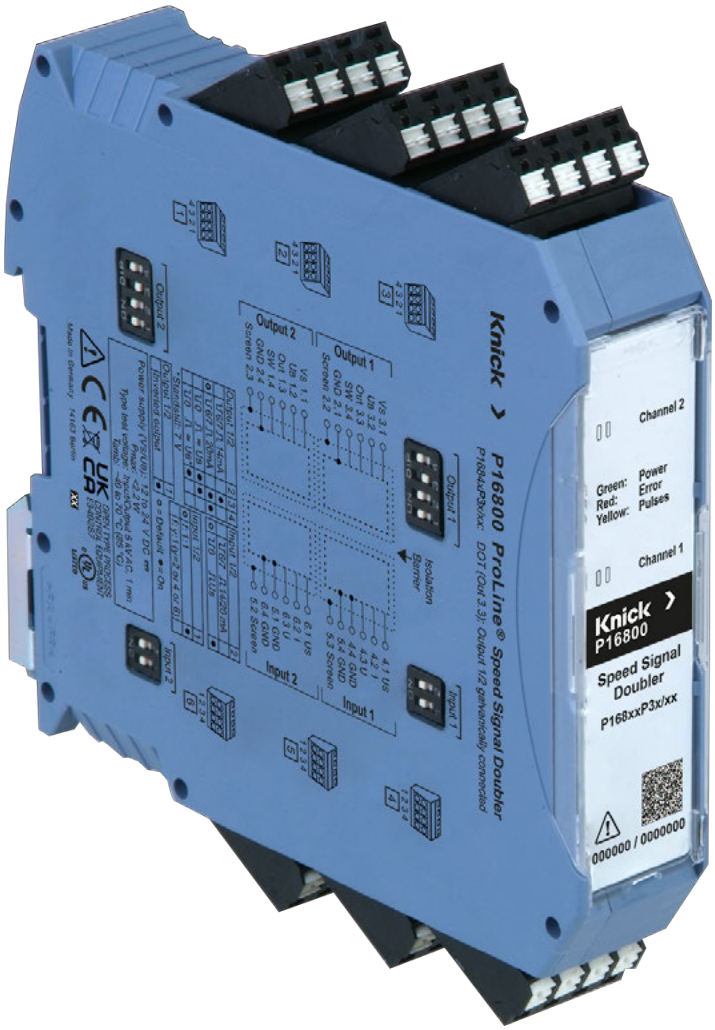
Knick

User Manual

ProLine P16800

Speed signal doubler



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 P16800 speed signal doubler detects pulses from speed sensors and transmits them, electrically isolated from each other, to the output with the specified characteristics. The inputs on the P16800 process the sensor signals without interaction.

The product is suitable for use in rolling stock and in industrial applications.

The speed signal doubler can be used in the following areas of application:

- decoupling and doubling speed sensor signals
- providing galvanically isolated and thus independent speed signals for ATP systems, door control systems, electronic journey registration, and other systems requiring route/time or speed information
- speed/velocity measurements om rolling stock
- industrial applications with speed signals

All references to “device,” “product,” or P16800 refer to the various versions of the speed signal doubler.

The nameplates on the products clearly specify the product properties.
→ *Nameplate, p. 8*

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.

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 Residual Risks

Note the different levels of functional safety depending on the selected product variant.

The product has been developed and manufactured in accordance with generally accepted safety rules and regulations, as well as an internal risk assessment. Despite the foregoing, the product may among others bear the following risks:

Environmental Influences

The effects of moisture, corrosion and ambient temperature as well as high voltages and transient overvoltages may affect the safe operation of the product. Observe the following instructions:

- Only operate the P16800 in compliance with the stated operating conditions.
  → *Specifications, p. 38*

1.4 Functional Safety (Optional)

The P16800 decouples signals from safety-related signal circuits without influencing them. The input signal is transmitted to the output signal with the specified accuracy in a functionally safe manner.

The nameplates on the products clearly specify the product properties.
→ *Nameplate, p. 8*

SRAC – Safety Related Application Conditions

The information regarding use of the P16800 and the conditions of use specified in this User Manual are to be followed as safety-related application conditions (SRACs) in order to achieve the specified functional safety characteristics regarding absence of interaction and signal transmission. The reinforced insulation of the SIL product between input and output and the specified limits for altitude, overvoltage category, and working voltage must be observed.

Absence of Interaction EN 50129: SIL 4

- FFR: 1.9 FIT, per channel at 50 °C (122 °F)
- Voltage input: R > 60 kΩ, I < 100 µA
- Current input: U < 1 V
- Electrical isolation as specified.

Signal Transmission EN 50129: SIL 2

- FFR: 94 FIT, per channel at 50 °C (122 °F)
- Signal transmission within specifications

1.5 Installation and Operation

All national and local regulations relating to the installation and operation of the product in force at the destination must be followed.

All connected current or voltage circuits must meet the SELV, PELV, or Area I requirements according to EN 50153.

- The product must be installed by qualified electrical engineering personnel.
- The product may not be opened, modified, or independently repaired. but replace it with an equivalent product. Repairs may only be carried out by Knick.
- The operating company must ensure compliance with the specified interface parameters and ambient conditions.
- The product must be installed in a lockable control cabinet.

See also
→ *Installation, p. 22*
→ *Operation, p. 32*

1.6 Disposal

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

2 Product

2.1 Package Contents

- P16800 in the version ordered
- Insertable jumper (1-channel device: x1, 2-channel device: x2)
- 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 P16800 are encoded in a product code.

2.2.1 Product Code

Speed signal doubler ProLine	P	1	6	8	_	_	P	3	1	/	_	0
Pulse input / pulse output				8								
1 input → 1 output					1							
2 inputs → 2 outputs					2							
2 inputs → 1 output and DOT (direction of travel) [1]					4	0						
Without SIL						0						
With non-interacting input (SIL 4)						1						
With non-interacting input (SIL 4) and safe transmission of signals to output (SIL 2)						2						
Modular housing [2]							P	3				
Push-in two-tier terminals, pluggable									1			
Frequency division 1:1 or 2:1											2	
Frequency division 1:1 or 4:1											4	
Frequency division 1:1 or 8:1											8	
Voltage supply/power supply 12 ... 24 V												0

2.2.2 Example of a Version

Speed signal doubler ProLine	P	1	6	8	2	2	P	3	1	/	2	0
Pulse input / pulse output				8								
2 inputs → 2 outputs					2							
With non-interacting input (SIL 4) and safe transmission of signals to output (SIL 2)						2						
Modular housing							P	3				
Push-in two-tier terminals, pluggable									1			
Frequency division 1:1 or 2:1											2	
Voltage supply/power supply 12 ... 24 V												0

[1] Without SIL

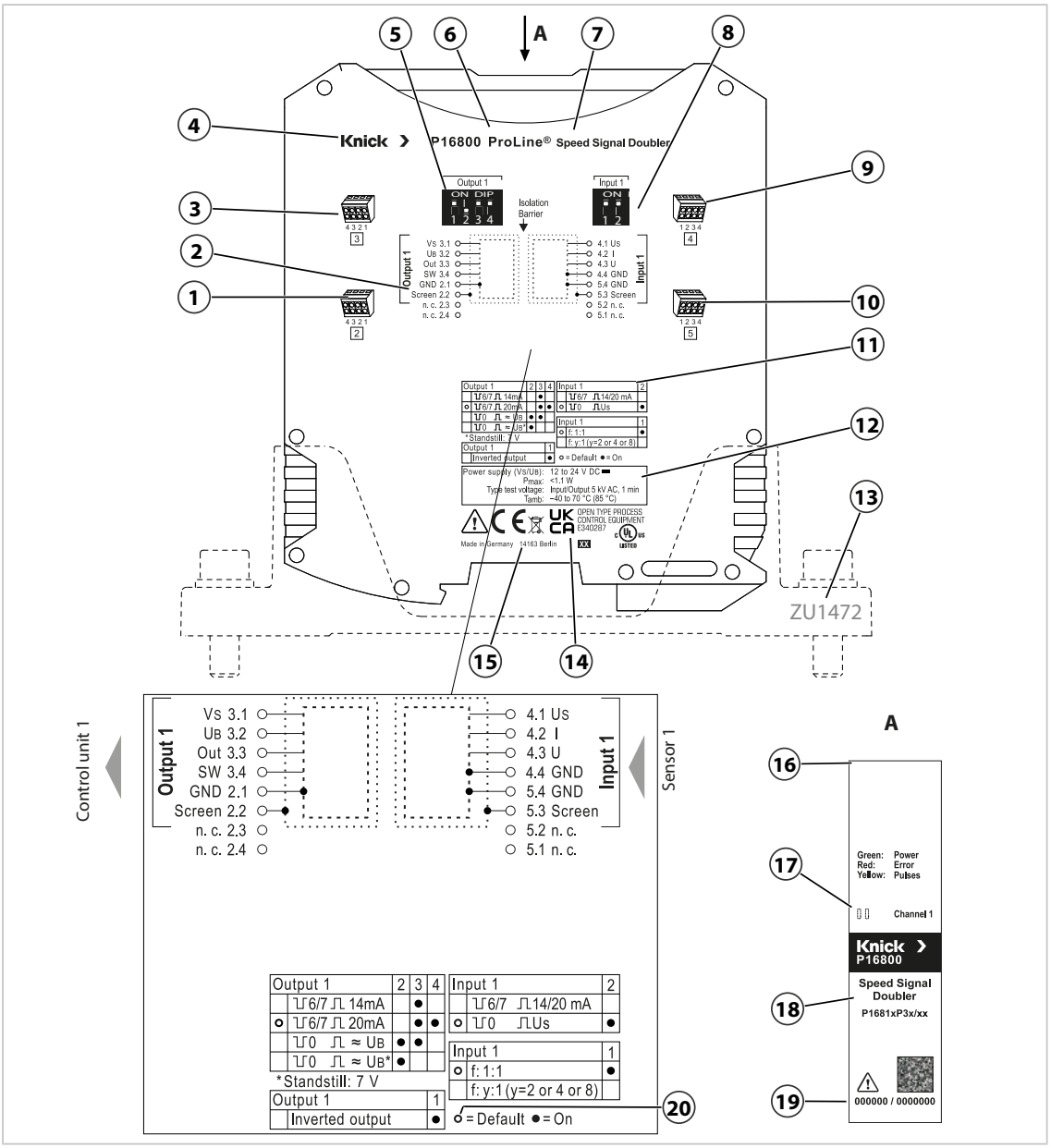
[2] for 35-mm DIN rail or wall-mount adapter ZU1472 (optional)

2.2.3 Nameplate

The P16800 is identified by nameplates on the side and front of its housing. The information provided on the nameplates varies according to the product version.

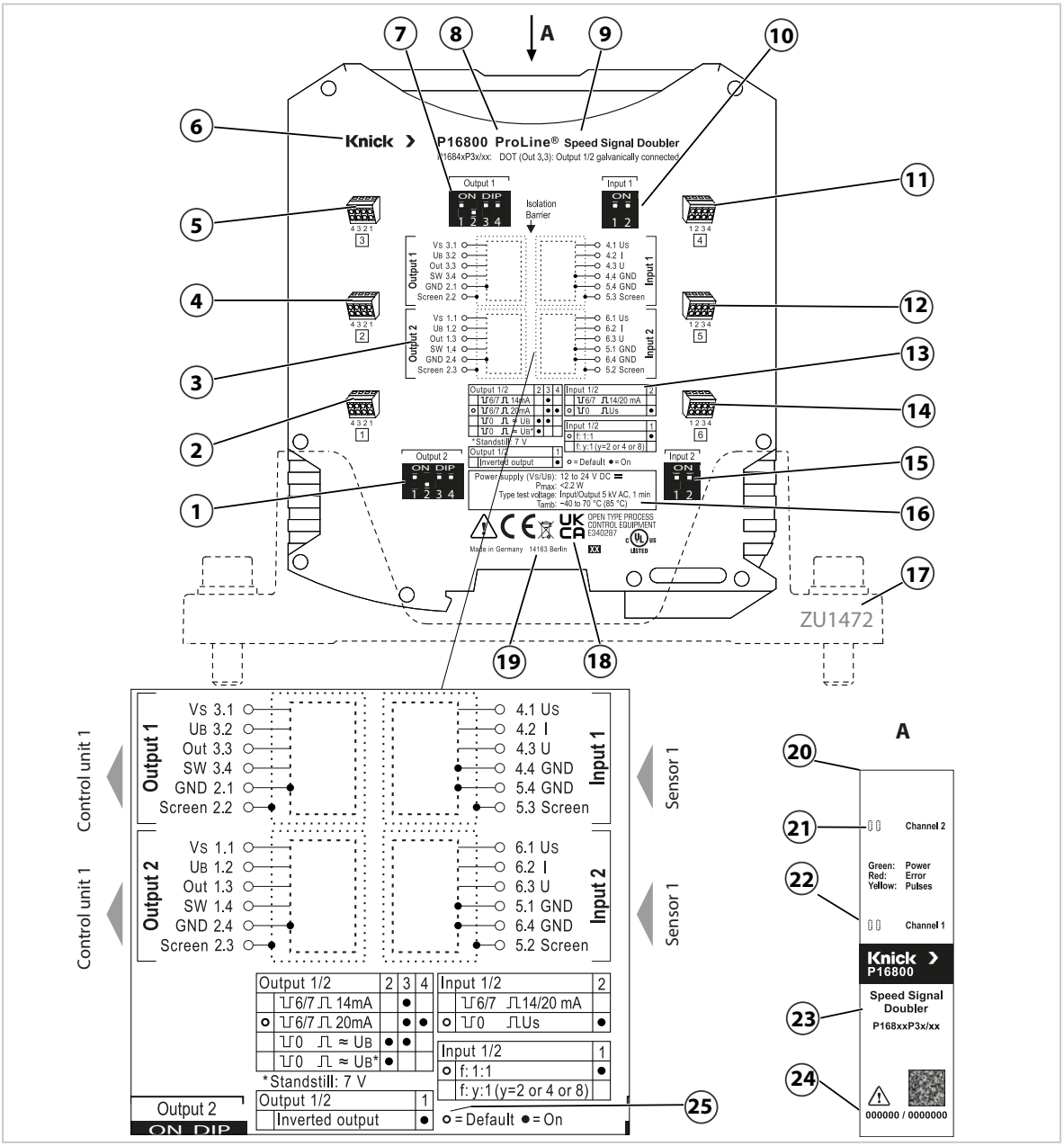
→ *Product Code, p. 7*

1-channel Speed Signal Doubler



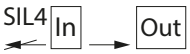
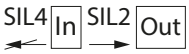
1	Two-tier terminal 2	**11**	Configuration matrix
2	Connection diagram	**12**	Connected loads
3	Two-tier terminal 3	**13**	Wall-mount adapter (optional accessory)
4	Manufacturer	**14**	Conformity/approvals
5	DIP switch output 1	**15**	Manufacturer's address with designation of origin
6	Product line	**16**	Nameplate A (front)
7	Product name	**17**	LED (x2) channel 1
8	DIP switch input 1	**18**	Product description with individual product version
9	Two-tier terminal 4	**19**	Item/serial number
10	Two-tier terminal 5	**20**	Factory settings

2-channel Speed Signal Doubler and Optional DOT Function

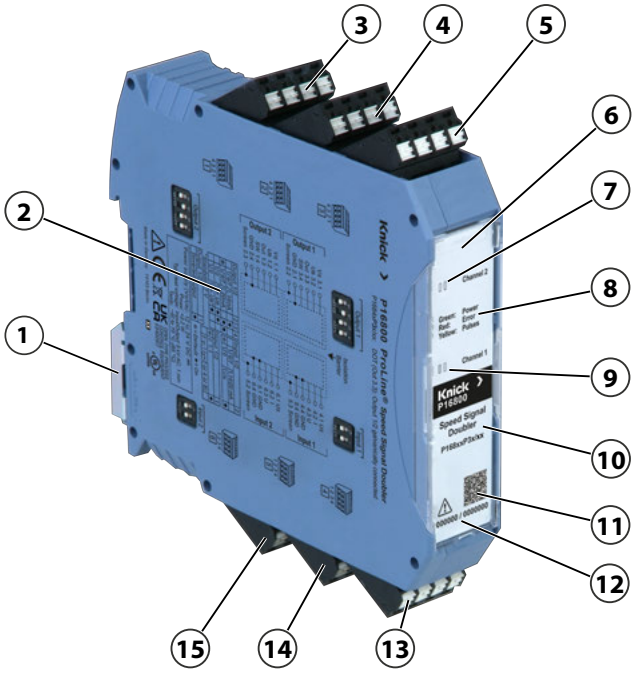


1	DIP switch output channel 2	**14**	Two-tier terminal 6
2	Two-tier terminal 1	**15**	DIP switch input channel 2
3	Connection diagram	**16**	Connected loads
4	Two-tier terminal 2	**17**	Wall-mount adapter (optional accessory)
5	Two-tier terminal 3	**18**	Conformity/approvals
6	Manufacturer	**19**	Manufacturer's address with designation of origin
7	DIP switch output channel 1	**20**	Nameplate A (front)
8	Product line	**21**	LED (2x) channel 2
9	Product name	**22**	LED (x2) channel 1
10	DIP switch input channel 1	**23**	Product description with individual product version
11	Two-tier terminal 4	**24**	Item/serial number
12	Two-tier terminal 5	**25**	Factory settings
13	Configuration matrix		

2.3 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.
	Attaching the CE marking to the product means that the product satisfies the applicable requirements specified in the European Union harmonization legislation.
	UL Listed: Combined UL mark for Canada and the United States
	UK Conformity Assessed: Conformity mark for the United Kingdom of Great Britain and Northern Ireland.
	Labeling according to the European WEEE Directive. The product must be separately disposed of with electrical and electronic equipment.
	Square-wave signal, high level.
	Square-wave signal, low level.
	Absence of interaction SIL (crossed-out arrow)
	Transmission SIL
	DIP switch: Function ON
	DIP switch: Function OFF
	DIP switch: Factory setting (default)

2.4 Design



1	Mounting metal foot catch	**9**	LED (x2) channel 1
2	Nameplate (side)	**10**	Product name
3	Two-tier terminal 1	**11**	DataMatrix code
4	Two-tier terminal 2	**12**	Item/serial number
5	Two-tier terminal 3	**13**	Two-tier terminal 4
6	Nameplate A (front)	**14**	Two-tier terminal 5
7	LED (x2) channel 2 (if available)	**15**	Two-tier terminal 6
8	Meaning of the LED display		

2.5 Functional Description

The P16800 is available in 1 and 2-channel versions and is used to detect speed sensor signals. The input of the P16800 is designed in such a way that speed sensors with current or voltage output can be connected. The outputs of the product can be configured as current or voltage outputs and behave like a speed sensor for the controls. → *Product Code, p. 7*

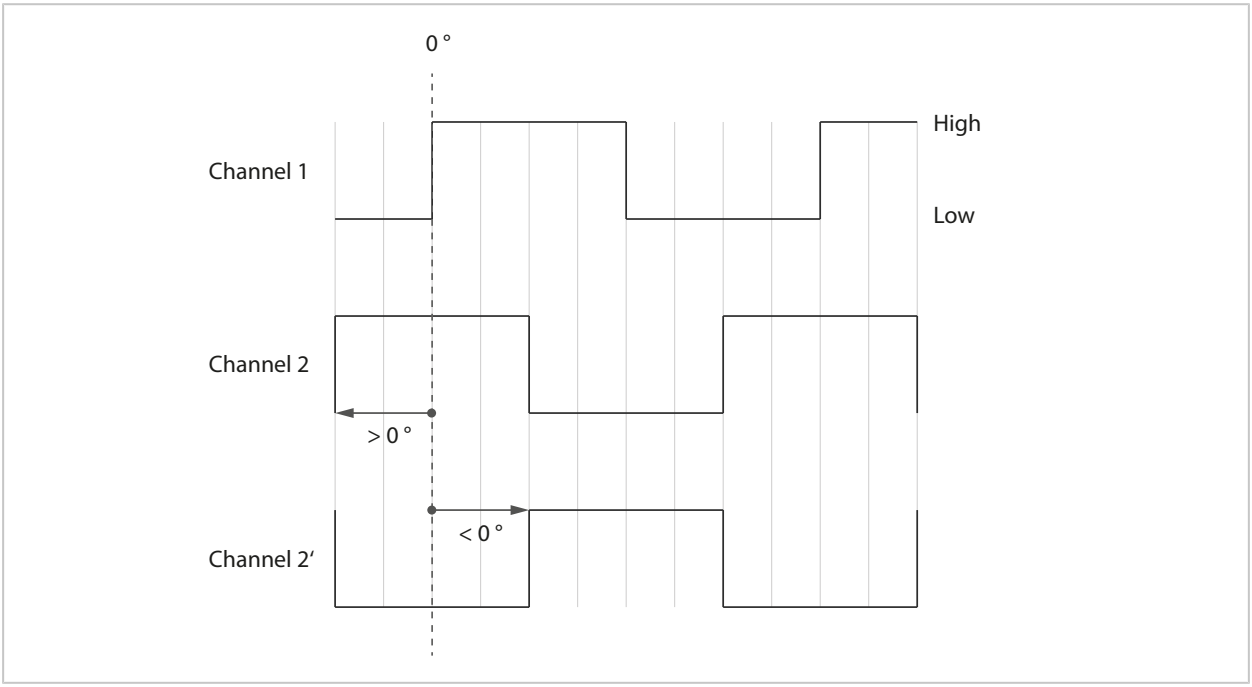
P16810	1 input, 1 output
P16820	2 inputs, 2 outputs
P16840	2 inputs, 1 output, 1 DOT output

- The P16800 transmits galvanically isolated the pulse signal from speed sensors from the input to the output. The product is used to double signals, i.e., to decouple them from existing measuring circuits, or to protect controls from voltage loads on the speed sensor.
- P16840 only: The product can detect the direction of rotation of an axle or the direction of travel of a vehicle.
- In the absence of input pulses, the product can detect the standstill of an axle or a vehicle.
- The reinforced insulation according to EN 61140 ensures protective separation, and the protection of persons from electric shock.
- The galvanic isolation protects the equipment and contributes to an unaltered transmission of the measuring signals. This may improve the signal quality and decouple the controls.
  EMC interference at the controls can thus be reduced.
- The P16800 can process signals from speed sensors and other pulse transmitters, e.g., flow sensors.
- The P16800 detects the pulse signals from speed sensor circuits without influencing them.
  The absence of interaction can optionally be set for safety-related applications up to SIL 4.
- The pulse transmission from the input to the output can optionally be set for safety-related applications up to SIL 2.
- Pulse transmission can be set as 1:1 or, with frequency division, as 2:1 (4:1 or 8:1 available ex works). With enabled frequency division, the output signal has a pulse-pause ratio of 50 %.
- The pulse signals can be inverted.
- The speed sensor's voltage supply U_S at the input of the P16800 is required in order to set the switching threshold during operation. U_S is not used to supply the P16800.
- The output is the binary image of the input signals (high/low level).
- The compact enclosure is suitable for mounting on 35-mm DIN rails and walls
  (ZU1472 wall-mount adapter, optional → *Accessories, p. 36*).
- The following SIL products are suitable for safety-related applications:
  - SIL: P16811, P16812 in 1-channel version
  - SIL: P16821, P16822 in 2-channel version

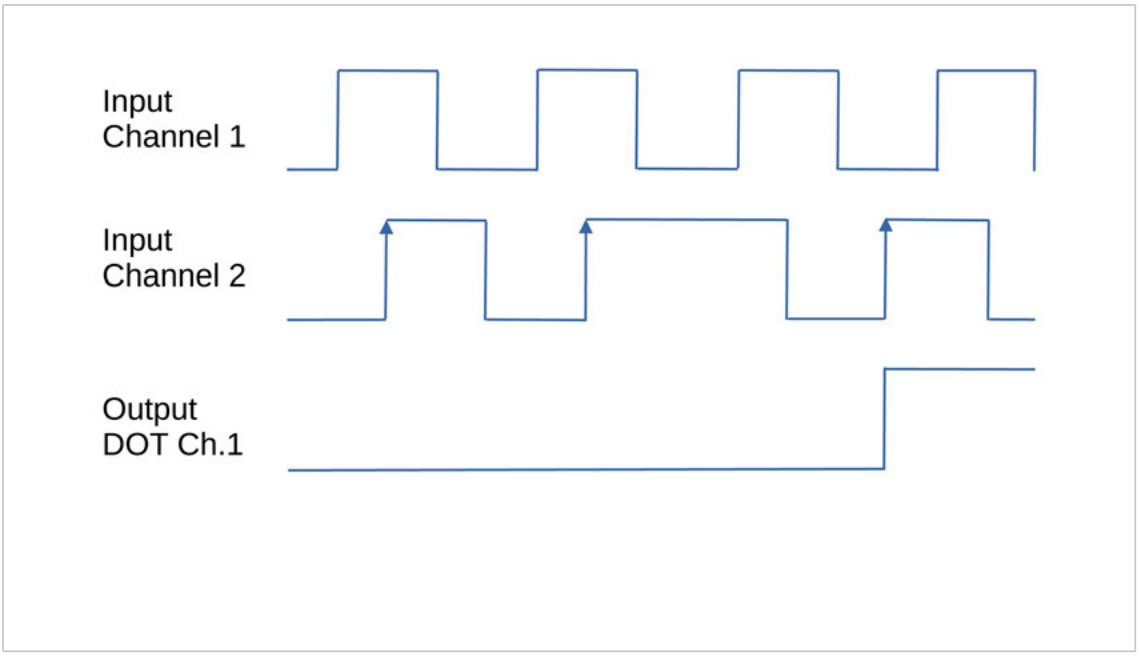
Product Version with DOT Function

Device version P16840 generates a direction-of-travel (DOT) signal. The output of the first channel (terminal 3.3) supplies the result of the input channel phase comparison as a DOT signal.

The output of the second channel reproduces the signal from the input of the second channel. With the P16840, the outputs are galvanically interconnected. The inputs are galvanically isolated from each other and from the outputs.



The phase shift of 2-channel speed sensors is approximately 90°.



With a rising signal edge at the input of channel 2, the output level of the DOT signal is set at the output of the first channel.

The DOT signal is inverted when the polarity of a channel is changed (set DIP switch 1 at the output → *DIP Switches, p. 29*).

See also

→ *Transmission Behavior, p. 40*

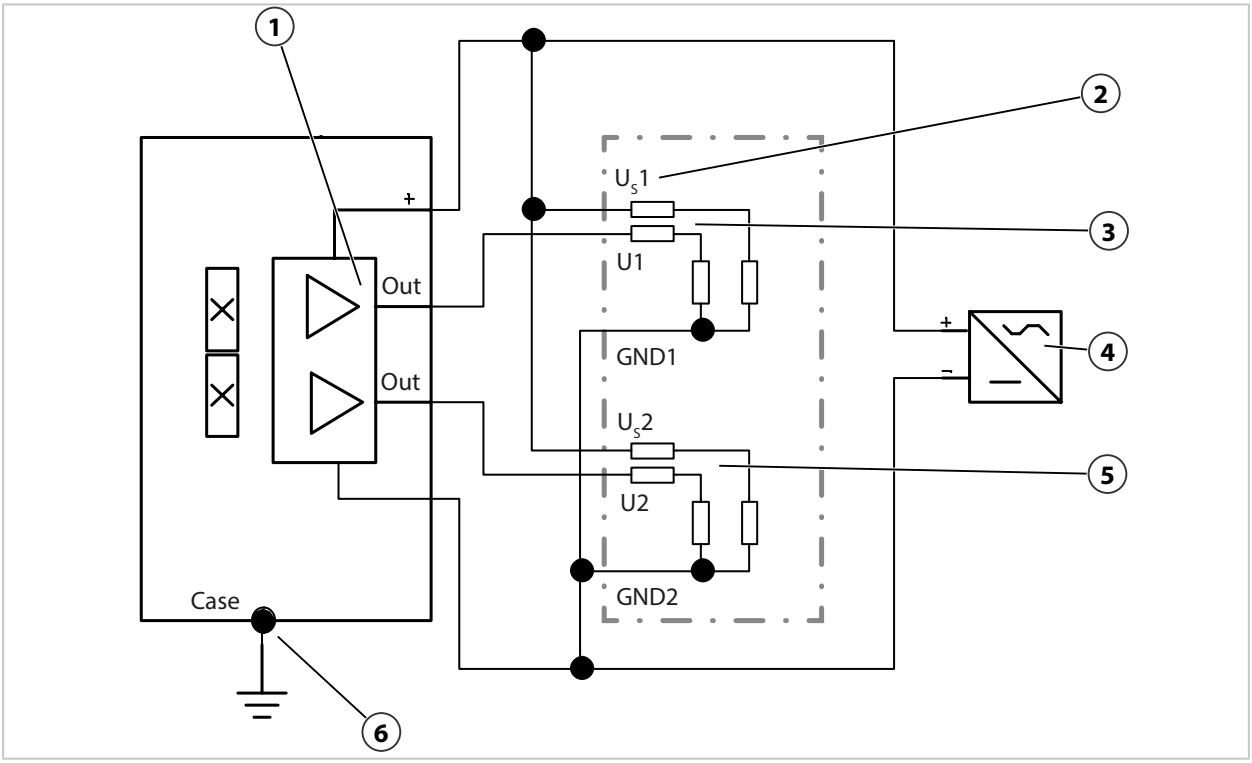
2.6 Input/Output

Speed sensors with voltage output and current output can be connected at the input of the P16800.

2-channel speed sensor with voltage output

With speed sensors with voltage output, the voltage supply of the speed sensor is connected to the inputs U_S and GND of the P16800. The threshold voltage for the level detection of the input is set via input U_S. P16800 is supplied with energy via the V_S terminal and GND (not shown in the diagram).

The output signals of the speed sensor are connected at the U and GND voltage inputs of the P16800.

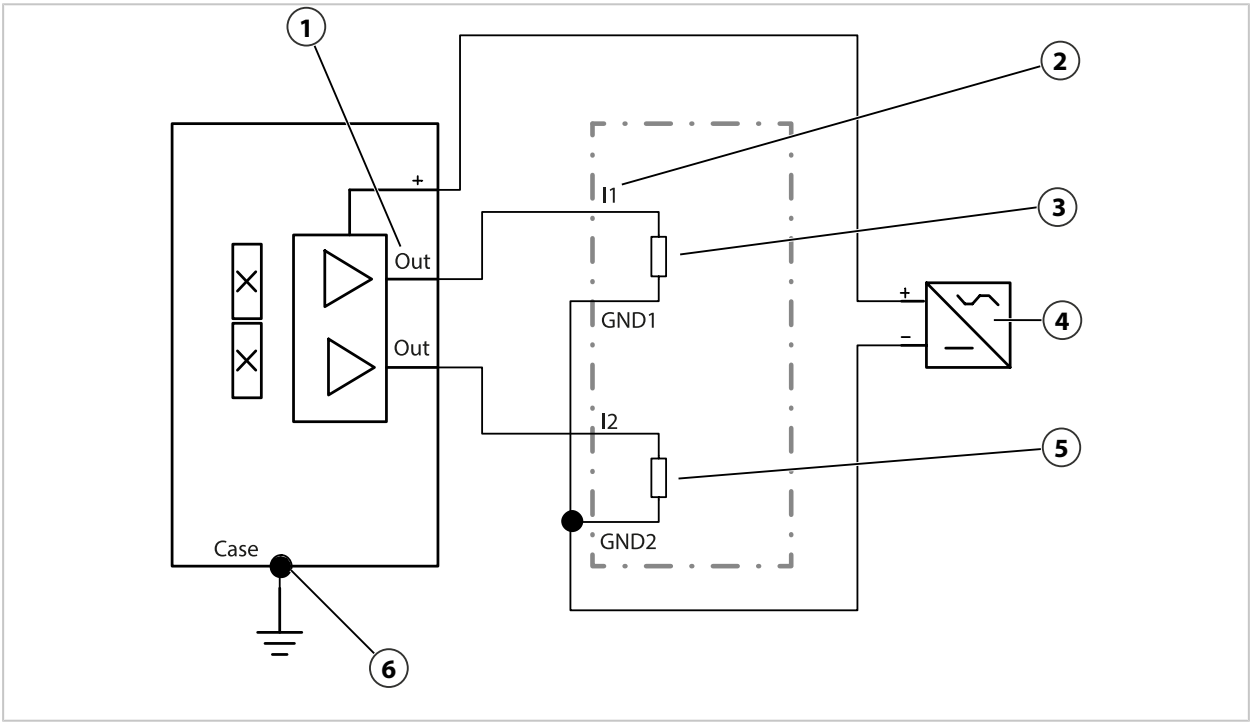


1	Voltage outputs of a 2-channel speed sensor	**4**	Power supply
2	Voltage inputs of the P16820	**5**	Input voltage divider channel 2 with U input 2 and GND input 2
3	Input voltage divider channel 1 with U input 1 and GND input 1	**6**	Equipotential bonding

With 2-channel speed sensors, U_S1 and U_S2 must each be connected. The voltage connected to U_S is not used to supply the product's inputs because the U_S input and the signal input are disconnected from the input circuit of the P16800 with high resistance. In this case, the input remains unconnected.

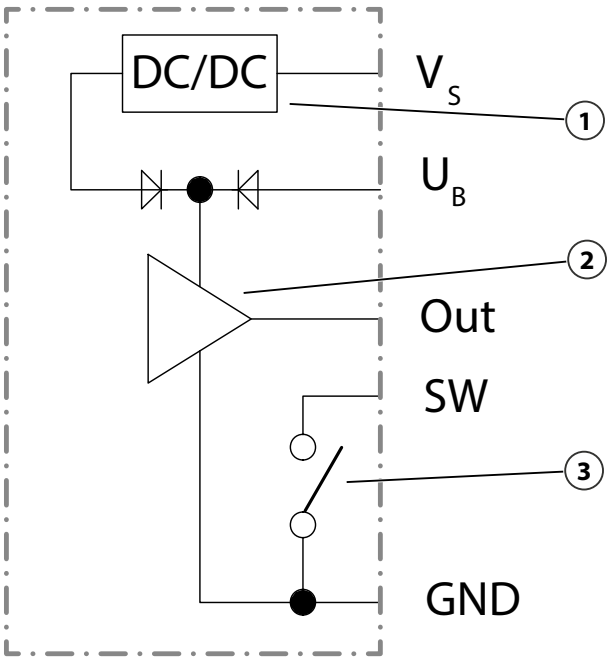
2-channel speed sensor with current output

With speed sensors with current output, the signal currents are conducted via internal shunt resistors of the P16800. The shunt resistors are protected against overload with diodes connected in parallel. With the help of the external accessory diode jumper ZU1473, the current flow in the input circuit is not interrupted when the plug is disconnected.



1	Current outputs of a 2-channel speed sensor	**4**	Power supply
2	Current inputs of the P16800	**5**	Measuring shunt channel 2
3	Measuring shunt channel 1	**6**	Equipotential bonding

Output stage of a P16800 channel



1 Internal voltage transformer	**3** Solid state relay switching output for status signaling, diagnostics switch SW (switch)
2 Output driver for current and voltage	

The P16800 is supplied via the V_S terminal and GND (supply not shown in the diagram).

The output of the P16800 has two supply connections: V_S and U_B. If the U_B terminal is used, then the output driver is supplied by the voltage applied to U_B via the diode network. If the U_B terminal is open, the output driver is supplied via V_S and an internal voltage converter.

→ *Voltage Output, p. 39* → *Current Output, p. 39*

The signal output OUT can be parameterized as current or voltage output via DIP switches. With an active standstill detection and detected standstill (frequency < 1 Hz), a constant voltage of 7,2 V is measured at the output. The U_B terminal must be connected in this mode. To activate the standstill detection, the voltage output must be selected via the DIP switches. The switching output SW is a diagnostic switch (switch) and, when it is open, signals a detected error. All output connections are protected with bipolar suppressor diodes.

2.7 Voltage Supply

P16800 is supplied via the output stages. The voltage supply is not galvanically isolated from the output.

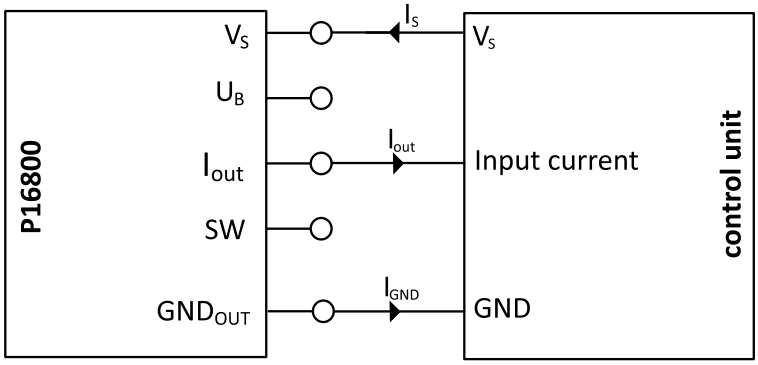
The typical voltage supply is nominally 12 ... 24 V (the permissible voltage range is 10 ... 32 V DC). The voltage supply must be provided by a SELV, PELV power supply. The output stage and the associated galvanically isolated input circuit are supplied via terminal V_S or U_B. The channel 1 and 2 supplies are galvanically isolated.

The output of the P16800 can be supplied via a downstream controller or a power supply. The available currents (power output) are usually limited when power is supplied via a controller. If the current is exceeded, an error message may be displayed in the controller. By selecting the terminal variant it is possible to adjust the current through the downstream controller.

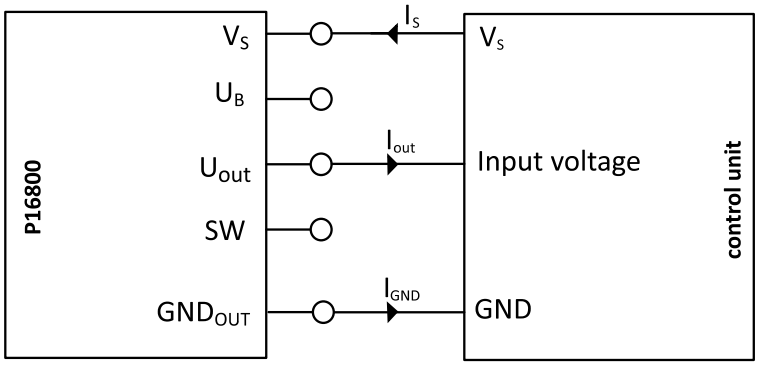
The following figures show the supply options for current and voltage outputs. The terminal options shown differ in their use of terminal U_B. If the U_B terminal is not connected, the P16800 supplies the output driver internally. This reduces the energy absorption and the temperature, so that the long-term availability increases. If the downstream controller can evaluate reduced levels, the U_B terminal can remain open.

2.7.1 Supply of Active Current Output

Supply via the controller at terminal V_S (active current output)



$I_S = I_{out} + I_{GND}\ (R_{max} = 200\ \Omega)$

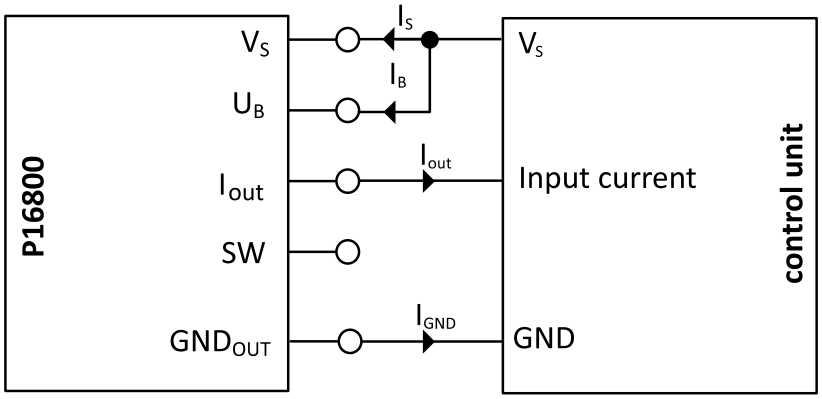


$I_s = I_{out} + I_{GND}\ (U_{out} \approx 4\ V)$

The current I_S, which flows into terminal V_S, is provided by the controller. The signal output voltage U_{Out}, or the load voltage of a channel is approx. 4 V. The use of the standstill detection with an output voltage of 7.2 V is not possible in this terminal type.

2.7.2 Supply of Passive Current Output

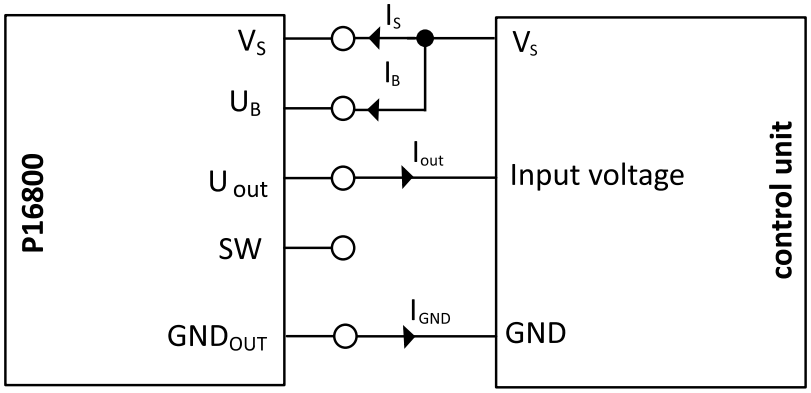
Supply via the controller at terminal V_S and U_B (passive current output)



$$I_B \approx I_{OUT}$$

$$I_S \approx I_{GND}$$

The current which flows from the controller and into the supply of the P16800, is shared as I_S for terminal V_S and I_B for terminal U_B.



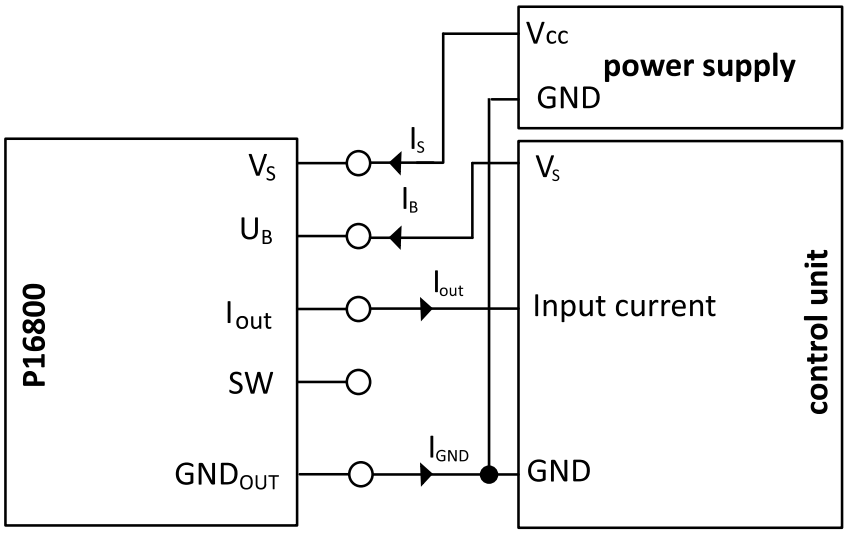
$$I_B \approx I_{OUT}\ (U_{out} \approx U_B)$$

$$I_S \approx I_{GND}$$

The current into terminal U_B is equal to the current that flows out of terminal I_{OUT}/U_{OUT}.

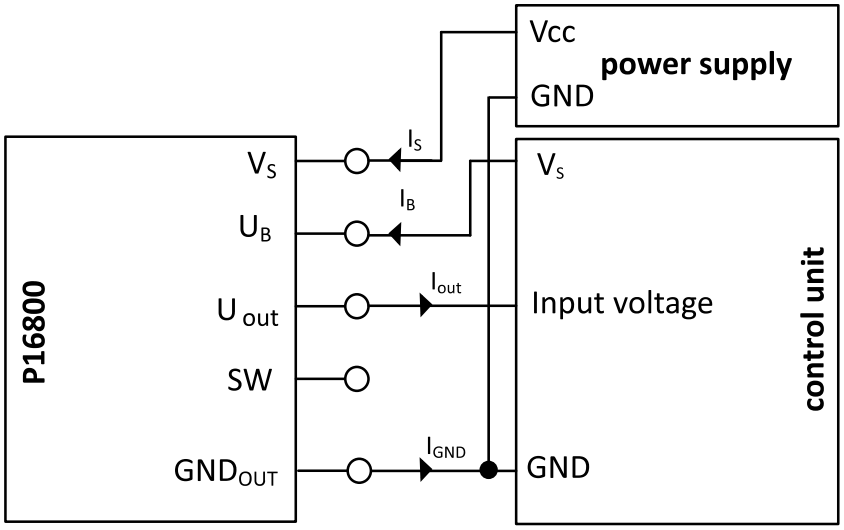
2.7.3 Auxiliary Power Supply at Voltage Supply Terminal, Output Side

Auxiliary power supply at terminal V_S



$I_B \approx I_{OUT}$

$I_S \approx I_{GND}$

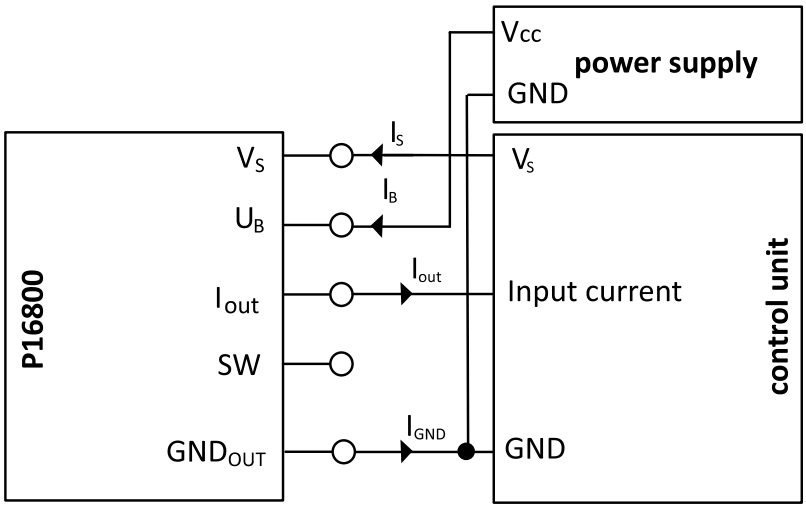


$I_B \approx I_{OUT}$

$I_S \approx I_{GND}$

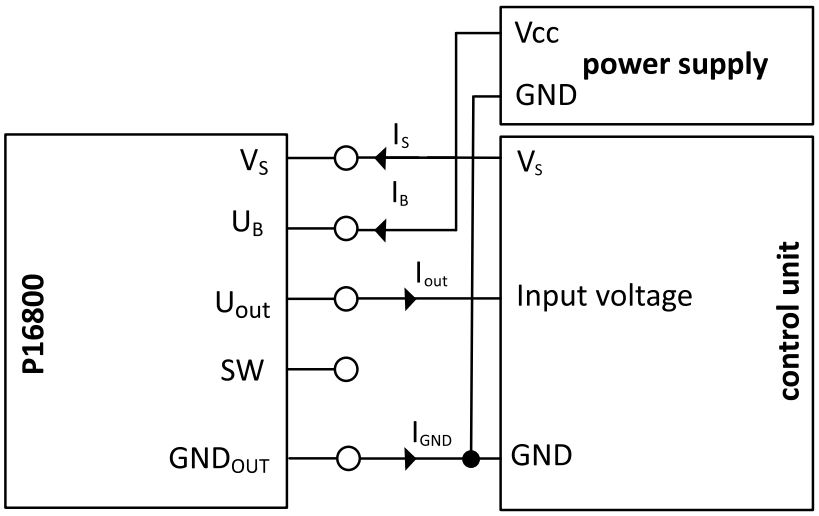
2.7.4 Auxiliary Power Supply at Voltage Supply Terminal (Output Driver)

Auxiliary power supply at terminal U_B



$I_B \approx I_{OUT}$

$I_S \approx I_{GND} \approx$ constant



$I_B \approx I_{OUT}$

$I_S \approx I_{GND} \approx$ constant

If the load on the controller is to correspond to the load through a speed sensor, an additional power supply may be used. Should the controller tolerate a higher load, the external supply source may be omitted. In this case, change the configuration of the terminal to
→ *Supply of Active Current Output, p. 17* or → *Supply of Passive Current Output, p. 18*.

2.8 Shielding

The input and output range of the P16800 are separately and doubly shielded. The double shielding consists of an inner shield with connection to the circuit ground and a floating, outer shield.

Shielding for current input

Changing input currents generate a changing potential at the base of the measuring resistor and thus also at the input ground. The input ground is firmly connected to the inner shield, so that an alternating potential is created between the inner shield and the outer shield. The outer input shield is connected to the cable shield. Due to the double shielding of the input and the shielding of the output, the alternating currents do not affect the output.

Various shielding configurations are shown in the → *Configuration, p. 25* chapter.

NOTICE! There may be signal interference if the shielding is not connected. The screen terminals must be correctly connected and must not be left open.

The wire shields are connected to control cabinet ground in the respective control cabinets. Whether this is done on one or both sides depends on the equipotential bonding and the distance between the control cabinets.

3 Installation

3.1 Mounting

Comply with the conditions below:

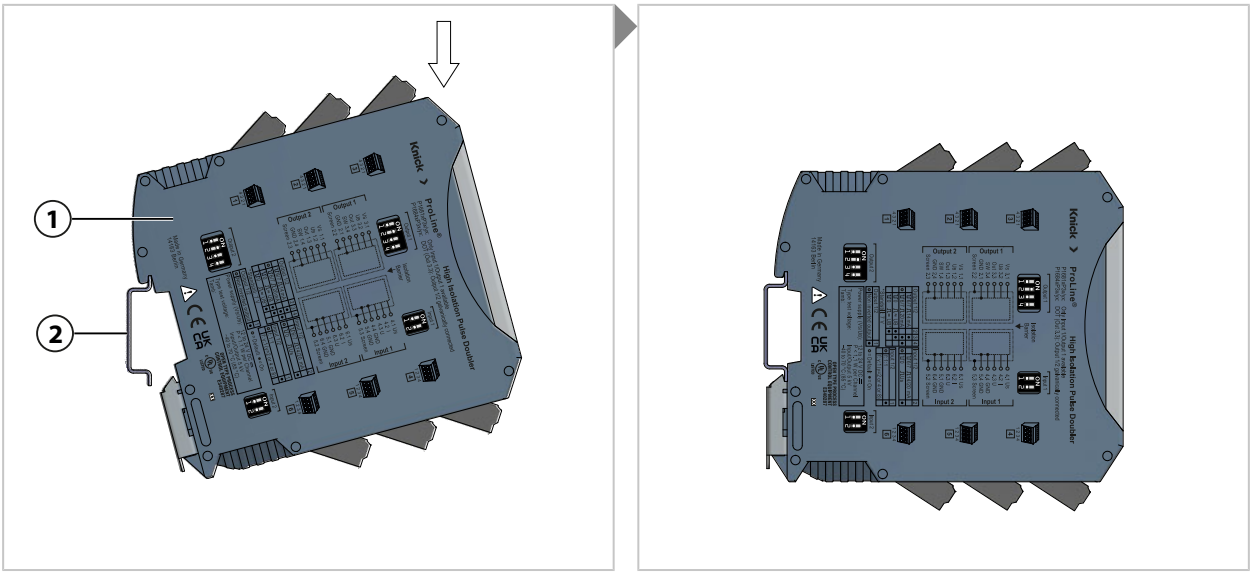
The product may be installed in underfloor containers, roof containers, and engine rooms of locomotives and traction units. Inside rolling stock, the product must be installed inside a closed, lockable control cabinet.

In industrial installations, the product must be operated inside a closed, lockable control cabinet.

P16800 can be installed in any installation position as follows:

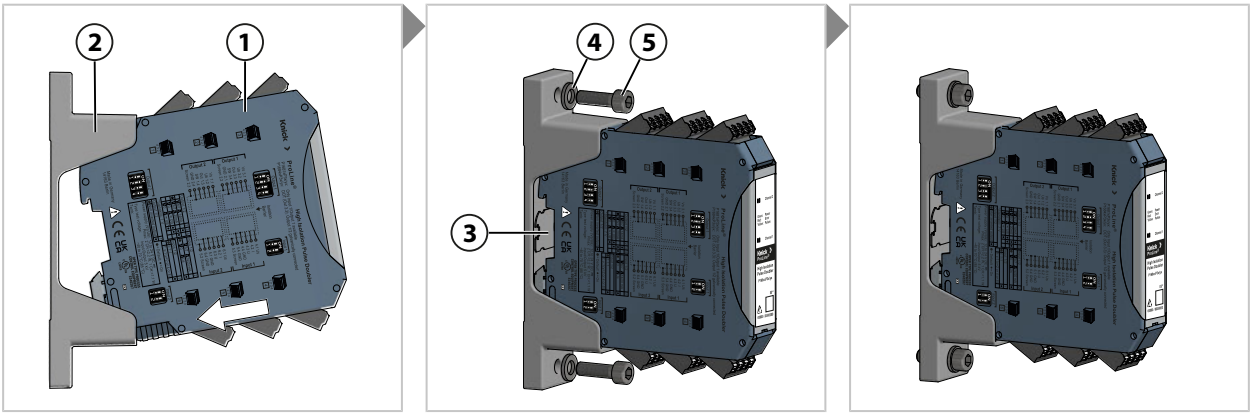
- On 35-mm DIN rails, side-by-side mounting possible (without using a DIN rail bus connector)
- On flat surfaces with accessory ZU1472 wall-mount adapter

Mounting on 35-mm DIN rail



01. Snap the P16800 **(1)** on to the 35-mm DIN rail **(2)**.

Mounting on flat surfaces with accessory ZU1472 wall-mount adapter (can be ordered separately)



Note: The miniature depiction **(3)** on the wall-mount adapter shows the correct installation position of the P16800 **(1)** in the ZU1472 wall-mount adapter **(2)**.

01. Snap the P16800 **(1)** into the ZU1472 **(2)**.
02. Position ZU1472 **(2)** with the P16800 **(1)** at the installation location.
03. Fasten ZU1472 **(2)** with two M6 screws **(5)** and washers **(4)**. Tighten the M6 screws **(5)** with 5 Nm.

Removing the P16800 from the wall-mount adapter

To remove the P16800 in the wall-mount adapter, the M6 screws must first be loosened. Slightly bend up one side of the wall-mount adapter to separate it from the product.

See also
→ *Dimension Drawing, p. 37*

3.2 Terminal Assignments

Terminal	Label	Input/ output	Channel	Function
1.1	V_S	Output	2	Voltage supply
1.2	U_B	Output	2	Voltage supply (output driver) If terminal U_B is open, the output driver is supplied via V_S and an internal DC/DC converter.
1.3	Out	Output	2	Output signal (current or voltage)
1.4	SW	Output	2	Switching output, open in the case of a detected error.
2.1	GND	Output	1	Ground (reference potential)
2.2	Screen	Output	1	Shield
2.3	Screen	Output	2	Shield
2.4	GND	Output	2	Weight
3.1	V_S	Output	1	Voltage supply
3.2	U_B	Output	1	Voltage supply (output driver) If terminal U_B is open, the output driver is supplied via V_S and an internal DC/DC converter.
3.3	Out	Output	1	Output signal (current or voltage); With product variant with DOT function (P16840, direction of rotation/direction of travel detection): Result of the phase comparison.
3.4	SW	Output	1	Switching output, open in the case of a detected error.
4.1	U_S	Input	1	Voltage supply speed sensor
4.2	I	Input	1	Signal current from speed sensor
4.3	U	Input	1	Signal voltage from speed sensor
4.4	GND	Input	1	Speed sensor ground
5.1	GND	Input	2	Speed sensor ground
5.2	Screen	Input	2	Shield
5.3	Screen	Input	1	Shield
5.4	GND	Input	1	Speed sensor ground
6.1	U_S	Input	2	Voltage supply speed sensor
6.2	I	Input	2	Signal current from speed sensor
6.3	U	Input	2	Signal voltage from speed sensor
6.4	GND	Input	2	Speed sensor ground

3.3 Electrical Installation

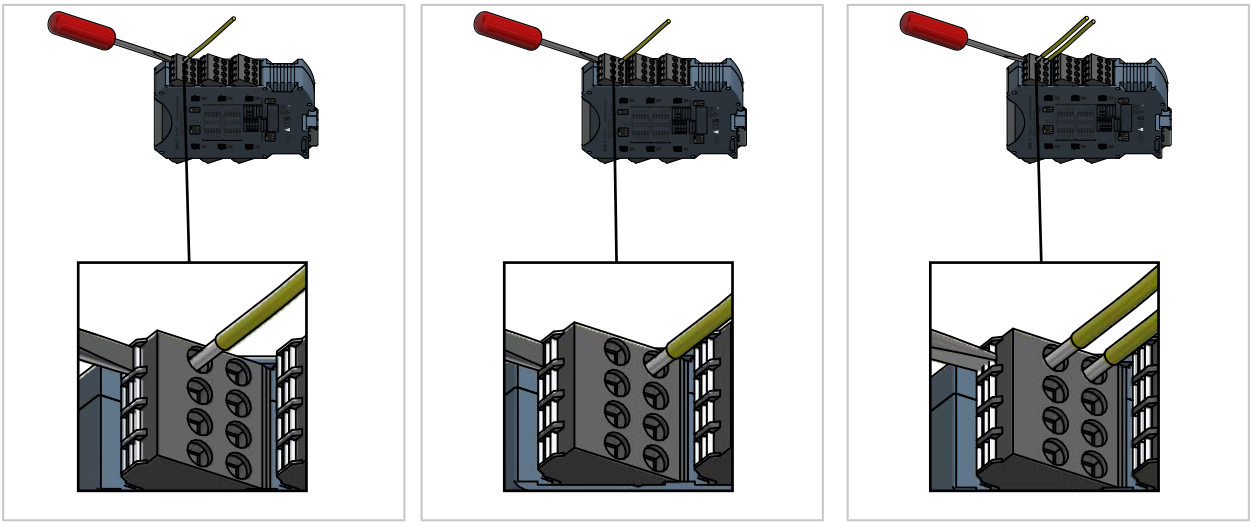
⚠ WARNING! Shock potential. Install the product with the power off.

Wire preparation

Note: Use only shielded wires suitable for the ambient conditions. Connected cables and wires must be rated for the current limit of the protective device for the circuit at minimum.

Conductor cross-sections
0.2 ... 1.5 mm², AWG 24 ... 16
Stranded with ferrule or solid

01. Strip 10 mm of insulation from the wire ends. Fit fine-stranded wires with ferrule.



01. Insert the wire into the two-tier terminal (push-in version) without using tools. If necessary, open the two-tier terminal with a screwdriver to make it easier to insert the wire. To remove the wire from the two-tier terminal, use the screwdriver as shown.
02. Alternatively, use screw terminals.

⚠ WARNING! Shock Potential. Maintain the necessary distances to the two-tier terminals and DIP switches to maintain galvanic isolation.

Wiring

Note: The current output must always terminate with a load.

Note: For 2-channel devices, input signals 1 and 2 must come from the same speed sensor. The output signals must only go to one controller.

Note: When using the current input, U_S, U_{in}, and GND must be connected to the insertable jumper. If voltage inputs are used, the current input must not be used. P16480: the DOT signal is available at output 3.3.

01. Connect the P16800 in accordance with the selected circuit (signal type, shielding, equipotential bonding).
02. Check that the wire is securely attached.

See also
→ *Terminal Assignments, p. 23*
→ *Connections, p. 25*

4 Configuration

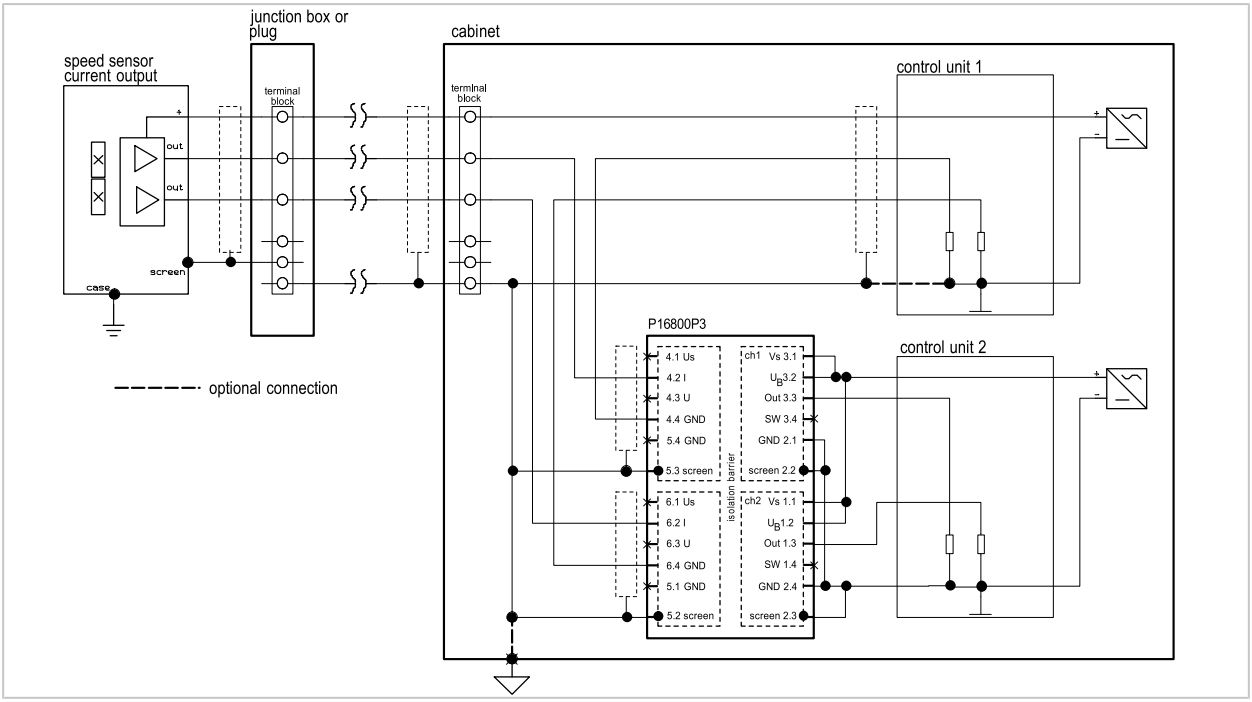
4.1 Connections

The diagrams below show the terminals of a speed sensor on the P16800 in the control cabinet.
In all configurations, the output of the product can be set individually to current or voltage for each channel. The P16800 acts like a speed sensor on the output side.

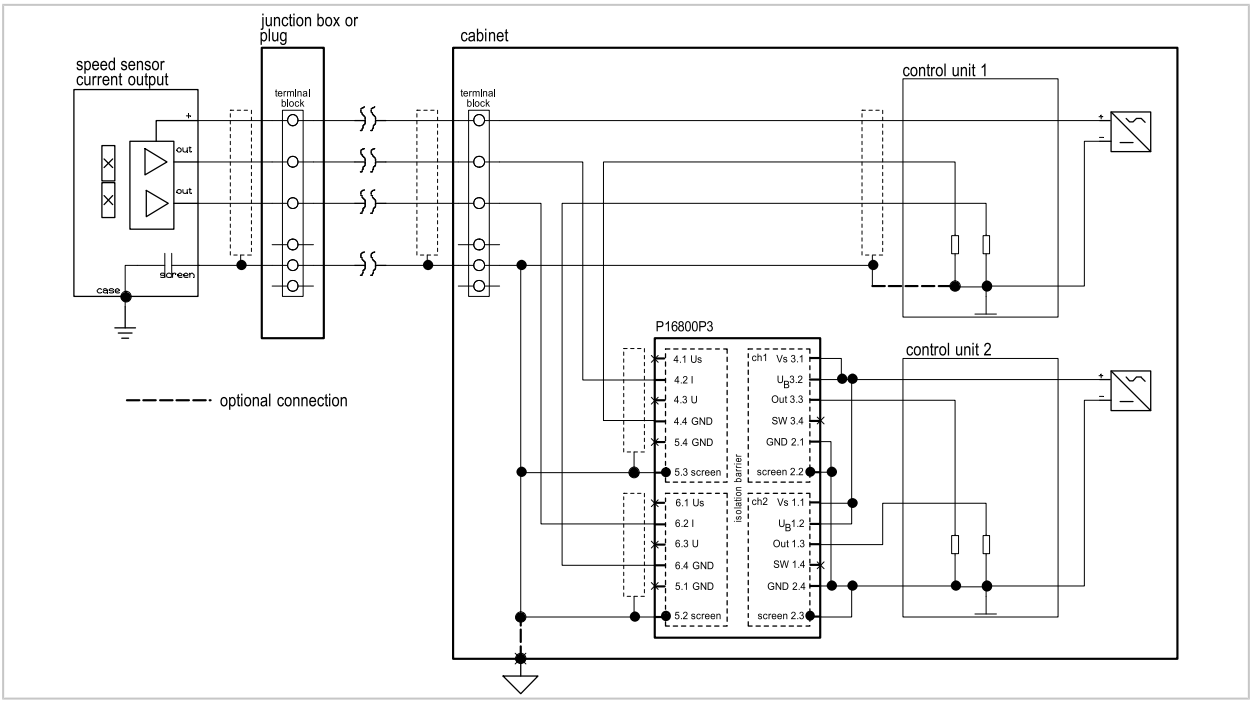
Due to the different circuit options for the output of the product, it is possible to adjust the load of the controller so that it corresponds to the load of a speed sensor. → *Voltage Supply, p. 17*

4.1.1 Terminal of the Speed Sensor to the Current Input of the Speed Signal Doubler.

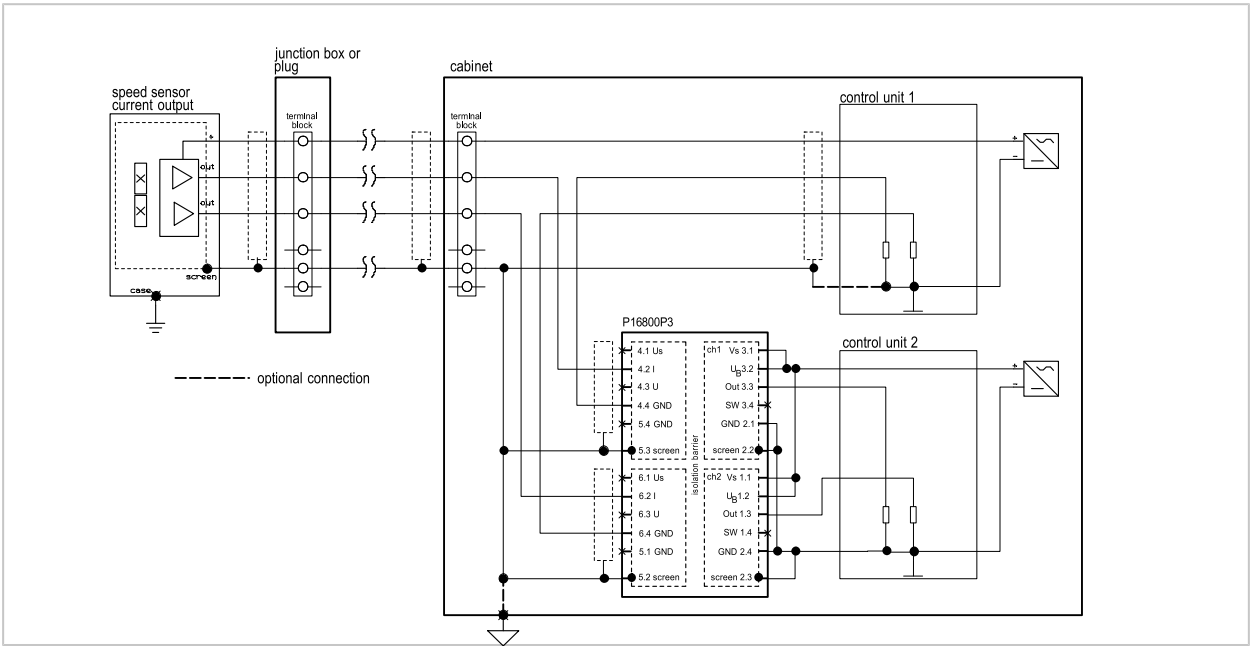
Shielding via the enclosure of the speed sensor:



Shielding via a capacitor in the enclosure of the speed sensor:

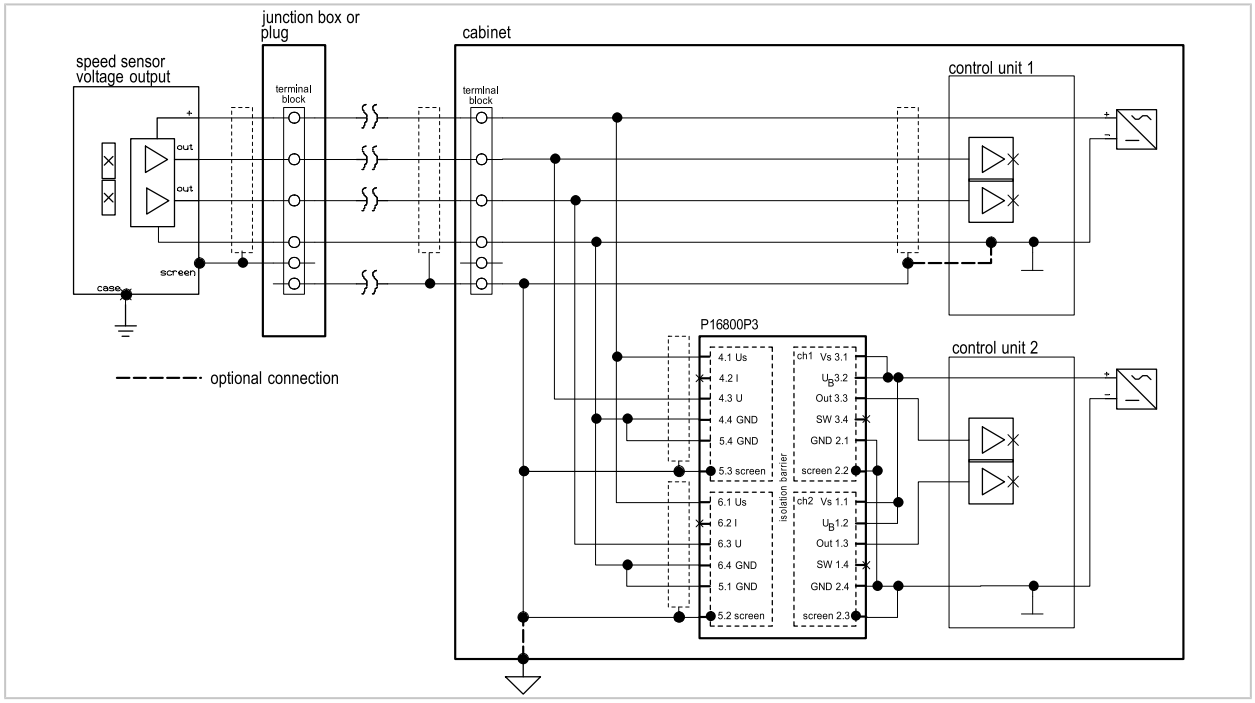


Shielding via the inner shield of the speed sensor enclosure:

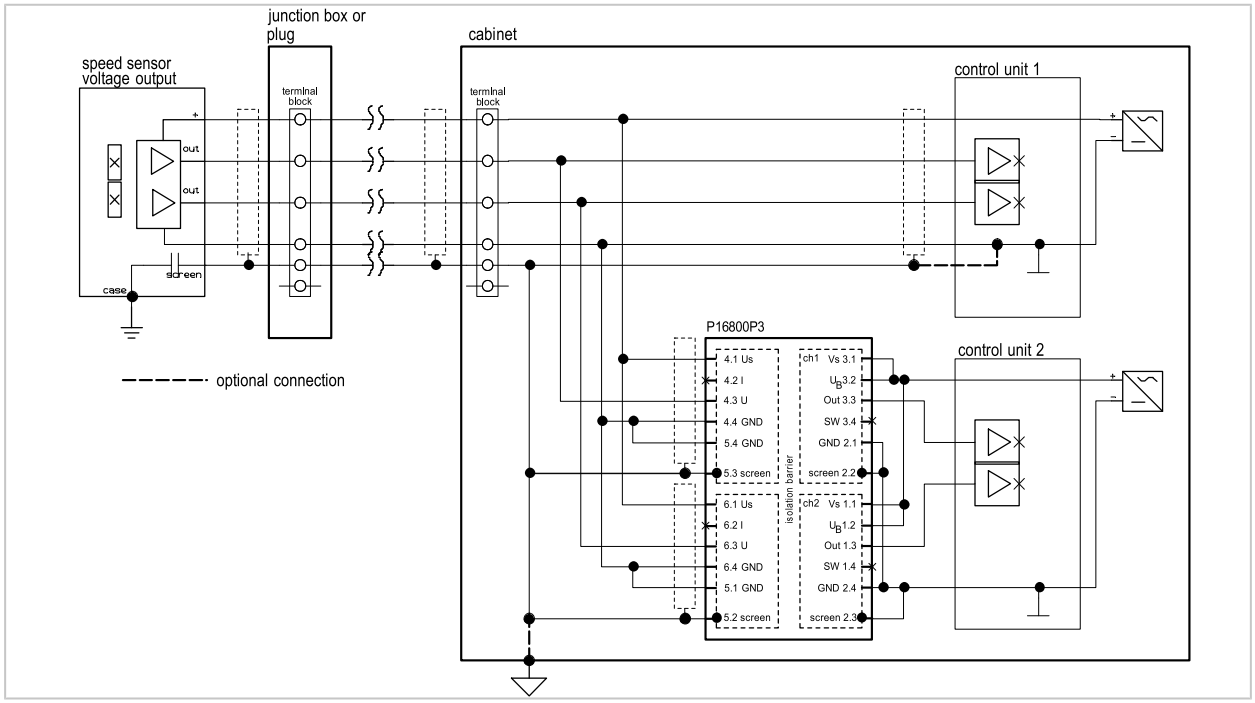


4.1.2 Terminal of the Speed Sensor to the Voltage Input of the Speed Signal Doubler

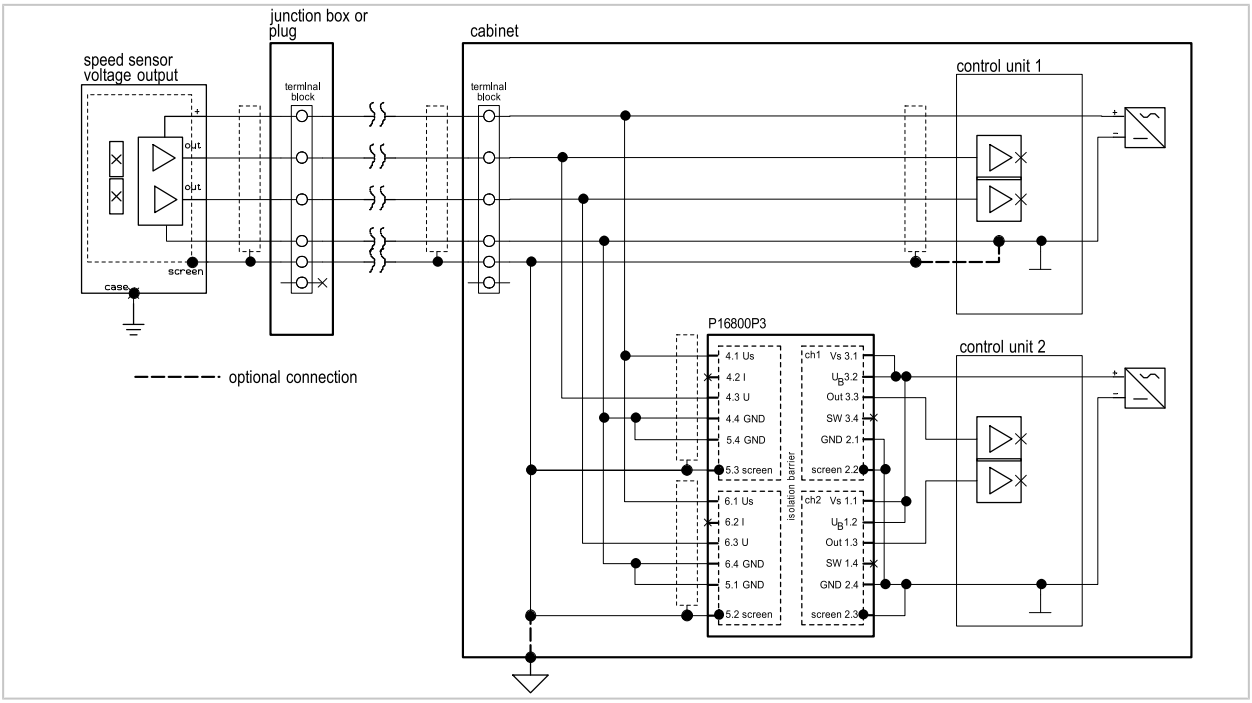
Shielding via the enclosure of the speed sensor:



Shielding via a capacitor on the enclosure of the speed sensor:



Shielding via the inner shield of the speed sensor enclosure:



4.2 DIP Switches

The input and output functions of the P16800 can be individually adjusted via DIP switches on the product. Which functions go with which DIP switch positions is indicated on the nameplate.

NOTICE! Do not change the measuring range during operation.

01. Set the DIP switches according to the desired function.
02. Following configuration, check the speed signal doubler to make sure it is functioning correctly.

DIP switch at input

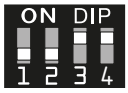
Overview of the functions of the DIP switches at input:

- DIP switch input 1 and input 2 (optional)
  - Choice of current or voltage input
  - Choice between 1:1 pulse transmission or frequency division 2:1 (optional ex works: 4:1 or 8:1)

DIP 1	DIP 2	Input value	Notes	Factory setting
On (ON)	On	Low 0 V High U_S	Voltage input, pulse transmission 1:1, no frequency division	◯
On	Off (OFF)	Low 6/7 mA High 14/20 mA	Current input, pulse transmission 1:1, no frequency division	
Off	On	Low 0 V High U_S	Voltage input, frequency division 2:1 (optional ex works: 4:1 or 8:1)	
Off	Off	Low 6/7 mA High 14/20 mA	Current input, frequency division 2:1 (optional ex works: 4:1 or 8:1)	

DIP switch at output

Overview of the functions of the DIP switches at output:



- DIP switch output 1 and output 2 (optional)
  - Choice of current or voltage output
  - For current output: Choice of high level 14 mA or 20 mA
  - Choice of standstill detection (middle voltage)
  - Choice of an inverted or non-inverted output signal

DIP 1	DIP 2	DIP 3	DIP 4	Output value	Note	Factory setting
Off	Off	On	On	Low 6/7 mA High 20 mA	Current output	○
Off	Off	On	Off	Low 6/7 mA High 14 mA	Current output	
Off	On	On	Off	Low 0 V High ≈ U_B	Voltage output	
Off	On	Off	Off	Low 0 V High ≈ U_B	Voltage output with standstill detection	
On	Off	On	On	Low 20 mA High 6/7 mA	Current output, *inverted*	○
On	Off	On	Off	Low 14 mA High 6/7 mA	Current output, *inverted*	
On	On	On	Off	Low ≈ U_B High 0 V	Voltage output, *inverted*	
On	On	Off	Off	Low ≈ U_B High 0 V	Voltage output with standstill detection, voltage output, *inverted*	

See also

→ *Nameplate, p. 8*

5 Commissioning

01. Set the desired function using the DIP switches. → *DIP Switches, p. 29*
02. Mount P16800. → *Mounting, p. 22*
03. Electrically install the P16800. → *Electrical Installation, p. 24*
04. Check functionality of the P16800.

6 Operation

6.1 LED Signaling

There are two LEDs for each channel on the front of the device. → *Design, p. 11*

Green	LED left	Operating display, operating voltage available.
Red	LED left	Error detected. → *Troubleshooting, p. 35*
Yellow	LED right	Pulse signaling (LED blinks in time with the input pulses. With high pulse frequencies, this is perceived as a continuous light). With DOT function, the second channel's LED blinks in time with the second channel's input pulses. The first channel's LED shows the result of the direction-of-travel detection.

7 Maintenance and Repair

Maintenance

The devices are maintenance-free. They are not to be opened.

Repair

The product cannot be repaired by the user. The local contact persons and information on the repair procedure can be found at www.knick.de.

Storage

Familiarize yourself with the information on storage temperatures and relative humidity in the Specifications. □ Table : Ambient conditions

8 Decommissioning

The product must be removed from operation and secured against reconnection if the following applies:

- The product is visibly damaged
- Failure to perform the intended function
- Prolonged storage at temperatures outside the specified temperature range

The product may only be recommissioned following a professional routine test conducted by the manufacturer.

9 Troubleshooting

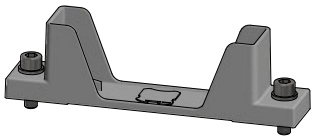
USE CAUTION WHEN CONDUCTING ANY TROUBLESHOOTING. FAILURE TO ABIDE BY THE REQUIREMENTS SET FORTH HEREIN MAY RESULT IN SERIOUS INJURY OR DEATH, AS WELL AS DAMAGE TO PROPERTY.

Malfunction state	Possible causes	Remedy
The LED lights up red and switching output SW is open.	Overtemperature	Check the ambient temperature
	Voltage supply	Check the power supply
	Speed sensor voltage connection < 9.5 V	Check the connection
	Signal current from speed sensor < 2.2 mA	Check the speed sensor, cable, and connections
	Open line U/I	Check cable and connections
	U/I low	Check the controller
	Internal device error	Replace the device
	Open circuit	Check wiring
The LEDs do not light up and switching output SW is open.	Undervoltage	Check the power supply

See also

→ *LED Signaling, p. 32*

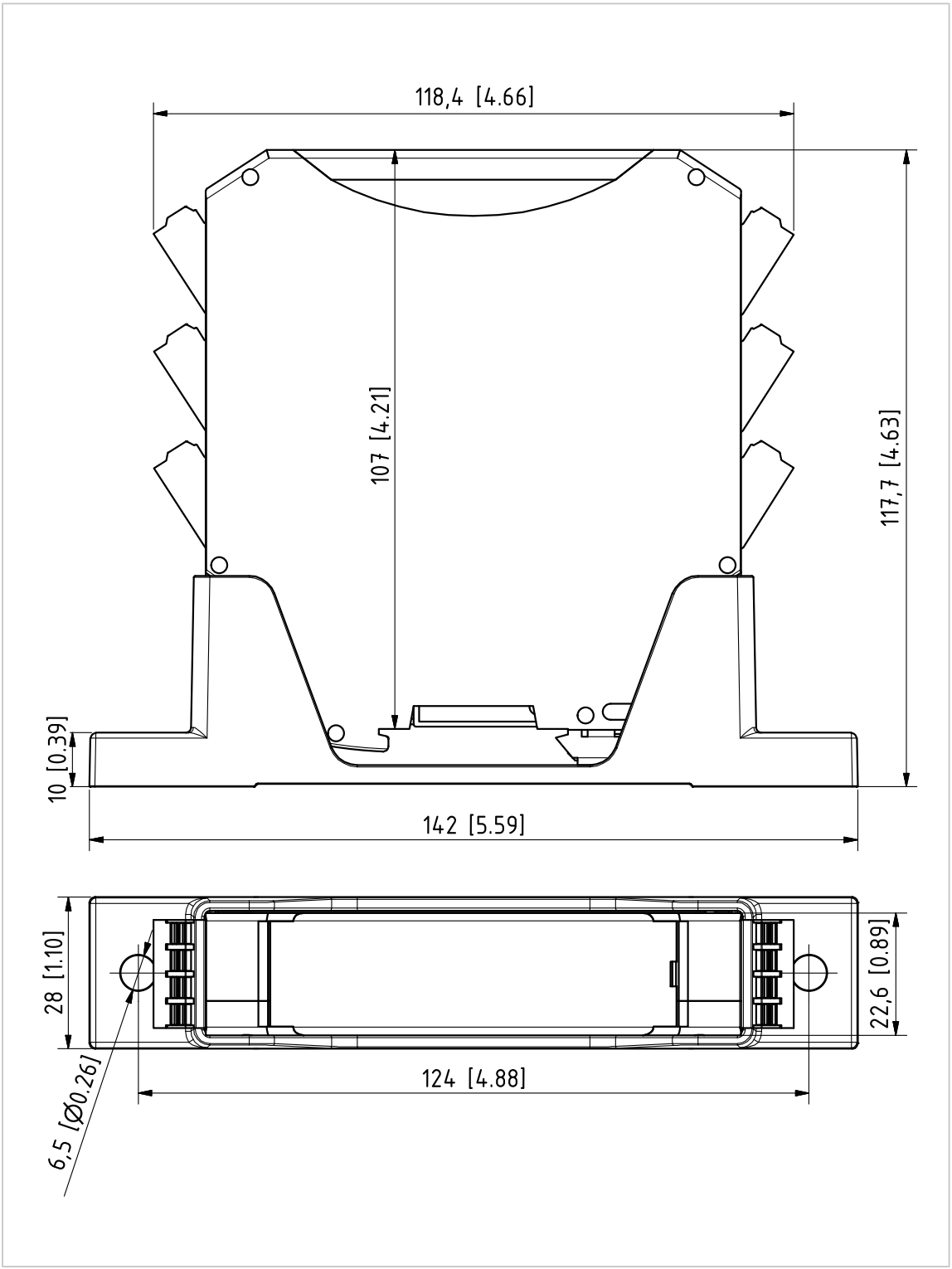
10 Accessories

	**ZU1472 Wall-mount adapter P16800, optional** The accessory ZU1472 enables the installation of the P16800 on a flat surface. The accessories include a wall-mount adapter. Use two M6 screws (EN 912/ISO 4762) with washers (EN 125/ISO 7089) to mount the wall-mount adapter. (Screws and washers are not included in the scope of delivery).
(not shown)	**ZU1473 Diode and insertable jumper set** The ZU1473 accessory includes the following components: • 2 x wired diodes for parallel connection of the internal shunt resistor on the two-tier terminal. The signal current from the speed sensor continues to flow even if an input plug-in terminal is disconnected from the product. • 6 x bipolar insertable jumpers To connect the power supply (V_S - U_B), and for the connection between ground and shield. → *Electrical Installation, p. 24*

11 Dimension Drawing

The diagram shows the P16800 together with ZU1472 “Wall-mount adapter”. The accessory ZU1472, “Wall-mount adapter,” is available as an option and is not included in the P16800package contents.
→ *Accessories, p. 36*

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



12 Specifications

12.1 Input

Waveform	Square
Input sources	Signals from a speed sensor
Speed encoder supply	From primary controller Or via external supply

12.2 Voltage input

Voltage input U_S	10 ... 33.6 V DC ± 2 % peak-peak (max. 35 V)
Fault detection	U_S < approx. 9.5 V; open wire U_S, switch SW opens
Switching level	Logical 0: < 30 % of U_S Logical 1: > 70 % of U_S
Tolerance of the switching level	< 10 %
Protection from overload/external voltage	Up to max. 35 V DC continuous load
Input resistance	> 120 kΩ With absence of interaction SIL 4: > 60 kΩ
Input capacitance	≤ 100 pF

12.3 Current Input

Switching level (dependent on setting of the DIP switches) Low: 6/7 mA; High: 14/20 mA	Logical 0 (low): < 8.5 mA Logical 1 (high): > 12.5 mA
Fault detection	< 2.2 mA; open line, switch SW opens
Tolerance of the switching level	< 5 %
Voltage drop	< 0.7 V
Protection from overload	Up to max. 0.2 A continuous load
Input resistance	< 20 Ω
With absence of interaction: Voltage drop	< 1 V

12.4 Output

Waveform	Square
Output types	Current or voltage signal The configuration of the two output circuits does not have to be identical.
Signal conversion options	Current → Current Voltage → Voltage Current → Voltage Voltage → Current

12.5 Voltage Output

Voltage level	Low < 1 V High ≈ U_B High (U_B open) ≈ 5 V 7.2 V ± 0.3 V with detected standstill (U_B may not be open)
Reaction to middle voltage at input of P16800	Dependent on U_S and prior input level
Voltage signal load capability	Max. 20 mA Max. 2 mA with detected standstill
Protection from overload caused by external voltage	With max. U_B/max. 200 mA
Short-circuit response	Short-circuit-proof (limited to 50 mA)
Voltage output cable lengths	Max. 100 m (0.25 nF/m)
Rise time	$t_{10 \ldots 90}$ < 10 µs

12.6 Current Output

Passive current output, configurable	Suitable for following control inputs: Low 6/7 mA, High 14 mA
	Suitable for following control inputs: Low 6/7 mA, High 20 mA
Active current output, configurable	Suitable for following control inputs: Low 6/7 mA, High 14 mA
	Suitable for following control inputs: Low 6/7 mA, High 20 mA
Fault current signal	No Can be activated at the factory: With detected error 0 mA
Current signal level error	Max. 2 mA
Maximum load voltage	< U_B – 2 V at 20 mA < 5 V, if U_B open
Internal parallel resistance to output	> 150 kΩ
Overload capacity, external voltage	Up to max. U_B / max. 200 mA
Open-circuit response	Open-circuit-proof
Rise time	$t_{10...90}$ < 10 µs (pulse edge slope for ohmic loads)

12.7 Switching Output

Switching output (solid state relay): SW	Fault contact, normally closed contact (NC), opens in case of fault
$U_{SW\,max}$ / $I_{SW\,max}$	33.6 V / 100 mA
Internal voltage drop	< 0.2 V at 20 mA
U_{SW} with open switch without external switching voltage	> 1 V
I_{SW} with open switch	Approx. 130 µA
Reference potential	GND
Fault response time	< 1 s

12.8 Transmission Behavior

Rated frequency range	0 ... 25 kHz
Duty cycle of speed sensor signals to be transmitted	20 % ... 80 %
Response time	t_{99} < 1 ms
Response time difference in both channels	< 10 µs
Frequency division, factory set	P168*****/2*: 1:1, 2:1, switchable P168*****/4*: 1:1, 4:1, switchable P168*****/8*: 1:1, 8:1, switchable
Maximum duty cycle deviation output signal to input signal without frequency division	± 10 %
Duty cycle of output signal with frequency division independent of input signal duty cycle	50 % ± 10 %
Standstill detection	f < 1 Hz ± 0.3 Hz
Reference voltage generation for standstill signaling	U_{out} = 7.2 V
True zero speed	The output level follows the input level (valid for 1:1 transmission)
Response in the event of input frequency jump	Immediate transmission with specified latency period
Direction of travel signal DOT (without SIL), only P16840	Δφ = φ2 - φ1; Δ φ > 0 → High; Δφ < 0 → Low

12.9 Reaction to Input Signals

		Input level	U_{out} 1/2	I_{out} 1/2	Switching output SW 1/2
Voltage input	U	Low	Low	Low	Closed
		High	High	High	Closed
		Middle voltage	Low or high, depending on input level/hysteresis	Low or high, depending on input level/hysteresis	Closed
		f < 1 Hz (with enabled middle voltage generation only)	7.2 V	Invalid setting	Closed
		Open	Low	Low	Closed
	U_S	10 ... 33.6 V	Dependent on input level/hysteresis	Dependent on input level/hysteresis	Closed
		< approx. 9.5 V	Undefined	Undefined	Open
Current input	I	Low	Low	Low	Closed
		High	High	High	Closed
		< Low	High	High	Open
		Open	High	High	Open
Active inversion of the input signals via DIP switch: High and low levels are swapped.					
The output signal evaluates middle voltage generation. All input errors are also evaluated in the process.					

12.10 Power Supply

Input channel supply	From the respective output circuit, galvanically isolated
Supply of the output channels	V_S: Output circuit U_B: Output driver → *Voltage Supply, p. 17*
Power supply V_S, U_B (rail applications)	24 V, SELV, PELV
Power supply V_S, U_B (industrial applications)	12 ... 24 V, SELV, PELV
Electrical safety	All connected current or voltage circuits must meet the SELV, PELV, or Area I requirements according to EN 50153.
Overvoltage and undervoltage limits	V_S: 10 ... 33.6 V DC U_B: 10 ... 33.6 V DC
Interruption class	S1 according to EN 50155 table 6
Switching class	C1 according to EN 50155 table 8
Power consumption via V_S per channel	Max. 600 mW
Current via U_B per channel	Max. 5 mA + I_{OUT} Max. 5 mA + U_{OUT}/R_L
Maximum power conversion P_{Max}	< 2.2 W P1681****/**: < 1.1 W
DC ripple factor	5 % according to EN 50155 table 7
Readiness for operation (after switching on the power supply)	≤ 50 ms
Inrush current at V_S per channel With V_S = 24 V, U_{OUT} at R_L = 1 kΩ	< 0.0002 A^2 per s
Inrush current at U_B per channel With U_B = 24 V, U_{OUT} at R_L = 1 kΩ	< 0.0001 A^2 per s

12.11 Isolation

Galvanic isolation	Across input circuits and output circuits, across channel 1 and channel 2 according to EN 50124, EN 61010-1, UL 61010-1
Type test voltages	Across input and output: 8.8 kV AC/5 s 5 kV AC/1 min Across channel 1 and channel 2: 3.55 kV AC/5 s 3 kV AC/1 min
Routine test voltages	Across input and output: 4.6 kV AC/10 s Across channel 1 and channel 2: 1.9 kV AC/10 s
Rated insulation voltage	→ *Details on Isolation, Isolating Distances, Contamination and Overvoltage, p. 45*
Reinforced insulation	→ *Details on Isolation, Isolating Distances, Contamination and Overvoltage, p. 45*

12.12 Safety Function: Absence of Interaction, Input

Safety level	SIL 4
FFR	$< 2.0 \cdot 10^{-9}$
U, U_S	Input impedance > 60 kΩ Current from input < ±100 µA
I	U < 1 V
Reinforced insulation	→ *Details on Isolation, Isolating Distances, Contamination and Overvoltage, p. 45*
Reinforced insulation between shield and the rest of the signals of a channel	50 V, OV IV, 4000 m, PD 2
Routine test of the insulation between shield and the rest of the signals of a channel	1.4 kV AC, duration 60 s

12.13 Safety Function: Signal Transmission

Safety level	SIL 2
FFR	$< 1.0 \cdot 10^{-7}$
Safety function	Frequency-precise transmission $f_{out} = f_{in} \pm 0.1$ % of measured value

12.14 Ambient Conditions

Operating environment	Use in enclosed, non-forced-ventilated areas on rolling stock
Installation site according to EN 50155	Closed control cabinet, Appendix C: 1 and 2
Pollution degree	PD 2
Height class according to EN 50125	AX, reduced isolation data for altitudes of 2000 to 4000 m above MSL
Temperature class according to EN 50125	TX
Operating temperature class according to EN 50155	OT4
Increased operating temperature class during switch-on according to EN 50155	ST1, ST2
Temperature change class for rapid temperature changes according to EN 50155	H1
Ambient temperature range: Operation	-40 ... 70 °C (-40 ... 158 °F) short-time 85 °C (185 °F)
Ambient temperature range: Storage and transport	-40 ... 90 °C (-40 ... 194 °F)
Temperature at enclosure	Max. 95 °C (203 °F)
Relative humidity (operation, storage, and transport)	
Annual mean value	≤ 75 %
Continuous operation	15 ... 75 %
Continuously for 30 days a year	75 ... 95 %
Occasionally on the other days	95 ... 100 %

12.15 Further Data

Terminals	Push-in two-tier terminals, pluggable
Conductor cross-sections	0.2 ... 1.5 mm^2 AWG 24 ... 16, Fine-stranded with ferrule or solid
Cable types	Shielded cables
Degree of protection according to EN 60529	Input, IP20 Output, IP20
Mechanical load Shock and vibration according to EN 61373, IEC 61373	Category 1, Class B Tested by independent test laboratory
MTBF	> $2.6 \cdot 10^6$ h (383 FIT per channel)
Service life according to EN 50155	20 years, L4 according to EN 50155
Useful operating life according to EN 13849	20 years
Weight	Approx. 170 g

13 Appendix

13.1 Standards and Directives

The devices have been developed in compliance with the following standards and directives:

Directives	
Directive 2014/30/EU (EMC)	
Directive 2014/35/EU (Low voltage)	
Directive 2011/65/EU (RoHS)	
Directive 2012/19/EU (WEEE)	
Regulation (EC) No. 1907/2006 (REACH)	
Standards	
Rail applications	EN 50155, EN 50153
Resistance to vibration and shock	EN 61373, IEC 61373
Fire protection	EN 45545-1, EN 45545-2, EN 45545-5
EMC	EN 50121-1, EN 50121-3-2
Functional safety	EN 50129
Isolation requirements	EN 50124-1
Climate	EN 50125-1
Industrial applications	EN 61010-1
EMC	EN IEC 61326-1
Isolation requirements	EN 61010-1, EN IEC 60664-1
Restriction of Hazardous Substances/RoHS	EN IEC 63000
Electrical safety and fire protection (Canada)	CAN/CSA-C22.2 No. 61010-1-12
Electrical safety and fire protection (USA)	UL 61010-1, UL File: E340287

The current standards and directives may differ from those specified here. The standards applied are documented in the Declaration of Conformity and the corresponding certificates. You can find these at www.knick.de under the corresponding product.

13.2 Material Evaluation

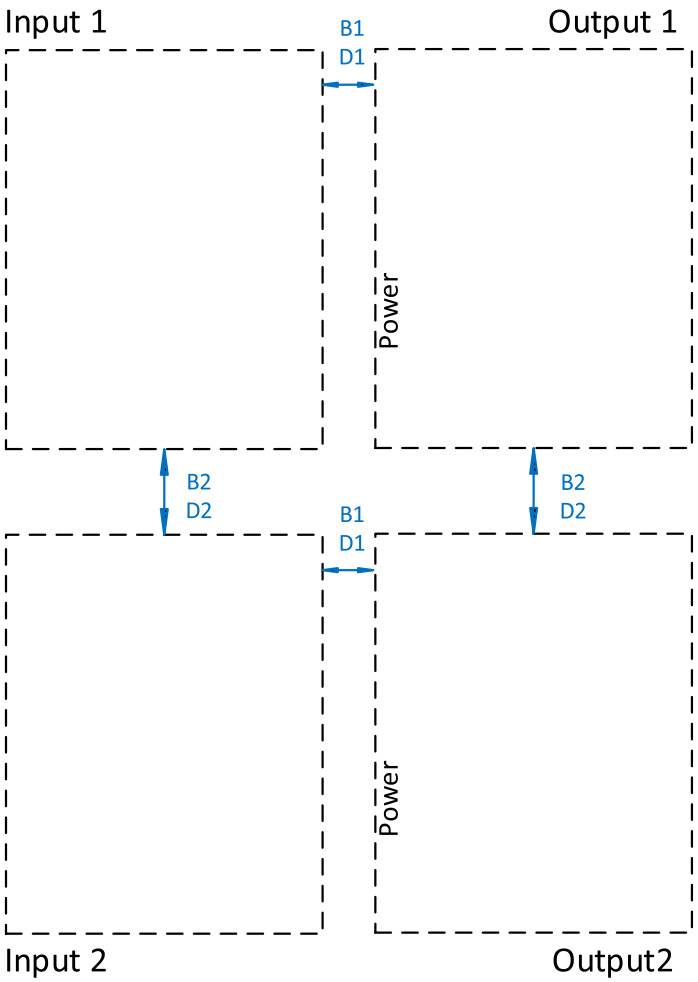
Fire protection

The product does not contain flammable materials according to EN 45545. The product is certified for interior and exterior applications up to hazard level HL3 certified according to EN 45545-2. This was confirmed by a notified body.

Protective coating

All assembled printed circuit boards were provided with a protective coating of class PC2 on both sides..

13.3 Details on Isolation, Isolating Distances, Contamination and Overvoltage



Rated isolation voltages (excerpt)

Section	Actual value [mm]		ISO	OV	PD	≤ Altitude [km]		Rated isolation voltage [V]
	Clear-ance	Creep-age dis-tance				2	4	EN 50124-1, EN 60664-1, EN 61010-1, UL 61010-1
B1	11	11	B	III	2	x	x	1000
D1	11	11	D	II	2	x		1000
D1	11	11	D	III	2	x		600
D1	11	11	D	II	2	x	x	600
D1	11	11	D	III	2	x	x	300
B2 [1) 2)]	3	3	B	III	2	x		300
D2 [1) 2)]	3	3	D	II	2	x		300
D2 [1) 2)]	3	3	D	II	2	x	x	150

Legend:

D: Reinforced insulation

B: Basic insulation

OV: Overvoltage category

PD: Pollution degree

1) No galvanic isolation of outputs in versions with DOT.

2) No galvanic isolation of inputs when the two inputs are connected in parallel.

14 Abbreviations

AWG	American Wire Gauge
CE	Conformité Européenne (European conformity)
CH	Channel: 1-channel or 2-channel version of a product
DIP	Dual Inline Package: Slide switch with position ON and OFF
DOT	Direction of travel
FFR	Functional Failure Rate (failure rate of a product)
f_{in}	Frequency of the input signal
FIT	Failures in Time (failures per 10^9 hours)
f_{out}	Frequency of the output signal
GND	Ground
GND (output 1)	Common ground at output for U_{B1}, V_{S1}, SW_1
GND (output 2)	Common ground at output for U_{B2}, V_{S2}, SW_2
I	Current input
I_B	Current into terminal V_B
I_{GND}	Current from terminal GND
I_{out}	Output current
I_s	Current into terminal V_S
NC	Normally closed contact
Out	Output
OV	Overvoltage category
PD	Pollution degree
PELV	Protective extra low voltage
P_{max}	Maximum power output used by the device
R_L	Resistance at output
R_{max}	Maximum resistance value
Screen, SHLD	Shield (input/output)
SELV	Safety extra low voltage
SIL	Safety integrity level
SW	Switch (switching output)
$t_{10...90}$	Rise time from 10 ... 90 % of voltage curve
t_{99}	Response time: Time from the start of an event at the input until the output signal has reached 99 % of its value.
U	Voltage input
U_B	Voltage supply (output driver)
UL	Underwriter Laboratories® (recognized testing body and certification body)
U_S	Voltage supply speed sensor, input side, definition of the level detection of the voltage supply
V_S	Voltage supply/power supply

Index

Q

R

S

T

V

W

Notes

Knick
Elektronische Messgeräte
GmbH & Co. KG

Headquarters
Beuckestraße 22 • 14163 Berlin
Germany
Phone: +49 30 80191-0
Fax: +49 30 80191-200
info@knick.de
www.knick.de

Local Contacts
www.knick-international.com

Translation of the original instructions

Version 3 • This document was published on September 15, 2022.
The latest documents are available for download on our
website under the corresponding product description.

TA-257.401-KNEN03

099635