

# Rexroth Inline analog input terminal, 4 inputs for connecting current signals

**R911336655**  
Edition 01

## Data sheet R-IB IL AI 4/I-PAC

4 analog differential inputs  
2-wire technology  
0 - 20 mA, 4 - 20 mA

04 / 2014



## 1 Description

The terminal is designed for use within an Inline station.

It is used to acquire analog current signals.

## Features

- 4 analog differential input channels for connecting current signals
- Connection of sensors in 2-wire technology
- Current ranges: 0 mA ... 20 mA, 4 mA ... 20 mA
- Mean-value generation of the inputs
- Process data update of all channels in 250  $\mu$ s
- Diagnostic and status indicators



This data sheet is only valid in association with the "Automation terminals of the Rexroth Inline product range" application description (DOK-CONTRL-ILSYS-INS\*\*\*-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

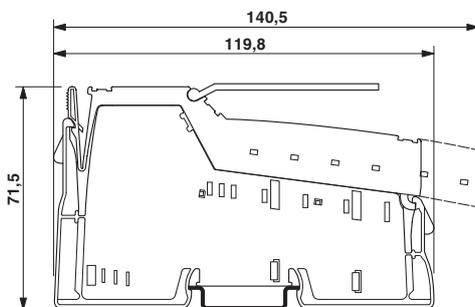
Description	Type	MNR	Pcs. / Pkt.
Rexroth Inline analog input terminal, complete with accessories (connector and marking field), inputs: 0 - 20 mA, 4 - 20 mA, 2-conductor connection technology	R-IB IL AI 4/I-PAC	R911172894	1
Documentation	Type	MNR	Pcs. / Pkt.
Application description	DOK-CONTRL-ILSYSINS***-	R911317021	1
Automation terminals of the Rexroth 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	12.2 mm
Height	119.8 mm
Depth	71.5 mm
Note on dimensions	Housing dimensions
General data	
Color	gray
Weight	66 g (with connector)
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (according to DIN EN 61131-2)
Permissible humidity (storage/transport)	10 % ... 95 % (according to DIN EN 61131-2)
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
Connection data	
Designation	Inline connector
Connection method	Spring-cage connection
Conductor cross section solid / stranded	0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup> / 0.2 mm <sup>2</sup> ... 1.5 mm <sup>2</sup>
Conductor cross section [AWG]	24 ... 16

**Interface Inline local bus**

Connection method	Inline data jumper
Transmission speed	500 kBit/s
Transmission physics	Copper

**Inline potentials / Power consumption**

Communications power $U_L$	7.5 V DC (via voltage jumper)
Current consumption from $U_L$	typ. 55 mA
I/O supply voltage $U_{ANA}$	24 V DC
Current consumption from $U_{ANA}$	typ. 30 mA
Power consumption	typ. 0.94 W (total)

**Analog inputs**

Number of inputs	4 (differential inputs, current)
Connection method	2-wire
Current input signal	0 mA ... 20 mA , 4 mA ... 20 mA
Resolution A/D	12 bit
A/D conversion time	max. 6.5 $\mu$ s
Measured value representation	13 bits (12 bits + sign bit)
Data formats	IB IL, S7-compatible
Process data update	typ. 250 $\mu$ s (all channels)
Filtering	None or mean-value generation over 4, 16, or 32 measured values
Input resistance current input	typ. 113 $\Omega$
Limit frequency (3 dB)	300 Hz
Open circuit response	Going to 0 mA; open-circuit detection from 4 mA ... 20 mA
Permissible voltage	max. 5.2 V (between positive and negative current connection; corresponds to 50 mA, maximum, through the resistance detectors)

**Programming Data**

ID code (hex)	7F
ID code (dec.)	127
Length code (hex)	04
Length code (dec.)	04
Process data channel	64 Bit
Input address area	8 Byte
Output address area	8 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	64 Bit

**Fieldbus data telegram**

Required parameter data	10 Byte
Need for configuration data	5 Byte

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

Failure of the internal I/O supply	I/O error message sent to the bus coupler
I/O supply failure	Message in the diagnostic code (in the IB IL format)
Overrange or underrange	Message in the diagnostic code (in the IB IL format)
Configuration invalid	Message in the diagnostic code (in the IB IL format)

**Electrical isolation/isolation of the voltage areas**

Test section	Test voltage
5 V supply, incoming remote bus/7.5 V supply (bus logics)	500 V AC, 50 Hz, 1 min
5 V supply, outgoing remote bus/7.5 V supply (bus logics)	500 V AC, 50 Hz, 1 min
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 earth ground	500 V AC, 50 Hz, 1 min
I/O / functional earth ground	500 V AC, 50 Hz, 1 min



To achieve electrical isolation between the logic level and the I/O area, supply these areas from separate power supply units. Connecting the supply devices in the 24 V area is not permitted (see also the "Automation terminals of the Rexroth Inline product range" application description (DOK-CONTRL-ILSYSINS\*\*\*-AW...-EN-P, MNR R911317017)).

**Conformance with EMC Directive 2004/108/EC****Noise immunity test in accordance with EN 61000-6-2**

Electrostatic discharge (ESD) EN 61000-4-2/ IEC 61000-4-2	Criterion B; 6 kV contact discharge, 8 kV air discharge
Electromagnetic fields EN 61000-4-3/IEC 61000-4-3	Criterion A; Field intensity: 10 V/m
Fast transients (burst) EN 61000-4-4/IEC 61000-4-4	Criterion B, 2 kV
Transient surge voltage (surge) EN 61000-4-5/ IEC 61000-4-5	Criterion B; supply lines DC: $\pm 1$ kV/ $\pm 1$ kV (symmetrical/asymmetrical); shielded I/O cables: $\pm 1$ kV
Conducted interference EN 61000-4-6/IEC 61000-4-6	Criterion A; Test voltage 10 V

**Noise emission test according to EN 61000-6-3**

Radio interference properties EN 55022	Class A
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**Approvals**

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

## 5 Tolerance data

### The following applies for tolerance values:

The data is valid for nominal operation ( $U_A = 24\text{ V}$  in the default configuration (unless documented otherwise)).

Default configuration: 16-sample mean-value, IB IL format

Tolerances at $T_A = 25^\circ\text{C}$ ; 500 kbps, without mean-value				
	Absolute		Relative	
	Typ.	Max.	Typ.	Max.
0 mA ... 20 mA,	$\pm 60\ \mu\text{A}$	$\pm 120\ \mu\text{A}$	$\pm 0.3\%$	$\pm 0.6\%$
4 mA ... 20 mA		A		

Typical data contains offset error, gain error, and linearity error in the respective default setting.

All tolerances indicated as a percentage are related to the positive measuring range final value.

Please also observe the values for temperature drift and the tolerances under influences of electromagnetic interferences.

Tolerance and temperature response at $T_A = -25^\circ\text{C} \dots +55^\circ\text{C}$		
	Drift	
	Typical	Maximum
0 mA ... 20 mA,	$\pm 100\ \text{ppm/K}$	$\pm 140\ \text{ppm/K}$
4 mA ... 20 mA		

The drift values refer to the relevant measuring range final value.

Tolerances influenced by electromagnetic interference		
Electromagnetic fields	EN 61000-4-3/ IEC 61000-4-3	$< \pm 1.0\%$
Fast transients (burst)	EN 61000-4-4/ IEC 61000-4-4	$< \pm 1.0\%$
Conducted interference	EN 61000-4-6/ IEC 61000-4-6	$< \pm 1.0\%$

Additional tolerances may occur due to the influence of high-frequency electromagnetic interference caused by wireless transmission systems in the near vicinity. The values specified refer to nominal operation in the event of direct interference to components without additional shielding such as a steel cabinet, etc.

The above mentioned tolerances can be reduced by providing further shielding measures for the I/O module (e.g., use of a shielded control box/control cabinet, etc.).

### 6 Internal circuit diagram

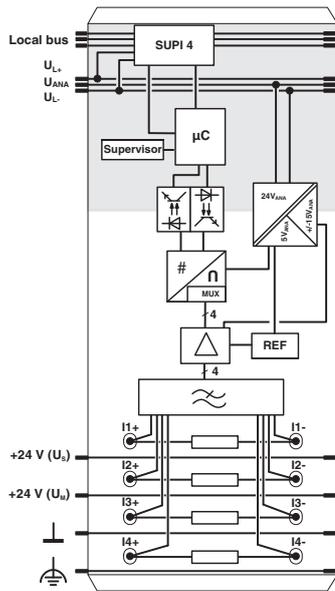
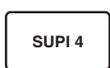


Fig. 1 Internal wiring of the terminal points

Key:

-  Protocol chip
-  Microprocessor
-  Hardware monitoring
-  Optocoupler
-  Power supply unit with electrical isolation
-  Analog-digital converter with integrated multiplexer
-  Input amplifier
-  Low pass filter
-  Electrically isolated area
-  Reference voltage source



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

### 7 Electrical isolation

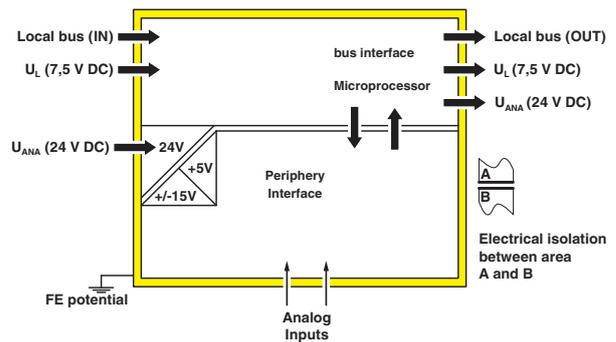


Fig. 2 Electrical isolation of the individual function areas

### 8 Terminal point assignment

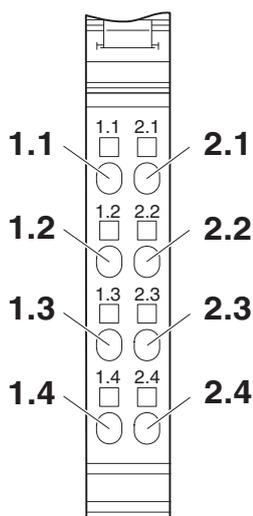


Fig. 3 Terminal point assignment

Terminal point	Signal	Meaning
1.1	+I1	Positive current connection for channel 1
1.2	+I2	Positive current connection for channel 2
1.3	+I3	Positive current connection for channel 3
1.4	+I4	Positive current connection for channel 4
2.1	-I1	Negative current connection for channel 1
2.2	-I2	Negative current connection for channel 2
2.3	-I3	Negative current connection for channel 3
2.4	-I4	Negative current connection for channel 4

### 9 Connection notes

Always connect the analog sensors using shielded, twisted pair cables.  
 Connect the shielding with the shielding accessories given in the ordering data.  
 Insulate the shielding at the sensor or connect it with a high resistance and a capacitor to the PE potential.

### 10 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 also "Automation terminals of the Rexroth Inline product range" application description (DOK-CONTRL-ILSY-SINS\*\*\*-AW...-EN-P, MNR R911317021).

### 11 Connection examples

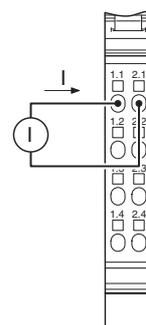


Fig. 4 Connection for current measurement

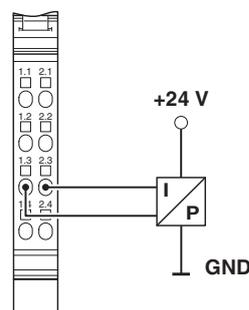


Fig. 5 Passive pressure sensor at a differential current input

## 12 Local status and diagnostic indicators

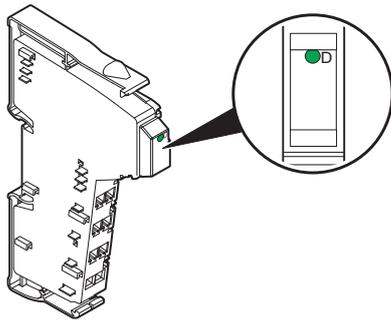


Fig. 6 Local status and diagnostic indicators

Designation	Color	Meaning
D	green	Diagnostics (bus and logic voltage)



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

### Function identification

Green

## 13 Process data

The terminal uses four input process data words and four output process data words.

Each channel is mapped to a word.

The analog values are transmitted via the input process data.

The configuration is specified via the output process data.

### 13.1 OUT process data

The terminal can be configured channel-by-channel with the output process data.

Order of the process data words:

OUT0	OUT1	OUT2	OUT3
Channel 1	Channel 2	Channel 3	Channel 4

Assignment of the configuration words (OUT0 ... OUT3):

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Config-uration	0	0	0	0	0	Filter		0	0	For-mat		Measur-ing range			

### Bit 15

Code (bin)	Configuration
0	Do not accept
1	Accept

The configuration specified in the word is accepted if bit 15 is set. If bit 15 is not set, the last accepted configuration is used.

The configuration is not saved retentively in the terminal.

It is therefore not necessary to transmit the configuration constantly. That means, bit 15 must not be set constantly.

If bit 15 remains set, the transmitted configuration is compared with the configuration of the terminal in every bus cycle.

The terminal is reconfigured if the configurations are different.

Please make sure that the configuration is sent from the master to the terminal in the event of a restart.

**Bit 9 ... 8**

Code (bin)	Filter
00	<b>16-sample mean-value (default)</b>
01	No filter
10	4-sample mean-value
11	32-sample mean-value

**Bits 5 ... 4**

Code	Format
00	<b>IB IL (default setting)</b>
10	S7-compatible
Other	Reserved

See also Section "Measured value representation in the different formats".

**Bits 3 ... 0**

Code	Measuring range
0100	<b>0 mA ... 20 mA (default)</b>
0110	4 mA ... 20 mA
Other	Reserved

**13.2 IN process data**

The measured values and diagnostic messages (in the IB IL format) are transmitted channel-by-channel to the PLC via the process data input words IN0 to IN3.

Order of the process data words:

IN0	IN1	IN2	IN3
Channel 1	Channel 2	Channel 3	Channel 4

The measured values are transmitted in the IB IL format or in the S7-compatible format (see Section "Measured value representation in the different formats").

**13.3 Read firmware version**

OUT0																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment (hex)	3				C				0				0			
Meaning	Read firmware version															

To read the firmware version transmit the value  $3C00_{\text{hex}}$  in the output data word OUT0. The words OUT1 ... OUT3 still contain the configuration words for channels 2 to 4.

In response you get the firmware version in input data word IN0. The input data of the associated channels are transmitted in the other input data words.

IN0																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment (hex)	1				2				3				3			
Meaning	Firmware version 1.23												Device ID			

The device ID allows you to distinguish between two devices with the same programming data (ID code, length code).

Inline terminal	ID code	Length code	Device ID
R-IB IL AI 4/I-PAC	$7F_{\text{hex}}$	$04_{\text{hex}}$	3
R-IB IL AI 4/U-PAC	$7F_{\text{hex}}$	$04_{\text{hex}}$	6

## 14 Measured value representation in the different formats

### 14.1 IB IL format

The measured value is represented in bits 14 to 3.  
An additional bit (bit 15) is available as a sign bit.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value												X	X	X

- V Sign bit  
X This bit can have the value 0 or 1. The bit is always 0 when a measured value is transmitted. The bit can have the value 1 only when a diagnostic code is transmitted.

### Significant measured values

Input data		0 mA ... 20 mA	4 mA ... 20 mA
hex	dec	mA	mA
8001	Overrange	> 21.675	> 21.339
7F00	32512	21.675	21.339
7530	30000	20.0	20.0
0008	8	0.00533	4.00427
0000	0	≤ 0	4.0 ... 3.2
8002	Open circuit	-	< 3.2

In the IB IL format a diagnostic code is mapped to the input data in the event of an error.

Code (hex)	Cause
8001	Measuring range exceeded (overrange)
8002	Open circuit
8004	Measured value invalid/no valid measured value available
8010	Configuration invalid
8020	Faulty supply voltage
8040	Device faulty

### 14.2 S7-compatible format

The measured value is represented in bits 14 to 3.  
An additional bit (bit 15) is available as a sign bit.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value												0	0	0

- V Sign bit

### Significant measured values

Input data		0 mA ... 20 mA	4 mA ... 20 mA
hex	dec	mA	mA
7FFF	Overrange	> 23.513	> 23.513
7EF8	32504	23.513	22.810
6C00	27648	20.0	20.0
0008	8	0.00579	4.00463
0000	0	≤ 0	4.0
FFF8	-8	-	3.999537
9400	-27648	-	3.0
8000	Open circuit	-	< 1.1852

The value 8000<sub>hex</sub> is specified in S7-compatible format for all errors for which diagnostic codes 8001<sub>hex</sub> to 8040<sub>hex</sub> are output in IB IL format.