

2-way proportional throttle valve for block installation

RE 29202/07.05
Replaces: 03.00

1/12

Types FE; FEE

Size 16
Component series 2X
Maximum operating pressure 315 bar
Maximum flow 190 L/min bei $\Delta p = 10$ bar



H4538

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Features

- Pilot operated 2-way proportional throttle valve for block installation
- Installation dimensions to DIN ISO 7368-BA-06-2-A
- Electrically position-controlled orifice spool
- Direction of flow A to B
- In the event of a power failure or cable break (or withdrawal of the enable ¹⁾) the orifice spool moves automatically to the closed position and blocks the flow from A to B
- In conjunction with a pressure compensator, can be used for pressure-compensated flow control
- Type FE for external control electronics (separate order), see page 5
- Type FEE: completely matched unit with integrated electronics (OBE), optionally available with voltage or current interface

¹⁾ Type FEE only

Information on available spare parts:
www.boschrexroth.com/spc

Ordering code

FE 16 C-2X/ / / / / *

Electrically operated
2-way proportional throttle valve
for block installation

For external control electronics = **No code**
With integrated electronics (OBE) = **E**

Size 16 = **16**

Kit = **C**

Component series 20 to 29 = **2X**
(20 to 29: unchanged installation and connection dimensions)

Flow characteristic "linear"¹⁾

100 L/min = **100L**

190 L/min = **190L**

¹⁾ Nominal flow in L/min at $\Delta p = 10$ bar between ports
A and B (see also hydraulic technical data on page 4)

Further details in clear text

Seal material

M = NBR seals,
suitable for mineral oil
(HL, HLP) to DIN 51524
V = FKM seals

Electronics interface (see page 7)

B1 = Command value input 0 to 10 V/
actual value output 0 to -10 V
G1 = Command value input 4 to 20 mA/
actual value output 4 to 20 mA
No code = For FE
for external control electronics

Electrical connection

for FE:

K4 = Without cable sockets, with component plug
to DIN EN 175301-803
for proportional solenoid and GSA20 made by
Hirschmann for position transducer
Cable sockets – separate order,
see page 6

for FEE:

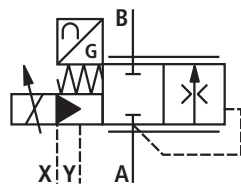
K0 = Without cable socket, with component plug to
DIN 43651, cable socket – separate order, see
page 7

Standard type

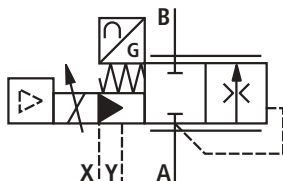
Type	Material no.
FEE 16 C-2X/190LK0B1M	R900954413

Symbols

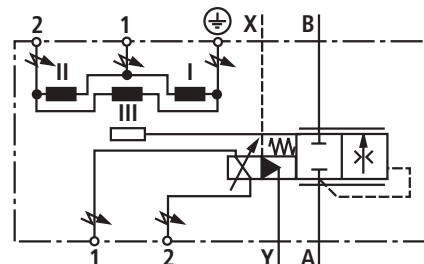
Simplified
FE 16 C-2X/...²⁾



FEE 16 C-2X/...²⁾



Detailed (example of type FE)
FE 16 C-2X/...



Direction of flow: A to B (X connected with A)

Note: Connect pilot oil port X with A
or connect externally

Caution! In the case of external pilot oil supply at X,
the pressure in X **must be** \geq pressure in A!

²⁾ **A** service port
B service port
X pilot oil supply
Y pilot oil drain

Function, section

Valves of type FE(E) are pilot operated 2-way proportional throttle valves for block installation for the infinitely variable control of a flow.

Technical structure:

The valve consists of four main assemblies:

- Cover (1) with mounting face for pilot oil ports.
- Main valve (2) with orifice spool (3).
- Pilot valve (4) with proportional solenoid (5).
- Integrated control electronics (6) (not provided for type FE) with position transducer (7).

General function:

- Command value-related closed-loop position control of orifice spool (3) and therefore defined opening of orifice (8).
- The flow depends on the Δp across orifice (8) and the position of orifice spool (3).
- Actual value acquisition of the position of orifice spool (3) by position transducer (7); command/actual value comparison in electronics (6); deviations are conditioned and passed on to proportional solenoid (5) of pilot valve (4) in the form of a control output for correcting the position of orifice spool (3).
- Area ratio of area (15) to area (12) = 1 : 1.
- Direction of flow A → B; connect X to A or connect externally.
- **Caution!** With external pilot oil supply, the pressure in X must be \geq pressure in A to ensure proper functioning of the valve.
- A pilot oil by-pass via nozzle (16) increases vibration damping.
- When the enable is withdrawn, orifice spool (3) moves against mechanical limit stop (17) in the valve bushing (closed position) and blocks the flow A → B.
- The orifice spool position is already controlled at a command value of 0 V or 4 mA, with orifice (8) still being in the positive overlap position and closing A → B.
- For leakage across orifice spool (3) and pilot valve (4) at command 0 V or 4 mA and inactive enable, see Technical data on page 4.

Function of opening orifice spool:

Flow A → B and A connected with X

- Proportional solenoid (5) shifts pilot spool (4.1) against spring (13) and opens the connection between control chamber (12) and Y; the pressure in control chamber (12) is reduced, and orifice spool (3) moved to the direction of opening by the pressure in A that acts on area (15).

Function of closing orifice spool:

Flow A → B and A connected with X

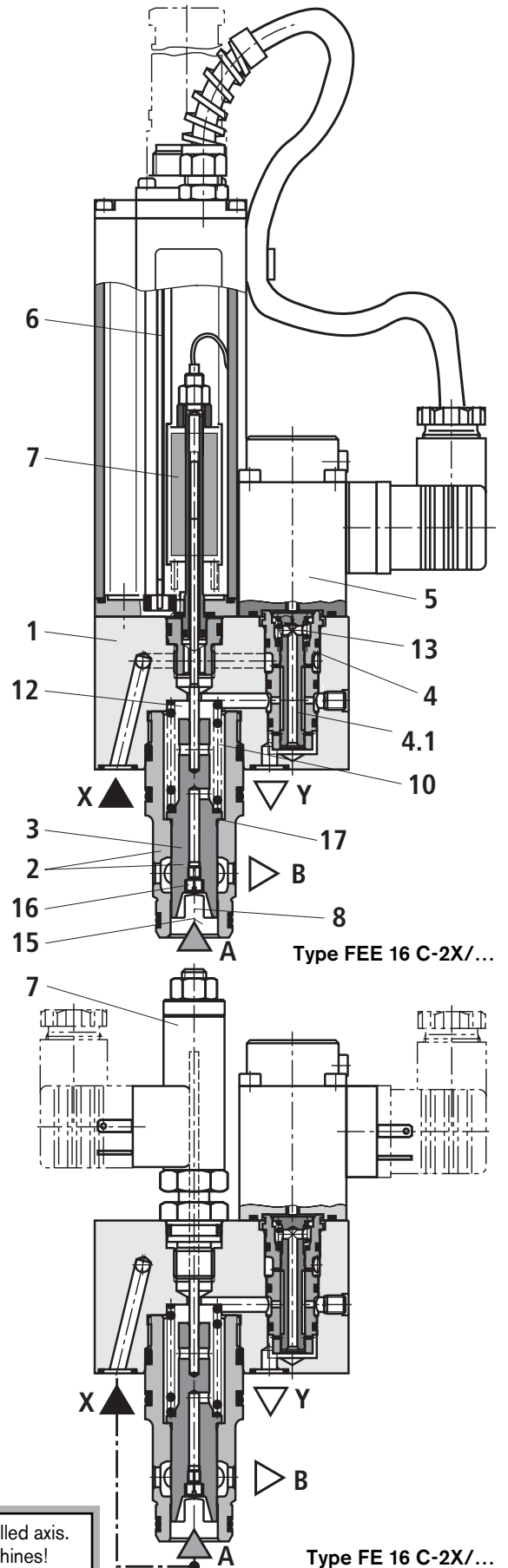
- Current reduced in proportional solenoid (5); spring (13) shifts pilot spool (4.1) against the proportional solenoid and opens the connection between X and control chamber (12); pressure builds up in control chamber (12); the pressure acting on the orifice spool area in control chamber (12) plus spring force (10) shift orifice spool (3) in the closing direction.

Flow control function:

- In conjunction with a pressure compensator, can be used for the pressure-compensated control of a flow.

Failure of the supply voltage:

- The integrated electronics de-energises the solenoid in the event of a supply voltage failure or cable break in position transducer (7).
- The spool is shifted to the closed position by the pressure applied to pilot port X plus spring force (10) and blocks the flow A → B.



⚠ Caution: A voltage supply failure results in a sudden standstill of the controlled axis. Accelerations that can occur in conjunction with this can cause damage to machines!

Technical data (for applications outside these parameters, please consult us!)**General**

Weight	- FE	kg	2.7
	- FEE	kg	2.9
Installation orientation			Optional
Storage temperature range		°C	- 20 to + 80
Ambient temperature range	- FE	°C	- 20 to + 70
	- FEE	°C	- 20 to + 50

Hydraulic (measured with HLP 46; $v_{oil}^{\circ} = 40 \text{ °C} \pm 5 \text{ °C}$)

Max. operating pressure – Ports A, B		bar	315
Max. pilot pressure – Port X		bar	315
Return flow pressure – Port Y			At zero pressure to tank
Min. inlet pressure – in A (direction of flow A → B)		bar	7
Max. flow q_{Vmax} of main valve at Δp 10 bar			
Direction of flow A → B		L/min	190
Pilot oil volume for switching process from seated position			
0 → 100%		cm ³	0.9
Max. pilot oil flow in port Y:			
With stepped input signal		L/min	2.5
Direction of flow			A → B
Pilot oil port			Connect X to A or connect externally. ⚠ Caution! With external pilot oil supply, the pressure in X must be \geq pressure in A.
Leakage fluid	- State: Command value 0 V or 4 mA		From A → B, see characteristic curve on page 9 Max. 0.4 L/min from A → X and across the nozzle in the main spool to Y at Δp 315 bar
	- State: Enable inactive (solenoid de-energised)		Max. 1.5 L/min from A → B at Δp 315 bar; max. 0.2 L/min from A → X and across the nozzle in the main spool to Y at Δp 315 bar
Hydraulic fluid			Mineral oil (HL, HLP) to DIN 51524; further hydraulic fluids on enquiry!
Hydraulic fluid temperature range		°C	- 20 to + 80
Viscosity range		mm ² /s	15 to 380
Max. permissible degree of contamination of the hydraulic fluid			
Cleanliness class – Pilot valve			Class 17/15/12 ¹⁾
to ISO 4406 (c) – Main valve			Class 20/18/15/ ¹⁾
Hysteresis		%	< 0.2
Response sensitivity		%	< 0.1
Range of inversion		%	< 0.15

¹⁾ The cleanliness classes specified for components must be adhered to in hydraulic systems. Effective filtration prevents malfunction and, at the same time, prolongs the service life of components.

For the selection of filters, see data sheets RE 50070, RE 50076, RE 50081, RE 50086 and RE 50088.

Technical data (for applications outside these parameters, please consult us!)**Type FE** – external control electronics**Electrical, solenoid** (pilot valve for type FE)

Type of voltage	V	24 DC
Nominal current	mA	1000
Coil resistance	– Cold value at 20 °C	Ω 12.7
	– Max. hot value	Ω 19.3
Duty cycle	%	100
Electrical connection	With component plug to DIN EN 175301-803	
	Cable socket to DIN EN 175301-803 ¹⁾	
Type of protection of the valve to EN 60529	IP65 with cable socket mounted and locked	

Electrical, inductive position transducer (main stage)

Coil resistance at 20 °C (see Symbols on page 2)	Total resistance of coils between	1 and 2	2 and \perp	\perp and 1
		Ω	31.5	45.5
Inductance	mH	6 to 8		
Oscillator frequency	kHz	2.5		
Electrical connection	With component plug GSA20 made by Hirschmann			
	Cable socket GM209N (Pg9) made by Hirschmann ¹⁾			
Type of protection to EN 60529	IP65 with cable socket mounted and locked			
Electrical position measuring system	Differential throttle			


Control electronics (type FE only; separate order)

Amplifier in Euro-card format	analogue	VT-VRPA1-50-1X to data sheet RE 30117
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Type FEE – integrated electronics (OBE)**Electrical**

Duty cycle	%	100
Current consumption – I_{max}	A	1.3
	– Pulse load	A 1.5
Electrical connection	With component plug to DIN 43651	
	Cable socket to DIN 43651 11-pin + PE/Pg16 ²⁾	
Type of protection of the valve	IP65 with cable socket mounted and locked	
Control electronics	Integrated in the valve (see page 8)	

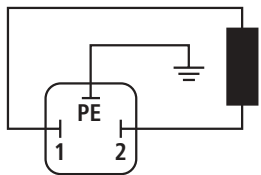
¹⁾ Separate order, see page 6²⁾ Separate order, see page 7

 **Note:** For details regarding **environment simulation testing** in the fields of EMC (electromagnetic compatibility), climate and mechanical stress, see RE 29202-U (declaration on environmental compatibility).

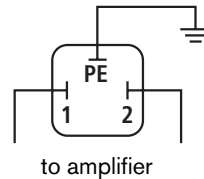
Electrical connection, cable sockets (nominal dimensions in mm)

Type FE – for external control electronics

Connection to component plug

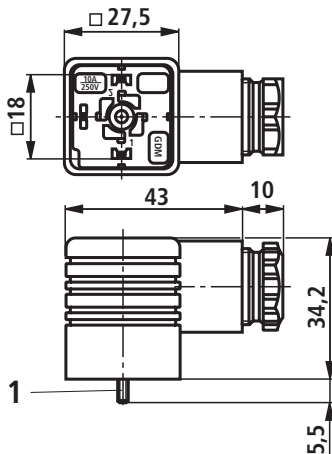


Connection to cable socket



Cable socket to DIN EN 175301-803

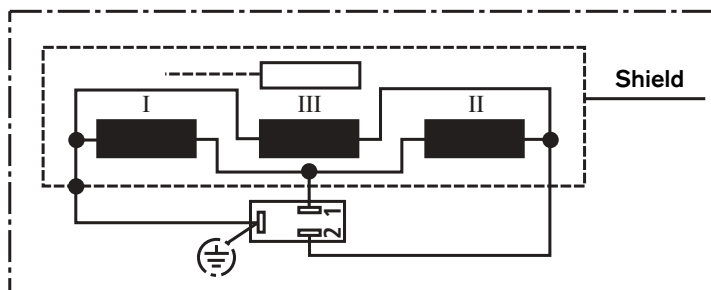
Separate order stating material no. **R901017011**
(plastic version)



1 Fixing screw M3

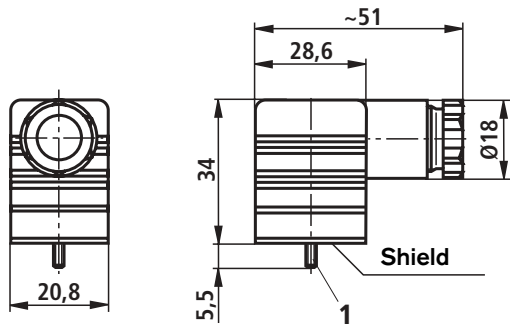
Tightening torque $M_T = 0.5 \text{ Nm}$

Inductive position transducer



Cable socket GM209N (Pg 9) made by Hirschmann

Separate order stating material no. **R900013674**
(plastic version)



1 Fixing screw M3

Tightening torque $M_T = 0.5 \text{ Nm}$

Electrical connection, cable sockets (nominal dimensions in mm)

Type FEE – with integrated electronics (OBE)

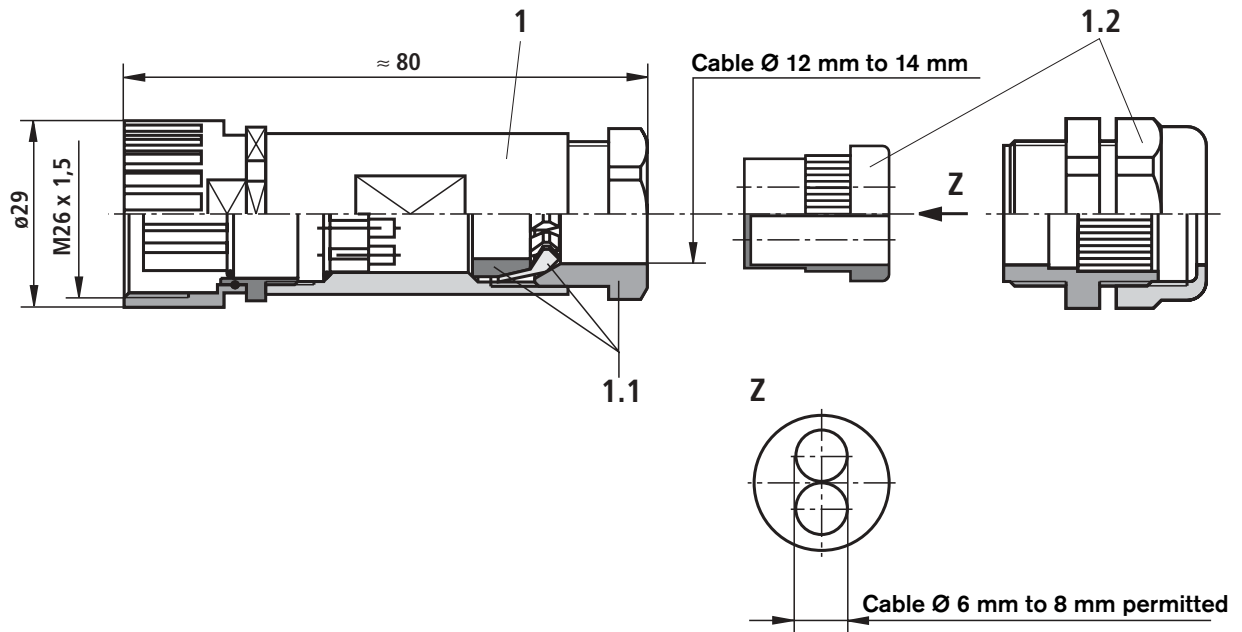
Cable socket to DIN 43651/11-pin + PE/Pg16

Separate order stating material no. **R900884671**
(plastic version)

Assembly consisting of items 1 and 1.1 or
items 1 and 1.2, type of protection IP65

Note:

- If **one** cable is used, combine item 1 with item 1.1
- If **two** cables are used, combine item 1 with item 1.2



Pin	Function	Conditions		
1	Operating voltage +UL	$U_O = 24 \text{ VDC}$; $u_O(t)_{\max} = 36 \text{ V}$; $u_O(t)_{\min} = 21,6 \text{ V}$		
2	Ground L0			
3	Enable input / reference for pin 2	$\log 1 = 10 \text{ V to } 36 \text{ V}$; $\log 0 = U < 8 \text{ V}$		
		<table border="1"> <tr> <td>Type FEE.../...B1...</td> <td>Type FEE.../...G1...</td> </tr> <tr> <td>Voltage interface</td> <td>Current interface</td> </tr> </table>	Type FEE.../...B1...	Type FEE.../...G1...
Type FEE.../...B1...	Type FEE.../...G1...			
Voltage interface	Current interface			
4	Command value input	$0 \text{ V to } +10 \text{ V}$ ($R_i > 50 \text{ k}\Omega$)		
5	Command value input, reference	$+4 \text{ mA to } +20 \text{ mA}$ / load = 100Ω		
6	Actual value output	$0 \text{ V to } -10 \text{ V}$ ($I_{\max} = 5 \text{ mA}$)		
7	Actual value output, reference	$+4 \text{ mA to } +20 \text{ mA}$ / load $\leq 500 \Omega$		
8	free			
9	free			
10	free			
11	Ready for operation (output)	Valve not ready for operation: $U_{\text{Pin11}} < 8 \text{ V}$;		
		Valve ready for operation: $U_{\text{Pin11}} = U_O - 3 \text{ V}$		
PE	Protective conductor \perp	Reference – pin 2: (I_{\max} against 0 V ; 50 mA);		

Recommended connecting cable

- Up to 25 m → min. 0.75 mm^2 per wire
- Up to 50 m → min. 1.5 mm^2 per wire
- Connect shield to PE only on the supply side

Integrated electronics (OBE) bei Type FEE

Function

1. Making operation/disturbance characteristic:

After the supply voltage of 24 V was applied, the electronics is ready for operation, if the following conditions are fulfilled:

- Operating voltage $U_O > 18$ VDC
- The internal ± 7.5 V supply voltage is symmetrical
- The connection to the position transducer is not interrupted.
- The command value cable is not interrupted (only with 4 mA to 20 mA interface)

If one of these conditions is not fulfilled, the controller and the output stage are blocked and the signal "ready for operation" is set to < 8 V.

2. Normal operation

When the enable is inactive (< 8 V) and an optional command value is fed forward (0 to 10V or 4 to 20 mA) the orifice spool is in the seated position and blocks the flow from A to B.

By applying a voltage > 10 V to the enable, the position controller for the orifice spool and the output stage for the pilot valve are switched on. At the same time, the position control-

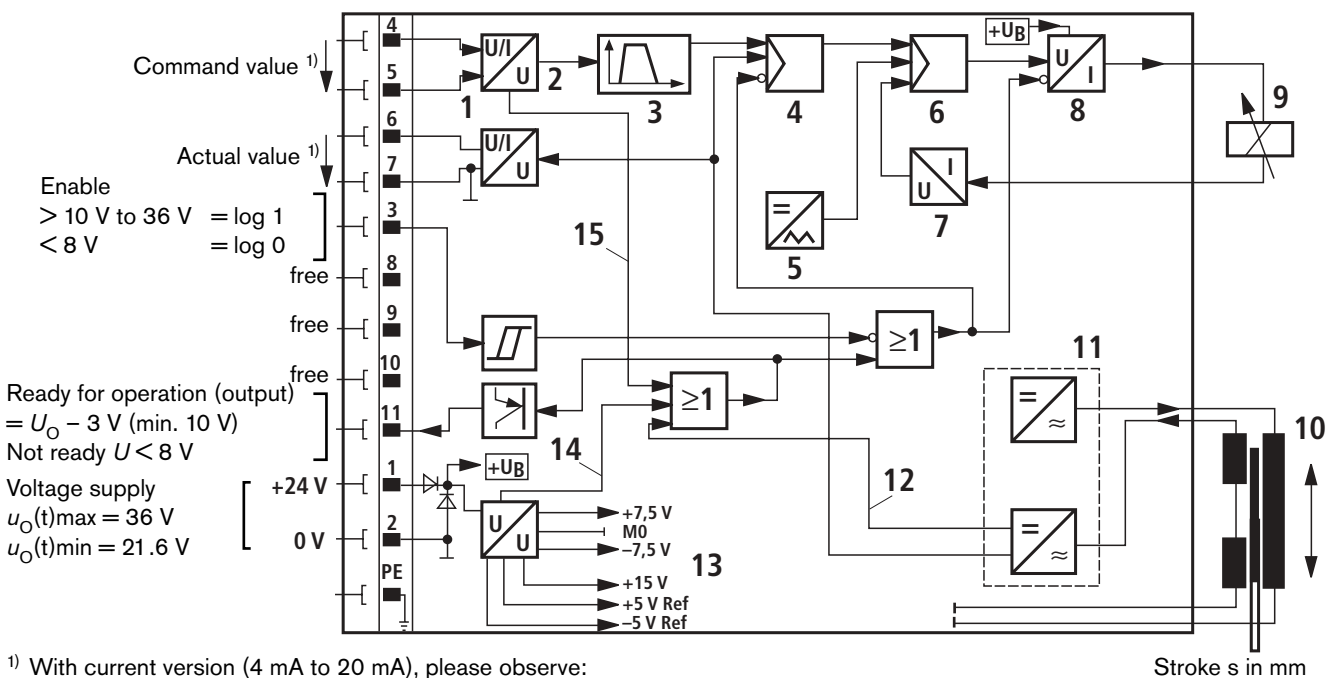
ler (PID) compares the actual value of the orifice spool position with the applied command value, and a control output is fed to the output stage, which changes the solenoid current until the orifice spool position corresponds to the command value.

The actual value of the orifice spool position is sensed by an inductive position transducer. The signal of the latter is rectified by the demodulator and fed back to the PID-controller.

The following output signals are available on the plug:

- Actual position value FEE.../...B1 (pin 6)
 - 0 V to -10 V corresponds to 0 % to 100 % valve opening
 - Orifice spool at mechanical limit stop \rightarrow actual value > 0.2 V
- Actual position value FEE.../...G1 (pin 6)
 - 4 mA to 20 mA corresponds to 0 % to 100 % valve opening
 - Orifice spool at mechanical limit stop \rightarrow actual value < 3.65 mA
- Signal "ready for operation" (pin 11)
 - All conditions listed above are fulfilled $\rightarrow > 10$ V
 - One of the conditions is not fulfilled $\rightarrow < 8$ V

Block circuit diagram / pin assignment of integrated electronics



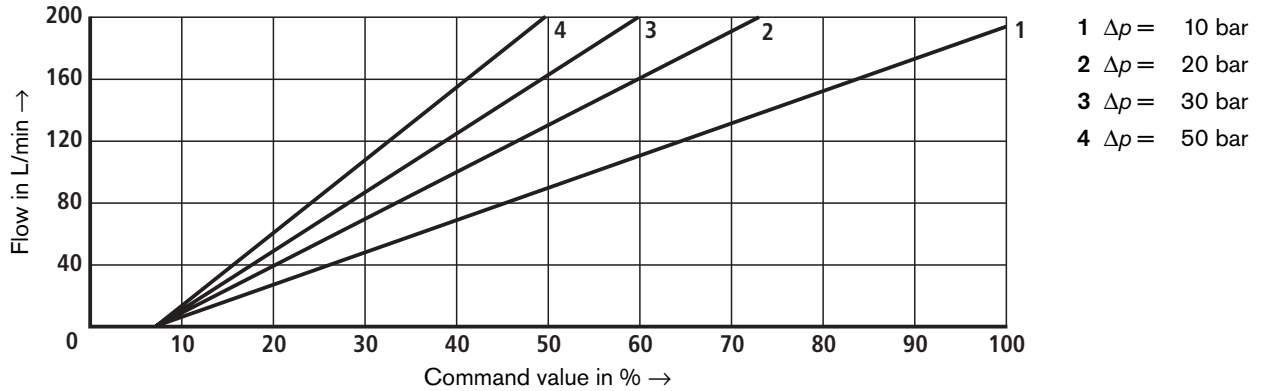
- 1 Input
- 2 Output
- 3 Fixed ramp
- 4 Position controller
- 5 Clock pulse
- 6 Current regulator
- 7 I/U converter
- 8 Output stage

- 9 Proportional solenoid
- 10 Position transducer
- 11 Oscillator / demodulator
- 12 Fault signal of position transducer
- 13 Power supply unit
- 14 Fault signal in the event of $+U_O$ undervoltage and asymmetry in the power supply unit
- 15 Cable break signal with current command value

Characteristic curves (measured with HLP 46 and $\nu_{oil} = 40\text{ °C} \pm 5\text{ °C}$)

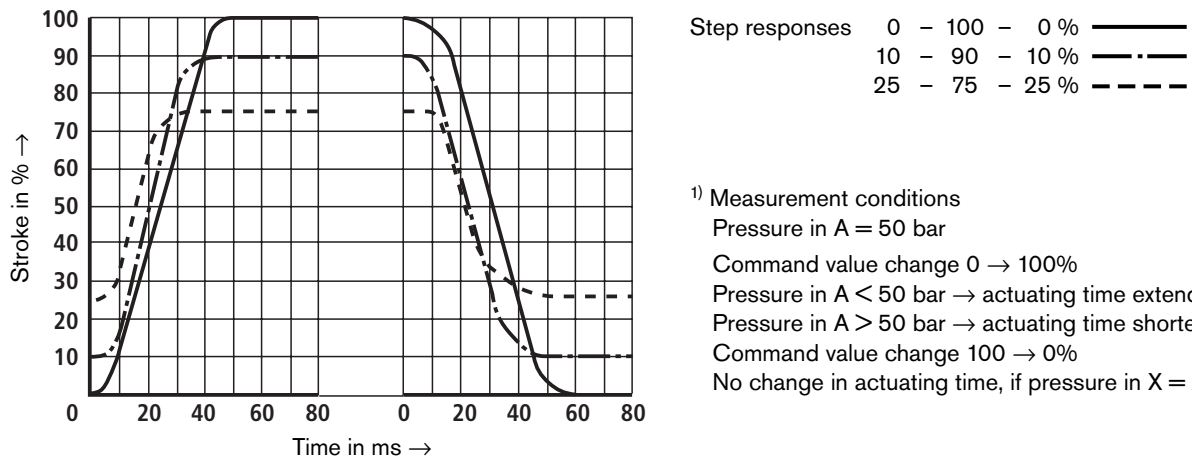
Flow characteristic linear

FE(E) 16 C...



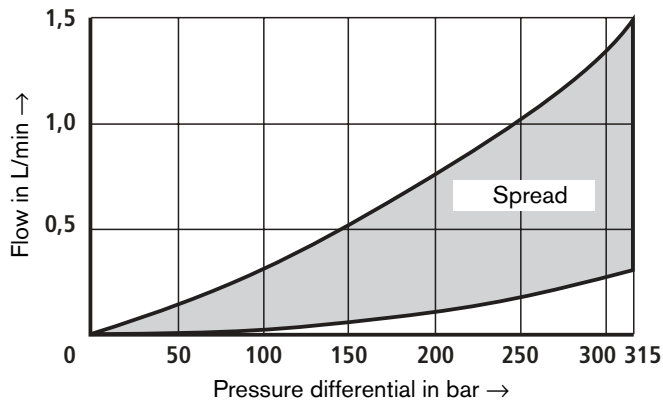
Transient function with stepped command value change ¹⁾

FE(E) 16 C...

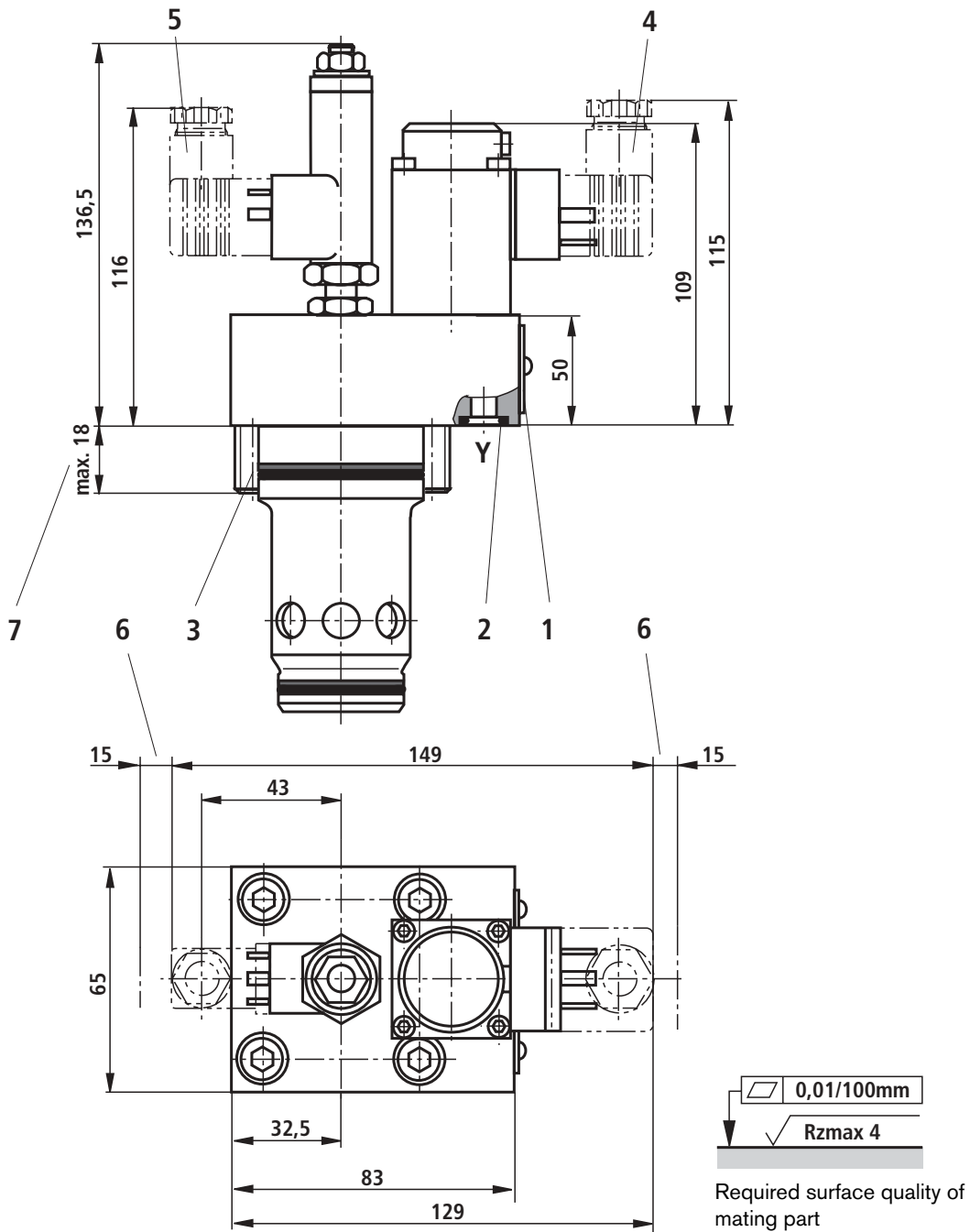


Leakage from A → B in dependence upon the pressure differential Δp (command value 0 V or 4 mA, resp.)

FE(E) 16 ../..190L..



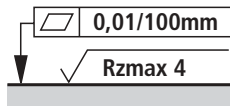
Unit dimensions: Type FE (nominal dimensions in mm)



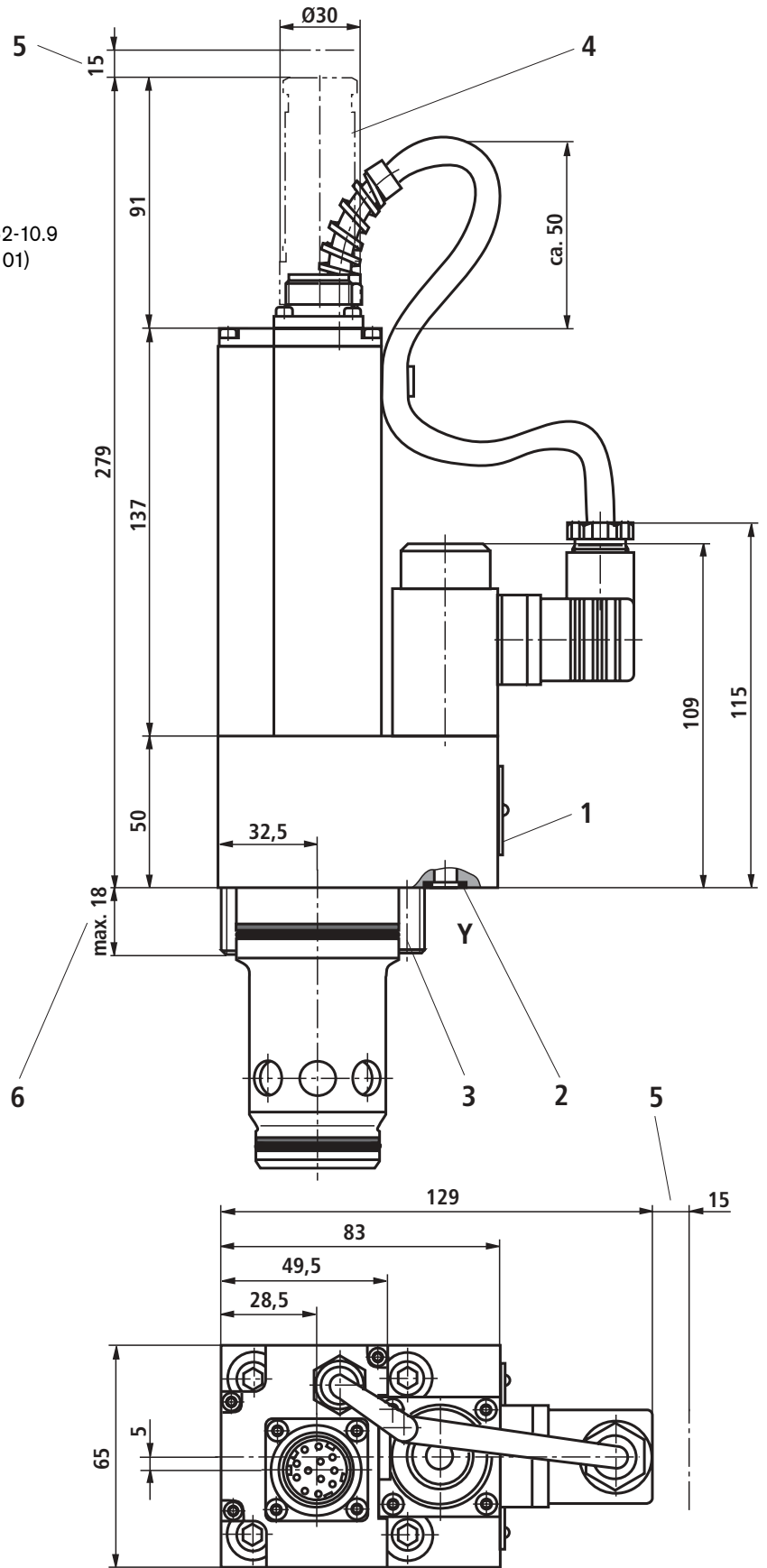
- 1 Nameplate
- 2 Identical seal rings for ports X and Y
- 3 Valve fixing screws
(included in the scope of supply)
4 socket head cap screws M8 x 35 to ISO 4762-10.9
(friction coefficient 0.09 ... 0.14 to VDA 235-101)
Tightening torque $M_T = 25 \text{ Nm}$
- 4 Cable socket to DIN EN 175301-803
Separate order, see page 6
- 5 Cable socket GM209N (Pg 9) made by Hirschmann
Separate order, see page 6
- 6 Space required to remove cable socket
- 7 Screw-in length of valve fixing screws

Unit dimensions: Type FEE (nominal dimensions in mm)

- 1 Nameplate
- 2 Identical seal rings for ports X and Y
- 3 Valve fixing screws
(included in the scope of supply)
- 4 socket head cap screws M8 x 35 to ISO 4762-10.9
(friction coefficient 0.09 ... 0.14 to VDA 235-101)
Tightening torque $M_T = 25 \text{ Nm}$
- 4 Cable socket to DIN 43651
11-pin + PE/Pg16
Separate order, see page 7
- 5 Space required to remove cable socket
- 6 Screw-in length of valve fixing screws



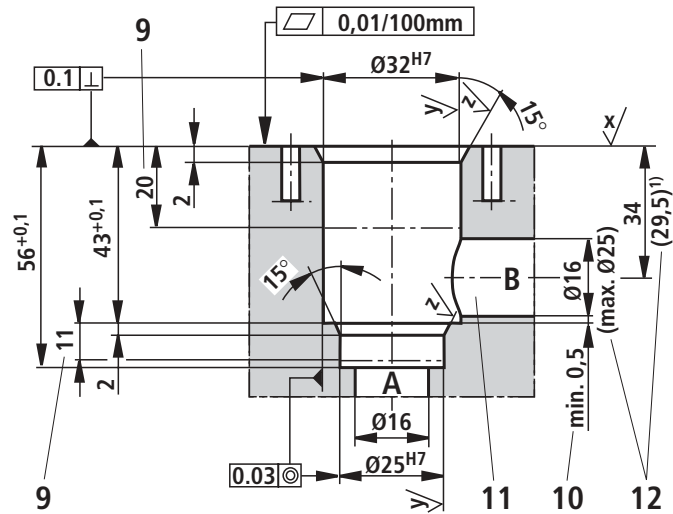
Required surface quality of mating part



Installation dimensions (nominal dimensions in mm)

Installation dimensions to DIN ISO 7368-BA-06-2-A

- 6 Port X
- 7 Port Y
- 8 Locating bore for locating pin
- 9 Depth of fit
- 10 Reference dimension
- 11 Port B can optionally be arranged around the central axis of port A. However, care must be taken that the fixing bores and pilot bores are not drilled.
- 12 In the case of a diameter of port B other than specified, the distance from the cover contact face to the centre of the bore must be calculated.



1) Minimum distance (29.5 mm) with maximum diameter (Ø25 mm)

Tolerances to:

- General tolerances ISO 2768-mK

