connection, A connected to B and C to D, cable connection yellow connected to brown and green to white.

Series or differential circuit: mating plug connection, B connected to C, cable connection, brown connected to green.

Electrical control from A (+) to D (−) with plug connection or from yellow lead (+) to white lead (−) with cable connection (differential circuit $f$, from A → B > D → B or yellow → brown > white → brown) gives flow direction in the second stage from P → A and B → T. Reversed current direction gives flow in the second stage from P → B and A → T.

### Positional transducer

**Plug connection**
- Green/yellow
- Blue
- Black
- Red
- Brown

**Cable connection**
- Green
- Brown
- White
- Green/yellow
- Brown
- Blue
- Yellow
- Black
- Grey
- Red

If the valve spool goes into end position during commissioning (closed loop control), it may be necessary to change over electrical connections B and C, or brown and green.

**Control Electronics: Power Supply**

Power supplies type SV.../8 have unregulated, smoothed outputs suitable for feeding voltage regulators type SN...

Any H.F. interference is suppressed within this power unit.

**SV 100/8**

<table>
<thead>
<tr>
<th>Type SV..</th>
<th>100/8</th>
<th>101/8</th>
<th>102/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage (U)</td>
<td>220 V ~</td>
<td>110 V ~</td>
<td>220 V ~</td>
</tr>
<tr>
<td>Output voltage (U)</td>
<td>± 22 ± 30 V</td>
<td>± 22 ± 30 V</td>
<td>± 22 ± 30 V</td>
</tr>
<tr>
<td>+ 10 ± 13 V</td>
<td>+ 10 ± 13 V</td>
<td>+ 10 ± 13 V</td>
<td></td>
</tr>
<tr>
<td>Output current (I)</td>
<td>at 60% duty $\Sigma/A = 9A$ max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 100% duty $\Sigma/A = 5.5A$ max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature range (°C)</td>
<td>0... + 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space required</td>
<td>26 divisions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VT-1600
Servo amplifiers type VT 1600 serve to control servo valves. The P-I-D controller is uncoupled by changing an internal bridge; the following fixed current generator can therefore be directly controlled. The ammeter fitted in the front plate shows the servo valve current directly.

<table>
<thead>
<tr>
<th>Type</th>
<th>VT-1600</th>
<th>VT-1610</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>(U) ± 22 28 V stabilised</td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>(U) ± 12 V</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>(I) max 60 mA</td>
<td></td>
</tr>
<tr>
<td>Oscillator frequency</td>
<td>(f)</td>
<td>2.5 kHz</td>
</tr>
<tr>
<td>Dither frequency</td>
<td>200 Hz / 3 mA3s (coils in parallel)</td>
<td></td>
</tr>
<tr>
<td>Temperature range</td>
<td>(t) 0 °C up to + 50 °C</td>
<td></td>
</tr>
<tr>
<td>Plug connection</td>
<td>indirect/DIN 41 612/Model D/32 pin</td>
<td></td>
</tr>
<tr>
<td>Space required</td>
<td>8 divisions</td>
<td></td>
</tr>
<tr>
<td>Euro design</td>
<td>100 x 160 mm</td>
<td></td>
</tr>
</tbody>
</table>

Unit Dimensions: Servo Valve, Mechanical Feedback
(dimensions in mm)

1 Model with cable connection “C”
2 Space required to remove plug with Z8 connection
3 Plug type MS 3106 E 14S-2S
4 Adjustment of hydraulic zero point on both sides (A/F 5)
5 Interchangeable filter element (A/F 10)
6 4 off valve fixing screws
7 Nameplate
8 Cap can be rotated 180°
9 Pilot control (1st stage)
10 2nd stage

Require surface finish of mounting face if our subplate is not used.
Unit Dimensions: Servo Valve, Electrical Feedback

1 Model with cable connection “C”
2 Space required for removal of plug with ZB connection
3 Plug type MS 3106 E 14S-5S
4 Adjustment of hydraulic zero point (3 A/F – 10 A/F)

Unit Dimensions: Servo Valve, Barometric Feedback

1 Adjustment of hydraulic zero point (5 A/F)

Unit Dimensions: Servo Valve, Electrical or Barometric Feedback

External pilot supply and drain

1 1/4” BSP, 12 deep
Ports X (external pilot supply) and Y (external pilot drain) are available rotated 90° (2 off each)
The explosionproof insulation according to VDE 0171, insulation type “special insulation (Ex) s G5” for the first stage of the model with coils no. 1, 2 and 3, was certified by the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig under test certificate PTB No. III B/E 24 701, amendments 1–4, and also by the Bayerisches Staatsministerium für Arbeit und Sozialordnung in Munich.

The electro-hydraulic servo valve is suitable for use in areas, where there is danger of explosion by flammable materials within the range of ignition groups G1 to G5. G1 to G5.
The valve should be adequately protected against mechanical damage.
A fuse corresponding to the nominal current should be connected in front of the valve.
Electrical feedback is not permitted.

The flameproof insulation according to VDE 0170, insulation (Sch) s for the first stage of the model with coil no. 1 and coil no. 2 was approved by the Berggewerkschaftliche Versuchsstrecke (BVS) in Dortmund-Derne under the test certificate no. T 5770 dated 8.12.1976, and by the Landesoberbergamt Nordrhein-Westfalen with approval no. XV Rexroth 1.

A pre-requisite is that the valve and the junction box are fitted on a common surface or on surfaces which are fixed rigidly to one another.
The connection line must be laid rigidly.
A fuse corresponding to the nominal current should be connected before the valve.
Electrical feedback is not permitted.
In certain cases, e.g. where human life or high value goods are endangered, we recommend that redundantly controlled servo valves be used. Built in redundancy is often demanded by legislation, as is the case, for example, in the aircraft industry.

The redundant control of the Rexroth servo valves operates to the principle of active redundancy.

A redundant control on two-stage servovalves, is only practical with electrical feedback.

When using a pilot control valve for 3 stage valves, barometric feedback may also be used.

**Function**

Under the active redundancy principle, three first stages operate in parallel to control the second stage. The electrical input signals of the three first stages are transformed into a common hydraulic signal to operate the second stage. As the three first stages operate in parallel, the machine will still function if there should be a malfunction or if one of the first stages should fail.

The electrical control can also have built in redundancy or be a simple control.

Possible variations of redundantly controlled servo valves:
- cable connection
- round plug

**System circuit diagram**

1 Mechanical operation by lever deflection

max. lever deflection does not correspond to \(Q_N\)
## Important Spare Parts

<table>
<thead>
<tr>
<th>Part no.</th>
<th>Plug for pilot control (1st stage)</th>
<th>MS 3106E-14S-2S</th>
<th>002 460</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plug for electrical feedback</td>
<td>MS 3106E-14S/5S</td>
<td>011 921</td>
</tr>
<tr>
<td></td>
<td>Valve fixing screws</td>
<td>M5 x 50 DIN 912 8.8</td>
<td>003 028</td>
</tr>
<tr>
<td></td>
<td>O-ring(second stage connections)</td>
<td>12 x 2 NBR 75-80 sh</td>
<td>004 255</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 x 2 Viton</td>
<td>004 449</td>
</tr>
<tr>
<td></td>
<td>O-ring (first stage connections)</td>
<td>7 x 1,5 NBR 75-80 sh</td>
<td>004 244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 x 1,5 Viton</td>
<td>004 445</td>
</tr>
<tr>
<td></td>
<td>O-ring (filter cartridge)</td>
<td>7 x 1,5 NBR 75-80 sh</td>
<td>004 244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 x 1,5 Viton</td>
<td>004 445</td>
</tr>
<tr>
<td></td>
<td>Filter cartridge without seal</td>
<td></td>
<td>148 319</td>
</tr>
<tr>
<td></td>
<td>Protective plate for valve mounting surface (valve storage, despatch)</td>
<td></td>
<td>140 053</td>
</tr>
</tbody>
</table>

## Weight (without fluid)

- **4 WS 2 EM 10-30 (basic model)** ........................................ 1,1 kg
- **4 WS 2 EE 10-30 (basic model)** ........................................ 1,9 kg
- **4 WS 2 EB 10-30 (basic model)** ........................................ 1,6 kg

**Additionally:**
- Special insulation (Ex) s G5 ........................................... 0,30 kg
- Special insulation (Sch) .................................................. 3,20 kg
- Plate for external pilot oil supply (–, E, T) ......................... 0,25 kg
- Cable connection 2000 mm long .................................................. 0,20 kg
- Redundant control ............................................................... 1,40 kg
- Mechanical operation ........................................................... 0,30 kg
- Subplate G 66/01 .................................................................. 2,30 kg
- Subplate G 67/01 .................................................................. 2,30 kg
- Subplate G 534/01 ................................................................. 2,50 kg
- Flushing plate ................................................................. 1,00 kg
- Battery operated control unit .................................................. 0,45 kg

## Important Information for Commissioning

Before the valve is fitted, compare and check the type designation with the data given on the order.

- It is important to maintain the specified inlet pressure to the pilot control stage on servo valves with barometric feedback.
- Due to the regulating characteristics, pilot pressure must be constant, i.e. it must not fluctuate.
- In the case of valves with the type designation "E" or "–", please check that the external return line is connected up.
- Has the correct seal material been used, Type designation "V" must be used for highly flammable fluids HFD and for temperatures > 90 °C.
- Notes on the hydraulic servo system.
  - Sealing materials such as hemp, putty and sealing tape are not permissible. Any unavoidable hoses should be painted on the inside with a wear-resistant smooth coat of polyamid.
  - Seamless precision steel tubes, DIN 2391/C, should be used as pipes. These pipes must be cleaned of dirt, scale, sand, chippings, etc., before they are connected up. Hot bent pipes and/or welded pipes must be pickled, washed and oiled. The connection lines between the user and the valve should be as short as possible.
  - We recommend that the servo valve be fitted directly to the user.
  - NB: Are the hydraulic ports connected correctly?
    - Have the electrical connections been wired up correctly?

## Flushing Instructions for Servo Valves

In order to guarantee perfect servo valve function, it is necessary to flush all supply, user and return lines before commissioning a unit.

External pilot oil ports must also be flushed.

The following formula gives an average value for the flushing time:

\[
t = \frac{V}{Q} \cdot 5
\]

whereby

- \(t\) = flushing time in hours
- \(V\) = tank capacity in dm³
- \(Q\) = pump flow per minute

During the flushing process, all filters must be continuously monitored and the filter elements changed if necessary. After the connection lines have been opened, the unit should be flushed again for approximately 30 minutes.

Any mounting surfaces unused during assembly should be cleaned only with a fluff-free cloth or non-fibrous paper.

When refilling with hydraulic fluid, at least one filter must be used. The mesh of this filter must be less than 0.06 mm.

The flushing process must be repeated if topping up requires, the tank to be filled up with over 10% of its capacity.

A directional control valve with connections to DIN 24 340 is more suitable than a flushing plate.

- **Electrically operated:** 4 WE 10 G 10 ...
- **Manually operated:** 4 WMM 10 G 10 ...

Using these valves, the service connections can also be flushed.

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16
Flushing Instructions for Servo Valves

Part no. 1 5 off o-rings 12 x 2
308 492
2 4 off S.H.C.S. M6 x 30 DIN 912
(included in supply)

Valve Assembly

Should the valve be fitted directly on to a serviced unit, the valve should not be mounted in such a way that the valve piston is parallel to the acceleration direction of the working unit.

After completion of the flushing process, the protective plate on the 4 way servo valve should be removed and the valve fitted correctly. Release ensure that the 4 O-rings are in the correct position on the connection surface of the valve.

The 4 valve fixing screws M6 x 50 DIN 912-8.8 included with the 4 way servo valve should be tightened to a torque of 9 Nm.

The unit can now be supplied with pressure.

Note:
Under no circumstances may an electrical signal be given to the valve before operating pressure has been built up in the first stage.

Hydraulic Zero Point Adjustment

On all servo valves, the hydraulic zero point depends among other things on the system concerned. Consequently, the hydraulic zero point must be adjusted during commissioning and occasionally at a later date.

The zero point adjusting device is easily accessible.

The adjustment is made as follows:

Mechanical feedback

The setting may only be made at pressures up to 140 bar. Higher pressures must be reduced to this level. The electrical plug must be disconnected to ensure that no supply is present. Now turn the screws on the ends of the valve to the left or to the right.

(5 A/F Allen key)

Clockwise rotation of the adjustment screw on port A side causes flow from P → B and A → T; anti-clockwise rotation causes flow from P → A and B → T.

The correct direction of rotation can be seen from the reaction of the machine. Once the valve has been corrected, lock the two screws on the face against each other.

Zero point adjustment screws (5 A/F)
Hydraulic Zero Point Adjustment

Electrical feedback
With closed loop control, the hydraulic zero point is set at nominal valve zero.
This is done by loosening the grub screw on the face of the electrical feedback and turning it either to the left or to the right.
Clockwise rotation causes flow from P → B and A → T.
Anti-clockwise rotation causes flow from P → A and B → T.
The correct direction of rotation can be seen from the reaction of the machine. After adjustment, the grub screw must be tightened again.
The zero point should be checked again locking the screws.

Barometric feedback
The electrical plug must be disconnected, to ensure that no supply is present.
The adjustment screw is on the same side as port A.
This screw (5 A/F) is turned either to left or to right.
Clockwise rotation causes flow from P → A and B → T.
Anti-clockwise rotation causes flow from P → B and A → T.
The adjustment limit is as follows:
The face of the adjustment screw should not protrude from the sleeve by more than 0.5 mm or be more that 1.0 mm inside the edge of the sleeve.
If the hydraulic zero point is not reached within the adjustment ranges, there must be a fault. The basic function should then be checked using a battery operated control unit. This refers to all feedback types.

Battery Operated Control Unit
Fault finding on a machine is greatly simplified by use of the battery operated control unit. The servo valve can be tested in situ and does not need to be dismantled.
The power supply to the drive unit is by 4 "Mignon" batteries (1.5 V each)
The inspection is carried out as follows:
- Unplug the servo valve from the electronics
- Select coil type on the drive unit
- The adjustment potentiometer must be set to zero
- Plug the servo valve in to the drive unit
- Turn the potentiometer slowly to left and right, observing the motor or cylinder movement.
If the servo valve with mechanical or barometric feedback is functioning perfectly, the motor or cylinder operated in this way can be moved sensitively in the required direction.

Note: On valves with electrical feedback, modulation using this battery unit is not possible. As the feedback is not connected, any signal in either direction will cause full operation (maximum flow) at the valve. Thus, the valve may only be checked as a simple directional control valve.

Warning: For valves with electrical feedback, maximum flow will always be set.
Valve Cleaning (see also RE 09 240)

If, after a long period of operation, the regulation speed of the servo valve becomes gradually slower, it is advisable to check whether the filter and inlet jets to first stage have become clogged.

Checking the Filter

After the hydraulic pressure has been decreased to zero, the filter cartridge (1) can be unscrewed. The actual filter can now be drawn from the filter housing by means of an M4 screw.

Should the filter be dirty, it must be replaced by a new filter.

The part number for the Perbunan filter is 306 842, and for the Viton filter 306 843.

In cases of emergency, the filter can be cleaned using compressed air. Care must be taken to ensure that no dirt gets into the filter or into the first stage.

The new filter cartridge should be removed from its packing only when you are ready to fit it.

If the filter was dirty, flush out the complete hydraulic system as described under paragraph "flushing instructions for servo valves".

Now check the function of the system again.

Checking the Inlet Jet

Here again the hydraulic pressure must be turned off. The inlet jet is checked first on the one side and then on the other side after it has been refitted into position. The clamping screw of the inlet jet can be unscrewed by means of an Allen key (3 A/F). This clamping screw must not be mistaken for the control jet, which is locked with a hexagonal nut. The inlet jet (5) is located in the face of the screw which has been removed.

NB: Do not lose or mix up inlet jets.

Clean the removed parts in petroleum cleanser or a similar cleaning agent. Thorough cleaning must be ensured.

After refitting, check the other side. In this way, the jets cannot be mixed up.

Should the valve still not function properly, please return it to the factory for inspection and repair, if you do not have a test stand with the necessary spare parts.

Checking the Regulating Jets

Checking and re-adjusting the regulating jets requires technical skill and can be carried out by trained personnel, according to instructions RE 09 240 Port A.

1 Filter cartridge
2 Check here for dirt
3 M4 thread to dismantle filter
   (if necessary, use the fixing screw of the first stage)
4 Do not undo hexagonal nut
5 Inlet jet
6 Pressure screw
Changing the Pilot Control (1st Stage)

Electrical and barometric feedback

The first stage can be replaced completely without difficulty. The 4 fixing screws (M4 x 30 or M4 x 60 DIN 912-8.8 for external pilot control) are loosened with an Allen key (3 A/F) and the defective first stage replaced by a "replacement first stage". The replacement valve must have the same technical data as the replaced valve.

NB:
Amend the nameplate or order the correct nameplate for the 2 stage servo valve when ordering the first stage. The fixing screws are tightened up alternately with a torque of 2.6 Nm.

Mechanical feedback

Replacing the first stage is not recommended, due to the difficulty in fitting the mechanical feedback into the control spool. However, this is possible.

Changing the Control Sleeve

It is possible to replace the control sleeve. However, in order to ensure proper re-assembly and to minimise the risk of contamination, we do not recommend that this be done by the valve situ. If replacement becomes necessary, please return the valve to the manufacturer for this purpose.

Returning the Valve for Repair

When returning the defective valve, a protective plate must be fastened on the base surface of the valve. Careful packing is advisable, so that no further damage is done to the valve while in transit.