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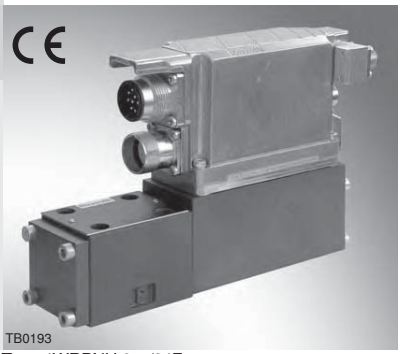
High-response valve with integrated digital axis controller (IAC-R) and clock-synchronized PROFIBUS DP/V2 (PROFIdrive profile)

RE 29291/06.13 1/18
Replaces: 02.11

Type 4WRPNH.../24F..

Size 6 and 10
Component series 2X
Maximum operating pressure 315 bar
Maximum flow 100 l/min (Δp = 70 bar)



Type 4WRPNH 6 .../24F..

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Features

- Direct operated high-response valves size 6 and size 10 with servo performance type control spool and sleeve
- Single-side operated, 4/4 fail-safe position in deactivated state
- Integrated digital axis control functionality (IAC-R) for:
  - position control with underlying velocity control
  - DSC functionality
- Analog sensor interfaces for
  - current and voltage
- Digital sensor interfaces for
  - 1 x length measurement system 1Vpp or
  - 1 x length measurement system SSI or
  - 1 x length measurement system EnDat 2.2
- Clock-synchronous command value provision according to PROFIdrive profile V4.0
  - telegram 5 or 105
- PROFIBUS DP/V1, DP/V2
- Quick commissioning via PC and commissioning software WinHPT from version 2.1

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Ordering code

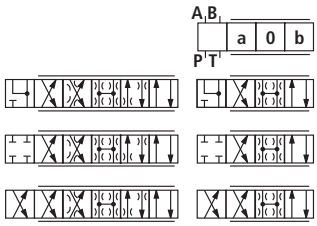
4WRP | N | H | | | B | | –2X / M / 24 | F | | | *

With integrated digital axis controller for NC control systems **= N**

Control spool / sleeve **= H**

Size 6 **= 6**
Size 10 **= 10**

Spool symbols
4/4 directional design



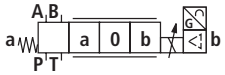
= C3, C5

= C4, C1

= C

With symbols C5 and C1:
P → A: q_v B → T: q_v / 2
P → B: q_v / 2 A → T: q_v

Mounting side of the inductive position transducer



(standard) **= B**

Rated flow at 70 bar valve pressure differential (35 bar / control edge)

Size 6
2 l/min [1] **= 02**
4 l/min **= 04**
12 l/min [5] **= 12**
15 l/min [2] **= 15**
24 l/min [5] **= 24**
25 l/min [2] **= 25**
40 l/min [3] **= 40**

Size 10
50 l/min **= 50**
100 l/min **= 100**

Flow characteristics
Linear **= L**
Inflected characteristic curve [4] **= P**

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

M = **Seal material** NBR gaskets suitable for mineral oils (HL; HLP) according to DIN 51524

24 = Supply voltage 24 V

F = **Drive bus** PROFIBUS DP/V2 PROFIdrive profile

A6 = ±10 VDC
F6 = 4 to 20 mA
Electronics interface

A = X4, M12-5, ±10 V X7, M12-5, ±10 V
B = X4, M12-5, ±10 V X7, M23-12, SSI
C = X4, M12-5, ±10 V X7, M23-12, 1 Vpp
G = X4, M12-5, 4-20 mA X7, M12-5, 4-20 mA
T = X4, M12-5, ±10V X7, M12-8, EnDat 2.2
Sensor interfaces

Further details in clear text

[1] Rated flow 2 l/min not with flow characteristics **"P"**
[2] Only in connection with flow characteristics **"P"**
[3] q_V 2:1 only with rated flow = 40 l/min
[4] Inflection 60% at size 6 with rated flow **"15"** and **"25"**, otherwise inflection 40%
[5] Only in connection with flow characteristics **"L"**

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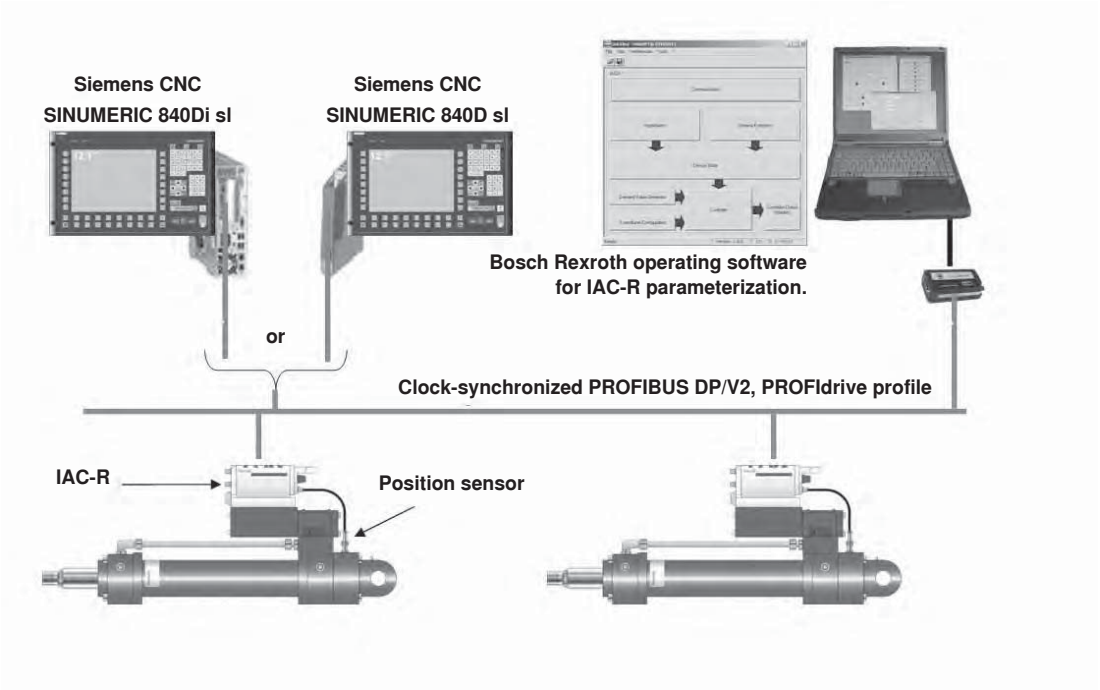
System overview



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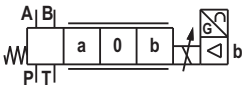
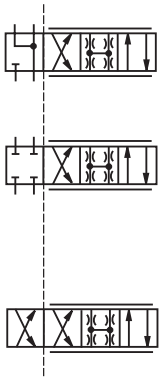
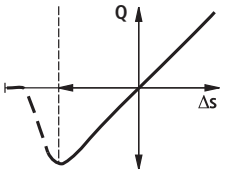
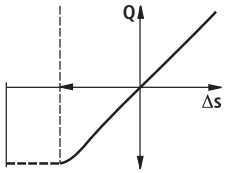
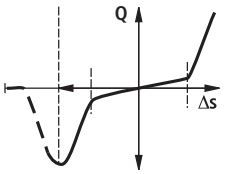
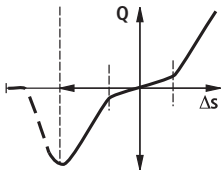
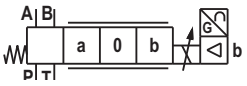
Symbols

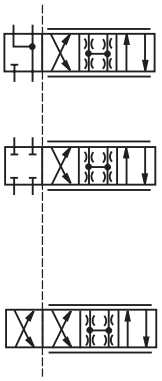
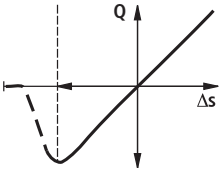
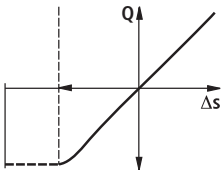
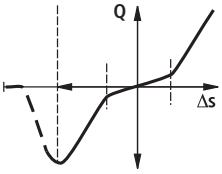
Size 6



Linear	*p*: Inflection 60 % [q_n 15.25 l/min]	*p*: Inflection 40 % [q_n 40 l/min]
 C3, C5 C4, C1 C	 C3, C5, C4, C1  C	  C3, C5, C4, C1
Standard = 1:1, from q_n = 40 l/min also 2:1		

Size 10



Linear	*p*: Inflection 40 %
 C3, C5 C4, C1 C	 C3, C5, C4, C1  C
	 C3, C5, C4, C1

Function, section

Construction

The IAC-R valve mainly consists of:

- Direct operated high-response valve (1) with servo performance type control spool
- Integrated digital axis controller (2) with analog (X4/X7) or digital (X7) sensor interface
- PROFIBUS interface (X3) with functionality according to DP/V1 with clock synchronization according to DP/V2

Functional description

The IAC-R valve is a digital high-response valve with integrated axis controller with the following functionalities:

- Position control
- DSC functionality
- Analog (X4/X7) or digital (X7) sensor interface
- Clock-synchronous command value specification according to PROFIdrive profile V4.0
  - telegram 5 or 105
- The controller parameters are set via the PROFIdrive parameter protocol.
- Separate supply voltage for bus/controller and power part (output stage) for safety reasons.

PC program WinHPT

To implement the project planning task and to parameterize the IAC-R valves, the user may use the commissioning software WinHPT (see accessories).

- Parameterization
- Diagnosis
- Comfortable data management on a PC
- PC operating systems: Windows 2000 or Windows XP

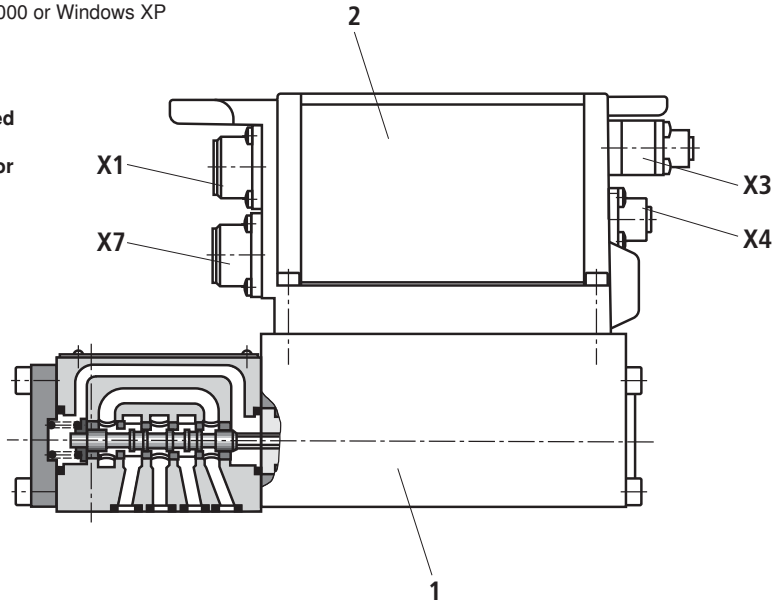
The digital integrated control electronics enables the following fault detection:

- Cable rupture of sensorics system
- Undervoltage
- Temperature of the integrated electronics
- Communication fault
- Watchdog
- Synchronous monitoring

The following additional functions are available:

- Fault output 24 V or control of an isolator valve
- Control output adjustment
  - deadband compensation
  - zero offset
  - valve inflection compensation
  - friction compensation
  - direction-dependent gain
- PIDT1 controller
- State controller
- Automatic/semi-automatic drive measurement for simple controller optimization

High-response valve with integrated axis controller and analog (X4/X7) or digital (X7) sensor interface



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Technical data (For applications outside these parameters, please consult us!)

General			Size 6	Size 10
Type			Spool valve, directly operated, with steel sleeve	
Actuation			Proportional solenoid with position control, OBE	
Type of connection			Subplate mounting, porting pattern according to ISO 4401	
Installation position			any	
Ambient temperature range		°C	–20 … +50	
Weight		kg	2.7	7.5
hydraulic (measured with HLP46, ϑ_{oil} = 40 °C ±5 °C)				
Hydraulic fluid			Hydraulic oil according to DIN 51524…535, other media upon request	
Viscosity range	recommended	mm^2/s	20 … 100	
	max admissible	mm^2/s	10 … 800	
Hydraulic fluid temperature range		°C	–20 … +60	
Maximum admissible degree of contamination of the hydraulic fluid – cleanliness class according to ISO 4406 (c)			Class 18/16/13 [1]	
Flow direction			according to symbol	

Hydraulic, size 6								
Rated flow at Δp = 35 bar per edge [2]		l/min	2	4	12	15	24/25	40
Max operating pressure	Ports P, A, B	bar	315					
	Port T	bar	250					
Limitations of use Δp pressure drop across valve q_{Vnom}: > $q_{N\ valves}$	Spool symbols C, C3, C5	bar	315	315	315	315	315	160
	Spool symbols C1, C4	bar	315	315	315	280	250	100
Leakage oil at 100 bar	linear characteristic curve L	cm^3/min	< 150	< 180	< 300	–	< 500	< 900
	inflected characteristic curve P	cm^3/min	–	–	–	< 180	< 300	< 450

Hydraulic, size 10						
Rated flow at Δp = 35 bar per edge [2]		l/min	50 (1:1)	50 (2:1)	100 (1:1)	100 (2:1)
Max. operating pressure	Ports P, A, B	bar	315			
	Port T	bar	250			
Limitations of use Δp pressure loss at valve q_{Vnom}: > $q_{N\ valves}$	Spool symbols C, C3, C5	bar	315	315	160	160
	Spool symbols C1, C4	bar	250	250	100	100
Leakage oil at 100 bar	linear characteristic curve L	cm^3/min	< 1200	< 1200	< 1500	< 1500
	inflected characteristic curve P	cm^3/min	< 600	< 500	< 600	< 600

Static / dynamic		Size 6	Size 10
Hysteresis	%	≤ 0.2	
Manufacturing tolerance	%	< 10	
Acutating time for signal step 0 … 100 %	ms	≤ 10	25
Temperature drift		Zero point drift < 1% at $\Delta\vartheta$ = 40 °C	
Zero point calibration		ex factory ±1 %	
Conformity		CE according to EMC directive 2004/108/EC	

The footnotes are explained on the following page.

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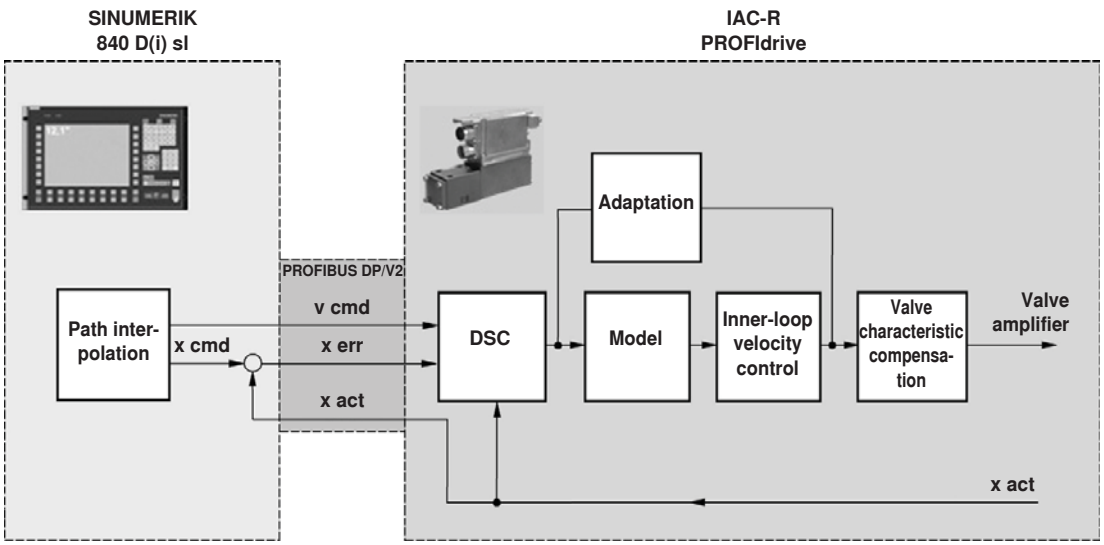
Technical data (For applications outside these parameters, please consult us!)

Electrical				
Relative duty cycle			%	100 (continuous operation)
Protection class				IP 65 according to EN 60529 with mounted and locked line connectors
Supply voltage	Nominal voltage		VDC	24
	Lower limit value		VDC	21
	Upper limit value		VDC	36
	Max. admissible residual ripple		Vpp	2 (at supply voltage of 23 V … 34 V)
Power consumption		Size 6	W	max. 40
		Size 10	W	max. 60
Protective earthing conductor and shielding				see pin assignment (CE-compliant installation)
Adjustment				Calibrated ex factory, see valve characteristic curve

[1] The cleanliness classes stated for the components need to be maintained in hydraulic systems.
Effective filtration prevents faults and at the same time increases the service life of the components.
For selecting the filters, see www.boschrexroth.de/filter

[2] Flow at different Δp: $q_x = q_{nom} \cdot \sqrt{\frac{\Delta p_x}{35}}$

Block diagram of the controller functionality



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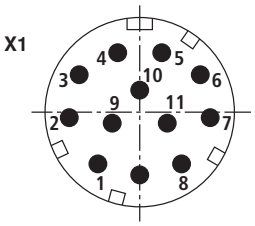
Electrical connections, assignment

Unit connector assignment X1, 11-pin + PE according to DIN EN 175201-804

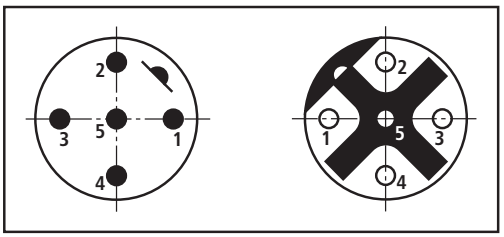
Pin	No. or Litz wire color[1)]	Assignment interface A6/F6
1	1	24 VDC (supply for output stage and power switching signal)
2	2	0 V ≙ load zero (for output stage)
3	white	reserved
4	yellow	reserved
5	green	reserved
6	purple	reserved
7	pink	reserved
8	red	reserved
9	brown	24 VDC (supply for signal part and bus)
10	black	0 V reference potential for pin 9 (supply for signal part and bus)
11	blue	Switching output 24 V (error signal or power switching signal) max 1.8 A
PE	green-yellow	Protective earthing conductor (connected directly to metal housing)

Connect shield on PE only on the supply side!

[1)] Litz wire colors of the connection lines for line socket (see accessories)



Unit connector assignment for PROFIBUS DP "X3" (code B), M12, 5-pin, socket / pins



Pin	Pinout of plug	Pinout of socket
1	n.c.	VP
2	RxD/TxD-N (A line)	RxD/TxD-N (A line)
3	DGND	DGND
4	RxD/TxD-P (B line)	RxD/TxD-P (B line)
5 [1)]	Shield	Shield

[1)] We recommend connecting the shield on both sides via the metallic housing of the plug-and-socket-connectors. Using pin 5 will have adverse effects on the effectiveness of the shield!

The unit socket and the unit plug are equivalent as PROFIBUS connections.
The electrically isolated voltage +5 V (pin 1 - VP) at the socket allows for passive termination of the PROFIBUS.

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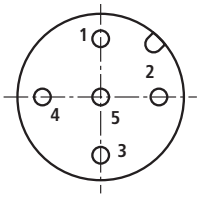
Electrical connections, assignment

Analog sensor interfaces, connection "X4" and "X7" (code A), M12, 5-pin, socket

Pin	Pinout Voltage interface	Pinout Current interface
1	Supply 24 VDC	Supply 24 VDC
2	Signal 3 (X4) / 4 (X7), (–10 … +10 V)	Signal 3 (X4) / 4 (X7), (4 … 20 mA)
3	Zero 0 V	Zero 0V
4	Signal 1 (X4) / 2 (X7), (–10 … +10 V)	Signal 1 (X4) / 2 (X7), (4 … 20 mA)
5	Shield	Shield

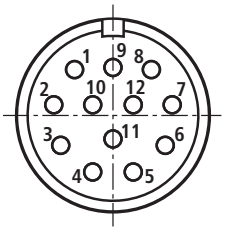


Note:

The analog sensor interfaces at the connections X4 and X7 are not coded. Danger of confusing the same! The user has to ensure proper wiring!

Digital sensor interface 1Vpp or SSI measurement system "X7", M23, 12-pin, socket

Pin	Pinout 1Vpp	Pinout SSI
1	$\overline{B}$	0 V
2	sense +5 V [1)]	Data
3	R	Clock
4	$\overline{R}$	n.c.
5	A	n.c.
6	$\overline{A}$	n.c.
7	n.c.	n.c.
8	B	n.c.
9	n.c.	24 V
10	0 V [1)]	$\overline{Data}$
11	Sense 0 V [1)]	$\overline{Clock}$
12	+5 V [1)]	n.c.

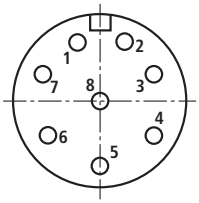


Note:

The sense signal is not evaluated.

Digitale Sensorschnittstelle EnDat 2.2 Messsystem „X7“, M12, 8-polig, Buchse

Pin	Belegung EnDat 2.2
1	0 V [2)]
2	+5 V [2)]
3	Data
4	$\overline{Data}$
5	0V [2)]
6	$\overline{Clock}$
7	Clock
8	supply +5 V [2)]



Note:

We recommend connecting the shields on both sides via the metallic housings of the plug-and-socket-connectors.
Using connector pins will affect the effectiveness of the screen!
Internal shields are not required.

[1)] **Recommendation**: Connect the voltages +5 V (pin 12) and +5 V-Sense (pin 2), as well as 0 V (pin 10) and 0 V-Sense (pin 11) for transducer supply.

[2)] **Recommendation**: Connect the voltages +5 V (pin 2 and 8) as well as 0 V (pin 1 and 5) for transducer supply.

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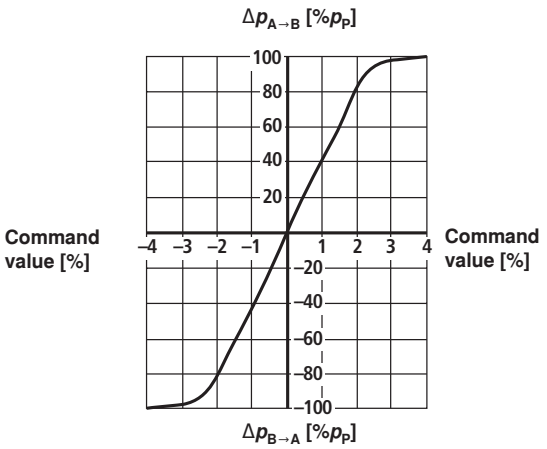
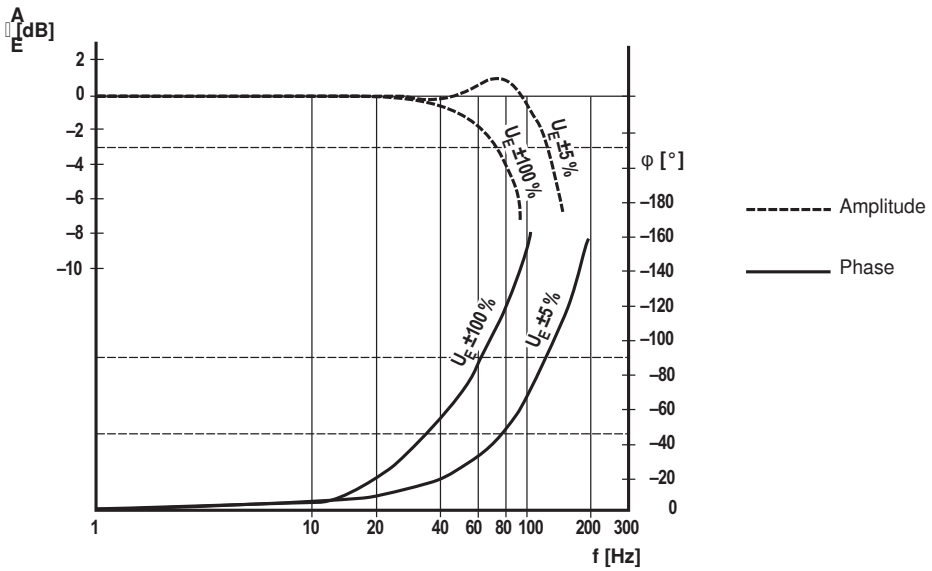
Characteristic curves size 6 (measured with HLP46, ϑ_{oil} = 40 °C ±5 °C)

Pressure gain



Bode diagram



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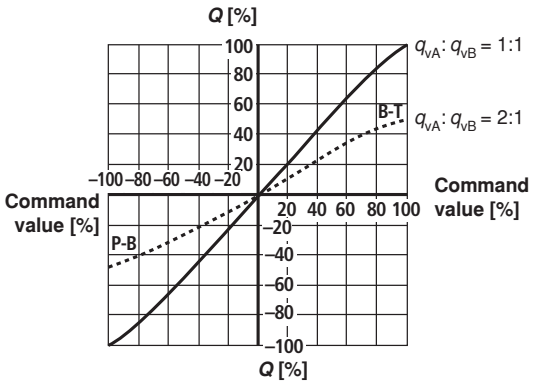
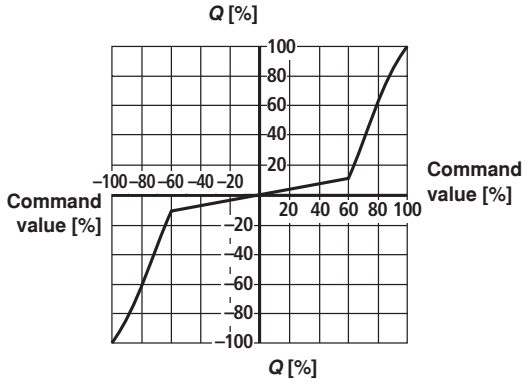
Characteristic curves size 6 (measured with HLP46, ϑ_{oil} = 40 °C ±5 °C)

Flow - signal function

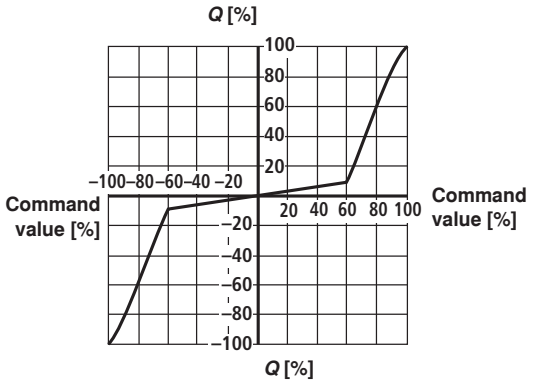
L: Linear



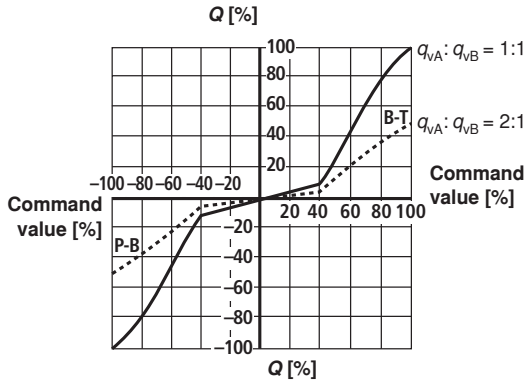
P: Inflection 60 %



P: Inflection 60 %



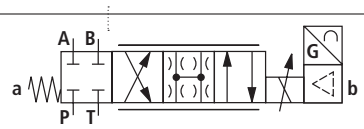
P: Inflection 40 %



Note:

Ex factory the inflection-compensation is activated at the valve electronics. In order that the P-characteristic curve appears linear.

Fail-safe position

	Leakage oil at	100 bar	P → A	50 cm³/min
			P → B	70 cm³/min
	Flow at	Δp = 35 bar	A → T	10 ... 20 l/min
			B → T	7 ... 20 l/min
	Leakage oil at	100 bar	P → A	50 cm³/min
			P → B	70 cm³/min
			A → T	70 cm³/min
			B → T	50 cm³/min

Fail-safe	p = 0 bar => 7 ms	Shut-down U_B (output stage) X1 / pin 1+2
	p = 100 bar => 10 ms	

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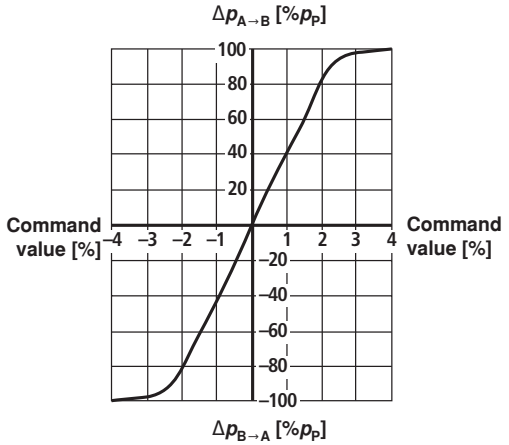
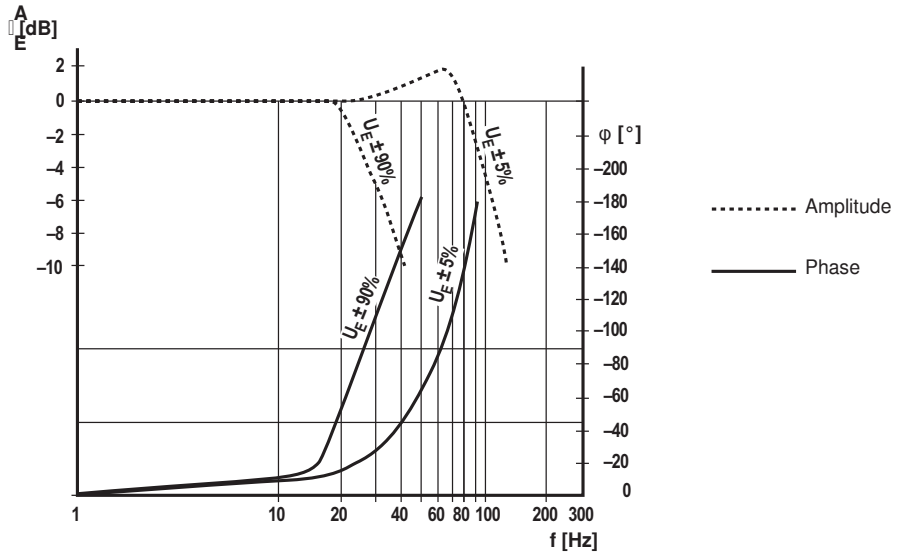
Characteristic curves size 10 (measured with HLP46, ϑ_{oil} = 40 °C ±5 °C)

Pressure gain



Bode diagram



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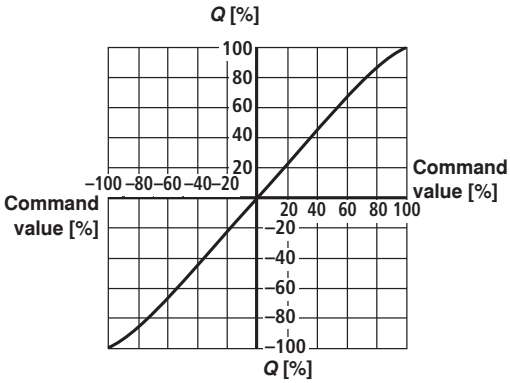
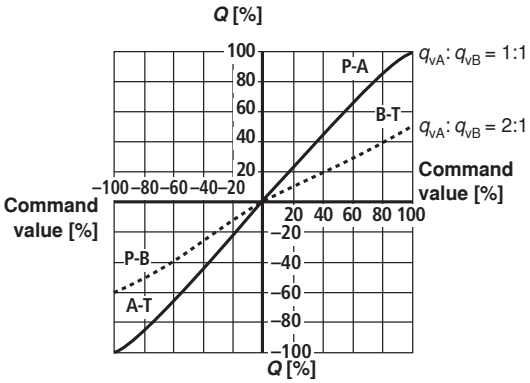
Characteristic curves size 10 (measured with HLP46, ϑ_{oil} = 40 °C ±5 °C)

Flow - signal function

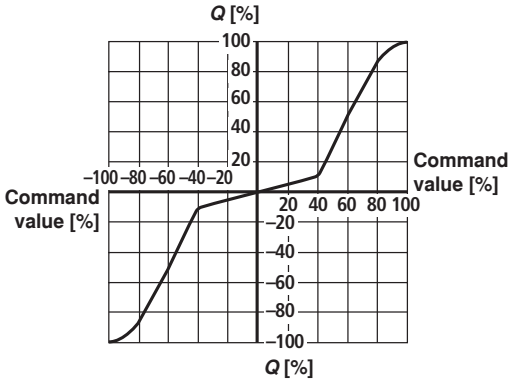
L: Linear 1:1



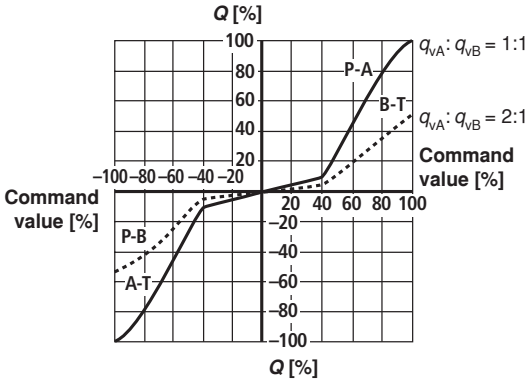
L: Linear 2:1



P: Inflection 40% 1:1



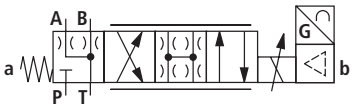
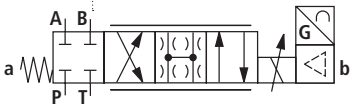
P: Inflection 40% 2:1



Note:

Ex factory the inflection-compensation is activated at the valve electronics. In order that the P-characteristic curve appears linear.

Fail-safe position

	Leakage oil at	100 bar	P → A	50 cm³/min
			P → B	70 cm³/min
	Flow at	Δp = 35 bar	A → T	10 ... 20 l/min
		q_n = 50/100 l/min	B → T	7 ... 20 l/min
	Leakage oil at	100 bar	P → A	50 cm³/min
			P → B	70 cm³/min
			A → T	70 cm³/min
			B → T	50 cm³/min

Fail-safe	p = 0 bar => 12 ms	Shut-down U_B (output stage) X1 / pin 1+2
	p = 100 bar => 16 ms	

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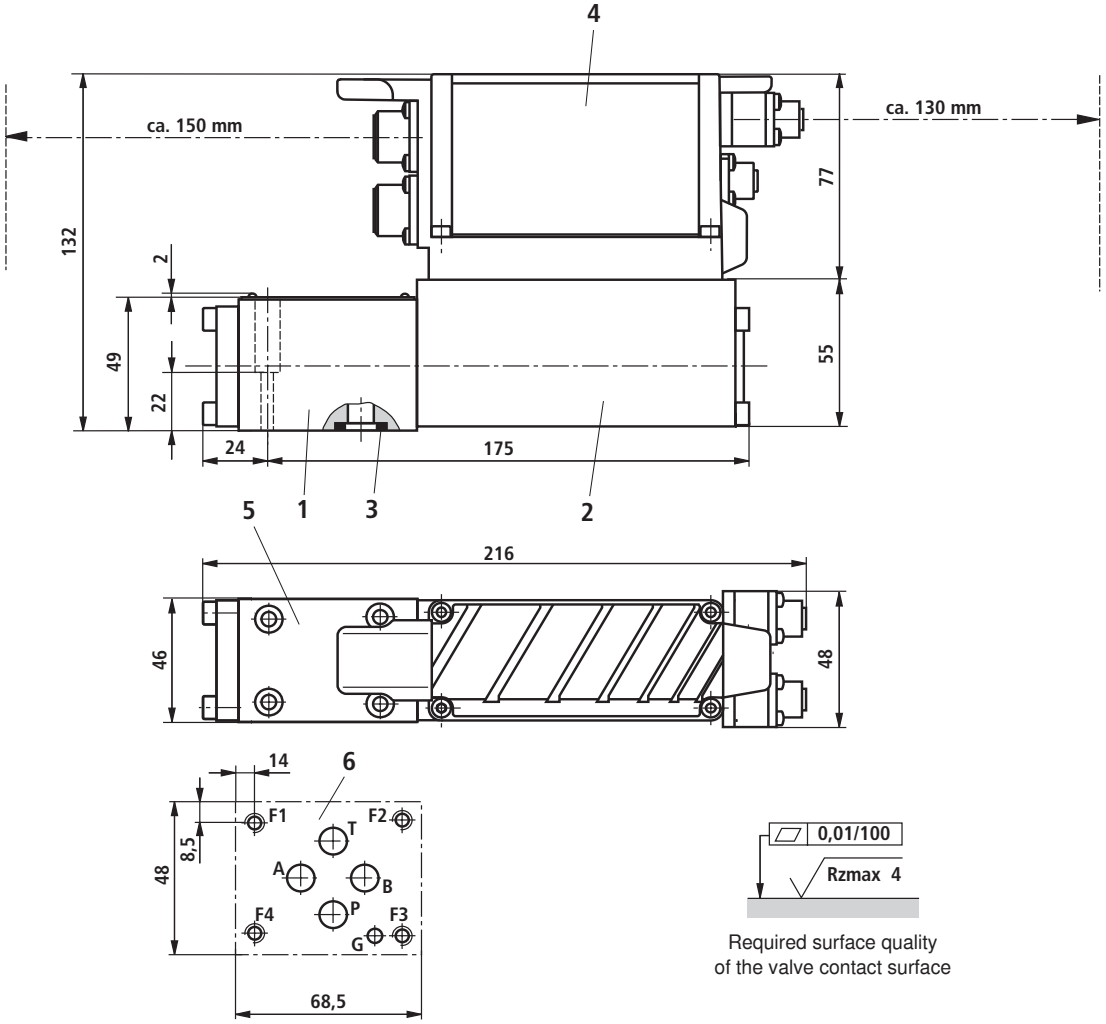
Unit dimensions size 6 (dimensions in mm)



Required surface quality
of the valve contact surface

1 Valve housing
2 Control solenoid with position transducer
3 Identical seal rings for ports P, A, B, T
4 Integrated digital control electronics
5 Nameplate
6 Machined valve contact surface, position of the ports according to ISO 4401-03-02-0-05

Valve mounting screws
(not included in scope of delivery):

4 units of hexagon socket head cap screws according to ISO4762-M5x30-10.9-N67F 821 70
(galvanized according to Bosch standard N67F 821 70)
M_T = 6 +2 Nm
material no. **2910151166**

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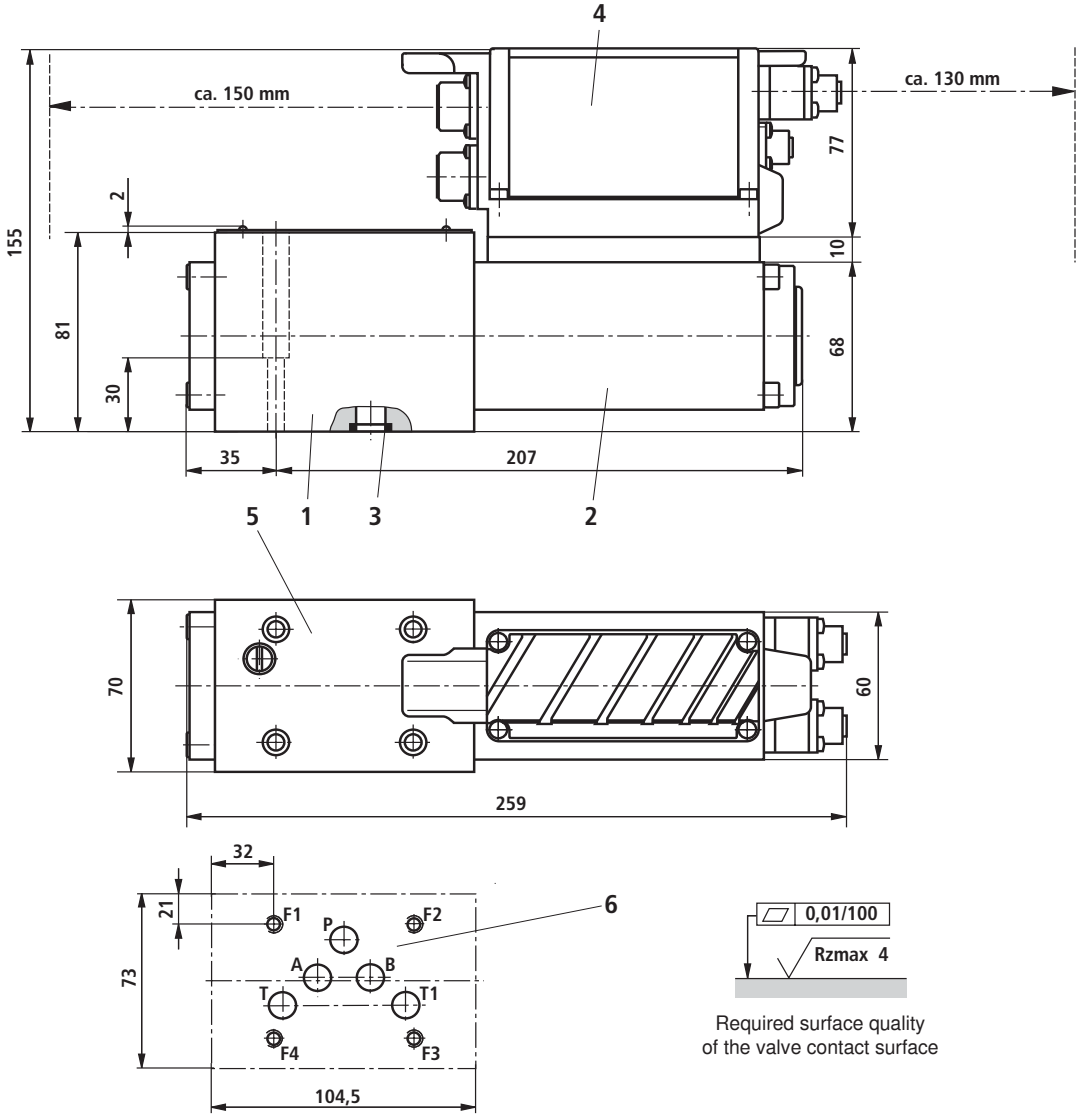
Unit dimensions size 10 (dimensions in mm)



Required surface quality
of the valve contact surface

1 Valve housing
2 Control solenoid with position transducer
3 Identical seal rings for ports P, A, B, T, T1
4 Integrated digital control electronics
5 Nameplate
6 Machined valve contact surface, position of the ports according to ISO 4401-05-04-0-05

Deviating from the standard:
– port T1 exists additionally

Valve mounting screws
(not included in scope of delivery):

4 units of hexagon socket head cap screws according to ISO4762-M6x40-10.9-N67F 821 70
(galvanized according to Bosch standard N67F 821 70)
M_T = 11 +3 Nm
material no. **2910151209**

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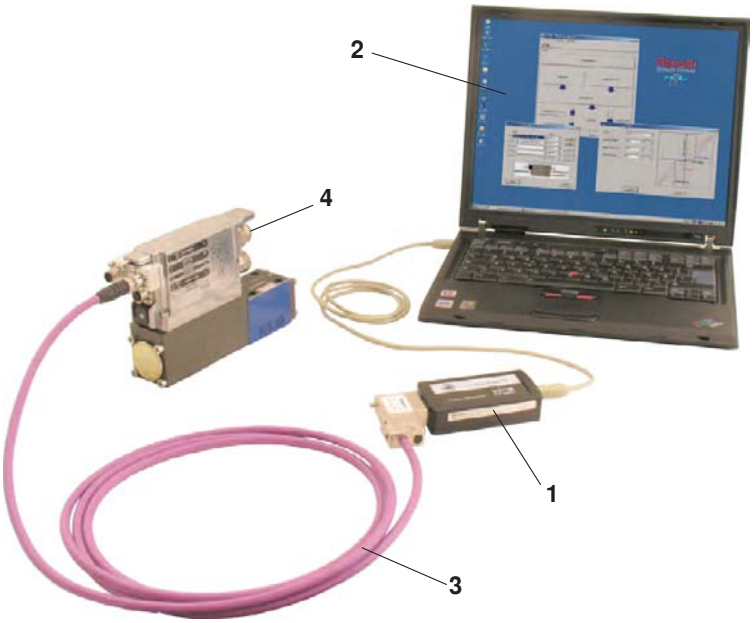
Accessories for parameterization (not included in scope of delivery)

For parameterization using the PC, the following is required:	PROFIBUS DP (code B)
1 Interface converter (USB-PROFIBUS DP)	VT-ZKO-USB/P-1-1X/V0/0 Mat.no. **R901071962**
2 Start-up software	WinHPT (from version 2.1) Download at www.boschrexroth.com/IAC
3 Connecting cable, 3 m	D-Sub/M12, Mat.no. **R901078053**
4 24 V supply voltage	Mating connector for X1 (see below)

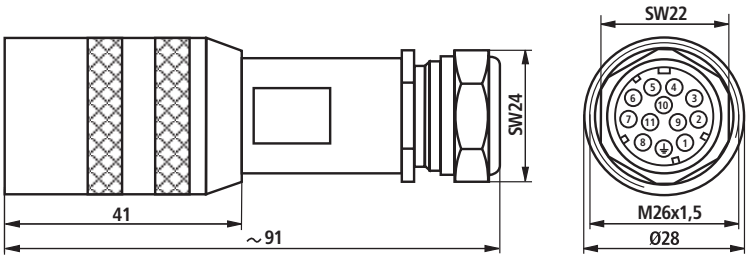


Accessories, port X1 (not included in the scope of delivery)

Mating connector for X1

Mating connector according to EN 175201-804 (12-pole, metal design)

- Mating connector (construction set) for a cable diameter of 12-15 mm, Material no. **R901268000**
- Mating connector with 5 m cable, 12 x 0.75 mm^2 with cable shield, assembled, Material no. **R901272854**
- Mating connector with 20 m cable, 12 x 0.75 mm^2 with cable shield, assembled, Material no. **R901272852**



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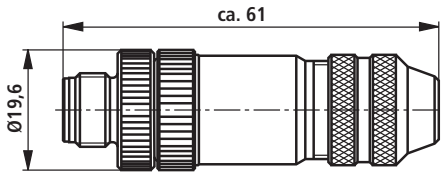
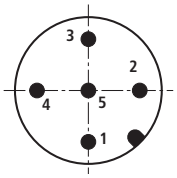
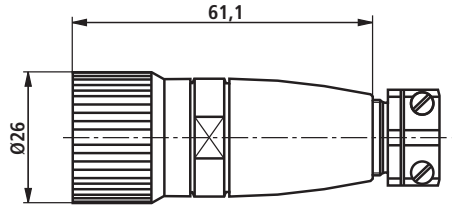
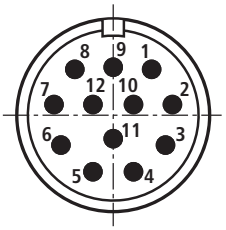
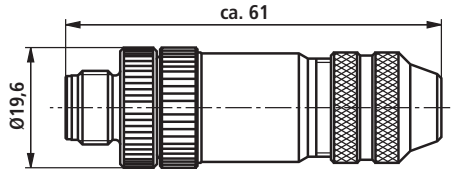
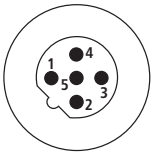
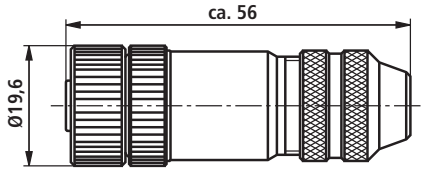
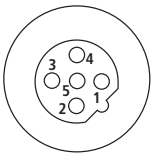
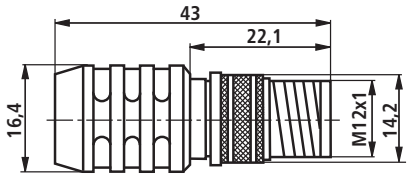
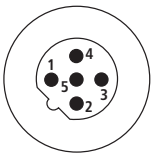
Accessories, sensor connections (not included in scope of delivery)

Description	View, dimensions	Pin pattern, order details
X4, X7 (analog sensors) Plug-in connector, 5-pole, M12 x 1, pins, A coding, metal design		 Mat. no.: **R901075542** (cable diameter 4 … 6 mm)
X7 (digital sensors, 1 Vpp and SSI) Plug-in connector, 12-pole, M23, pins, soldered joint, metal design with cap nut		 Mat. no.: **R901076284** (cable diameter up to 10.5 mm)

Accessories, PROFIBUS (B code) (not included in scope of delivery)

Description	Detail, dimensions	Pin pattern, order details
X3 Round connector, to be wired by user, 5-pin, M12 x 1 Straight line connector in metal design		 Material no.: **R901075545** (cable diameter 6 - 8 mm)
X3 Round connector, to be wired by user, 5-pin, M12 x 1 Straight mating connector from metal		 Material no.: **R901075550** (cable diameter 6 - 8 mm)
PROFIBUS terminating resistor Round plug-in connector, 5-pin, M12 x 1		 Material no.: **R901078086**

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Project planning / maintenance instructions / additional information

Product documentation for IAC-R with clock-synchronized PROFIBUS DP/V2 (PROFIdrive profile)

- **Data sheet 29291** (this data sheet)
- **Declaration on environmental compatibility 29191-U**
- **Operating instructions 29291-B**
- **General Information on the Maintenance and Start-up of Hydraulic Components 07800 / 07900**

Commissioning software and documentation on the internet: www.boschrexroth.com/IAC

Mainenance notes:

- The devices have been tested in the factory and are supplied with default settings.
- Only complete units can be repaired. The repaired units will be supplied with default settings and current firmware. User-specific settings are not maintained. The operator will have to retransfer the corresponding user parameters.

Notes:

- Connect the valve to the supply voltage only when this is required for the functional processes of the machine.
- Electric signals brought out via control electronics (e.g. signal "ready for operation") may not be used for the actuation of safety-relevant machine functions! (see also the European standard "Safety requirements for fluid power systems and their components - Hydraulics", EN 982.)
- If electromagnetic interference must be expected, take appropriate measures to safeguard the function (depending on the application, e.g. shielding, filtering)!

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