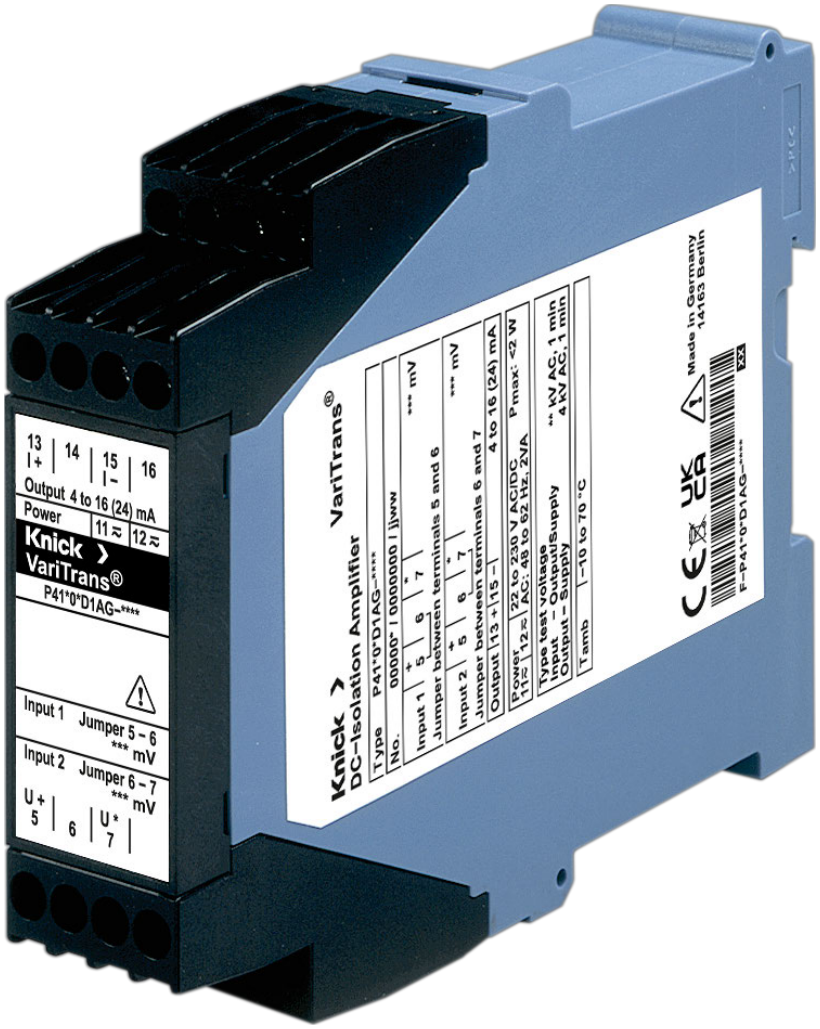
Knick

User Manual

P41000 AG

High Voltage Transducer



Read before installation.
Keep for future use.

www.knick.de

Supplemental Directives

READ AND SAVE THIS DOCUMENT FOR FUTURE REFERENCE. BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT, PLEASE ENSURE A COMPLETE UNDERSTANDING OF THE INSTRUCTIONS AND RISKS DESCRIBED HEREIN. ALWAYS OBSERVE ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS IN THIS DOCUMENT COULD RESULT IN SERIOUS INJURY AND/OR PROPERTY DAMAGE. THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE.

These supplemental directives explain how safety information is laid out in this document and what content it covers.

Safety Chapter

This document's safety chapter is designed to give the reader a basic understanding of safety. It illustrates general hazards and gives strategies on how to avoid them.

Warnings

This document uses the following warnings to indicate hazardous situations:

Symbol	Category	Meaning	Remark
⚠	**WARNING**	Designates a situation that can lead to death or serious (irreversible) injury.	The warnings contain information on how to avoid the hazard.
⚠	**CAUTION**	Designates a situation that can lead to slight or moderate (reversible) injury.	
None	**NOTICE**	Designates a situation that can lead to property or environmental damage.	

Table of Contents

1 Safety

This document contains important instructions for the use of the product. Always follow all instructions and operate the product with caution. If you have any questions, please contact Knick Elektronische Messgeräte GmbH & Co. KG (sometimes hereafter referred to as "Knick") using the information provided on the back page of this document.

1.1 Intended Use

The P41000 AG (adaptive gain) is a high voltage transducer for measuring currents. The product is usually connected to a shunt resistor. → *Application Example, p. 10*

The special transfer function of the product enables the detection of overloads up to 11 times the rated input range. The P41000 AG is used in installations such as DC substations.

The product is configured ex works and does not have any operating elements.

The specific version of the product (including deviating characteristics for special versions) is stated on the nameplates attached to the product. The information on the nameplates is binding.

The defined operating conditions must be observed when using this product. → *Specifications, p. 15*

USE CAUTION AT ALL TIMES WHEN INSTALLING, USING, OR OTHERWISE INTERACTING WITH THE PRODUCT. ANY USE OF THE PRODUCT EXCEPT AS SET FORTH HEREIN IS PROHIBITED, AND MAY RESULT IN SERIOUS INJURY OR DEATH, AS WELL AS DAMAGE TO PROPERTY. THE OPERATING COMPANY SHALL BE SOLELY RESPONSIBLE FOR ANY DAMAGES RESULTING FROM OR ARISING OUT OF AN UNINTENDED USE OF THE PRODUCT.

Comply with the information on proper storage. → *Specifications, p. 15*

See also
→ *Product Identification, p. 5*
→ *Nameplates, p. 6*
→ *Functional Description, p. 7*

1.2 Personnel Requirements

The operating company shall ensure that any personnel using or otherwise interacting with the product is adequately trained and has been properly instructed.

The operating company shall comply and cause its personnel to comply with all applicable laws, regulations, codes, ordinances and relevant industry qualification standards related to product. Failure to comply with the foregoing shall constitute a violation of operating company's obligations concerning the product, including but not limited to an unintended use as described in this document.

1.3 Isolation

Distances to slave devices and conductive parts in the vicinity of the device must be measured according to the applied standard. The operating company must carry out, evaluate, and safeguard isolation coordination with the clearance and creepage distances and the relevant standards (e.g., EN 50124-1).

See also
→ *Isolation, p. 16*

2 Product

2.1 Package Contents

- P41000 AG in the version ordered
- Insertable jumper
- Test Report 2.2 according to EN 10204
- Installation Guide with safety instructions

Note: The User Manual (this document) is published in electronic form. → *knick.de*

2.2 Product Identification

The different versions of the P41000 AG are encoded in a model designation.

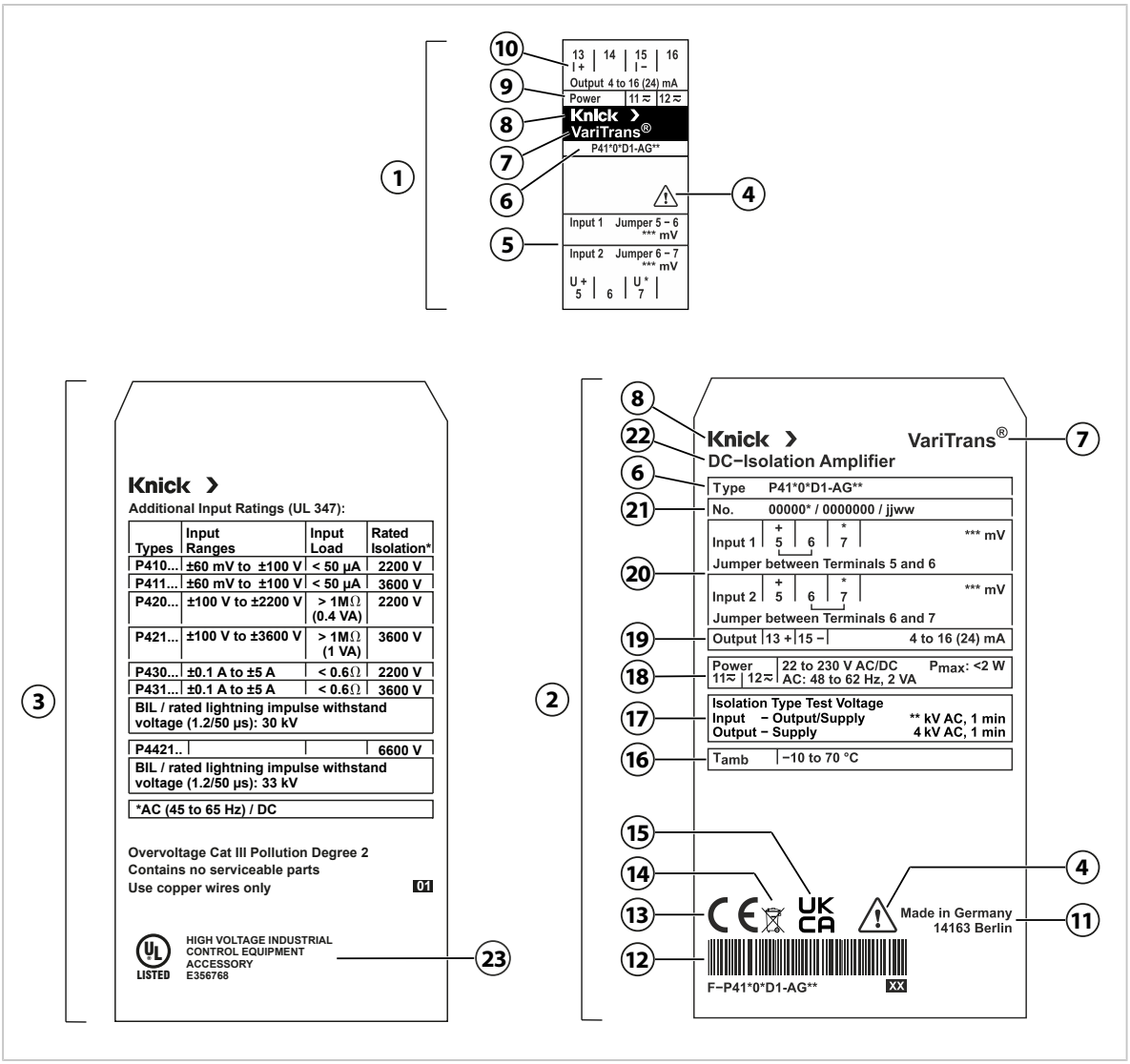
The model designation can be found on the nameplate and the delivery note. → *Nameplates, p. 6*

Input[1)]		Output	Test Voltage	Model Designation for Version	
Insertable jumper in terminals 5 and 6	**Insertable jumper in terminals 6 and 7**			**Without shunt monitoring**	**With shunt monitoring**
±30 mV	±60 mV	4 ... 16 mA	10 kV	P41000D1-AG07	P41001D1-AG07
			15 kV	P41100D1-AG07	P41101D1-AG07
±50 mV	±100 mV	4 ... 16 mA	10 kV	P41000D1-AG02	P41001D1-AG02
			15 kV	P41100D1-AG02	P41101D1-AG02
±60 mV	±120 mV	4 ... 16 mA	10 kV	P41000D1-AG03	P41001D1-AG03
			15 kV	P41100D1-AG03	P41101D1-AG03
0 ... 30 mV	0 ... 60 mV	4 ... 16 mA	10 kV	P41000D1-AG08	P41001D1-AG08
			15 kV	P41100D1-AG08	P41101D1-AG08
0 ... 50 mV	0 ... 100 mV	4 ... 16 mA	10 kV	P41000D1-AG05	P41001D1-AG05
			15 kV	P41100D1-AG05	P41101D1-AG05
0 ... 60 mV	0 ... 120 mV	4 ... 16 mA	10 kV	P41000D1-AG06	P41001D1-AG06
			15 kV	P41100D1-AG06	P41101D1-AG06

1) Versions with 10 mV available on request → *info@knick.de*

2.3 Nameplates

The P41000 AG is identified by nameplates on the side and front of its housing. The information on the nameplates varies depending on the version of the product. → *Product Identification, p. 5*



1	Nameplate, device front	**13**	CE mark
2	Nameplate, right side	**14**	WEEE mark
3	UL nameplate, left side	**15**	UKCA mark
4	Special conditions and danger points	**16**	Permissible ambient temperature
5	Input terminal assignments	**17**	Type test voltage
6	Model designation	**18**	Power supply[1)]
7	Product line	**19**	Output range
8	Manufacturer	**20**	Input ranges[2)]
9	Power supply terminal assignments	**21**	Item number/serial number/ production year and week yyww
10	Output terminal assignments	**22**	Product name
11	Manufacturer's address with designation of origin	**23**	UL mark with identification number
12	Barcode: item number, serial number, check digit		

1) The device is supplied with power from a broad-range power supply (DC or AC). → *Power Supply, p. 15*

2) The placeholder (*) in the specifications for terminal 7 is replaced with (-) for a bipolar input range and with (0) for a unipolar input range.

2.4 Symbols and Markings

	Special conditions and danger points! Observe the safety information and instructions on safe use of the product as outlined in the product documentation.
	CE marking.
	UK Conformity Assessed: Conformity mark for the United Kingdom (England, Scotland, and Wales)
	UL Certification Mark
	The symbol on Knick products means that the waste devices must be disposed of separately from unsorted municipal waste.

2.5 Function

2.5.1 Functional Description

The P41000 AG is available in different versions for unipolar and bipolar input ranges. Each version has two input ranges, one of which is selected by installing an insertable jumper.
→ *Product Identification, p. 5*

The product maps the nominal input range (unipolar or bipolar) to the nominal output signal of 4 ... 16 mA.

If the input voltage exceeds the nominal full scale value, the input signal is transmitted to the output with reduced gain.

This allows overloads up to 11 times the nominal input range to be detected. The gain changes at the setpoints of the transmission curve and is thus dependent on the input signal (adaptive gain).
→ *Transmission Curves, p. 9*

The product is configured ex works and does not have any operating elements.

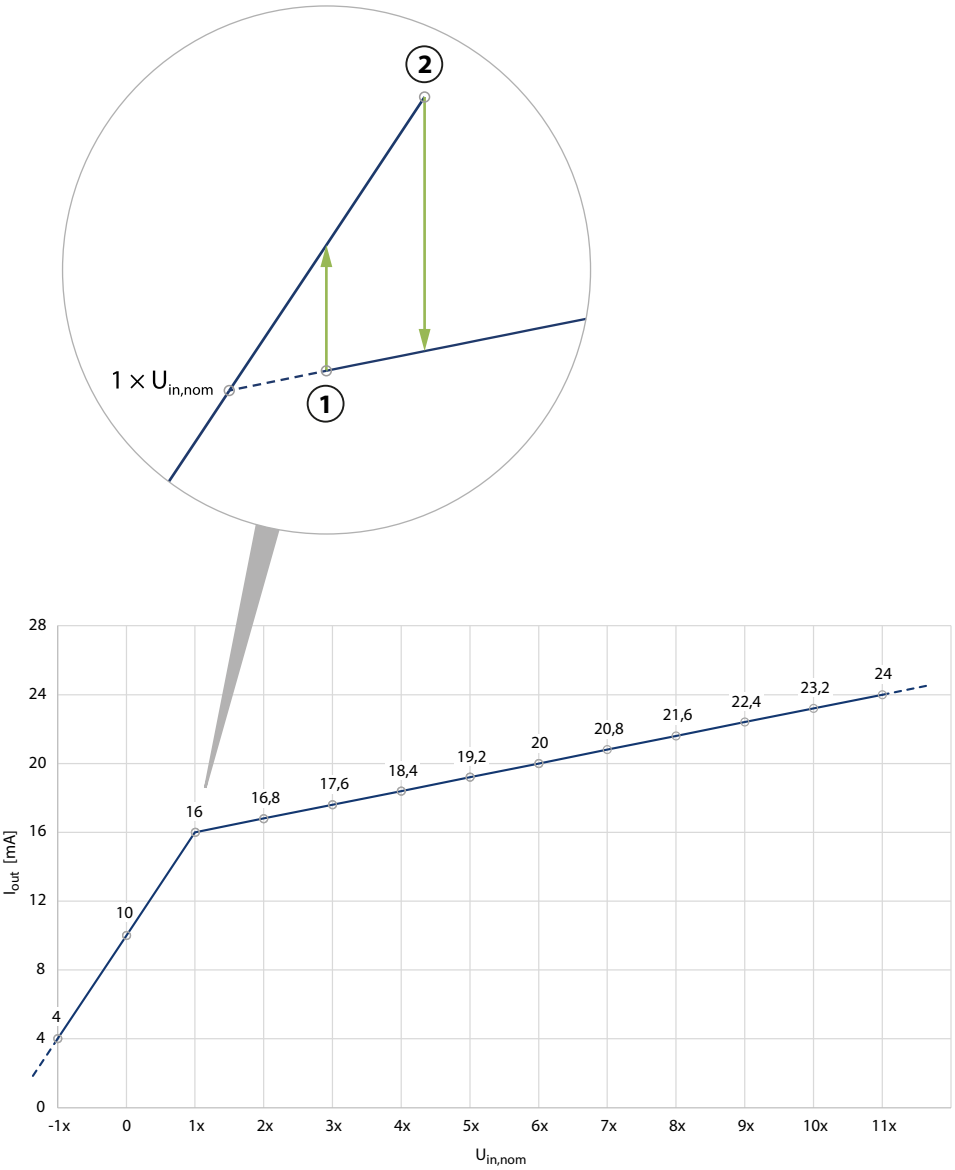
The power supply to operate the P41000 AG is provided by an integrated broad-range power supply.
→ *Power Supply, p. 15*

See also
→ *Intended Use, p. 4*
→ *Installation and Commissioning, p. 11*
→ *Specifications, p. 15*

Hysteresis

When traversing the transmission curve, the gain switches with a delay (hysteresis).
→ *Transmission Curves, p. 9*

The following figure shows the hysteresis between the upper and lower setpoints as an example of the bipolar transmission curve.

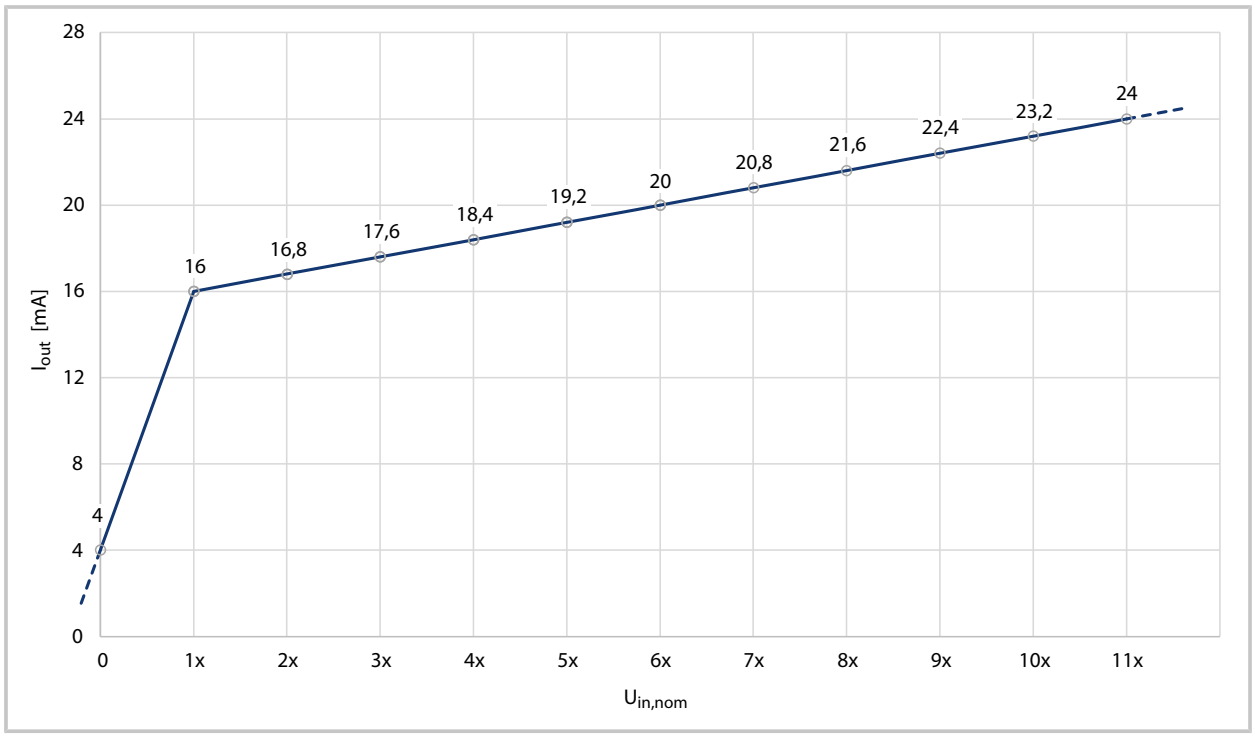


1 Lower setpoint

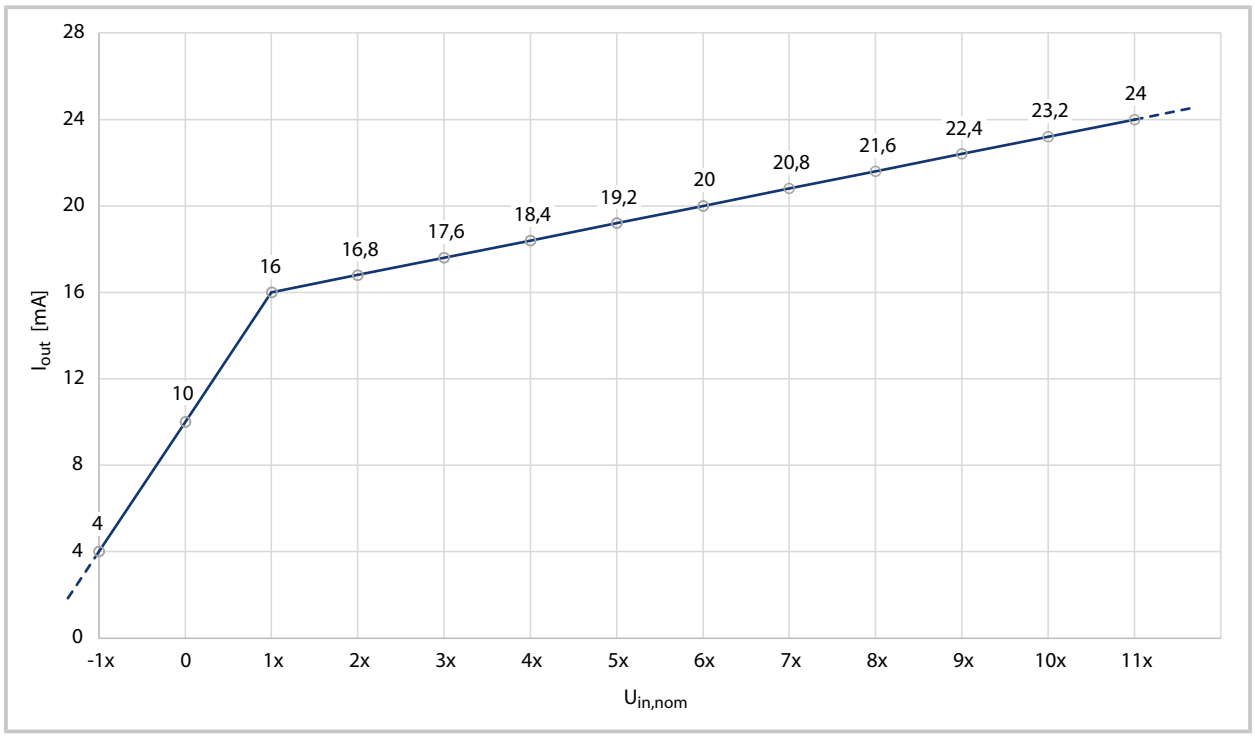
2 Upper setpoint

2.5.2 Transmission Curves

Transmission Curve with Unipolar Input Range



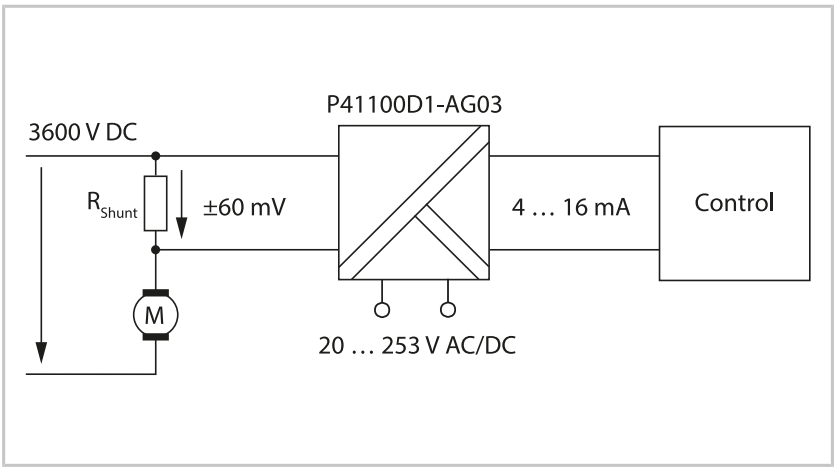
Transmission Curve with Bipolar Input Range



2.5.3 Application Example

Note: The figure shows an example of current measurement via a shunt resistor. The specified values refer to the version P41100D1-AG03 with a mounted insertable jumper in terminals 5 and 6.

Note: In the figure, *Control* is used as an umbrella term for any form of further processing of the output signal.



See also
→ *Product Identification, p. 5*

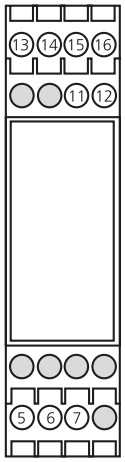
2.5.4 Shunt Monitoring

The P41000 AG is optionally available with shunt monitoring. → *Product Identification, p. 5*

The product detects an interruption in the connection to the shunt resistor. An interruption is present, for example, if the input is not connected or the cable is damaged.

An interruption is indicated by output overdrive (maximum output current) on the P41000 AG.
→ *Output, p. 15*

2.6 Terminal Assignments



5	Input	Voltage	(+)
6	Insertable jumper		
7	Input	Voltage	(-)
11	Power supply	AC/DC	
12	Power supply	AC/DC	
13	Output	Current	(+)
14	*Do not connect terminal*		
15	Output	Current	(-)
16	*Do not connect terminal*		

See also
→ *Nameplates, p. 6*

2.7 Installation and Commissioning

⚠WARNING! Shock potential. Do not install the product live.

NOTICE! Product damage due to electrostatic discharge (ESD). Take protective measures against electrostatic discharge.

NOTICE! Damage to the screw terminals due to excessive tightening torque. Tighten the screw terminals with a max. torque of 0.8 Nm.

Note: P41000 AG may only be operated in a (lockable) control cabinet.

01. Disconnect the electrical system from live parts.
02. Secure the electrical system against restart.
03. Verify that the electrical system is dead.
04. Ground and short-circuit the electrical system.
05. Cover or isolate adjacent live parts with insulating materials.
06. Snap the P41000 AG on to the 35 mm DIN rail.
07. Strip 8 mm of insulation from the cable ends, fit ferrules to the stranded wires. Twist pairs of cables to a point close to the connection.
    Note: Use only copper cables for UL conformity. → *Specifications, p. 15*

Maximum cable cross-section	1 x 2.5 mm^2 stranded wire with ferrule
	1 x 4 mm^2 solid
	2 x 1.5 mm^2 stranded wire with ferrule
	2 x 2.5 mm^2 solid
Minimum cable cross-section	1 x 0.5 mm^2 solid or stranded wire with ferrule

08. Connect the cables for the output. Do not connect terminals 14 and 16.
09. Connect the power supply cables.
    Note: The polarity of the auxiliary power can be freely selected during connection.

10. Connect the cables for the input. Mount the insertable jumper **(1)** according to the desired input range (see example figure: Insertable jumper in terminals 5 and 6).
11. Reset the electrical system to its initial state. Reverse the steps taken to ensure voltage-free operation.
12. Switch on the power supply.

Note: The power supply to operate the P41000 AG is provided by an integrated broad-range power supply (20 … 253 V AC/DC).

See also
→ *Nameplates, p. 6*
→ *Terminal Assignments, p. 10*
→ *Troubleshooting, p. 12*

2.8 Operation

The P41000 AG is designed for continuous operation. The product must be operated inside a lockable control cabinet.

The defined operating conditions must be observed when using this product. → *Specifications, p. 15*

The product is configured ex works and does not have any operating elements.

See also

→ *Product Identification, p. 5*
→ *Nameplates, p. 6*

2.9 Maintenance

The P41000 AG does not require maintenance. Because it is fully encapsulated, it is not possible to repair the product.

2.10 Troubleshooting

USE CAUTION WHEN CONDUCTING ANY TROUBLESHOOTING. FAILURE TO ABIDE BY THE REQUIREMENTS SET FORTH HEREIN MAY RESULT IN SERIOUS INJURY OR DEATH, AS WELL AS DAMAGE TO PROPERTY.

Malfunction State	Possible Causes	Remedy
Incorrect measured value.	Polarity of inputs/outputs reversed.	Connect the inputs/outputs correctly.
	Insertable jumper not mounted according to the desired input range.	Mount the insertable jumper correctly.
No output current.	P41000 AG is not connected to the power supply.	Check the installation and switch on the power supply.
Output overdrive (maximum output current), although the input is not overdriven.	For product version with shunt monitoring: Input not connected or connection to shunt resistor interrupted.	Connect the inputs correctly.
		Establish the connection to the shunt resistor.

Further troubleshooting support can be obtained from → *support@knick.de*.

See also

→ *Terminal Assignments, p. 10*
→ *Installation and Commissioning, p. 11*

2.11 Decommissioning

2.11.1 Removal

⚠ **WARNING! Shock potential.** Do not uninstall the product live.

01. Disconnect the electrical system from live parts.
02. Secure the electrical system against restart.
03. Verify that the electrical system is dead.
04. Ground and short-circuit the electrical system.
05. Cover or isolate adjacent live parts with insulating materials.
06. Check the input of the P41000 AG to ensure it is dead.
07. Switch off the power supply.
08. Open the screw terminals with a screwdriver and remove the cables.
09. Pull down the housing's base latch using a screwdriver. Lift the P41000 AG up and off the 35 mm DIN rail.

2.11.2 Return

If required, send the product in a clean condition and securely packed to your local contact. → *knick.de*

2.11.3 Disposal

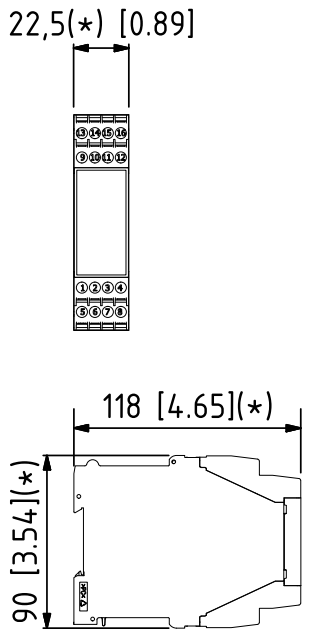
Local codes and regulations must be observed when disposing of the product.

Customers can return their waste electrical and electronic devices.

Details on the return and environmentally friendly disposal of electrical and electronic equipment can be found in the manufacturer's declaration on our website. If you have any queries, suggestions, or questions regarding the recycling of waste electrical and electronic equipment from Knick, please send an email to → *support@knick.de*

2.12 Dimension Drawings

Note: All dimensions are given in millimeters [inches].



2.13 Specifications

Input

Input, nominal[1]	Bipolar	–30 … 30 mV, –50 … 50 mV, –60 … 60 mV
		–100 … 100 mV, –120 … 120 mV
	Unipolar	0 … 30 mV, 0 … 50 mV, 0 … 60 mV
		0 … 100 mV, 0 … 120 mV
Input resistance	Approx. 100 kΩ	
Input capacitance	< 12 nF	
Overload capacity	Continuous	1100% of $U_{in,nom}$
	Short-time	10 V, for max. 500 ms, once per hour

Output

Output	4 … 16 mA … 24 mA
Max. output current	25 mA < I_{out} < 55 mA @ 0 Ω load
Max. load	400 Ω
Ripple	I_{rms} = 50 µA (R_L = 250 Ω)

Transmission Behavior

	Output	Gain	Gain error
Input –1 × $U_{in,nom}$ … 1 × $U_{in,nom}$	4 … 16 mA	6 mA / $U_{in,nom}$	±0.1% of measured value ± 20 µA
Input 1 × $U_{in,nom}$ … 11 × $U_{in,nom}$	16 … 24 mA	0.8 mA / $U_{in,nom}$	±0.5% of measured value ± 300 µA
Input 0 … 1 × $U_{in,nom}$	4 … 16 mA	12 mA / $U_{in,nom}$	±0.1% of measured value ± 20 µA
Input 1 × $U_{in,nom}$ … 11 × $U_{in,nom}$	16 … 24 mA	0.8 mA / $U_{in,nom}$	±0.5% of measured value ± 300 µA
Upper setpoint	109.5 % ± 2.5% of $U_{in,nom}$		
Lower setpoint	103.5 % ± 2.5% of $U_{in,nom}$		
Cutoff frequency (–3 dB)	Approx. 5 kHz		
Common-mode rejection ratio	CMRR[2]	Approx. 110 dB (applies to 1 × $U_{in,nom}$ range)	
Temperature coefficient[3]	< 0.005 %/K full scale		

See also
→ *Hysteresis, p. 8*

Power Supply

Power supply	22 … 230 V AC, ± 10 %, 48 … 62 Hz, approx. 2 VA
	22 … 230 V DC, ± 10 %, approx. 1.2 W

1) Versions with 10 mV available on request → *info@knick.de*

2) Common-mode rejection ratio = differential voltage gain / common-mode voltage gain

3) Reference temperature for temperature coefficient specifications = 23 °C (73.4 °F) The average temperature coefficient is stated.

Isolation

Galvanic isolation	3-port isolation between input, output, and power supply		
Type test voltage	Input against output/power supply	P4100*D1-AG0*	10 kV AC, 1 min
		P4110*D1-AG0*	15 kV AC, 1 min
	Across output and power supply	4 kV AC, 1 min	
Routine test voltage	Dependent on the version → *Product Identification, p. 5*		
Insulation coordination:	For applications with high working voltages, take measures to prevent accidental contact and make sure that there is sufficient distance or insulation between adjacent devices.		
Working voltage (basic insulation) according to EN 61010-1	Up to 3600 V AC/DC across input and output/power supply with overvoltage category III and pollution degree 2 (transient overvoltage: max. 20 kV)		
Rated insulation voltage according to EN 50124-1	Up to 3600 V AC/DC across input and output/power supply with overvoltage category III and pollution degree 2		
Protection against electric shock	Protective separation according to EN 61140 by reinforced insulation according to EN 61010-1. Working voltages at overvoltage category III and pollution degree 2: • Up to 1800 V AC/DC across input and output/power supply • Up to 300 V AC/DC across output and power supply		
Rated voltage according to UL 347	P4100*D1-AG0*	2200 V AC (45 ... 65 Hz) / DC	
	P4110*D1-AG0*	3600 V AC (45 ... 65 Hz) / DC	
	Input current	< 50 µA	
	BIL/rated surge voltage	30 kV (1.2/50 µs)	
	Overvoltage category	OV3	
	Pollution degree	PD2	
	The P41000 AG does not contain any components that require maintenance. Use copper cables only.		

Standards and Approvals

EMC[1)]	Product standard	EN 61326-1
	Emitted interference	Class B
	Immunity to interference	Industrial applications
UL	Listed according to UL 347	E356768
Mechanical strength	IEC 61373	
RoHS conformity	According to Directive 2011/65/EU	

Shunt Monitoring (Optional)

Diagnostic current impressed in the shunt	I_{diag} < 20 µA
Additional error ΔF in [%]	$\Delta F < I_{diag} \times (R_L + R_S) \times 100 / (I \times R_S)$ R_L: Total cable resistance of shunt to P41000 AG R_S: Shunt resistor I: Measuring current
I_{out} at open circuit R_{cable} > 100 kΩ	> 25 mA @ max. 400 Ω load
Response time	< 10 ms

1) Slight deviations are possible during interference.

Device

Ambient temperature	Operating[1]		–10 … 70 °C (14 … 158 °F)
	Transport and storage		–40 … 85 °C (-40 … 185 °F)
Ambient conditions	Indoor use[2]		
	Relative humidity 5 … 95 %, no condensation		
	Altitude up to 2000 m (6500 ft), air pressure: 790 … 1060 hPa[3]		
Design	Modular housing with screw terminals (max. tightening torque 0.8 Nm)		
	Housing width	P41000 AG	22.5 mm
	Other dimensions → *Dimension Drawings, p. 14*		
Connection	M3.5 connecting screws with self-lifting terminal clamps		
	Maximum cable cross-section		1 x 2.5 mm^2 stranded wire with ferrule
			1 x 4 mm^2 solid
			2 x 1.5 mm^2 stranded wire with ferrule
			2 x 2.5 mm^2 solid
	Minimum cable cross-section		1 x 0.5 mm^2 solid or stranded wire with ferrule
Degree of protection	Housing IP40, terminals IP20		
Mounting	35 mm DIN rail for snap-on mounting according to EN 60715		
Weight	Approx. 180 g		

1) Extended operating temperature range –40 … 75 °C (–40 … 167 °F), short-time 85 °C (185 °F) on request

2) In enclosed areas, protected from the weather; not permissible are: water or wind-driven precipitation (rain, snow, hail etc.)

3) At low air pressure, the permissible working voltages are reduced.

Abbreviations

AG	Adaptive gain
BIL	Basic impulse level (rated insulation voltage according to UL 347)
CE	Conformité Européenne (European conformity)
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
IP	International Protection / Ingress Protection
OV	Overvoltage category
PD	Pollution degree
UKCA	United Kingdom Conformity Assessed
UL	Underwriters Laboratories (recognized testing and certification organization)
WEEE	Waste from electrical and electronic equipment

Technical Terms

Adaptive Gain

Change in gain at a defined setpoint.

CE Marking

Manufacturer's declaration, in accordance with EU Regulation 765/2008, that the product is in conformity with the applicable requirements set out in the European Union harmonization legislation providing for its affixing.

Hazard

A hazard is defined as a potential source of damage. The term "hazard" can be specified to further describe the origin or nature of the expected damage. (Source: EN ISO 12100)

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Notes

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Translation of the original instructions

Version 2 • This document was published on June 26, 2023.
The latest documents are available for download on our website under the corresponding product description.

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