

# Inline terminal with one analog output

**R911170602**  
Edition 03

## Data sheet R-IB IL AO 1/SF-PAC

1 analog output  
2-conductor technology  
0 - 20 mA, 4 - 20 mA  
0 - 10 V

04 / 2023



## 1 Description

The terminal is designed for use within an Inline station.  
It is used to output analog current and voltage signals.

### Features

- 1 analog output for the connection of either voltage or current signals
- Connection of actuators in 2-conductor technology
- Current ranges: 0 mA ... 20 mA, 4 mA ... 20 mA
- Voltage range: 0 V ... 10 V
- Process data update including conversion time of the digital/analog converter < 1 ms

### NOTICE Terminal overheating

- Only assign one output to the terminal.
- Connect the actuator via the shield plug.



This data sheet is only valid in association with the "Automation terminals of the Inline product range" application description (DOK-CTRL-ILSYSINS\*\*\*-AW..-EN-P, MNR R911317021).



Make sure you always use the latest documentation.

It can be downloaded under  
[www.boschrexroth.com/electrics](http://www.boschrexroth.com/electrics).

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### 3 Ordering data

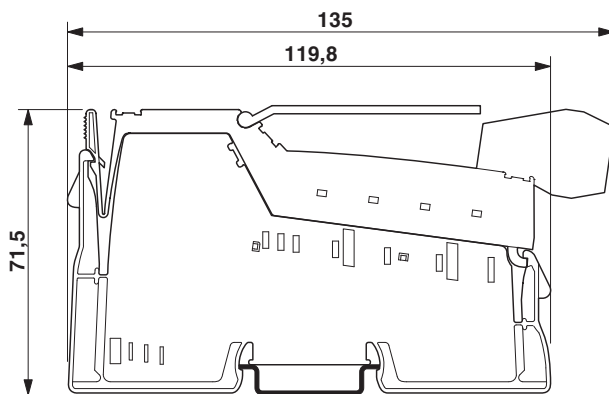
Description	Type	MNR	Pcs./Pkt.
Inline terminal with one analog output for either voltage or current signals; complete with accessories (plugs and labeling fields); plugs are numbered individually	R-IB IL AO 1/SF-PAC	R911170787	1
Documentation	Type	MNR	Pcs./Pkt.
Application description	DOK-CONTRL-ILSYSINS***-	R911317021	1
Automation terminals of the Inline product range	AW...-EN-P		

#### Additional ordering data

For additional ordering data (accessories), please refer to the product catalog at [www.boschrexroth.com/electrics](http://www.boschrexroth.com/electrics).

### 4 Technical data

#### Dimensions (nominal sizes in mm)



Width	24.4 mm
Height	135 mm
Depth	71.5 mm

#### General data

Color	gray
Weight	126 g (with connectors)
Operating mode	Process data mode with one word
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III (IEC 61140, EN 61140, VDE 0140-1)
Overvoltage category	II (IEC 60664-1, EN 60664-1)
Degree of pollution	2 (IEC 60664-1, EN 60664-1)
Mounting type	DIN rail mounting

**Connection data: Inline connector**

Connection method	Spring-cage connection
Conductor cross section, rigid	0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup>
Conductor cross section, flexible	0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup>
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

**Interface: Inline local bus**

Number of interfaces	2
Connection method	Inline data jumper
Transmission speed	500 kbps

**Communications power (U<sub>L</sub>)**

Supply voltage	7.5 V DC (via voltage jumper)
Current consumption	typ. 30 mA max. 40 mA

**Supply of analog modules (U<sub>ANA</sub>)**

Supply voltage	24 V DC (via voltage jumper)
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current consumption	typ. 50 mA max. 65 mA

**Power consumption**

Power consumption	typ. 1.425 W (total) max. 1.86 W (total)
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**Analog output**

Number of outputs	1
Connection technology	2-conductor, shielded
Current output signal	0 mA ... 20 mA, 4 mA ... 20 mA
Voltage output signal	0 V ... 10 V
D/A converter resolution	16 bit
Representation of output values	16-bit straight binary
Process data update	< 1 ms
Load/output load current output	< 500 Ω
Load/output load voltage output	> 2 kΩ
Tolerance, relative	typ. 0.15 % (of output range final value, current range 0 mA ... 20 mA) typ. 0.25 % (of output range final value, current range 4 mA ... 20 mA) typ. 0.3 % (of output range final value, voltage range 0 V ... 10 V) see tables for tolerance values
Settling time	< 0.15 ms (>99 % of final value, voltage output with R <sub>L</sub> = 10 kΩ)
Transient protection of outputs	yes

**Programming data (INTERBUS, local bus)**

ID code (hex)	7D
ID code (dec.)	125
Length code (hex)	01
Length code (dec)	01
Process data channel	16 Bit
Input address area	0 Byte
Output address area	2 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	16 Bit



For the programming data/configuration data for other bus systems, refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

**Configuration and parameter data in a PROFIBUS system**

Required parameter data	4 Byte
Required configuration data	4 Byte

**Error messages to the higher level control or computer system**

Failure of or insufficient communications power $U_L$	I/O error message sent to the bus coupler
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**Electrical isolation/isolation of the voltage areas**

Test section	Test voltage
7.5 V supply (bus logic), 24 V supply $U_{ANA}$ / I/O	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logic), 24 V supply $U_{ANA}$ / functional ground	500 V AC, 50 Hz, 1 min.
I/O/functional ground	500 V AC, 50 Hz, 1 min.

**Approvals**

For the current approvals, please visit [www.boschrexroth.com/electrics](http://www.boschrexroth.com/electrics).

## 5 Additional technical data

### 5.1 Mechanical requirements

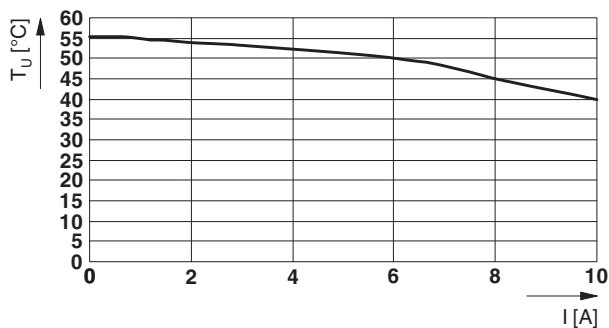
The following data deviates from the specifications in the “Automation terminals of the Inline product range” application description (DOK-CTRL-ILSYSINS\*\*\*-AW..-EN-P, MNR R911317021).

#### Mechanical tests

Shock in accordance with EN 60068-2-27/IEC 60068-2-27    15g load for 11 ms, half sinusoidal wave, three shocks per space direction and orientation  
25g load for 6 ms, half sinusoidal wave, three shocks per space direction and orientation

### 5.2 Derating

Fig. 1    Derating: permissible ambient temperature depending on the current in the potential jumpers  $U_M$  and  $U_S$  (total current)



Where:

$T_A$  [°C]    Ambient temperature in °C

$I$  [A]    Current through the potential jumpers  $U_M$  and  $U_S$  in A

### 5.3 Tolerance specifications



All percentage tolerance values refer to the relevant positive output range final value. Unless stated otherwise, nominal operation (nominal voltage, preferred mounting position) is used as the basis. The tolerance values refer to the operating temperature range specified in the tables. The operable range outside this temperature range is not taken into consideration. Please also take into consideration the tolerances influenced by electromagnetic interference.

The maximum tolerance values represent the worst-case measurement inaccuracy. They contain the theoretical maximum possible tolerances in the output range sections as well as the theoretical maximum possible tolerances of the calibration and test equipment.

#### 5.3.1 Tolerance and temperature response of the voltage output

The tolerance values refer to the output range final value of 10 V.

	Typical	Maximum
<b>Tolerance at 23°C</b>		
Total offset voltage	±0.03%	±0.05 %
Tolerance through gain	±0.10 %	±0.15 %
Differential non-linearity	±0.0012 %	±0.003 %
Total tolerance	±0.15 %	±0.25 %
<b>Temperature and drift response (T<sub>A</sub> = -25°C ... +55°C)</b>		
Offset voltage drift T <sub>KVO</sub>	±10 ppm/K	±65 ppm/K
Gain drift T <sub>KG</sub>	±30 ppm/K	±35 ppm/K
Total voltage drift T <sub>Ktot</sub> = T <sub>KVO</sub> + T <sub>KG</sub>	±40 ppm/K	±100 ppm/K
Total tolerance (tolerance through offset, gain, linearity, and drift)	±0.30 %	±0.60 %

#### 5.3.2 Tolerance and temperature response of the current output (0 mA ... +20 mA)

The tolerance values refer to the output range final value of 20 mA.

	Typical	Maximum
<b>Tolerance at 23°C</b>		
Offset current	±0.05 %	±0.15 %
Tolerance through gain	±0.09 %	±0.25 %
Differential non-linearity	±0.0012 %	±0.003 %
Total tolerance	±0.15 %	±0.25 %
<b>Temperature and drift response (T<sub>A</sub> = -25°C ... +55°C)</b>		
Offset current drift T <sub>KIO</sub>	±25 ppm/K	±65 ppm/K
Gain drift T <sub>KG</sub>	±10 ppm/K	±35 ppm/K
Total current drift T <sub>Ktot</sub> = T <sub>KIO</sub> + T <sub>KG</sub>	±35 ppm/K	±100 ppm/K

#### 5.3.3 Tolerance and temperature response of the current output (+4 mA ... +20 mA)

The tolerance values refer to the output range final value of 20 mA.

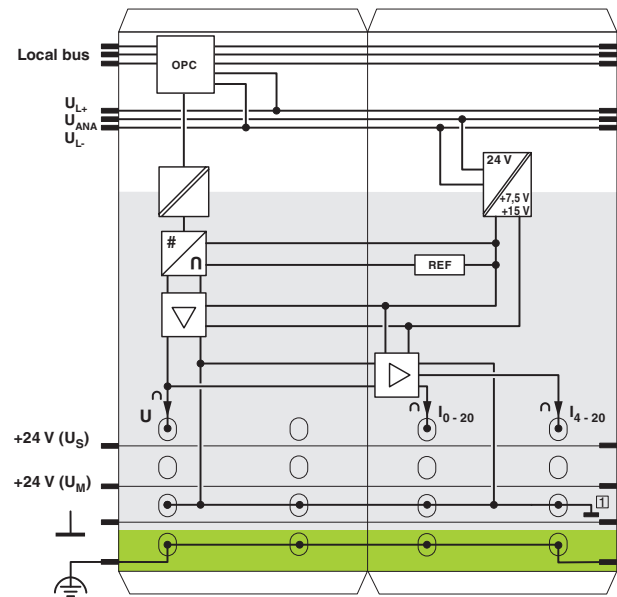
	Typical	Maximum
<b>Tolerance at 23°C</b>		
Offset current	±0.15 %	±0.45 %
Tolerance through gain	±0.25 %	±0.45 %
Differential non-linearity	±0.003 %	±0.005 %
Total tolerance	±0.25 %	±0.46 %
<b>Temperature and drift response (T<sub>A</sub> = -25°C ... +55°C)</b>		
Offset current drift T <sub>KIO</sub>	±28 ppm/K	±70 ppm/K
Gain drift T <sub>KG</sub>	±15 ppm/K	±40 ppm/K
Total current drift T <sub>Ktot</sub> = T <sub>KIO</sub> + T <sub>KG</sub>	±43 ppm/K	±110 ppm/K

### 5.3.4 Additional tolerances influenced by electromagnetic interference








Type of electromagnetic interference	Criterion	Typical deviation in % referencing the output range final value
Electromagnetic fields; field strength 10 V/m in accordance with EN 61000-4-3/IEC 61000-4-3	A	< 1 %
Conducted disturbances, Class 3 (10 V test voltage) in accordance with EN 61000-4-6/IEC 61000-4-6	A	< 6 %
Fast transients (burst) in accordance with EN 61000-4-4 / IEC 61000-4-4	B	< 1 %


## 6 Internal circuit diagram

Fig. 2 Internal wiring of the terminal points



Key:

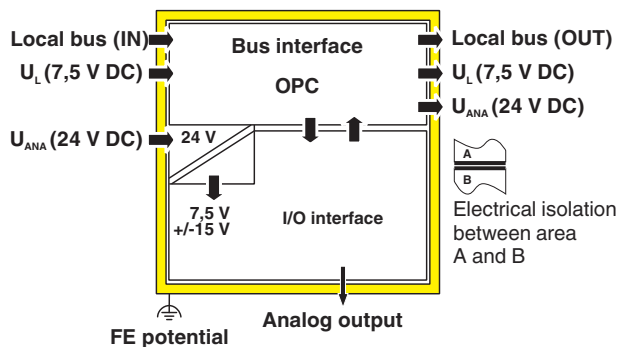
	Protocol chip (Bus logic including voltage conditioning)
	Electrical isolation for data or power supply
	Digital/analog converter
	Output amplifier
	Reference voltage source
	Analog ground, electrically isolated from ground of the potential jumper
	Electrically isolated areas

 For an explanation of the other symbols used, please refer to the “Automation terminals of the Inline product range” application description (DOK-CONTRL-ILSYSINS\*\*\*-AW..-EN-P, MNR R911317021).



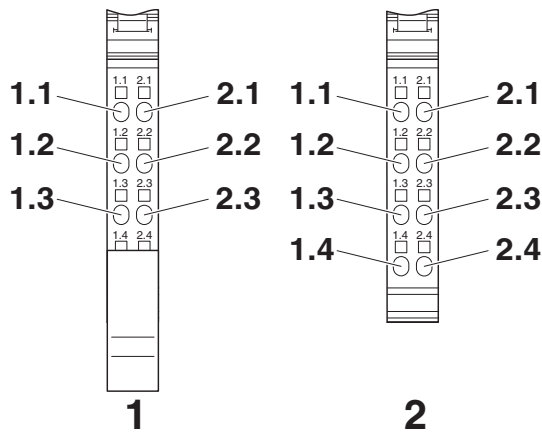
## 7 Electrical isolation

Fig. 3 Electrical isolation of the individual function areas



## 8 Terminal point assignment

Fig. 4 Terminal point assignment



Terminal point	Signal	Meaning
<b>Connector 1</b>		
1.1	U	Voltage output 0 V to 10 V
2.1	-	Not used
<b>Connector 2</b>		
1.1	I	Current output 0 mA to 20 mA
2.1	I	Current output 4 mA to 20 mA
<b>Connector 1 and 2</b>		
1.2, 2.2	-	Not used
1.3, 2.3	AGND	Analog ground
1.4, 2.4	Shield	Shield connection

### NOTICE Terminal overheating

- Only assign one output to the terminal.
- Connect the actuator via the shield plug.

## 9 Installation instructions

High current flowing through potential jumpers  $U_M$  and  $U_S$  leads to a temperature rise in the potential jumpers and inside the terminal. To keep the current flowing through the potential jumpers of the analog terminals as low as possible, always place the analog terminals after all the other terminals at the end of the main circuit (for the sequence of the Inline terminals: see "Automation terminals of the Inline product range" application description (DOK-CONTRL-ILSYSINS\*\*\*-AW..-EN-P, MNR R911317021).

## 10 Connection notes

Always connect the analog actuators using shielded twisted-pair cables.

Connect one side of the shielding on the Inline terminal to functional ground.

To do so, fold the shield on the cable back at the terminal. Connect the shield to the terminal via the shield connection clamp.

The shield is connected directly to functional ground on the terminal side via the clamp.

Recommendation: When using cables longer than 10 m in environments prone to interference, also connect the shield on the actuator to the functional ground potential via an RC element.

The capacitor C should typically have values of 1 nF to 15 nF. The resistor R should have a resistance of at least 10 MΩ.

Use an I/O plug with shield connection when installing the actuator. On the base side that is not used to connect an actuator, you may use one the plug without shield connection.

11 Connection examples


 Use a connector with shield connection when installing the actuator.

Fig. 5 Actuator at the voltage output

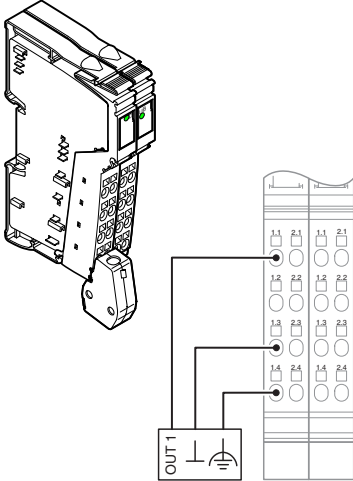
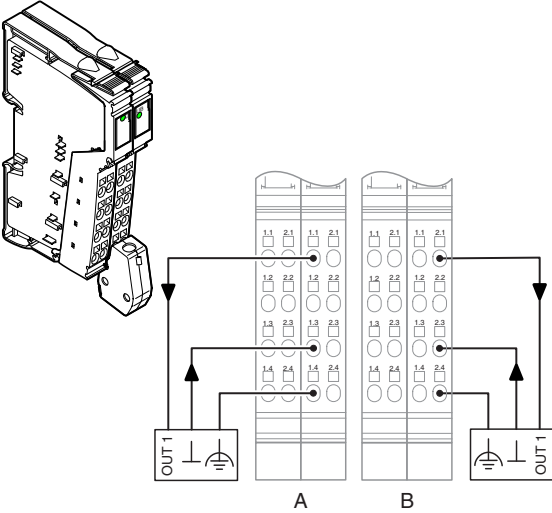


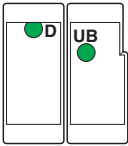
Fig. 6 Actuator at the current output




- A Current output 0 mA ... 20 mA
- B Current output 4 mA ... 20 mA

12 Local diagnostic and status indicators

Fig. 7 Local diagnostic and status indicators



Designation	Color	Meaning
D	green	Diagnostics (bus and logic voltage)
UB	green	I/O voltage is present (current level)

 For more detailed information on diagnostics, please refer to the “Automation terminals of the Inline product range” application description (DOK-CONTRL-ILSYSINS\*\*\*-AW...-EN-P, MNR R911317021).

Function identification

Yellow

13 Process data

The terminal uses one word of output process data. The process data output word transmits the output value in each cycle. All output values are represented in 16 bits.

(Word.bit) view	Word	Word 0		
	Bit	15	...	0
Connector 1	Terminal point (signal)	1.1: voltage output		
	Terminal point (GND)	1.3, 2.3		
	Terminal point (shield/FE)	1.4, 2.4		
Connector 2	Terminal point (signal)	1.1: current output 0 mA ... 20 mA		
		2.1: current output 4 mA ... 20 mA		
	Terminal point (GND)	1.3, 2.3		
	Terminal point (shield/FE)	1.4, 2.4		

## 14 Significant values

Abbreviations used in the following tables

QS	Quantization step(s)
ORF	Output range final value
Bit 15	Most significant bit (MSB)
Bit 0	Least significant bit (LSB)

### Process data output word for the voltage output 0 V ... 10 V (example)

Voltage output 0 V ... 10 V	Analog value [V]	Process data output word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
10 V - 1 QS	9.99985	FFFF	11111111	11111111
10 V - 2 QS	9.99969	FFFE	11111111	11111110
1/2 ORF	5.0000	8000	10000000	00000000
1 QS	0.153 mV	0001	00000000	00000001
Zero	0.0000	0000	00000000	00000000


### Process data output word for the current output 0 mA ... 20 mA (example)

Current output 0 mA ... 20 mA	Analog value [mA]	Process data output word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
20 mA - 1 QS	19.9997	FFFF	11111111	11111111
20 mA - 2 QS	19.9994	FFFE	11111111	11111110
1/2 ORF	10.000	8000	10000000	00000000
1 QS	0.305 $\mu$ A	0001	00000000	00000001
Zero	0.0000	0000	00000000	00000000

### Process data output word for the current output 4 mA ... 20 mA (example)

Current output 4 mA ... 20 mA	Analog value [mA]	Process data output word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
20 mA - 1 QS	19.99998	FFFF	11111111	11111111
20 mA - 2 QS	19.99995	FFFE	11111111	11111110
1/2 ORF	12.0000	8000	10000000	00000000
4 mA + 1 QS	4.000244	0001	00000000	00000001
Output range start	4.0000	0000	00000000	00000000


15 Output behavior

 When configuring your system, take into account output behavior in the event of an error.

Output behavior depending on the state of the power supply

Switching operation/state of the supply voltage	Marginal condition	OUT process data word [hex]	Behavior/status of the analog output		
			0 V ... 10 V	0 mA ... 20 mA	4 mA ... 20 mA
U <sub>ANA</sub> from 0 V to 24 V	U <sub>L</sub> = 0 V	xxxx	0 V	0 mA	4 mA
U <sub>ANA</sub> from 24 V to 0 V	U <sub>L</sub> = 7.5 V	xxxx	0 V	0 mA	0 mA
Bus in stop state	U <sub>ANA</sub> = 0 V	xxxx	0 V	0 mA	0 mA
Bus in stop state	U <sub>ANA</sub> = 24 V	xxxx	Hold last value		

- U<sub>ANA</sub>      Analog supply voltage of the terminal  
U<sub>L</sub>        Supply voltage for module electronics (communications power)  
xxxx      Any value in the range from 0000<sub>hex</sub> ... FFFF<sub>hex</sub>

 The behavior of the output depends on the output used.