p/Q closed-loop control amplifier

RE 30134 1/12
Edition: 2017-05
Replaces: 06.12

Type VT-VACAP-500-2X/V0/...

Component series 2X

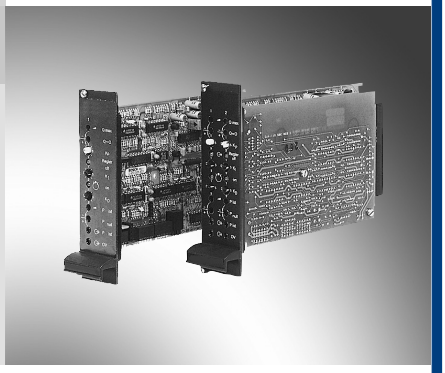


Table of contents

Features

- Suitable for controlling high-response valves with installed electronics
- Amplifier with additional electronics (daughter card)
- Analog amplifiers in Europe format for installation in 19" racks
- Valve position control with PID behavior
- Outputs short-circuit-proof
- External shut-off for pressure controller
- Suitable for pressure sensors (1...6 V, 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	P –	500 –	2X /	V0 /

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

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

Control
Analog = **A**

Function
p/*Q* control = **P**

500 = Standard variant without valve amplifier function

Serial number for types

2X = Component series 20 to 29 (20 to 29: Unchanged technical data and pin assignment)

Customer version
V0 = Catalog version

Option
no code = 1 channel
2CH = 2 channels

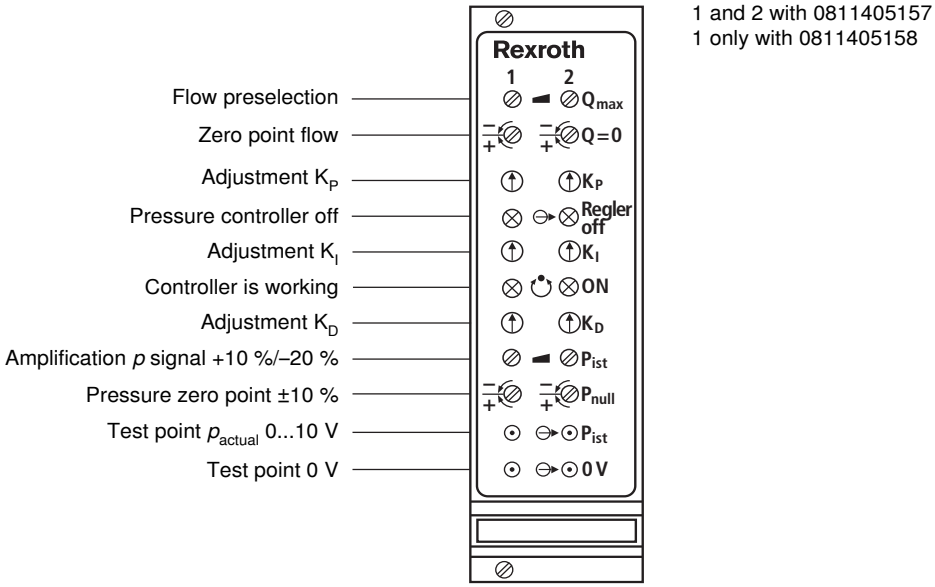
Preferred types

Amplifier type	Material number	For high-response valves
VT-VACAP-500-20/V0	0811405157	All valve types with installed electronics
VT-VACAP-500-20/V0/2CH	0811405158	

Suitable card holder:

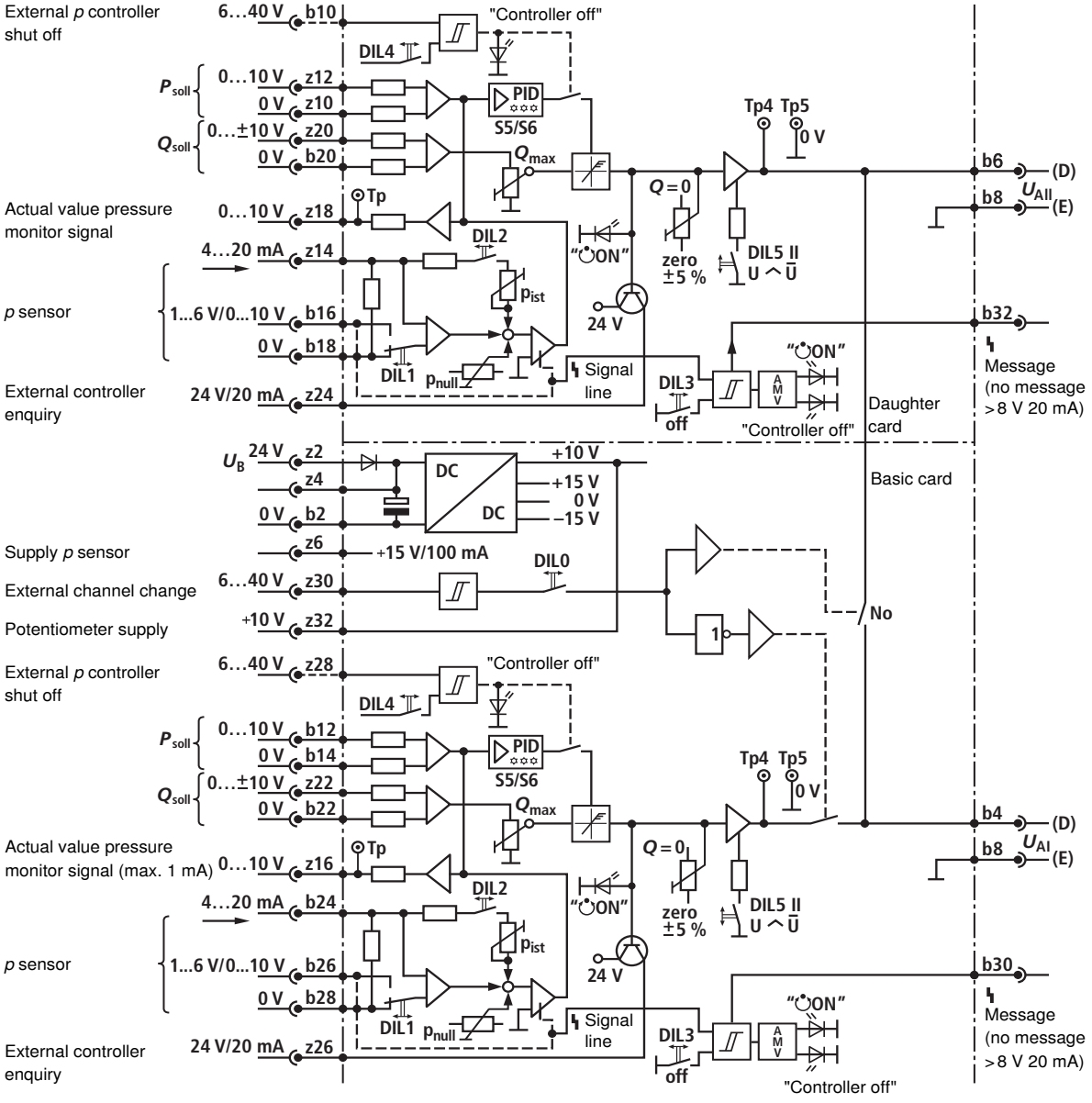
– Open card holder VT 3002-1-2X/32F (see data sheet 29928).
Only for control cabinet installation!

Front plate



1 and 2 with 0811405157
1 only with 0811405158

Block diagram with pin assignment



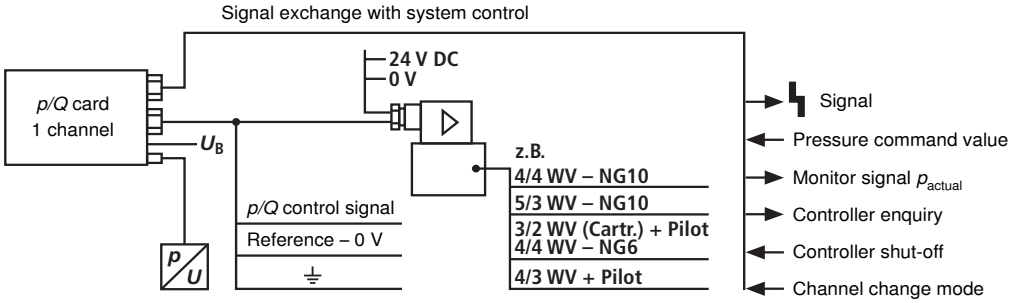
* Daughter card only attached with 2-channel variant

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

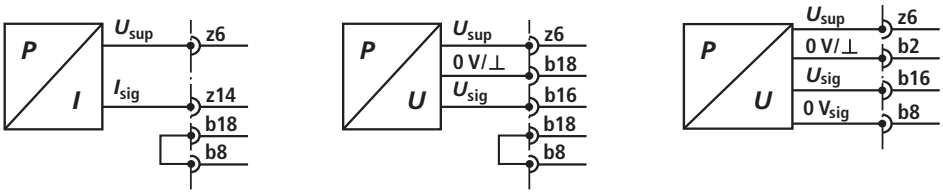
Supply voltage U_B at z2 – b2		Nominal 24 V = Battery voltage 21...40 V, Rectified alternating voltage U_{eff} = 21...28 V (one-phase, full-wave rectifier)	
Smoothing capacitor, separately at z2 – b2		Recommendation: Capacitor module VT 11110 (see data sheet 30750) (only necessary if the ripple of U_B > 10 %)	
Current consumption, max.	0811405157	160 mA	
	0811405158	220 mA	
		Basic card	**Daughter card**
Pressure sensor (1...6 V/0...10 V) Pressure sensor (4...20 mA)		b26 – Ref. b28 b24 – Ref. b28	b16 – Ref. b18z14 – Ref. b18
Pressure sensor supply – V		z6 (+15 V)/b8 (0 V)	
Pressure command value (0...10) V		b12/b14 (0 V)	z12/z10 (0 V)
External controller shut off		z28: 6...40 V =	b10: 6...40 V =
External controller enquiry		z26: 24 V =, max. 20 mA	z24: 24 V =, max. 20 mA
Monitor signal p_{actual}		z16: 0...10 V =	z18: 0...10 V =
External channel change mode		z30: 6...40 V =	
Flow command value		z22: 0...±10 V = b22: 0 V	z20: 0...±10 V = b22: 0 V
Potentiometer supply		z32: +10 V, max. 10 mA	
Output		U_{AI}: b4/b8 (0 V): 0...±10 V Load R_L > 1 kΩ	U_{AII}: b6/b8 (0 V): 0...±10 V Load R_L > 1 kΩ
Cable: Pressure sensor Valve PLC signals		4 x 0.5 mm² (shielded) 5 x 0.5 mm² (shielded) 0.5 mm² (shielded)	
LED displays/channel		Pressure controller OFF Controller is working Cable break pressure transducer (both a.-m. LEDs are flashing)	
Special features		Cable break monitoring for pressure sensor Test points for important characteristics External pressure controller shut-off External channel change mode Different pressure sensors possible	
Circuit board format	mm	(100 x 160 x approx. 35) / (W x L x H) Europe format with front panel 7 TE	
Plug-in connection		Connector DIN 41612 – F32	
Ambient temperature	°C	0...+70	
Storage temperature range	°C	–20...+70	
Weight	*m*	0811405157 – 0.35 kg, 0811405158 – 0.44 kg	

Connection scheme

Amplifier – Valve



Pressure sensor connection: Example channel II



Additional information

Applications

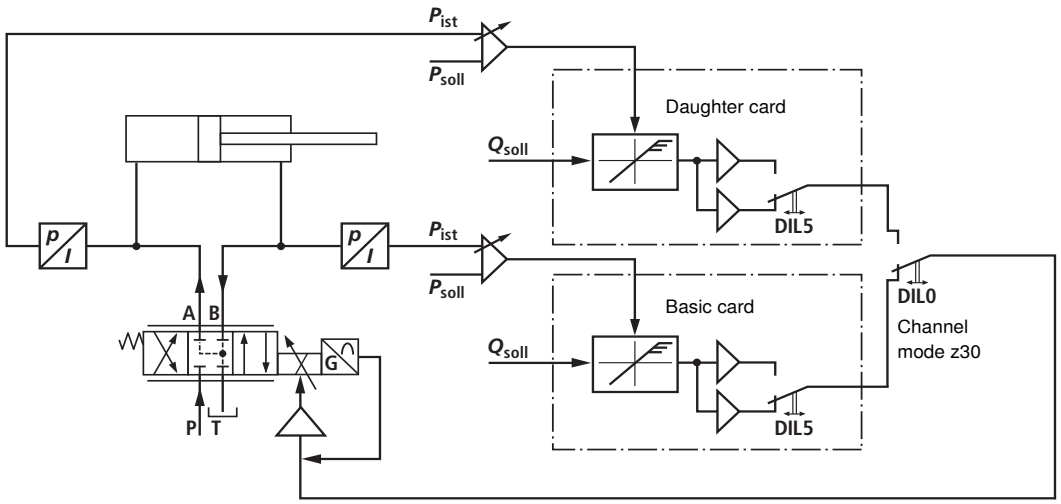
The "1-channel *p/Q* control card" consists of the basic card in Europe format with DC/DC converter and front plate. With the "2-channel *p/Q* control card", this basic card contains a *p/Q* daughter card with identical circuit and a joint front plate. The supply voltage is 24 V =. The voltage of the valve to be regulated is not supplied via this card.
Input variables for the cards are the valve position command value, the pressure command value, the actual pressure value and possible control mode signals. The pressure sensors with voltage interface receive their voltage supply from the card (z6/z8). At the card, pressure sensors with voltage and current signal can be connected.

The pressure command value can be specified by means of a potentiometer. The potentiometers can be supplied from the card (z32/b12).
For control and comparison, the front plate and the circuit board comprise test points for the most important characteristics.
The circuit of the "2-channel card" is designed so that the controllers on basic and daughter card work in a completely independent manner. In this mode, the card is suitable for controlling 2 valves with integrated electronics (see example 2, page 6).
An additional channel mode circuit allows for the considerable extension of the possible applications of the described card (see example 1, page 6).

Examples

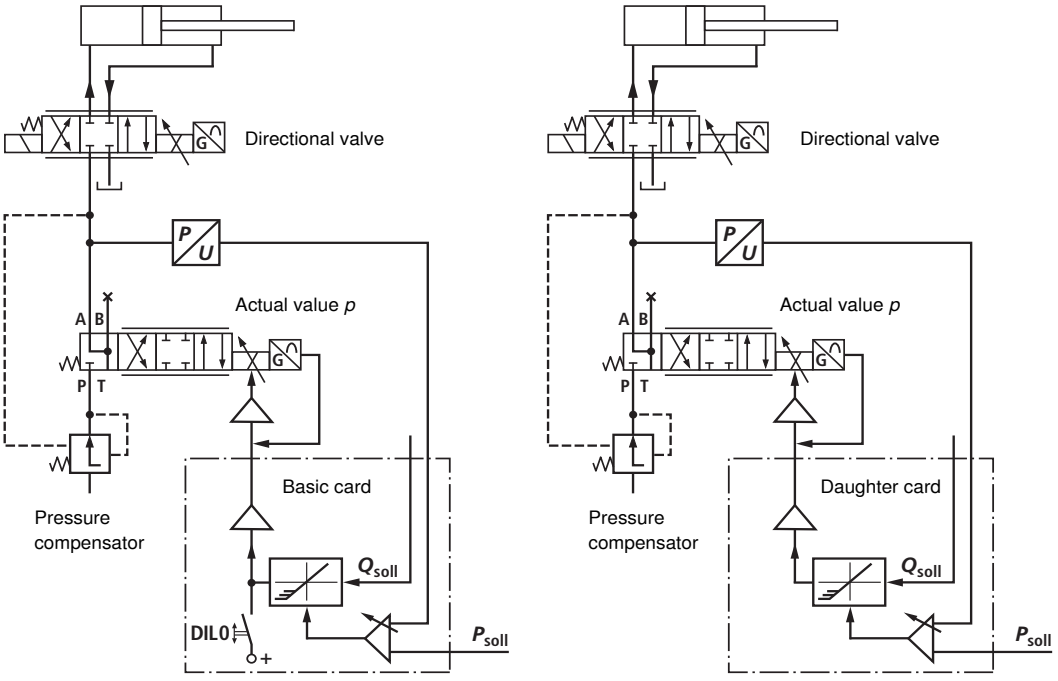
Example 1

Channel mode "joint output"



Example 2

Channel mode "separate outputs"



Functional presentation

Function and structure of the *p/Q* controller card are shown as block diagram (see page 3).
Pressure command value: It is specified by the user in the form of voltage (0...10 V; b12/b14 and/or z10/z12). You can do so by means of a potentiometer which can be supplied by the card (z32/b8).
Actual pressure value: It is optionally recorded by pressure sensors with voltage interface (1...6 V, 0...10 V) or current interface (4...20 mA) (which can be switched).
The actual pressure value can be tapped as monitor signal at z16 and/or z18. The command value is compared to the actual value. The variation and the differentiated actual value act on a PID controller. The controller output signal acts on the limiter circuit which influences the position command value. If the actual pressure value is smaller than the pressure command value, the controller signal is larger than the specified position command value. It is thus not influenced by the limiter; there is simple flow control of the valve.
If the pressure command value is reached, the limiter takes effect according to the actual pressure value so that the input signal for the valve position control is changed so that $p_{command} - p_{actual} = 0$ is maintained.
Controller characteristic: The PID controller and the derivative element can be roughly set by means of DIL switches (printed circuit board) and finely by means of front plate switches.
Controller display: The controller function is displayed by means of LED and can be used for switching purposes via an acknowledgement output.
Line break: Simultaneous flashing of the two yellow LEDs and the switching of output b30 and/or b32 signalizes a pressure sensor line break.
Controller shut-off: The controller can be shut off by means of an external signal (6...40 V =).
Channel selection: Is only possible for the 2-channel card. Detailed explanation (see below).

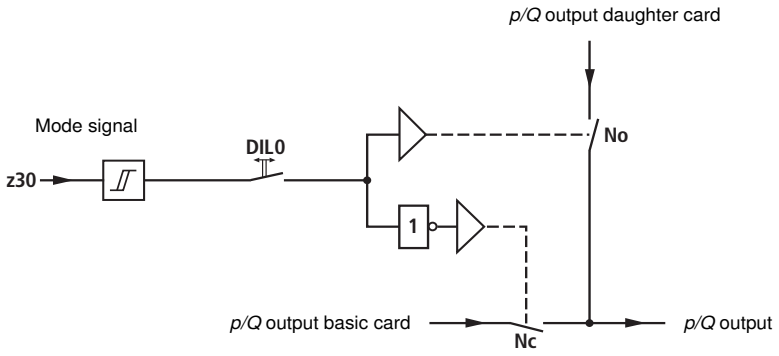
Special function "channel selection" of the "2-channel control card"

This special function can be used in all cases in which two actual pressure values have to act on one control distance via their two independent controllers. An external mode signal (z30/6...40 V =) is used to select basic or daughter *p/Q* control signal on the control distance. The DIL switch 0 must be ON; otherwise, this special function is blocked. The control signal of one channel must be inverted (DIL 5).

DIL 0	Mode signal z30	Basic card I	Daughter card II	DIL 5 I	DIL 5 II
ON	H	OFF	ON – out I (b4/b2)	ON	OFF
ON	L	ON – out I (b4/b2)	OFF	ON	OFF
OFF	X	ON – out I (b4/b2)	ON – out II(b6/b8)	X	X

X– without influence

Principle of the channel selection



Setting instructions

A: General instructions

- The measured values generally refer to the ground at the test point "0 V"
- Indication of the direction of rotation for potentiometers: cw – clockwise ccw – counterclockwise
- Before the commissioning, the position of the setting elements is to be checked according to the transfer condition (see adjustment table page 11)
- Proceed in the order b) to f) (page 10).

B: Mode settings

DIL no.	Status	Function
0	ON	Both controllers act on output 1
	OFF	Controller 1 and 2 act on output 1 and/or 2, irrespective of each other
1	ON	Pressure sensor 1...6 V/0...10 V
	OFF	Pressure sensor 4...20 mA
2	ON	Actual p value amplification p_{sys} [1] ≙ ~ p_{nom} [2]
	OFF	Actual p value amplification p_{sys} ≙ ~ 0.5 • p_{nom}
3	ON	Cable break detection active
	OFF	Cable break detection inactive
4	ON	*p* controller active
	OFF	*p* controller shut off, only the *Q* signal is analyzed
5	ON	*p*/*Q* output signal not inverted
	OFF	*p*/*Q* output signal inverted

[1] p_{sys} = System pressure
[2] p_{nom} = Nominal sensor pressure

C: Pressure sensor comparison

- Set the sensor type (DIL 1) and the gain factor (DIL 2)
- The zero point comparison is effected using the potentiometer p_{zero} in order to achieve 0 V (±10 mV) at the signal input with pressure-relieved pressure transducer
- The sensitivity is aligned using the potentiometer p_{actual} at system pressure (+10 %/–20 %).

D: Flow zero point

The zero position of the valve is set using the potentiometer Q_{zero} (±10 %). Due to the valve amplifier integrated in the valve, direct adjustment at the amplifier is not intended.

E: Comparison of the position signal

- Shut off the *p* controller (DIL 4)
- Set the command value amplification using the potentiometer $Q_{max.}$.

F: Optimization of the control characteristic

DIL no.	Status	Function		
6	ON	D	Pressure build-up	normal
	OFF			reduced [1]
7	ON		Pressure reduction	normal
	OFF			reduced [1]
8	ON		Share high	(9, 10 = OFF)
9	ON		Share medium	(8, 10 = OFF)
10	ON		Share low	(8, 9 = OFF)
11	ON	I	Share = 0	(12 = OFF)
12	ON		Share available	(11 = OFF)
13	ON	P	Reduced pressure reduction	Valve opening in case of pressure reduction < approx.15 %
	OFF			ineffective
14	ON		Share low	(16 = ON/15 = OFF)
15	ON		Share medium	(14, 16 = OFF)
16	ON		Share high	(14, 15 = OFF)

[1] With DIL 6 and 7 = OFF, DIL 8 is ineffective

G: Test points

The test points of the card may only be loaded with a R_L > 10 kΩ. in case of overload, the function of the control is impaired and/or the card is destroyed. The test points are located on the front plate and laterally on the printed circuit board.

Basic card and daughter card have separate test points each, however the identical reference ground.

Controller adjustment

The P, I and D shares of the closed-loop control amplifier are to be optimized according to the properties of the control distance, the disturbance variables and the static and dynamic requirements on the control result.

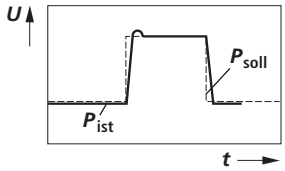
1) Pressure controller ON – DIL 4 ON
2) Connection of an oscilloscope at the test point "p_{actual}"
3) Usefully connection of a 2nd oscilloscope channel at the terminals "$p_{command}$"
4) DIL 6 and DIL 7 serve to compensate dynamic differences in the pressure build-up and reduction in the system
   DIL 6 ON = Normal application
   OFF = Special application
   DIL 7 ON = Normal application
   OFF = Special application
5) DIL 13 reduces the pressure reduction by means of a max. valve opening < approx. 15 %
   ON = Special application
   OFF = Normal application
6) **Aim of the controller optimization**

An optimum between change over characteristic (overshooting tendency with excessive static amplification) and static accuracy (control error with starting pressure cut off) is to be achieved (a).

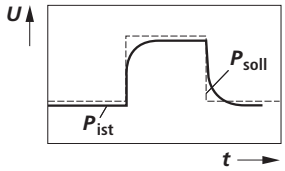
Procedure (see table, page 11):
An increase in the **P share** of the controller increases the dynamic of the control behavior (b). In case of excessive gain, the tendency to oscillate increases (c).
Limitation of the **I share** reduces the static gain. With increasing static gain, the control deviation is reduced (d). The **D share** can be used to influence the transition behavior (minimization of the tendency to oscillate); thus, the command value is only reached after a longer transition time (f).

Ideal development

a



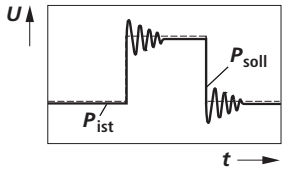
b



Problem:
P share too small
Solution:
→ Rotate K_p against F (fine adjustment)
→ P gain >

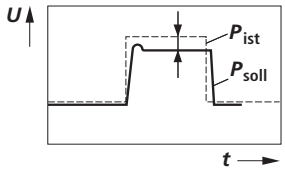
DIL 14	ON
DIL 15	OFF
DIL 16	ON

c



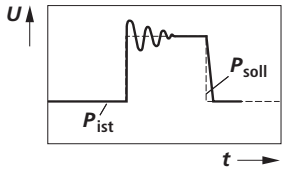
Problem:
P share too large
Solution:
→ Rotate K_p against 0 (fine adjustment)
→ use DIL 14–16 to reduce the P gain according to the table

d



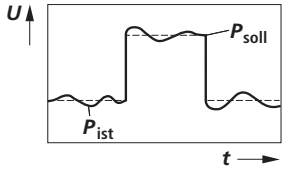
Problem:
P share correct
Control deviation too large
Solution:
→ Increase the I gain share
DIL 11 ON = I share = 0
DIL 12 ON = I share connected
→ Rotate K_i against F

e



Problem:
Time constant of the I share too low
Solution:
→ Rotate K_i against F until control deviation and vibration are perfect
→ If K_i = F is not sufficient, the P share must also be reduced

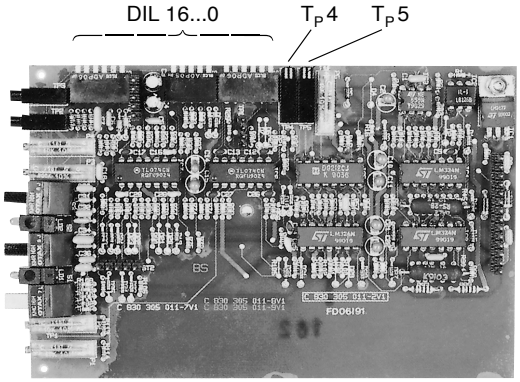
f



Problem:
D share too low
Solution:
→ Rotate K_D against F
→ D share >

DIL 8	ON
DIL 9	OFF
DIL 10	OFF

Adjustment table



T_P4: U_A
T_P5: 0 V

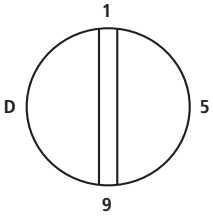
Basic card				
Set by		Rexroth		
Date		As-delivered state		
DIL 0	DIL switch	OFF		
DIL 1		OFF		
DIL 2		ON		
DIL 3		ON		
DIL 4		ON		
DIL 5		OFF		
DIL 6		OFF		
DIL 7		OFF		
DIL 8		OFF		
DIL 9		OFF		
DIL 10		OFF		
DIL 11		OFF		
DIL 12		OFF		
DIL 13		OFF		
DIL 14		OFF		
DIL 15		ON		
DIL 16		OFF		
HEX K_P	HEX code	B		
HEX K_I		1		
HEX K_D		D		

* Daughter card				
Set by		Rexroth		
Date		As-delivered state		
DIL 0	DIL switch	OFF		
DIL 1		OFF		
DIL 2		ON		
DIL 3		ON		
DIL 4		ON		
DIL 5		OFF		
DIL 6		OFF		
DIL 7		ON		
DIL 8		OFF		
DIL 9		OFF		
DIL 10		OFF		
DIL 11		OFF		
DIL 12		OFF		
DIL 13		OFF		
DIL 14		OFF		
DIL 15		ON		
DIL 16		OFF		
HEX K_P	HEX code	3		
HEX K_I		9		
HEX K_D		5		

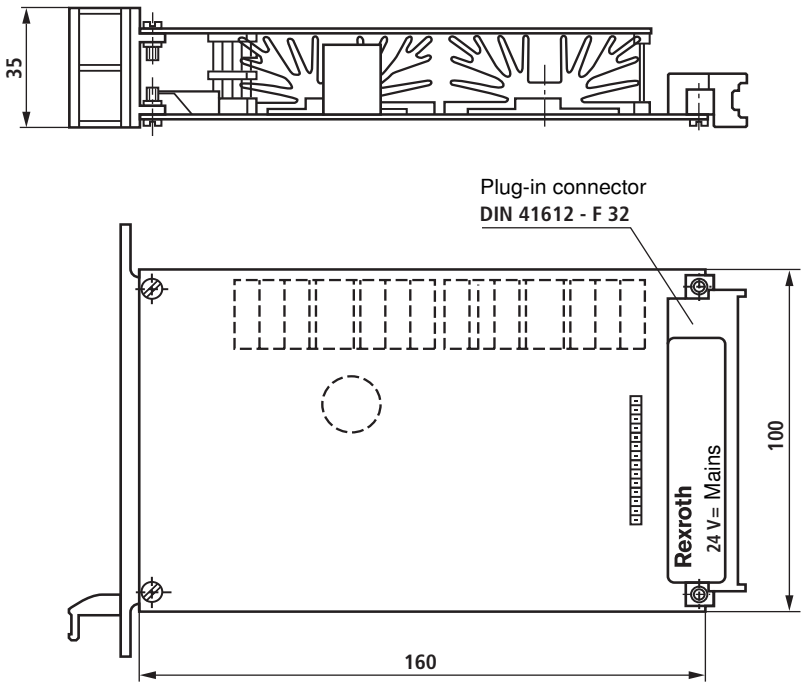
* Only with 2-channel variant

DIL switch

HEXCODE switch



Unit 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 protective circuits.
- The cable lengths and cross-sections specified on page 4 must be complied with.