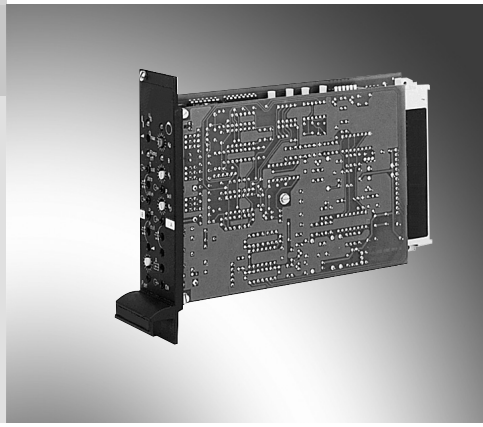
Rexroth
Bosch Group

Δp/Q controller

RE 30136/07.12 1/16
Replaces: 05.04

Type VT-VACAF



Component series 1X

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Features

- Suitable for controlling high-response valves
- Amplifier with additional electronics (daughter card)
- Analog amplifiers in Europe format for installation in 19 " racks
- Pressure differential controller (force controller) with PID behavior
- Short-circuit-proof outputs
- External shut-off for pressure controller
- Monitor signal for controller
- Separate acceleration and braking ramp
- Ramps can be separately adjusted and switched off
- Adjustable area adjustment for cylinder
- Suitable for pressure sensors (0...10 V, 4...20 mA), see data sheet 30271
- Supply for pressure sensors
- Cable break detection for pressure sensor

Notice:

The photo is an example configuration.
The delivered product differs from the figure.

Ordering code, accessories

VT– V | A | C | A | F – 500 –10 / V0

Hydraulic component (control)
Axis control **= A**

Valve type
High-response valve **= C**

Control
Analog **= A**

Function
Δ*p*/*Q* control **= F**

V0 = Customer version
Catalog version

1X = Component series 10 to 19
(10 to 19: Unchanged technical data and pin assignment)

Serial number for types

500 = Standard variant without valve amplifier function

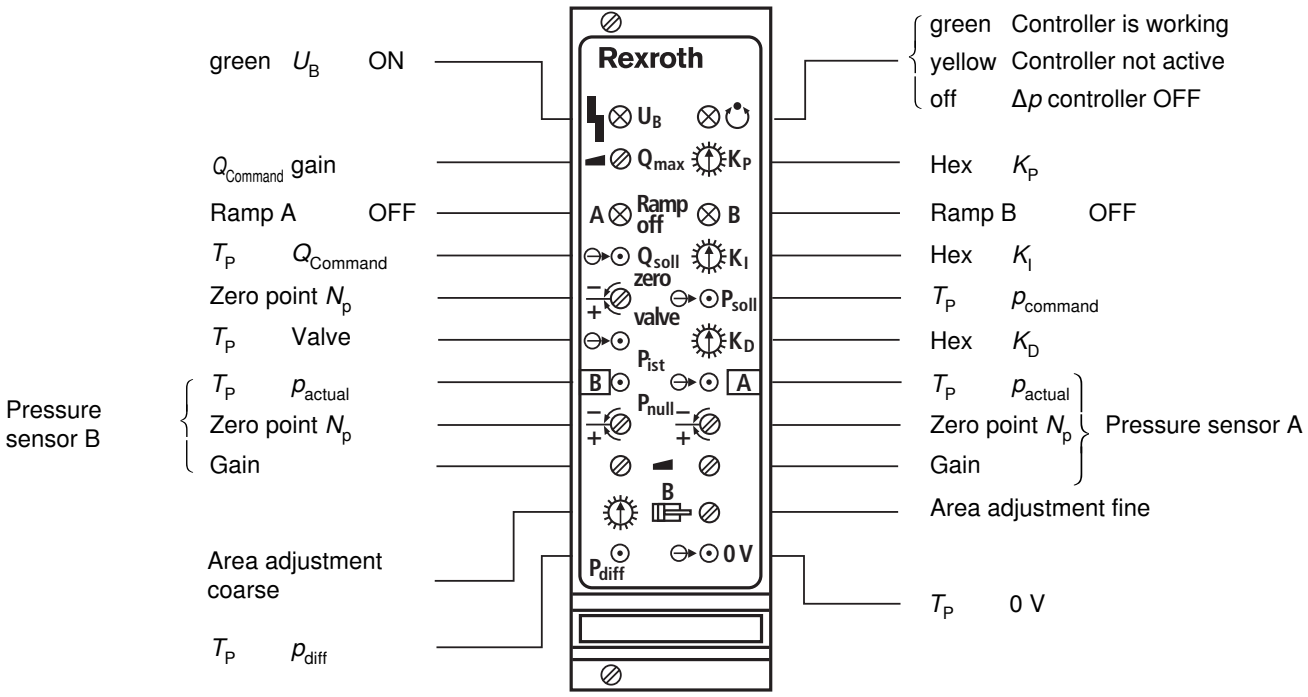
Preferred types

Amplifier type	Material number
VT-VACAF-500-10/V0	0811405147

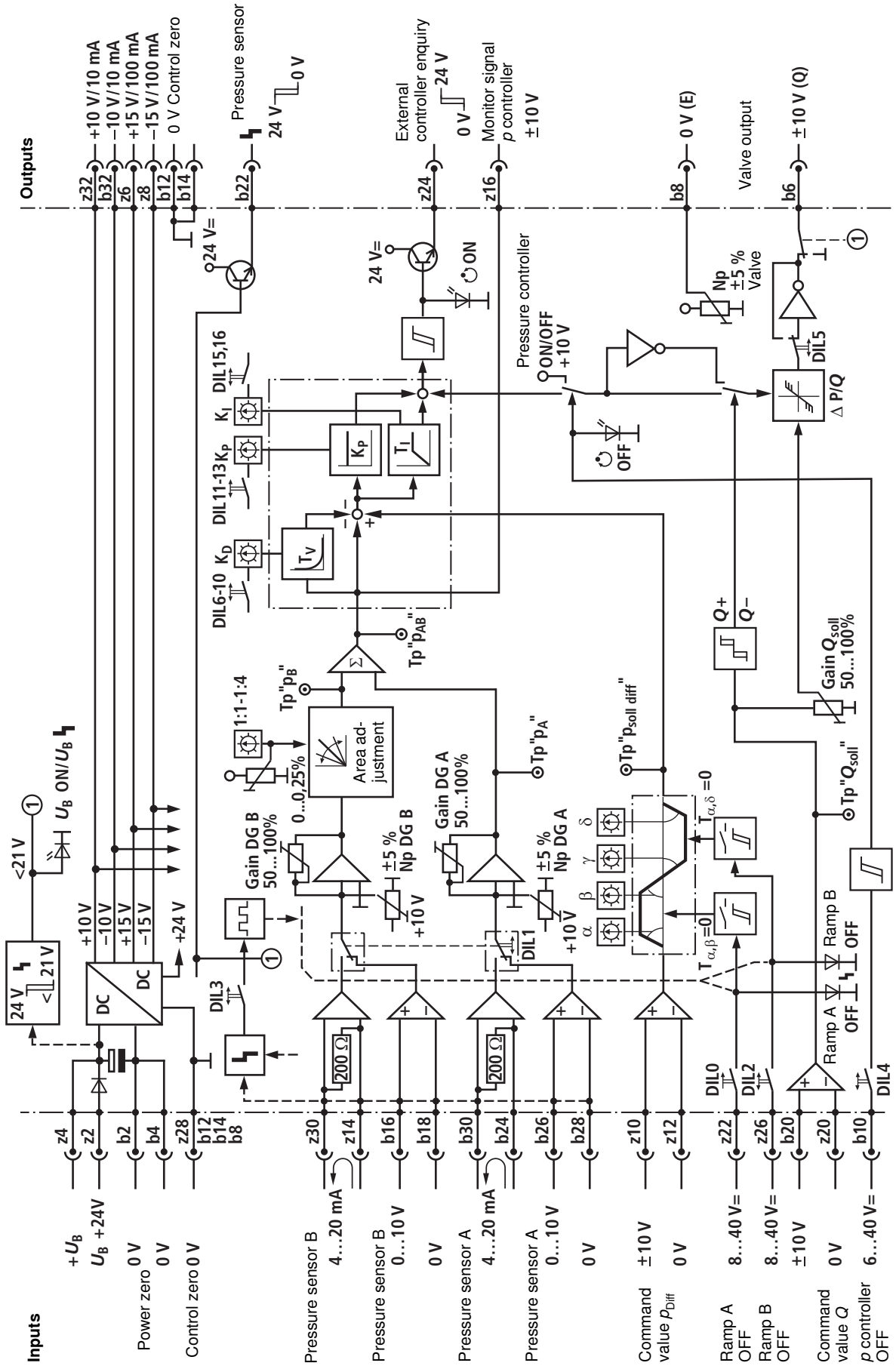
Suitable card holder:

– Open card holder VT 3002-1-2X/32F
(see data sheet 29928).
Only for control cabinet installation.

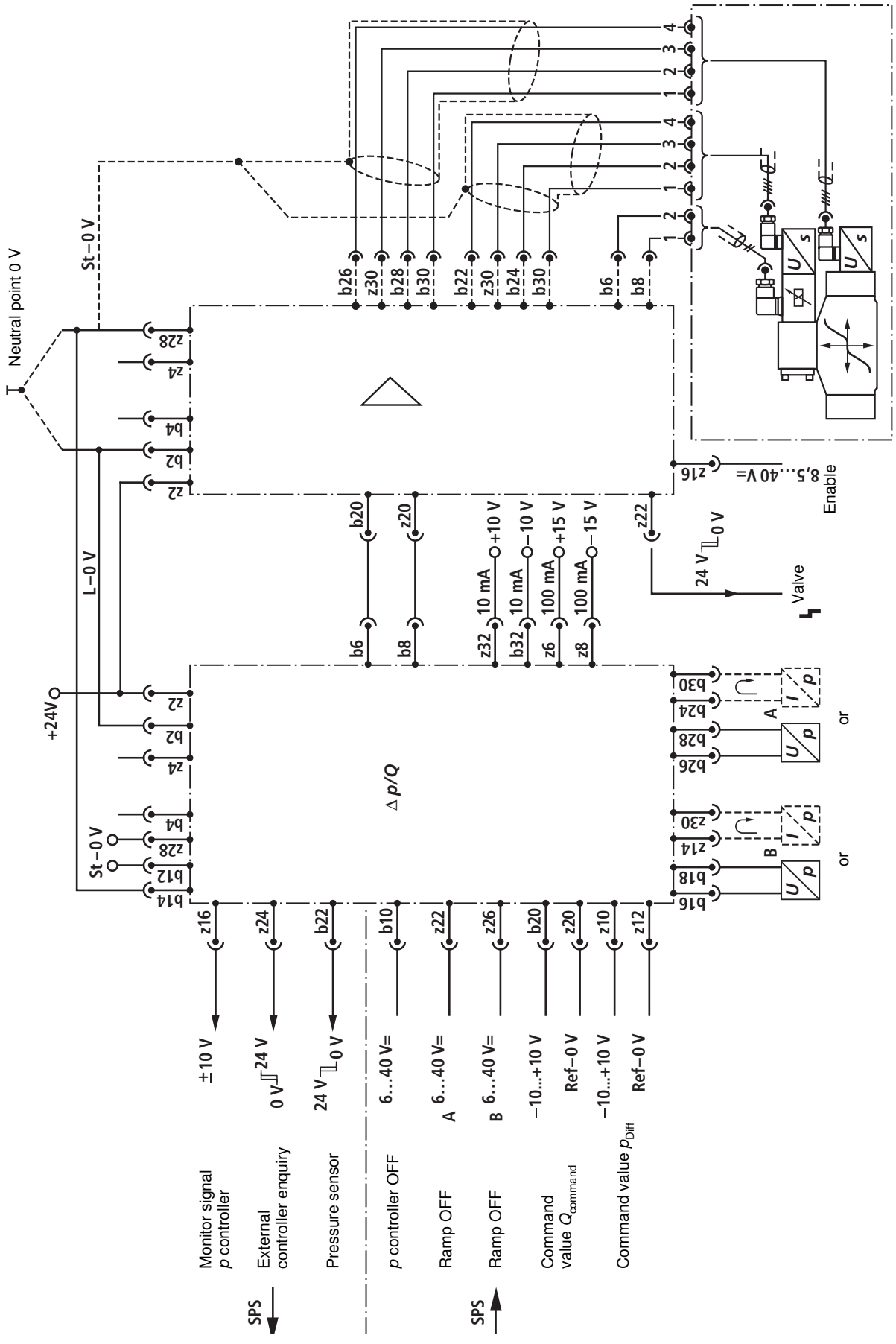
Front plate



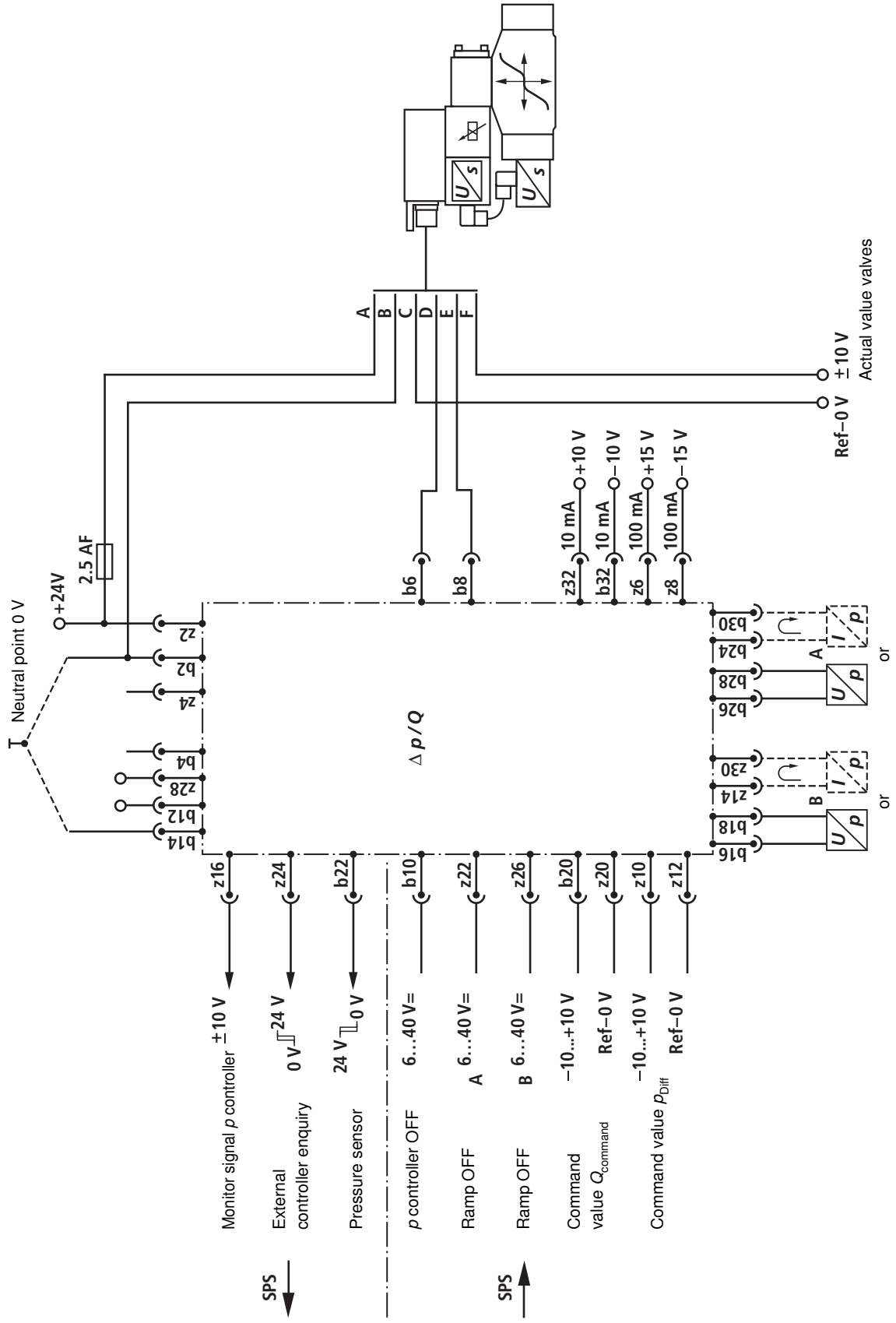
Block diagram with pin assignment



Wiring diagram with valve amplifier card



Wiring diagram – Valve with installed electronics



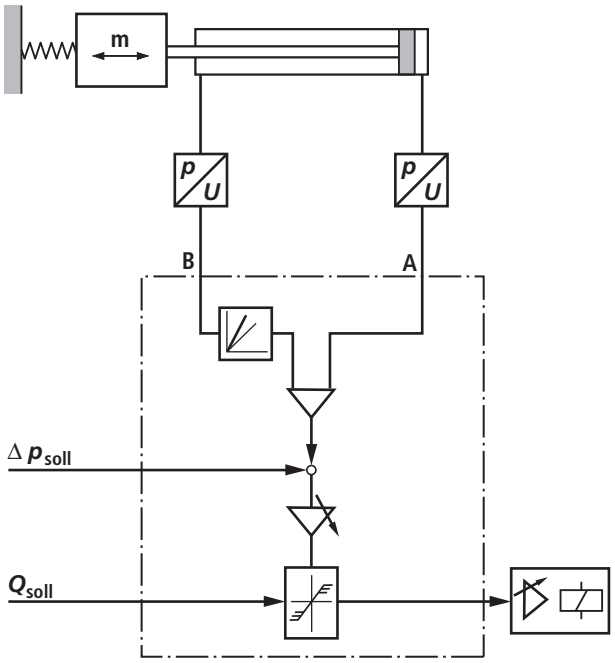
Technical data (For applications outside these parameters, please consult us!)

Supply voltage U_B at z2 – b2		Nominal 24 V = Battery voltage 21...40 V, Rectified alternating voltage U_{eff} = 21...28 V (one-phase, full-wave rectifier)
Smoothing capacitor, separately at z2 – b2		Recommendation: Capacitor module VT 11110 (see data sheet 30750) (only necessary if the ripple of U_B > 10 %)
Current consumption, max.	mA	250
Command value *Q*		b20: 0...±10 V z20: 0...±10 V } Differential amplifier (R_i = 100 kΩ)
Command value p_{diff}		z10: 0...±10 V z12: 0 V } Differential amplifier
Actual value from the pressure sensor	A	b26: 0...+10 V b28: 0 V } Differential amplifier b24: b30: ← 4...20 mA
	B	b16: 0...+10 V b18: 0 V } Differential amplifier b14: b30: ← 4...20 mA
Pressure sensor supply		z6: +15 V, max. 100 mA z8: –15 V, max. 100 mA
Pressure controller OFF		b10: 6...40 V =
External controller enquiry		z24: 24 V/0.1 A max., if controller is not active
Signal source		Supply ±10 V from b32, z32 (10 mA) or external signal source
Monitor signal F_{actual}		z16: ±10 V
Error pressure sensor (cable break, signal lines)		b22: No error: +U_B; max. 100 mA Error: 0 V : LED "Ramp A OFF" and "Ramp B OFF" flash
Ramp times		Min. 350 ms (1) } 16 steps Max. 5.6 s (16) } 350 ms/step
Ramp OFF	A	z22: 8...40 V =
	B	z26: 8...40 V =
Area adjustment cylinder		Min. 1:1 (1) } 16 steps Max. 1:4 (16) }
LED displays		red: Error U_B red: Ramp A OFF red: Ramp B OFF green/yellow: green: Controller active yellow: Controller not active off: Controller OFF
Format of the printed circuit board	mm	(100 x 160 x approx. 35) / (W x L x H) Europe format with front plate 7 TE
Plug-in connection		Connector DIN 41612 – F32
Ambient temperature	°C	0...+70
Storage temperature range	°C	–20...+70
Weight	*m*	0.44 kg

Notice:
Power zero b2 and control zero b12 or b14 or z28 must be separately led to the central ground (neutral point).

Functional principle

Force control



Additional information

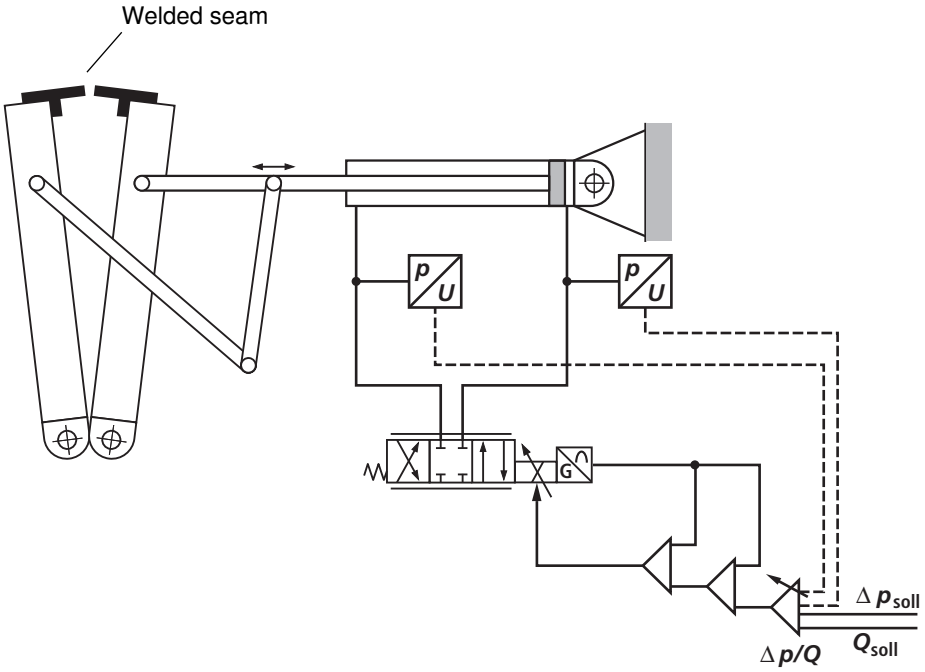
Applications

As opposed to *p/Q* control, pressure measurement in the A and B line of a hydraulic actuator by means of the "Pressure differential controller" printed circuit board can be used to allow for Δ*p/Q* control of the actuator.
Consequently, this control structure is used everywhere where you don't only have to control the pressure in one direction of motion of the actuator against a constant pressure but where there is also pressure control against a changing pressure, i.e. in all cases, in which force control is necessary.
The actual value adjustment allows for the connection of pressure sensors with 0...10 V and 4...20 mA output signal.

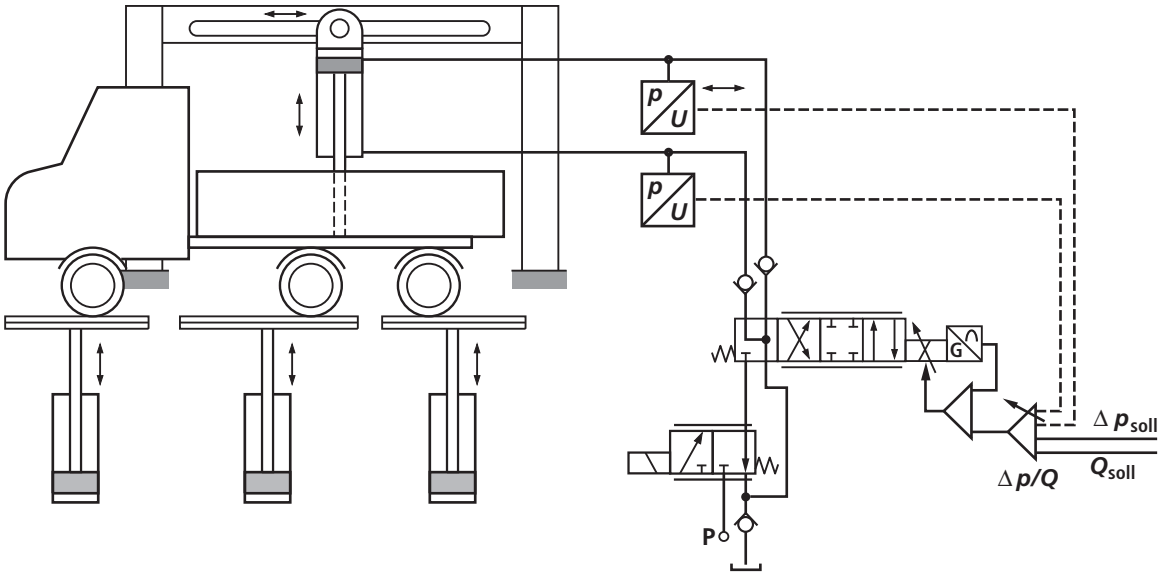
The command value ramps allow for the design of command value steps of $\Delta p_{command}$ as ramp function. The error monitoring logic detects cable break of the signal lines of the sensors and errors in the voltage supply. The pressure control circuit can also be switched off externally (flow control).
To control the actuator, this printed circuit board is to be coupled with a valve amplifier card or a valve with installed electronics.

Examples

Example 1
Welding machine



Example 2
Vehicle twisting test stand



Function

Input variables are the differential pressure Δp and flow Q command values. As actual values, pressure differential and valve spool path are fed back.

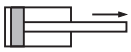
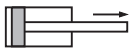
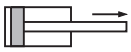
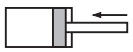
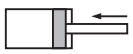
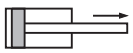
The $\Delta p/Q$ controller takes effect:

a) As long as $\Delta p_{command} > \Delta p_{actual}$ like a flow control, i.e. the pressure control does not yet take effect;

b) If $\Delta p_{command} = \Delta p_{actual}$, the pressure control takes effect, i.e. a limiter superimposes the command value Q.

The command value Q corresponds to the spool path as long as the pressure control does not take effect, yet, i.e. $\Delta p_{command} > \Delta p_{actual}$ or if the pressure controller is switched off. The command value Q may range between U_E = 0...±10 V.

Functional examples

$Q_{command}$	Direction	$p_{diff.\ command}$	Direction	Track traveling	Force control
+5.0 V		+3.5 V		with 50 % $v_{max.}$	After track traveling to 35 % of $p_{diff.\ max.}$
+7.5 V		–2.0 V		with 75 % $v_{max.}$	Not possible
–3.3 V		–4.8 V		with 33 % $v_{max.}$	After track traveling to 48 % of $p_{diff.\ max.}$
–10.0 V		+8.0 V		with $v_{max.}$	Not possible
↓	A command value of at least ±0.3 V must be specified!				

The numerical values listed in the table are examples, the signs of the values are decisive.

Settings DIL switch

DIL no.	Status	Function		
0	ON	External ramp control possible		A
	OFF	+ $p_{diff.\ command}$ via ramp		
1	ON	4...20 mA pressure sensors		
	OFF	0...10 V pressure sensors		
2	ON	External ramp control possible		B
	OFF	+ $p_{diff.\ command}$ via ramp		
3	ON	Cable break detection *p* sensor ON		
	OFF	Cable break detection OFF		
4	ON	External controller shut-off possible		
	OFF	External controller shut-off not possible		
5	ON/OFF	Inversion of the hydraulic direction of action → $+Q_{Command}$ must extend the cylinder		
6	OFF	D share	Switch combinations, see table 1	
7	OFF			
8	OFF			
9	OFF			
10	OFF			
11	OFF	P share	Switch combinations, see table 2	
12	ON			
13	OFF			
14	ON		Reduced pressure decrease with $p_{diff.\ actual} > p_{diff.\ command}$ Valve opening max. 20 %	
	OFF		No reduced pressure reduction	
15	ON	I share	Switch combinations, see table 3	
16	OFF			

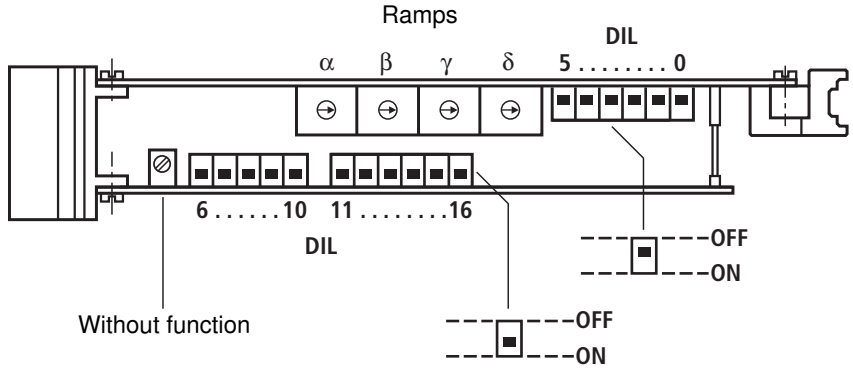


Table 1
Using the DIL switches 6 ... 10, the setting of the hex switch K_D (front plate) can be reduced.
The setting can be reduced in a direction-dependent form.
Step 1 is the lowest, step 8 the highest reduction.

	K_D					
	DIL 6	DIL 7	DIL 8	DIL 9	DIL 10	Effect
	OFF	OFF	OFF	OFF	OFF	No influence on the hex switch K_D
	OFF	OFF	ON	OFF	OFF	
	OFF	ON	OFF	OFF	OFF	
	OFF	ON	ON	OFF	OFF	
	ON	OFF	OFF	OFF	OFF	
	ON	OFF	ON	OFF	OFF	
	ON	ON	OFF	OFF	OFF	
	ON	ON	ON	OFF	OFF	
1	OFF	OFF	OFF	OFF	ON	Direction 1
	OFF	OFF	OFF	ON	OFF	Direction 2
	OFF	OFF	OFF	ON	ON	Direction 1 + 2
2	ON	OFF	OFF	OFF	ON	Direction 1
	ON	OFF	OFF	ON	OFF	Direction 2
	ON	OFF	OFF	ON	ON	Direction 1 + 2
3	OFF	ON	OFF	OFF	ON	Direction 1
	OFF	ON	OFF	ON	OFF	Direction 2
	OFF	ON	OFF	ON	ON	Direction 1 + 2
4	ON	ON	OFF	OFF	ON	Direction 1
	ON	ON	OFF	ON	OFF	Direction 2
	ON	ON	OFF	ON	ON	Direction 1 + 2
5	OFF	OFF	ON	OFF	ON	Direction 1
	OFF	OFF	ON	ON	OFF	Direction 2
	OFF	OFF	ON	ON	ON	Direction 1 + 2
6	ON	OFF	ON	OFF	ON	Direction 1
	ON	OFF	ON	ON	OFF	Direction 2
	ON	OFF	ON	ON	ON	Direction 1 + 2
7	OFF	ON	ON	OFF	ON	Direction 1
	OFF	ON	ON	ON	OFF	Direction 2
	OFF	ON	ON	ON	ON	Direction 1 + 2
8	ON	ON	ON	OFF	ON	Direction 1
	ON	ON	ON	ON	OFF	Direction 2
	ON	ON	ON	ON	ON	Direction 1 + 2

Direction 1 ≙ force reduction
Direction 2 ≙ force build-up

Table 2

DIL 11	DIL 12	DIL 13	Effect
OFF OFF	OFF OFF	OFF ON	No gain reduction to hex switch K_P
ON	OFF	ON	Low gain
OFF ON	ON ON	OFF OFF	Medium gain
ON	OFF	OFF	High gain
ON OFF	ON OFF	ON OFF	Forbidden

Table 3

DIL 15	DIL 16	Effect
OFF	OFF	No influence on the hex switch K_I
OFF ON	ON ON	I share = 0
ON	OFF	I max. ($\triangleq K_I = 16$) + K_I current

Commissioning and adjustment

General notes:

Setting during the commissioning is effected using potentiometers and HEXCODE switches on the front plate as well as using DIL switches on the printed circuit board.
Test points for voltage measurements as well as LED displays are located on the front plate. The measured values generally refer to the test point 0 V. The test points may only be loaded with measuring devices $R_L \geqq 10$ kΩ.

Overload impairs the control function and/or the printed circuit board is damaged. Before the commissioning, the basic settings of the as-delivered state are to be checked. In the card adjustment, proceed in the order of the points shown (see page 13).

Verification of the connections

- Electrical
  According to connection diagram, page 4 and/or 5
- Hydraulic
  Pressure sensor A for piston chamber
  Pressure sensor B for annulus area.

Default setting controller parameters

- According to the table, page 15, column as-delivered state.

Mode settings DIL 0...5

- Carry out the settings according to the table, page 10.

Pressure sensor adjustment

- Set an area ratio 1:1.
- **System depressurized:** Zero point adjustment
  → Potentiometer p_{zero} → $TP_{P\ actual}$ = 0 V.
- **Max. system pressure:** Gain adjustment
  → Potentiometer ◢ → $TP_{P\ actual}$ = 10 V.

Setting of the cylinder area ratio

- Set the hex switch to the area ratio of the cylinder; potentiometer to ccw.
  This potentiometer is used for the fine tuning during the controller adjustment.

Adjustment $Q_{max.}$

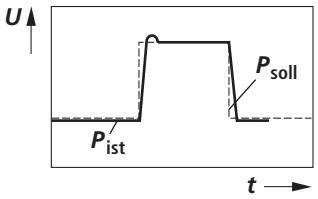
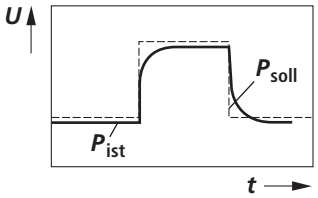
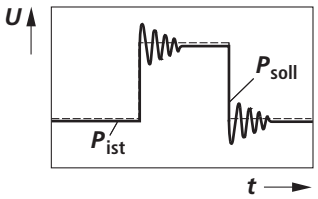
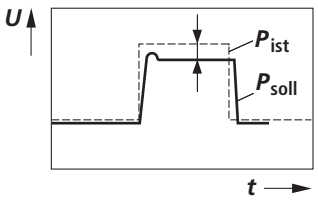
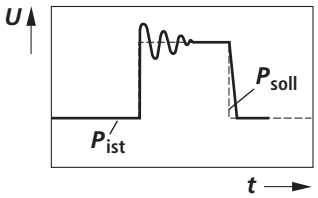
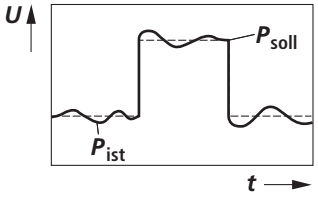
- Specification of the max. command value (e.g. 7 V)
  → Potentiometer ◢ $Q_{max.}$ → Adjustment to 10 V at TP-$Q_{Command}$.

Valve zero point adjustment

- Specification $Q_{Command}$ = 0 V → The forces at the cylinder must be balanced (i.e. pressure ratio p_K:p_R must correspond to the ratio A_K:A_R).

Controller adjustment

- Working in the control loop
  → Specification of command value steps $p_{diff.}$
  (e.g. 30 % → 70 % and –20 % → –60 %)
  → Comparison of command and actual value
  (see table, page 14)
  → Correction/adjustment of the parameters according to tables 1 to 3
  → Fine correction area ratio.

a 	**Ideal development** (only a square is shown)
b 	**Problem:** P share too low **Solution:** → Rotate K_p against 16 (fine adjustment) → P gain > see table 2, DIL 11–13
c 	**Problem:** P share too large **Solution:** → Rotate K_p against 1 (fine adjustment) → Use DIL 11–13 to reduce the P gain according to table 2
d 	**Problem:** P share correct, control deviation too large **Solution:** → Increase the I gain share according to table 3 → Rotate K_I against 16
e 	**Problem:** Time constant of the I share too low **Solution:** → Rotate K_I against 16 until control deviation and vibration are perfect → if K_I = 16 is not sufficient, the P share must also be reduced, see table 2
f 	**Problem:** D share too low **Solution:** → Rotate K_D against 16 → D share >, see table 1 (DIL 6–10)

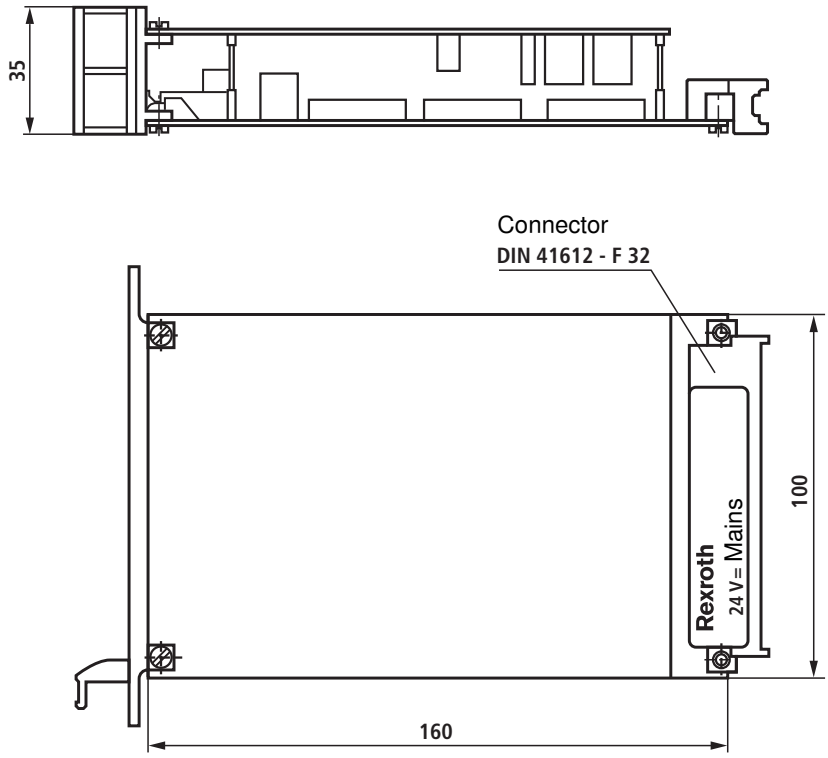
Adjustment protocol

Created by

Date

Switches	As-delivered state ↓		
DIL 0	ON		
DIL 1	ON		
DIL 2	ON		
DIL 3	ON		
DIL 4	OFF		
DIL 5	ON		
DIL 6	OFF		
DIL 7	OFF		
DIL 8	OFF		
DIL 9	OFF		
DIL 10	OFF		
DIL 11	OFF		
DIL 12	ON		
DIL 13	OFF		
DIL 14	ON		
DIL 15	OFF		
DIL 16	ON		
HEX α	3		
HEX β	3		
HEX γ	3		
HEX δ	3		
HEX K_P	1		
HEX K_I	1		
HEX K_D	1		

Device dimensions (dimensions in mm)



Project planning / maintenance instructions / additional information

- The amplifier card may only be unplugged and plugged when de-energized.
- The distance to aerial lines, radios and radar systems must be sufficient (> 1 m).
- Do not lay solenoid and signal lines near power cables.
- For signal lines and solenoid conductors, we recommend using shielded cables.
  The cable shield must be connected to the control cabinet extensively and as short as possible.
- The valve solenoid must not be connected to free-wheeling diodes or other protection circuits.