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The Drive & Control Company

Rexroth
Bosch Group

Valve amplifier for proportional pressure valves

Type VT-MRMA1-1

RE 30214
Edition: 2017-03
Replaces: 04.13


H7125

- Component series 1X
- Analog, modular design
- Suitable for controlling a direct current motor-operated pressure reducing valve with electric position feedback of the type (Z)DRS, size 6, component series 1X

Features

- Snap-in module housing with detachable plug-in screw connectors
- Configurable actual pressure value input
- Ramp times (up and down) can be separately adjusted
- Linearization
- Electronic limit stops for the actuator
- Position controller with "position command value reached" detection
- Enable input
- "Ready for operation" output
- "Position command value reached" output
- Configurable actual pressure value input
- Integrated pressure switch function with adjustable switching thresholds
- Switchable measuring socket
- Fault recognition (cable breaks, short-circuits etc.)
- LED indicators:
  - Ready for operation (green)
  - Enable (yellow)
  - Error detection of actual pressure value input (red)

Contents

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Ordering code

01	02	03	04	05	06
VT-MRMA1	**– 1 –**	**1X**	**/ V0**	**/ 0**	**/ ***

01	Analog amplifier in modular design	**VT-MRMA1**
02	For direct current motor-operated pressure reducing valve (Z) DRS, size 6, component series 1X	**1**
03	Component series 10 to 19 (10 to 19: unchanged technical data and pin assignment)	**1X**
04	Version: Standard	**V0**
05	Standard option	**0**
06	Further information in the plain text	*

Suitable pressure transducer:

- HM20-1X/..-C-K35
  (see data sheet 30270)

Functional description

General

The amplifier module is snapped onto top hat rails according to EN 60715. It is electrically connected via 4 plug-in screw connectors with 4 ports each. The module is operated with 24 V direct voltage.

Power supply unit [1]

An internal power supply unit supplies all internally required positive and negative supply voltages.

Pressure command value provision [2]

The internal pressure command value signal is generated from the external pressure command value signal available at input [2] and the zero point offset [2] (Zw zero point potentiometer on the front side). If the pressure command value increases/decreases, the pressure rises/falls. The differential input can be configured into a 4 to 20 mA current input via DIL switches S1.1 to S1.6 (see commissioning instructions).

Standard values	Current input	Differential input	Pressure command value at measuring socket v (position 0)
0 %	4 mA	0 V	0 V
100 %	20 mA	10 V	10 V

A cable break in a pressure command value line will be detected ("ready for operation" output) and deactivate the output stage.

Ramp generator [3]

In the ramp generator [3], a provided step signal is turned into a ramp-shaped output signal. The ramp time relates to a pressure command value modification of the input signal of 100 %. The ramp time is not extended or shortened by the downstream pressure command value attenuator [4].

The ramp times for pressure increase or pressure reduction can be adjusted separately on the front side of the module using potentiometers "t <" and "t >". The current ramp time values can also be checked or pre-set via the switchable measuring socket (also located on the front side).
Information on ramp time adjustment:

Value at measuring socket (position 4 or 5) U_t in V	10	5	3	2	1	0.5	0.1	0.05	0.03	0.02	0.01
Current ramp time t in s (±20 %)	0.1	0.2	0.33	0.5	1	2	10	20	33.3	50	100

The following applies: Example measured:

$$t = \frac{1\ \text{Vs}}{U_t}$$ Measurement: $U_t = 5$ V => $t = \frac{1\ \text{Vs}}{5\ \text{V}} = 0.2$ s

Gw pressure command value attenuator [4]

The Gw potentiometer acts as an attenuator [4] and determines the maximum internal pressure command value. The setting range lies between 0 % and 130 %.

Linearization of the valve characteristic curve [5]

The linearization [5] is used to compensate the non-linear valve characteristic curve. The required valve position command value is generated from the pressure command value.

Amplitude limiter [6]

The amplitude limiter [6] limits the internal valve position command value to +110 % and –5 %.

Actual valve position value acquisition [12]

A voltage output is used to supply the position transducer. The actual valve position value fed back by the position transducer can be corrected using the Zx zero point potentiometer and the Gx sensitivity potentiometer. The internal

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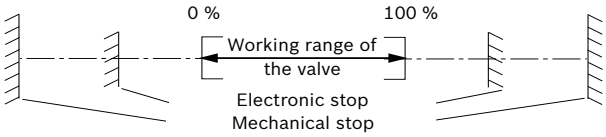
Functional description (continued)

actual position value signal generated this way is provided to the valve position controller [7] for further processing. Cable breaks in the position transducer lines are detected via the fault recognition [8].

Electronic limit stop
The electronic limit stops are a functional part of the actual value position acquisition [12].
The adjustable stroke of the valve is mechanically limited. The used working range is within these mechanical stops. To prevent the valve from moving into the mechanical stops when this is not intended (e.g. during setting), so-called "electronic stops" which are within these limits have been realized for safety purposes. The valves are prevented from moving beyond these limits by deactivation of the output stage. The electronic stops are only effective if sensor and motor are correctly wired.



Valve position controller [7]
The valve position controller [7] generates the control output for the clocked output stage on the basis of the position control deviation. The position controller has been optimized for a special valve type.

Output stage [10]
The output stage [10] generates the clocked control voltage for the DC motor acting as actuating element in the pressure reducing valve. The output stage output is short-circuit-proof. The output stage is de-energized in case of an internal fault signal [8] or if not enabled [11].

"Position command value reached" detection [9]
A "position command value reached" output is provided for as auxiliary process variable. This output is connected with 24 V operating voltage when the control deviation from the valve position command value and the regulated actual valve position value are ≤ **5 %** of the nominal stroke **and** the internal ramp output signal corresponds to the provided pressure command value.

Fault detection [8]
The following is monitored:
- Cable break of pressure command value lines
- Inversion of the pressure command value lines
- Cable break of the position transducer connecting lines
- Short-circuit of the position transducer supply at L0 (0 V)
- Thanks to the integrated motor protection the following is detected:
- Inversion of the motor lines (positive feedback)
- Jammed valve actuator
- Cable break of the motor lines

If there is **no** error, the green "ready for operation" LED on the front side is lit and the "ready for operation" output is connected to 24 V operating voltage.

Motor protection
The motor protection is a functional part of the fault recognition [8]. To ensure the correct functioning of the valve actuator, the adjustment time required for each pressure adjustment process is monitored. If an internally set maximum adjustment time (approx. 4 s) is exceeded, the output stage is deactived to prevent the motor from being damaged by continuous application of current.
The "ready for operation" output is connected to 0 V and the green LED on the front side goes out. After the cause of error has been eliminated, the electronics can be reactivated by resetting and enabling it.
The motor protection detects the following:
- Inversion of the motor lines (positive feedback)
- Cable break of the motor lines
- Jammed valve actuator

Enable function [11]
The enable function [11] can be used to activate both the position controller and the output stage via the external control. The enable signal is indicated by a yellow LED on the front side of the module.

Internal controller and output stage enable
The controller and the output stage are enabled if the external enable [11] has been set and the electronics is "ready for operation", i.e. the fault recognition [8] does not diagnose any error.

Actual pressure value input [13]
The internal actual pressure value signal is generated from the signal available at actual pressure value input [13] and the zero point offset (Zp zero point potentiometer on the front side). The Gp sensitivity potentiometer can be used to compensate tolerance-related variations of the pressure transducer. The input can be configured either as 0.5 to 5 V voltage input or 4 to 20 mA current input via the DIL switches S1.7 and S1.8 (see commissioning instructions) and a corresponding adjustment using the Zp zero point potentiometer and Gp sensitivity.
Notice: If the input is configured as 4 to 20 mA input and if the actual pressure value input is connected in series with another separate external current input, the module electronics supplies an offset current at terminal 1. This must be taken into account when adjusting the external current input.
The following is monitored at the actual pressure value

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Functional description (continued)

input (depending on the property of the pressure transducer electronics):

- Cable break of the actual pressure value lines
- Inversion of the actual pressure value lines
- Cable break of the pressure transducer's operating voltage
- Cable break of the pressure transducer's ground

If one of these errors is detected at the actual pressure value input, **both** pressure switch signals A and B are connected with 0 V and the red LED (!) on the front side of the amplifier module is lit.

Pressure switch function [14]

The integrated pressure switch [14] compares the internal actual pressure value to a window which can be individually adjusted by the pressure command value (DIL switches S2.1 to S2.9). Depending on whether the actual pressure value falls below the lower limit or exceeds the upper limit, the corresponding pressure switch signal A or B falls to 0 V. If the actual pressure value is within the pressure command value window, both pressure switch signals are connected to 24 V operating voltage. Exception: In case of a cable break of one of the two actual pressure value lines **both** signals A and B fall to 0 V. (Adjustment of the pressure switch thresholds via DIL switch S2, see commissioning instructions)

Measuring point switch-over [15]

The measuring sockets v and ⊥ on the module front side can be used to check various internal measuring points (v0 to v5). The measuring points are selected via the measuring point selector switch [15] on the housing front panel.

Measuring point	Switch position	Measurement signal v (⊥ is reference)
Pressure command value w_P	0	0 % ≙ 0 V and 100 % ≙ 10 V
Actual pressure value x_P	1	0 % ≙ 0 V and 100 % ≙ 10 V
Valve command value w_S	2	0 % ≙ 0 V and 100 % ≙ 10 V
Actual valve value x_S	3	0 % ≙ 0 V and 100 % ≙ 10 V
Ramp time "up" t <	4	10 mV to 10 V
Ramp time "down" t >	5	10 mV to 10 V
Without function	6	0 V
Without function	7	< –10 V
Without function	8	< –10 V
Without function	9	< –10 V

Notice:

Switch positions 6 to 9 have no function. They only serve to determine the switch position in case the arrow mark of the measuring point selector switch is no longer visible due to damage.

[ ] = references to the block diagram on page 5

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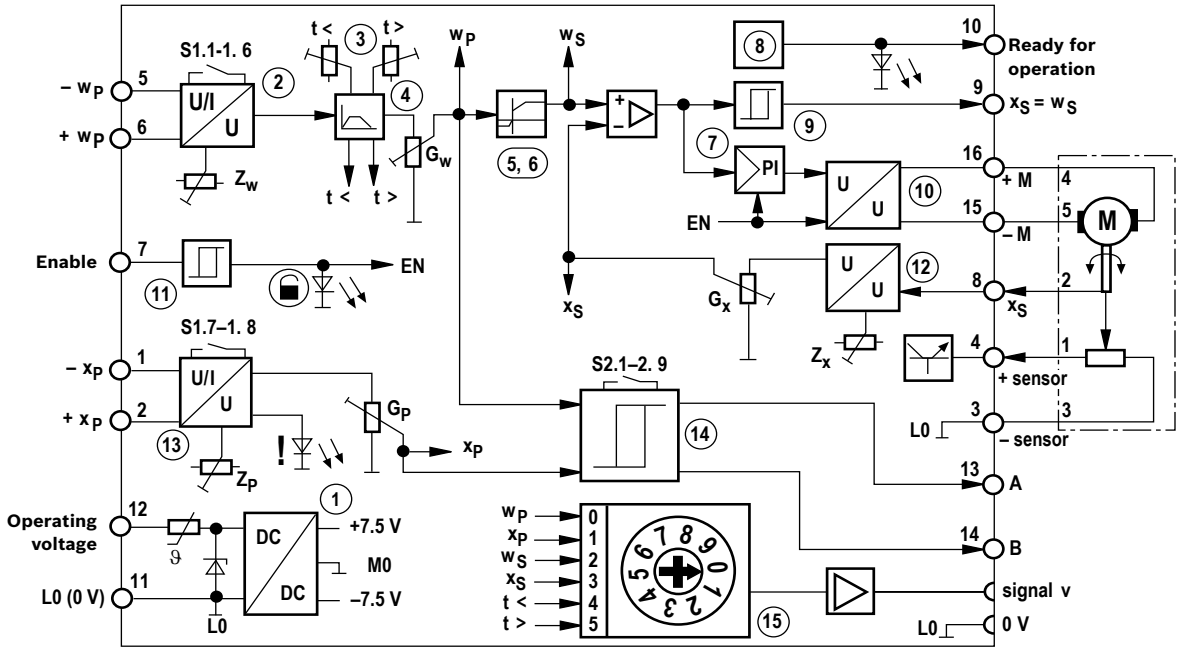
Block diagram/pin assignment



1 Power supply unit
2 Pressure command value provision
3 Ramp generator
4 Pressure command value attenuator
5 Linearization of the valve characteristic curve
6 Amplitude limiter
7 Valve controller
8 Fault recognition
9 Position command value reached – detection
10 Output stage
11 Enable function
12 Actual valve position value acquisition
13 Actual pressure value input
14 Pressure switch function
15 Measuring point switch-over

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

Operating voltage		U_B	24 VDC + 40 % – 20 %
Operating range	Upper limit value	$u_B(t)_{max}$	35 V
	Lower limit value	$u_B(t)_{min}$	21 V
Power consumption		P_S	< 50 VA
Current consumption	$i(t)_{max}$ (switching on the motor)		< 3.5 A
	I_{max} (during the actuating process)		< 1 A
	I_{min} (when output stage is switched off)		< 120 mA
Fuse			1.6 A, self-healing (thermal overload protection)
Inputs			
– Analog			
Pressure command value (differential input)		U_e	0 to +10 V; R_e > 100 kΩ
Pressure command value (current input)		I_e	4 to 20 mA; load R_B = 100 Ω
Actual pressure value (differential input)		U_e	0.5 to +5 V; R_e > 100 kΩ
Actual pressure value (current input)		I_e	4 to 20 mA; load R_B = 100 Ω
– Digital			
Enable	ON	U	+8.5 V to U_B; R_e > 100 kΩ
	OFF	U	0 to +6.5 V; R_e > 100 kΩ
Setting ranges			
Zero point pressure command value (Zw potentiometer)			±30 %
Pressure command value attenuator (Gw potentiometer)			0 to 130 % [1]
Actual pressure value sensitivity (Zp potentiometer)			±5 %
Actual pressure value amplification (Gp potentiometer)			90 to 120 % [1]
Sensitivity of actual valve position value (Zx potentiometer)			±15 %
Actual valve position value amplification (Gx potentiometer)			90 to 120 % [1]
Ramp times (potentiometer t < and t >)			0.1 to 100 s
Outputs			
Output stage		U_{eff}	0 V_{eff} to $U_{B,eff}$
Sensor supply voltage		U	0 V and +10 V ± 3 %
Measuring socket		U	0 V to +10 V ± 2 %; I_{max} = 2 mA
Ready for operation	"Ready for operation"	U	> 16 V (R_i = 10 kΩ; 50 mA)
	"Not ready for operation"	U	< 1 V (R_i = 10 kΩ; 50 mA)
Position command value	"Reached"	U	> 16 V (R_i = 10 kΩ; 50 mA)
	"Not reached"	U	< 1 V (R_i = 10 kΩ; 50 mA)
Pressure switch signal A			
Actual pressure value > lower pressure switch threshold		U	> 16 V (R_i = 10 kΩ; 50 mA)
Actual pressure value < lower pressure switch threshold		U	< 1 V (R_i = 10 kΩ; 50 mA)
Pressure switch signal B			
Actual pressure value < upper pressure switch threshold		U	> 16 V (R_i = 10 kΩ; 50 mA)
Actual pressure value > upper pressure switch threshold		U	< 1 V (R_i = 10 kΩ; 50 mA)
Type of connection			4 plug-in screw connectors with 4 ports each
Mounting type			Top hat rail TH 35-7.5 according to EN 60715
Protection class according to EN 60529			IP 20
Admissible operating temperature range		ϑ	0 to +50 °C
Storage temperature range		ϑ	–25 °C to +70 °C
Weight		m	0.15 kg

[1] Provided that the zero point has been correctly set

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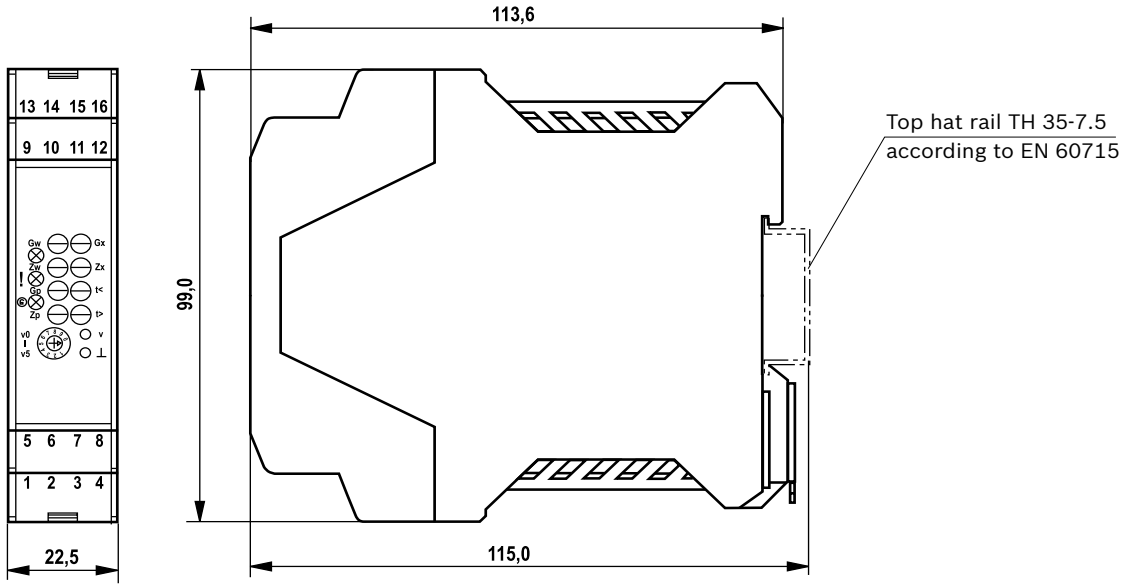
Terminal assignment

Actual pressure value input	$-x_p$	1	9	$x_s = w_s$	Position command value reached
	$+x_p$	2	10		Ready for operation
Position transducer supply	– sensor Valve connector contact 3	3	11	0 V	Operating voltage
	+ sensor Valve connector contact 1	4	12	$+U_B$	
Pressure command value input	$-w_P$	5	13	A	Pressure switch signals
	$+w_P$	6	14	B	
Enable	Enable	7	15	– M Valve connector contact 5	Valve motor connection
Actual position value input	x_s Valve connector contact 2	8	16	+ M Valve connector contact 4	

Dimensions (Dimensions in mm)



Potentiometers

Gw	Pressure command value attenuator
Zw	Zero point of pressure command value
Gp	Amplification of actual pressure value
Zp	Zero point of actual pressure value
Gx	Actual valve position value amplification
Zx	Zero point of actual valve position value
t <	Ramp time "up"
t >	Ramp time "down"

LED indicators

	Ready for operation	(green)
	Enable	(yellow)
!	Cable break in pressure load cell	(red)

Measuring sockets

v	Measurement signal
⊥	Load zero

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Project planning/maintenance instructions/additional information

- Prior to installation and commissioning it must be ensured that the DIL switches on the printed circuit board of the amplifier module have been correctly set (for function of the DIL switches, see commissioning instructions).
- DIL switches on the printed circuit board of the amplifier module may only be adjusted when de-energized.
- The amplifier module may only be wired or connected and opened when de-energized.
- The distance to aerial lines, radios, and radar systems has to be 1 m at least.
- Do not lay motor and signal lines near power cables.
- The valve is connected with a 5-wire line. For lines up to 50 m in length, use the line type LiYCY 0.5 mm^2. For greater lengths, please contact us.
- If the valve line has to be shielded, the shield must be connected to protective earth ("PE") on the module side. In some cases (e.g. if PE is subject to strong interference) it can be useful to connect the shield directly to the L0 of the amplifier module, other side open (risk of ground loops).
- If a differential input is used, both inputs must always be connected or disconnected at the same time.
- Cable ends should not be too short, so as to ensure that the module can still be opened when connected (e.g.: to adjust the DIL switches).
- Ensure that the ground of the pressure command value ("$-w_P$", terminal 5), has the same potential (→ equipotential bonding busbar) as the ground ("L0", terminal 11) of the power supply unit. This allows for a better suppression of interferences.
- For setting the potentiometers and the measuring point selector switch, use a screwdriver with a blade width of 4 mm.

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Setting recommendation

Condition as supplied
The condition as supplied of the electronics is characterized by the following features:
- Minimum ramp times.
- Gw attenuator is set to 100 %.
- The linearity of the overall system (module electronics and valve) is subject to deviations in series production.

Fine adjustment of the overall system
Prerequisites:
- The system-specific wiring must have been completed.
- Set DIL switches on printed circuit board of module electronics according to individual requirements.
- Turn on the hydraulic system.

It must be ensured that the hydraulic fluid already has the (regulated) operating temperature for fine-adjustment.

<table>
<tr><th></th><th>Signal</th><th>Setting</th></tr>
<tr><td>1</td><td>Pressure command value zero point</td><td>▶ Set external pressure command value provision to 0 %.
▶ Set measuring point selector switch to "0".
▶ Use the zero point potentiometer Zw to adjust the measurement signal at v: 0 V ± 5 mV (= 0 %).</td></tr>
<tr><td>2</td><td>Maximum pressure command value</td><td>Notice:
Before adjusting the maximum value, the zero point must be adjusted according to step 1.
▶ External pressure command value provision = 100 %.
▶ Set measuring point selector switch to "0".
▶ Use the potentiometer Gw to adjust the measurement signal at v: 10 V ± 5 mV (= 100 %).</td></tr>
<tr><td>3</td><td>Ramp times</td><td>▶ Use the measuring point selector switch to select the potentiometer that is to be set:
▶ Position 4 for ramp "up" t < and position 5 for ramp "down" t >.
▶ Set ramp time according to formula or table (see functional description "Ramp generator") and check at measuring socket v.</td></tr>
<tr><td>4</td><td>20 %-actual pressure value</td><td>Notice:
Prior to the 20 % actual pressure value adjustment the pressure command value must be adjusted according to steps 1 and 2.
▶ Electrically connect the valve.
▶ Measure sensor supply voltage on the module side between terminals 4 and 3: +10.0 V ± 300 mV
▶ Set external pressure command value provision to 20 %.
▶ Externally connect enable signal.
▶ Set actual pressure value signal (= voltage between terminals 2 and 1) using Zx to 20 % of the nominal pressure value:
→ Actual pressure value signal dependent on the pressure transducer used:
<table>
<tr><th>Used pressure transducer</th><th>Output signal (20 %)</th><th>Voltage between terminals 2 and 1</th></tr>
<tr><td>"0.5 ... 5 V" output</td><td>+1.40 V</td><td>+1.40 V</td></tr>
<tr><td>"4 ... 20 mA" output</td><td>+7.2 mA</td><td>+0.72 V (R_{load} = 100 Ω)</td></tr>
</table>
▶ Set measuring point selector switch to "1".
▶ Use the potentiometer Zp to adjust the measurement signal at v: +2.00 V ± 5 mV.</td></tr>
</table>

Continued on page 10

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<table>
<tr><th></th><th>Signal</th><th>Setting</th></tr>
<tr><td>5</td><td>Maximum actual pressure value</td><td>
Notice:
Before adjusting the maximum value, the 100 % actual pressure value must be adjusted accord-ing to step 4.
▶ Set external pressure command value provision to 100 %.
▶ Externally connect enable signal.
▶ Set actual pressure value signal (= voltage between terminals 2 and 1) using Gx to 100 % of the nominal pressure value:
→ Actual pressure value signal dependent on the pressure transducer used:
<table>
<tr><th>Used pressure transducer</th><th>Output signal (100 %)</th><th>Voltage between terminals 2 and 1</th></tr>
<tr><td>"0.5 ... 5 V" output</td><td>+5.00 V</td><td>+5.00 V</td></tr>
<tr><td>"4 ... 20 mA" output</td><td>+20 mA</td><td>+2.00 V (R_{load} = 100 Ω)</td></tr>
</table>
▶ Set measuring point selector switch to "1".
▶ Use the potentiometer Gp to adjust the measurement signal at v: +10.00 V ± 5 mV.
</td></tr>
<tr><td>6</td><td>Actual pressure value</td><td>▶ Check both working points (steps 4 and 5).
Repeat steps 4 and 5 if required.</td></tr>
<tr><td>7</td><td>Individually adjust the maximum pressure command value</td><td>
Set external pressure command value provision according to individual requirements.
Example:
Reduce 100 % external pressure command value to 80 %.
▶ Set external pressure command value provision to 100 %.
▶ Set measuring point selector switch to "0".
▶ Use the potentiometer Gw to set the measurement signal at the measuring socket v according to the requirements: adjustment according to example: 8.0 V ± 5 mV (= 80 %).
</td></tr>
</table>

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