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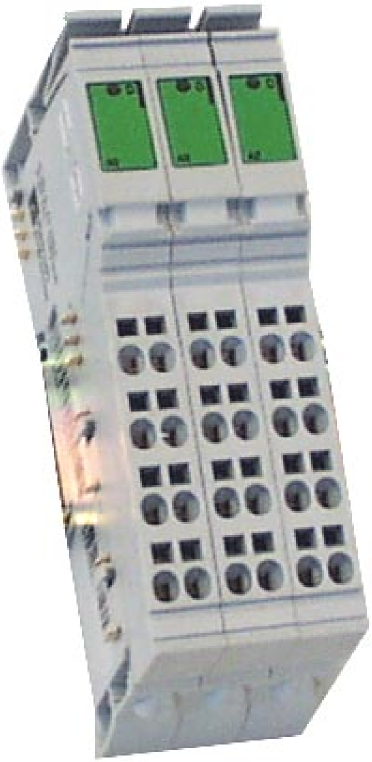

RECO Inline
Analog I/O Terminals

Functional Description

SYSTEM200

DOK-CONTRL-R-IL*AIO***-FK02-EN-P

Rexroth Indramat

Title RECO Inline
Analog I/O Terminals

Type of Documentation Functional Description

Document Typecode DOK-CONTRL-R-IL*AIO***-FK02-EN-P

Internal File Reference Document Number, 120-0400-B343-02/EN

Purpose of Documentation This documentation serves

- as general information for the module terminals,
- to specify technical data,
- to specify diagrams and formulas,
- as reference book for detailed information.

Record of Revisions

Description	Release Date	Notes
120-0400-B343-02/EN	09/02	First English issue

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Published by Rexroth Indramat GmbH
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Note This document has been printed on chlorine-free bleached paper.

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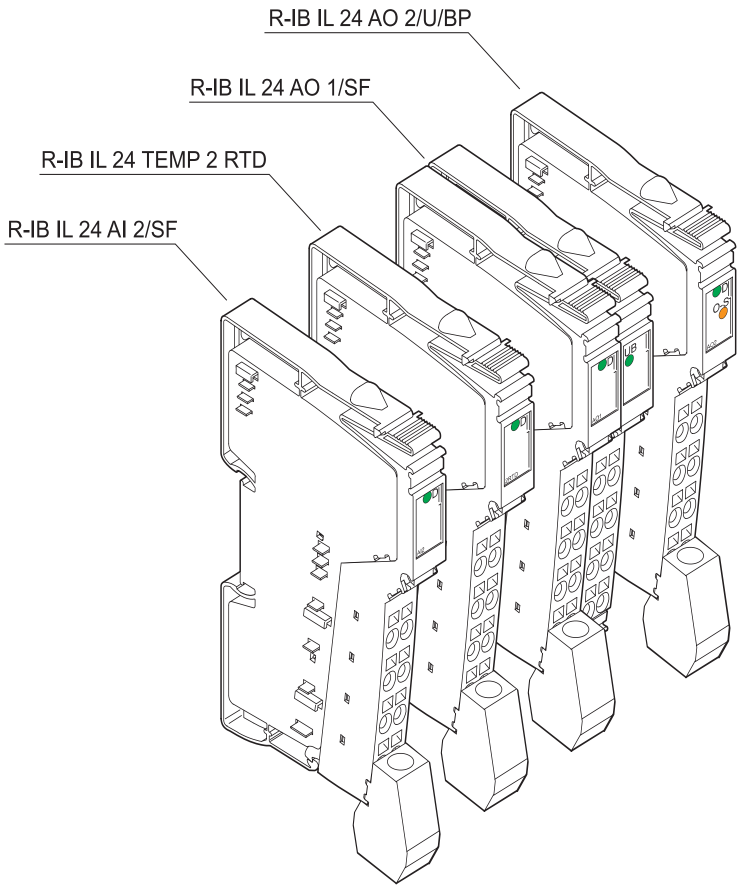
1 Presentation of the System

1.1 Overview



System.bmp

Fig. 1-1: Remote bus terminals and supply modules

The description includes the following components:

- INTERBUS Inline terminal with two analog input channels
  R-IB IL 24 AI 2/SF
- INTERBUS Inline terminal with two analog input terminals for the connection of variable temperature multipliers (RTD)
  R-IB IL 24 TEMP 2 RTD
- INTERBUS Inline terminal with an analog output R-IB IL 24 AO 1/SF
- INTERBUS Inline terminal with two analog voltage outputs
  R-IB IL 24 AO 2/U/BP

Note: This function description is valid only in connection with the application description "Project Planning and Installation of the Product Family RECO-Inline "DOK-CONTRL-R-IB-IL*IBSSYS" or "DOK-CONTRL-R-IB-IL*PBSSYS"

2 Important Directions for Use

2.1 Appropriate Use

Introduction

Rexroth Indramat products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: Rexroth Indramat, as manufacturer, is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth Indramat products, make sure that all the pre-requisites for appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

Areas of Use and Application

The RECO Inline system is a decentralized modular fieldbus-coupled input and output system.

The RECO Inline system by Rexroth Indramat is intended for the cases of use listed below.

- Machine tools
- Transfer systems
- General automation

Note: The RECO Inline system may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant functional descriptions.

The typical fields of application of RECO Inline modules are as follows:

- Turning machines
- Milling machines
- Machining centers
- General automation

The RECO Inline system may only be operated under the assembly, installation and ambient conditions as described here (temperature, system of protection, humidity, EMC requirements, etc.) and in the position specified.

2.2 Inappropriate Use

Using the RECO Inline system outside of the above-referenced areas of application or under operating conditions other than described in the document and the technical data specified is defined as "inappropriate use".

The RECO Inline system may not be used if

- they are subject to operating conditions that do not meet the above specified ambient conditions. This includes, for example, operation under water, in the case of extreme temperature fluctuations or extreme maximum temperatures or if

Rexroth Indramat has not specifically released them for that intended purpose. Please note the specifications outlined in the general Safety Instructions!

3 Safety Instructions for Electric Drives and Controls

3.1 Introduction

Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

Do not attempt to install or start up this equipment without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation of the equipment prior to working with the equipment at any time. If you do not have the user documentation for your equipment, contact your local Rexroth Indramat representative to send this documentation immediately to the person or persons responsible for the safe operation of this equipment.

If the equipment is resold, rented or transferred or passed on to others, then these safety instructions must be delivered with the equipment.

WARNING

Improper use of this equipment, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

3.2 Explanations

The safety instructions describe the following degrees of hazard seriousness in compliance with ANSI Z535. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions.

Warning symbol with signal word	Degree of hazard seriousness according to ANSI
DANGER	Death or severe bodily harm will occur.
WARNING	Death or severe bodily harm may occur.
CAUTION	Bodily harm or material damage may occur.

Fig. 3-1: Hazard classification (according to ANSI Z535)

3.3 Hazards by Improper Use

DANGER	**High voltage and high discharge current! Danger to life or severe bodily harm by electric shock!**
DANGER	**Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!**
WARNING	**High electrical voltage due to wrong connections! Danger to life or bodily harm by electric shock!**
WARNING	**Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!**
CAUTION	**Surface of machine housing could be extremely hot! Danger of injury! Danger of burns!**
CAUTION	**Risk of injury due to improper handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock or incorrect handling of pressurized systems!**
CAUTION	**Risk of injury due to incorrect handling of batteries!**

3.4 General Information

- Rexroth Indramat GmbH is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Only persons who are trained and qualified for the use and operation of the equipment may work on this equipment or within its proximity.
  - The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and equipment on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The equipment is designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Use only safety features and applications that are clearly and explicitly approved in the Project Planning Manual.
  For example, the following areas of use are not permitted: construction cranes, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, transport of hazardous goods, nuclear applications, applications sensitive to high frequency, mining, food processing, control of protection equipment (also in a machine).
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
  The machine and installation manufacturer must
  - make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  - make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

- Operation is only permitted if the national EMC regulations for the application are met.
  The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
  The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.

3.5 Protection Against Contact with Electrical Parts

Note: This section refers to equipment and drive components with voltages above 50 Volts.

Touching live parts with voltages of 50 Volts and more with bare hands or conductive tools or touching ungrounded housings can be dangerous and cause electric shock. In order to operate electrical equipment, certain parts must unavoidably have dangerous voltages applied to them.

DANGER

High electrical voltage! Danger to life, severe bodily harm by electric shock!

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain or repair this equipment.

⇒ Follow general construction and safety regulations when working on high voltage installations.

⇒ Before switching on power the ground wire must be permanently connected to all electrical units according to the connection diagram.

⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the ground wire is not permanently connected to the points of the components provided for this purpose.

⇒ Before working with electrical parts with voltage higher than 50 V, the equipment must be disconnected from the mains voltage or power supply. Make sure the equipment cannot be switched on again unintended.

⇒ The following should be observed with electrical drive and filter components:

⇒ Wait five (5) minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Install the covers and guards provided with the equipment properly before switching the equipment on. Prevent contact with live parts at any time.

⇒ A residual-current-operated protective device (RCD) must not be used on electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.

⇒ Electrical components with exposed live parts and uncovered high voltage terminals must be installed in a protective housing, for example, in a control cabinet.

To be observed with electrical drive and filter components:

DANGER

High electrical voltage on the housing!
High leakage current! Danger to life, danger of injury by electric shock!

⇒ Connect the electrical equipment, the housings of all electrical units and motors permanently with the safety conductor at the ground points before power is switched on. Look at the connection diagram. This is even necessary for brief tests.

⇒ Connect the safety conductor of the electrical equipment always permanently and firmly to the supply mains. Leakage current exceeds 3.5 mA in normal operation.

⇒ Use a copper conductor with at least 10 mm² cross section over its entire course for this safety conductor connection!

⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. Otherwise, high voltages can occur on the housing that lead to electric shock.

3.6 Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 0 and 50 Volts on Rexroth Indramat products are protective low voltages designed in accordance with international standards on electrical safety.

WARNING

High electrical voltage due to wrong connections! Danger to life, bodily harm by electric shock!

⇒ Only connect equipment, electrical components and cables of the protective low voltage type (PELV = Protective Extra Low Voltage) to all terminals and clamps with voltages of 0 to 50 Volts.

⇒ Only electrical circuits may be connected which are safely isolated against high voltage circuits. Safe isolation is achieved, for example, with an isolating transformer, an opto-electronic coupler or when battery-operated.

3.7 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of the connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily injury and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

DANGER

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

⇒ Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. Unintended machine motion is possible if monitoring devices are disabled, bypassed or not activated.

⇒ Pay attention to unintended machine motion or other malfunction in any mode of operation.

⇒ Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:

- use safety fences
- use safety guards
- use protective coverings
- install light curtains or light barriers

⇒ Fences and coverings must be strong enough to resist maximum possible momentum, especially if there is a possibility of loose parts flying off.

⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the machine if the emergency stop is not working.

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a starting lockout to prevent unintentional start.

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone. Safe standstill can be achieved by switching off the power supply contactor or by safe mechanical locking of moving parts.

⇒ Secure vertical axes against falling or dropping after switching off the motor power by, for example:

- mechanically securing the vertical axes
- adding an external braking/ arrester/ clamping mechanism
- ensuring sufficient equilibration of the vertical axes

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!

⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:

- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such equipment cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

3.8 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated near current-carrying conductors and permanent magnets in motors represent a serious health hazard to persons with heart pacemakers, metal implants and hearing aids.

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⇒ Persons with heart pacemakers, hearing aids and metal implants are not permitted to enter the following areas:

- Areas in which electrical equipment and parts are mounted, being operated or started up.
- Areas in which parts of motors with permanent magnets are being stored, operated, repaired or mounted.

⇒ If it is necessary for a person with a heart pacemaker to enter such an area, then a doctor must be consulted prior to doing so. Heart pacemakers that are already implanted or will be implanted in the future, have a considerable variation in their electrical noise immunity. Therefore there are no rules with general validity.

⇒ Persons with hearing aids, metal implants or metal pieces must consult a doctor before they enter the areas described above. Otherwise, health hazards will occur.

3.9 Protection Against Contact with Hot Parts

CAUTION

Housing surfaces could be extremely hot! Danger of injury! Danger of burns!

⇒ Do not touch housing surfaces near sources of heat! Danger of burns!

⇒ After switching the equipment off, wait at least ten (10) minutes to allow it to cool down before touching it.

⇒ Do not touch hot parts of the equipment, such as housings with integrated heat sinks and resistors. Danger of burns!

3.10 Protection During Handling and Mounting

Under certain conditions, incorrect handling and mounting of parts and components may cause injuries.

CAUTION

Risk of injury by incorrect handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock!

⇒ Observe general installation and safety instructions with regard to handling and mounting.

⇒ Use appropriate mounting and transport equipment.

⇒ Take precautions to avoid pinching and crushing.

⇒ Use only appropriate tools. If specified by the product documentation, special tools must be used.

⇒ Use lifting devices and tools correctly and safely.

⇒ For safe protection wear appropriate protective clothing, e.g. safety glasses, safety shoes and safety gloves.

⇒ Never stand under suspended loads.

⇒ Clean up liquids from the floor immediately to prevent slipping.

3.11 Battery Safety

Batteries contain reactive chemicals in a solid housing. Inappropriate handling may result in injuries or material damage.

CAUTION

Risk of injury by incorrect handling!

⇒ Do not attempt to reactivate discharged batteries by heating or other methods (danger of explosion and cauterization).

⇒ Never charge non-chargeable batteries (danger of leakage and explosion).

⇒ Never throw batteries into a fire.

⇒ Do not dismantle batteries.

⇒ Do not damage electrical components installed in the equipment.

Note: Be aware of environmental protection and disposal! The batteries contained in the product should be considered as hazardous material for land, air and sea transport in the sense of the legal requirements (danger of explosion). Dispose batteries separately from other waste. Observe the legal requirements in the country of installation.

3.12 Protection Against Pressurized Systems

Certain motors and drive controllers, corresponding to the information in the respective Project Planning Manual, must be provided with pressurized media, such as compressed air, hydraulic oil, cooling fluid and cooling lubricant supplied by external systems. Incorrect handling of the supply and connections of pressurized systems can lead to injuries or accidents. In these cases, improper handling of external supply systems, supply lines or connections can cause injuries or material damage.

CAUTION

Danger of injury by incorrect handling of pressurized systems !

⇒ Do not attempt to disassemble, to open or to cut a pressurized system (danger of explosion).

⇒ Observe the operation instructions of the respective manufacturer.

⇒ Before disassembling pressurized systems, release pressure and drain off the fluid or gas.

⇒ Use suitable protective clothing (for example safety glasses, safety shoes and safety gloves)

⇒ Remove any fluid that has leaked out onto the floor immediately.

Note: Environmental protection and disposal! The media used in the operation of the pressurized system equipment may not be environmentally compatible. Media that are damaging the environment must be disposed separately from normal waste. Observe the legal requirements in the country of installation.

Notes

4 R-IB IL 24 AI 2/SF (2 Analog Inputs)

4.1 General Notes

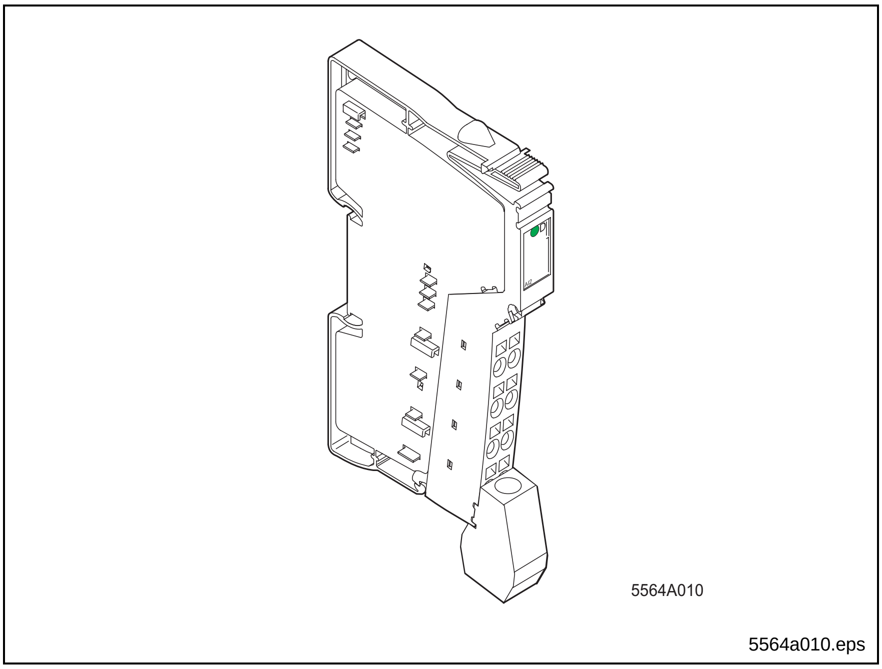


Fig. 4-1: Terminal R-IB IL 24 AI 2/SF with plugged-in connector

This terminal is used to record analog voltage and current signals.

Features

- Two analog single-ended signal inputs to connect voltage or alternatively current signals.
- Connection of the sensors in 2- and 3-wire method
- Three current measuring ranges:

  0 mA to 20 mA, ±20 mA, 4 mA to 20 mA
- Two voltage measuring ranges:

  0 V to 10 V, ±10 V
- Configuration of the channels, independent of each other, via INTERBUS
- The measured values can be represented in four different formats
- Resolution depends on the format of the representation and the measuring range
- Update of process data of both channels in a maximum of 1.5 ms
- Diagnostic indicators

Note: The connector is not included in the scope of delivery of the terminal. Please order the connector according to the ordering information.

Indicator Elements

Position of the Diagnostic Indicators

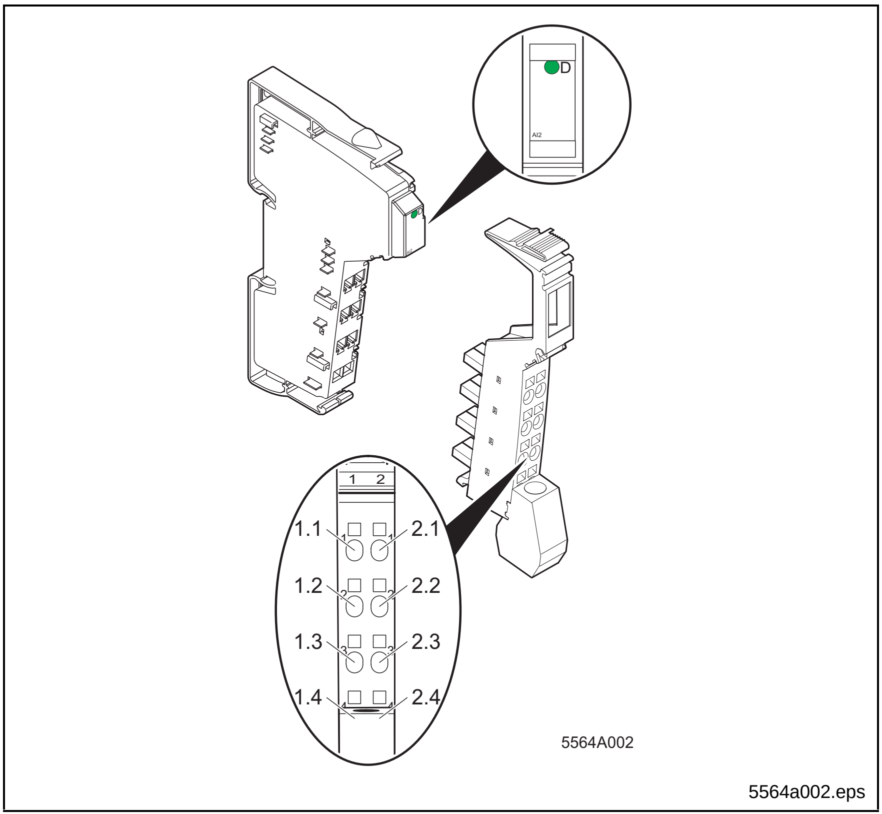


Fig. 4-2: Position of the diagnostic indicators R-IB IL 24 AI 2/SF

Meaning of the Diagnostic Indicators

Identification	Color	Meaning
D	Green	Bus diagnosis

Fig. 4-3: Meaning of the diagnostic indicators R-IB IL 24 AI 2/SF

4.2 Installation Instruction

A high current flowing through the voltage jumpers U_M and U_S results in the voltage jumpers heating up, thus increasing the temperature inside the terminals. To keep the current through the voltage jumpers of the analog terminals as low as possible, please observe the following instruction:

- Set up all analog terminals with a main circuit of their own!
- If this is impossible in your concrete case and you have to set up analog terminals in a main circuit together with other terminals, place the analog terminals behind all other terminals at the end of the main circuit.

4.3 Technical Data

General data		
Housing dimensions	12,2 x 120 x 71.5 mm without connector (W x H x D)	
Weight	47 g (without connector)	
Type of sensor connection	2- and 3-wire method	
Type of operation	Process data operation with 2 words	
Permissible temperature	Operation Storage/transport	-25°C to +55 °C -25 °C to +85 °C
Air humidity	Operation Storage/transport	75 % on average, 85 % occasionally 75 % on average, 85 % occasionally
Air pressure	Operation Storage/transport	80 kPa to 106 kPa (up to 2000 m above MSL) 76 kPa to 106 kPa (up to 3000 m above MSL)
Degree of protection	IP20 according to IEC 60529	
Protection class	Class 3, according to VDE 0106, IEC 60536	

Fig. 4-4: General technical Data R-IB IL 24 AI 2/SF

Information deviating from the common technical data according to the User Manual IB IL SYS PRO UM	
Immunity test according to EN 50082-2	
Discharge of static electricity (ESD) according to EN 61000-4-2; IEC 61000-4-2	Criterion B 6 kV contact discharge 6 kV air discharge
Mechanical requirements	
Shock test according to EN 60068-2-27; IEC 60068-2-27	Load 15 g over 11 ms, half sinusoidal wave, three shocks per room direction and orientation Load 25 g over 6 ms, half sinusoidal wave, three shocks per room direction and orientation

Fig. 4-5: Information deviating from the common technical data R-IB IL 24 AI 2/SF

Interface local bus	
Local bus interface	Data routing

Fig. 4-6: Technical Data R-IB IL 24 AI 2/SF

Performance balance	
Logic voltage U_L	7.5 V
Current input from U_L	Approx. 45 mA typical
Peripheral supply voltage U_{ANA}	24 V DC
Current input at U_{ANA}	12 mA typical
Total power input	625 mW typical

Fig. 4-7: Performance balance R-IB IL 24 AI 2/SF

Supply of module electronics and the periphery via the bus terminal/power terminal	
Connection method	Voltage routing

Fig. 4-8: Supply of module electronics and the periphery via the bus terminal/power terminal

Analog inputs				
Number		2 analog single-ended inputs		
Connection type of the signals		2-wire method, single-ended		
Signals/resolution in the process data word (quantization)				
Voltage	0 V to 10 V	0 V to 10.837 V	(Format IB IL)	0.333 mV/LSB
		0 V to 10,000 V	(Format IB ST)	2.441 mV/LSB
		0 V to 10,000 V	(Format IB RT)	0.305 mV/LSB
		0 V to 10.837 V	(Standardized representation)	1.000 mV/LSB
	±10 V	±10.837 V	(Format IB IL)	0.333 mV/LSB
		±10,000 V	(Format IB ST)	2.441 mV/LSB
		±10,000 V	(Format IB RT)	0.305 mV/LSB
		±10.837 V	(Standardized representation)	1.000 mV/LSB
Current	0 to 20 mA	0 to 21.6746 mA	(Format IB IL)	0.6666 µA/LSB
		0 to 20,000 mA	(Format IB ST)	4.8828 µA/LSB
		0 to 20,000 mA	(Format IB RT)	0.6105 µA/LSB
		0 to 21.6746 mA	(Standardized representation)	1.000 µA/LSB
	±20 mA	±21.6746 mA	(Format IB IL)	0.6666 µA/LSB
		±20.000 mA	(Format IB ST)	4.8828 µA/LSB
		±20.000 mA	(Format IB RT)	0.6105 µA/LSB
		±21.6746 mA	(Standardized representation)	1.000 µA/LSB
	4 to 20 mA	4 to 21.339 mA	(Format IB IL)	0.533 µA/LSB
		4 to 20,000 mA	(Format IB ST)	3.906 µA/LSB
		4 to 20,000 mA	(Format IB RT)	0.4884 µA/LSB
		4 to 21.339 mA	(Standardized representation)	1.000 µA/LSB
Representation of measured value		In the formats IB IL IB ST IB RT Standardized representation	 (15 bits with sign) (12 bits with sign) (15 bits with sign) (15 bits with sign)	
Averaging		More than 16 measuring values (can be switched off)		
Conversion time of the A/D transformer		Approx. 120 µs		

Fig. 4-9: Analog inputs R-IB IL 24 AI 2/SF

Analog input modules	
Voltage inputs	
Input resistor	> 220 kΩ
Cut-off frequency (-3 dB) of the input filters	40 Hz:
Process data update of both channels	< 1,5 ms
Behavior in case of sensor breakage	Running down to 0 V
Maximum admissible voltage between analog voltage inputs and analog reference potential	±32 V
Common-mode rejection (CMR)	90 dB minimum
Reference: Voltage input signal, valid for the admissible DC common-mode voltage range	110 dB (typical)
Admissible DC common-mode voltage for CMR	40 V between voltage input and FE
Current inputs	
Input resistor	50 Ω (variable multiplier))
Cut-off frequency (-3 dB) of the input filters	40 Hz:
Process data update of both channels	< 1,5 ms
Behavior in case of sensor breakage	Running down to 0 mA or 4 mA
Maximum admissible voltage between analog current inputs and analog reference potential	±5 V (corresponding to 100 mA above the feeler gauge)
Common-mode rejection (CMR)	90 dB minimum
Reference: Current input signal, valid for the admissible DC common-mode voltage range	110 dB (typical)
Admissible DC common-mode voltage for CMR	40 V between current input and FE
Maximum admissible current	±100 mA

Fig. 4-10: Analog input modules R-IB IL 24 AI 2/SF

Tolerance and temperature behavior of the voltage inputs (The data on tolerance refer to the upper output range value of 10 V.)		
	Typical	**Maximum**
Tolerance at 23°C		
Total offset voltage	±0,03 %	±0,06 %
Gain error	±0,05 %	±0,10 %
Differential non-linearity	±0,10 %	±0,20 %
Total tolerance of the voltage inputs at 23°COffset + amplification + linearity errors	**±0,15 %**	**±0,30 %**
Temperature behavior at –25°C to +55°C		
Offset drift T_{KVO}	±6 ppm/K	±12 ppm/K
Amplification drift T_{KG}	±30 ppm/K	±50 ppm/K
Total drift $T_{Kges} = T_{KVO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total tolerance of the voltage inputs (-25 °C to 55 °C) Offset + amplification + linearity + drift error	**±0,30 %**	**±0,50 %**
Tolerance and temperature behavior of the voltage inputs (The data on tolerance refer to the upper measuring range value of 20 mA.)		
	Typical	**Maximum**
Tolerance at 23°C		
Offset error	±0,03 %	±0,06 %
Gain error	±0,10 %	±0,10 %
Differential non-linearity	±0,10 %	±0,30 %
Total error of the current inputs at 23°C Offset + amplification + linearity error	**±0,20 %**	**±0,40 %**
Temperature behavior at –25°C to +55°C		
Offset drift T_{KIO}	±6 ppm/K	±12 ppm/K
Amplification drift T_{KG}	±30 ppm/K	±50 ppm/K
Total drift $T_{Kges} = T_{KIO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total tolerance of the current inputs (-25 °C to 55 °C) Offset + amplification + linearity + drift error	**±0,35 %**	**±0,60 %**

Fig. 4-11: Tolerance and temperature behavior R-IB IL 24 AI 2/SF

Additional tolerances under the influence of electromagnetic fields				
Type of electromagnetic interference	**Typical deviation from the upper measuring range value (voltage input)**		**Typical deviation from the upper measuring range value (current input)**	
	Relative	**Absolute**	**Relative**	**Absolute**
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3 / IEC 61000-4-3	< ±2 % mV	< ±200 mV	< ±2 %	< ±400 µA
Mains-borne disturbances Class 3 (test voltage 10 V) according to 61000-4-6 / IEC 61000-4-6	< ±1 %	< ±100 mV	< ±1 %	< ±100 µA
Quick transient disturbances (burst) supply 4 kV, input 2 kV according to EN 61000-4-4 / IEC 61000-4-4	< ±1 %	< ±100 mV	< ±1 %	< ±100 µA

Fig. 4-12: Additional tolerances under the influence of electromagnetic fields R-IB IL 24 AI 2/SF

Protective devices	
Overvoltage	Suppressor diodes in the analog inputs

Fig. 4-13: Protective devices R-IB IL 24 AI 2/SF

Error messages to the higher-level control or computer system	
Failure of the internal voltage supply	Yes
Peripheral / application error	Yes, error message via the process data input words

Fig. 4-14: Error messages to the higher-level control or computer system

4.4 Connections

Position of the Terminals

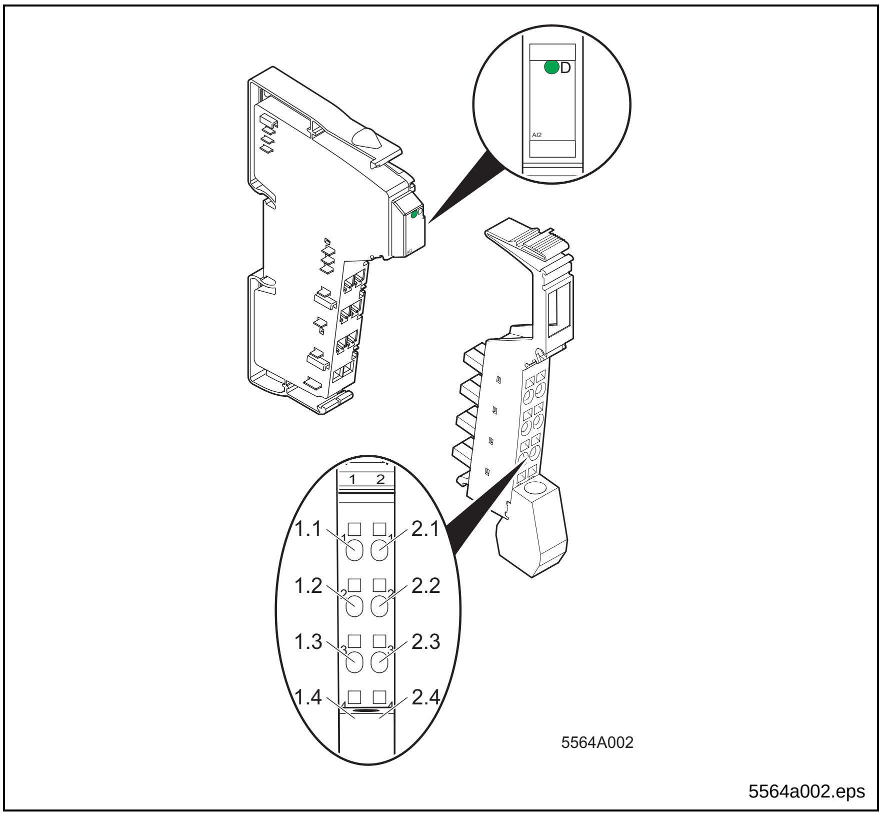


Fig. 4-15: Position of the terminals R-IB IL 24 AI 2/SF

Terminal Assignment

Terminal	Signal	Remark
1.1	+U1	Voltage input Channel 1
2.1	+U2	Voltage input Channel 2
1.2	+I1	Voltage input channel 1
2.2	+I2	Voltage input channel 2
1.3	-1	Minus input for channel 1 (common for current and voltage)
2.3	-2	Minus input for channel 2 (common for current and voltage)
1.4, 2.4	Shield	Shield connection

Fig. 4-16: Terminal assignment R-IB IL 24 AI 2/SF

Internal Block Diagram

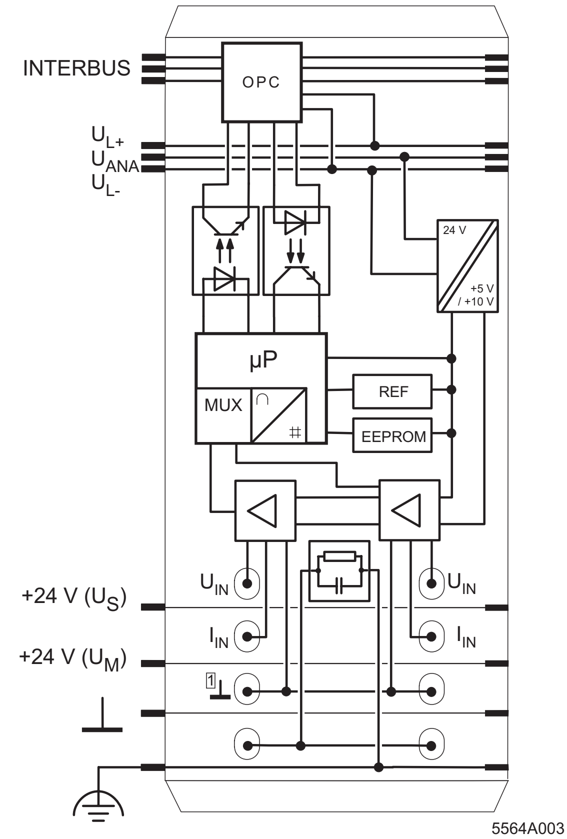


Fig. 4-17: Internal circuits of terminal points R-IB IL 24 AI 2/SF

Symbol Description

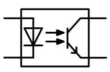
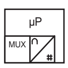
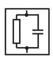
Symbol	Description
OPC	Protocol chip (bus logic including voltage treatment)
	Optocoupler
	Power supply unit with electrical isolation
	Microprocessor with multiplexer and analog-digital-transformer
REF	Reference voltage
EEPROM	Electrically erasable, re-programmable ROM
	Amplifier
	Coupling interface

Fig. 4-18: Symbol description

Notes on Connection

DANGER

Do not connect any voltages of more than ± 5 V to a current input. This would damage the electronics of the module as the permissible maximum current of ±100 mA would be exceeded.

Note: **Always** connect the analog sensors with twisted-pair and shielded lines.

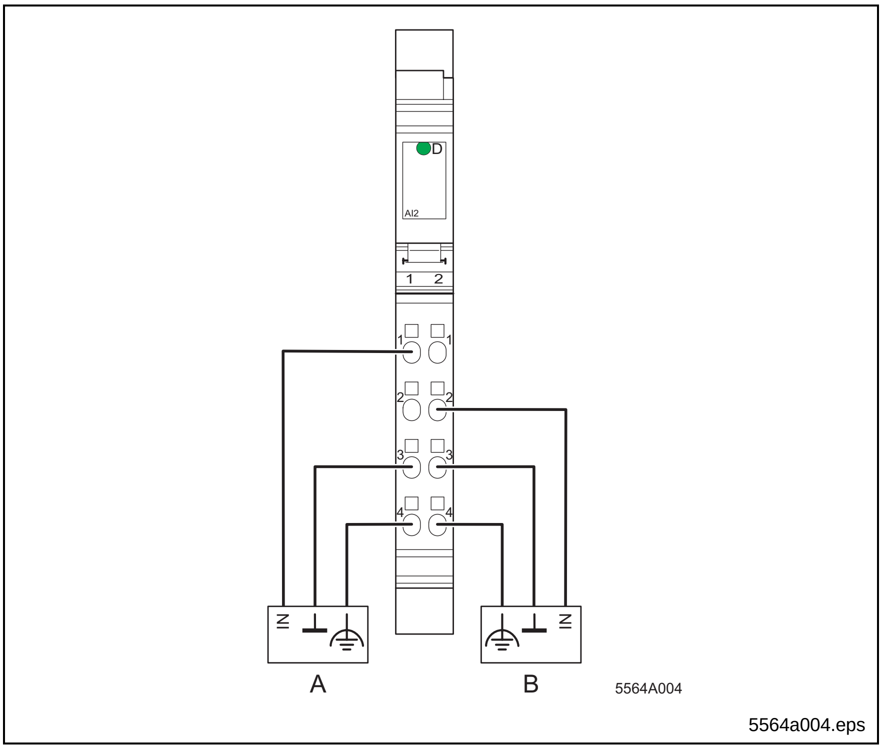
Connect the shield at the terminal via the shield connection clip. Through the clip, the shield is connected to FE at the module side capacitively and with a high-impedance value. No additional protective circuits are required.

Connect the shield system to the FE potential at the sensor.

Connection Examples

Note: Use the connector with the shield connection to connect the sensors. In Fig. 4-19 and Fig. 4-20, the connection is represented in a diagrammatic view (without the shield connection).

Connection of Active Sensors



L: A active sensor with voltage output (channel 1)
B active sensor with current output (channel 2)

Fig. 4-19: Connection of active sensors in 2-wire method with shield connection

Connection of Passive Sensors

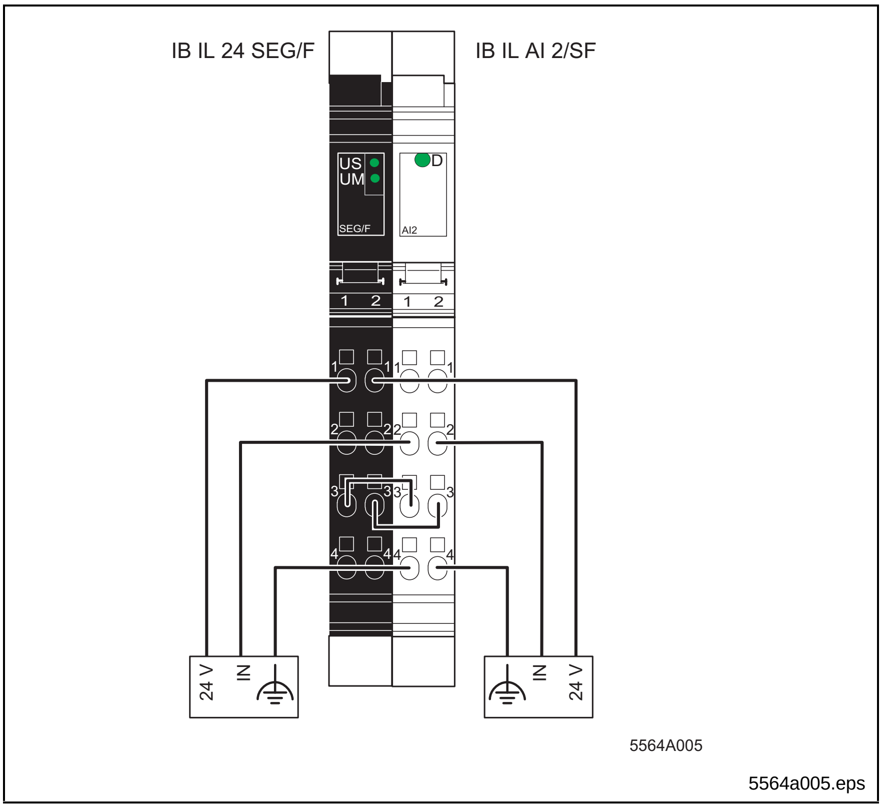


Fig. 4-20: Connection of two passive sensors in 2-wire method with shield connection

In Fig. 4-20, the supply of the passive sensors is represented. Here, supply takes place via a series-connected segment terminal with fuse. Alternatively, the sensors can be supplied via an external power supply unit.

Connection with Battery Monitoring

DANGER

Both reference inputs (minus inputs) of each terminal R-IB IL AI2/SF are connected to each other. With series connection of signal sources, faulty connection can cause short-circuit of individual signal sources.

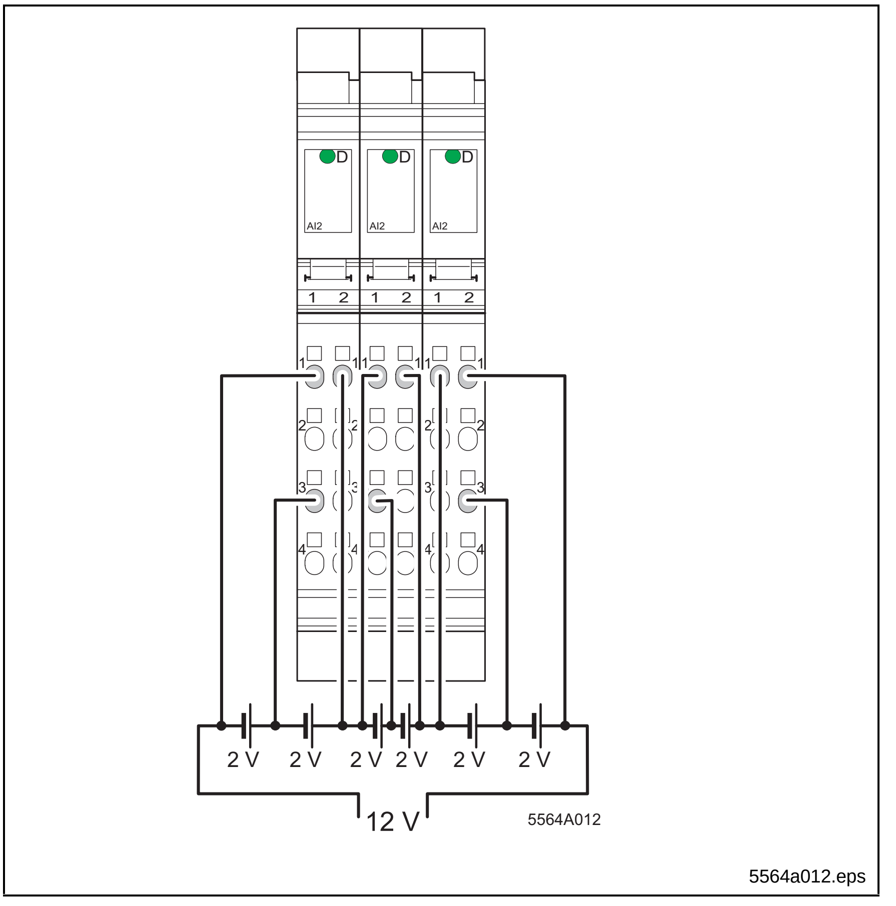


Fig. 4-21: Example of connection for battery monitoring

Because of the single-ended inputs, the series connection should be connected as follows:

Connect the reference input of a terminal between two voltage sources.

Then, channel 1 will measure the first voltage source with polarity reversal. The measured value must be adjusted to polarity within the control.

With correct polarity, channel 2 will measure the second voltage source. Configure the terminal as a bi-polar terminal (±10 V).

Programming Data

ID code	$07F_{hex}$ (127_{dec})
Length code	02_{hex}
Input address space	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

Fig. 4-22: Programming data R-IB IL 24 AI 2/SF

4.5 Process Data Words

Process Data Output Words for Configuration of the Terminal

INTERBUS reference	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			
Channel 2	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			

Fig. 4-23: Assignment of the process data output words for configuration of the terminal

Assignment of the Terminal Points to the Process Data Input Words

INTERBUS reference	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 1.1: Voltage input Terminal point 1.2: Current input															
	Signal reference	Terminal point 1.3															
	Shield (FE)	Terminal point 1.4															
Channel 2	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 2.1: Voltage input Terminal point 2.2: Current input															
	Signal reference	Terminal point 2.3															
	Shield (FE)	Terminal point 2.4															

Fig. 4-24: Assignment of the terminal points to the process data input words

Process Data Output Words

By means of the two process data output words, you can configure each channel of the terminal independently of the other channel. There are the following options for configuration:

- Selection of a measuring range according to the input signal
- Switching off averaging
- Changing over the representation formats of the measured values.

The configuration setting is not saved. It must be transferred in each BUS cycle.

After applying voltage (power up) to the Inline station, the message "Measured value invalid" (error code 8004_{hex}) will appear in the process data input words. After a maximum of 1 seconds, the preset configuration is taken over, and the first measured value is available.

On change of configuration, the respective channel is re-initialized. In the process data output words, the message "Measured value invalid" (error code 8004_{hex}) will appear for a maximum of 100 ms.

Preset values:

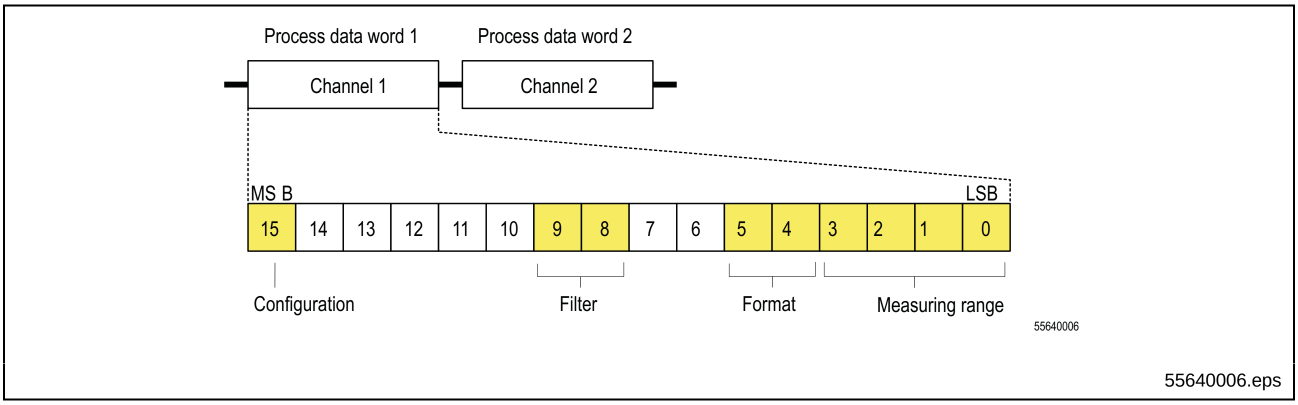
Measuring range:	0 V to 10 V
Averaging:	switched on
Output format:	IL format

Note: You cannot switch over the signal inputs via the process data output words. You decide whether to measure current or voltage by applying the measuring signal to the current or voltage input.

Additionally, select the respective measuring range by means of the process data output words.

Do not apply current and voltage signals simultaneously to one input channel; otherwise, you will not get any valid measured values.

DANGER



L: MSB Most Significant Bit
LSB Less Significant Bit

Fig. 4-25: Process data output words

One process data output word is available for configuring each channel.

To configure the terminal, set to 1 bit 15 of the respective output word. If bit 15 = 0, the preset configuration is active.

Bit 15				
Code	Configuration			
0	**Presetting**			
1	Configuration data			
Bit 5 and bit 4			**Bit 9 and bit 8**	
Code	Format		Code	Filter
00	**IB IL (15 bit) (preset)**		**00**	**Mean value times 16 (preset)**
01	IB ST (12 bit)		01	No filter
10	IB RT (15 bit)		10, 11	Reserved
11	Standardized representation			
Bit 3 to bit 0				
Code	Measuring range (voltage)		Code	Measuring range (current)
0000	**0 V to 10 V (preset)**		1000	0 mA to 20 mA
0001	±10 V		1001	±20 mA
0010 to 0111	Reserved		1010	4 mA to 20 mA
			1011 to 1111	Reserved

Fig. 4-26: Bit assignment of the output word

Note: Set all reserved bits to 0.

Process Data Input Words

For each channel, the measured values are transferred via the process data input words INTERBUS IN to the interface module or to the computer.

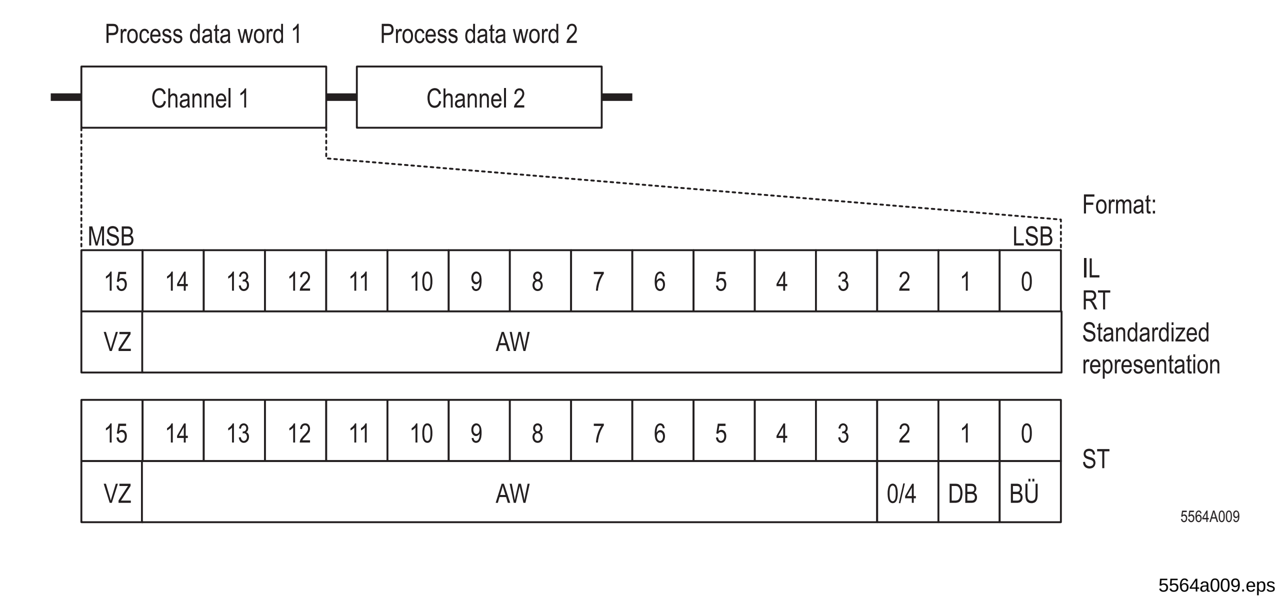


Fig. 4-27: Series of process data input words and representation of the bits of the first process data input word in the various formats.

Legend:

VZ Sign
AW Analog value
DB Wire breakage
BÜ Over-range
0/4 Measuring range 4 to 20 mA
MSB Most Significant Bit
LSB Less Significant Bit

The process data formats "IB IL" and "Standardized representation" support extended diagnosis.

The following **error codes** can occur:

Code (hex)	**Failure:**
8001	Out of measuring range (figure exceeds range)
8002	Wire breakage
8004	Measured value invalid/no valid measured value available
8010	Invalid configuration
8040	Module defect
8080	Out of measuring range (figure remains under range)

Fig. 4-28: Error codes process data input words

4.6 Formats for Representation of the Measured Values

Format "IB IL"

The measured value is represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

This format supports extended diagnosis. Values > 8000_{hex} signal an error. The error codes are listed in Fig. 4-28.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

55641008

55641008.eps

L: VZ Sign
AW Analog value

Fig. 4-29: Representation of measured value in the format "IB IL" (15 bit)

This is the preset format (default). To operate the terminal also in the data formats used up to now, the representation of measured values can be switched over to other formats.

Significant measured values

Note: Some codes are used for diagnosis functions. Accordingly, the resolution is not 15 bit, but mathematically exact 14.9886847 bit.

Measuring range 0 mA to 20 mA / 0 V to 10 V

Input data word (two's complement)		0 mA to 20mA I_{Input}	0 V to 10 V U_{nput}
hex	**dec**	**mA**	**V**
8001	Over-range	> +21,6746	> +10,837
7F00	32512	+21,6746	+10,837
7530	30000	+20,0	+10,0
0001	1	+0,66667 µA	+333,33 µV
0000	0	0	0
0000	0	< 0	< 0

Fig. 4-30: Measuring range 0 mA to 20 mA / 0 V to 10 V Format "IB IL"

Measuring range -20 mA to +20 mA / -10 V to +10 V

Input data word (two's complement)		-20 mA to 20mA I_{Input}	-10 V to 10 V U_{nput}
hex	**dec**	**mA**	**V**
8001	Over-range	> +21,6746	> +10,837
7F00	32512	+21,6746	+10,837
7530	30000	+20,0	+10,0
0001	1	+0,66667 µA	+333,33 µV
0000	-1	0	0
FFFF	0	-0.66667 µA	+333,33 µV
8AD0	-30000	-20,0	-10,0
8100	-32000	-21,6746	-10,837
8080	Figure is fallen below range	< -21,6746	< -10,837

Fig. 4-31: Measuring range -20 mA to +20 mA / -10 V to +10 V Format "IB IL"

Measuring range 4 to 20 mA

Input data word (two's complement)	4 mA to 20mA I_{Input}	
hex	**dec**	**mA**
8001	Over-range	> +21,339733
7F00	32512	+21,339733
7530	30000	+20,0
0001	1	+4,00053333
0000	0	+4.0 to 3.2
8002	Wire breakage	< +3,2

Fig. 4-32: Measuring range -20 mA to +20 mA / -10 V to +10 V Format "IB IL"

Format "IB ST"

The measured value is represented in the bits 14 to 3. The remaining 4 bits are available as sign, measuring range, and error bits.

This format corresponds to the data format used on the INTERBUS-ST modules.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW												0/4	DB	BÜ

55640007

55640007.eps

Fig. 4-33: Representation of measured value in the format "IB ST" (12 bit)

Legend:

VZ Sign

AW Analog value

DB Wire breakage

BÜ Over-range

0/4 Measuring range 4 to 20 mA

Significant measured values

Measuring range 0 mA to 20 mA / 0 V to 10 V

Input data word (two's complement)	0 mA to 20mA I_{Input}	0 V to 10 V U_{nput}
hex	**mA**	**V**
7FF9	> 21,5	> 10,75
7FF8	20.0 to 21.5	10.00 to 10.75
7FF8	19,9951	9,9975
4000	10,0	5,0
0008	0,0048828	0,002441
0000	0	0

Fig. 4-34: Measuring range 0 mA to 20 mA / 0 V to 10 V Format "IB ST"

Measuring range -20 mA to +20 mA / -10 V to +10 V

Input data word (two's complement)	-20 mA to 20mA I_{Input}	-10 V to 10 V U_{nput}
hex	**mA**	**V**
7FF9	> 21,5	> 10,75
7FF8	20.0 to 21.5	10.00 to 10.75
7FF8	19,9951	9,9975
0008	0,0048828	0,002441
0000	0	0
FFF8	-0,0048828	-0,002441
8000	-20.0 to -21.5	-10.00 to -10.75
8001	< -21,5	< -10,75

Fig. 4-35: Measuring range -20 mA to +20 mA / -10 V to +10 V Format "IB ST"

Measuring range 4 to 20 mA

Input data word (two's complement)	4 mA to 20mA I_{Input}
hex	**mA**
7FFD	> 21,5
7FFC	20.0 to 21.5
7FFC	19,9961
000C	4,003906
0004	3.2 to 4.0
0006	< 3,2

Fig. 4-36: Measuring range 4 mA to 20 mA format "IB ST"

Format "IB RT"

The measured value is represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

This format corresponds to the data format used on the INTERBUS-RT modules.

In this data format, no error codes or error bits are defined. Wire breakage is announced by the positive final value 7FFF.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

55641008

55641008.eps

L: VZ Sign
AW Analog value

Fig. 4-37: Representation of measured value in the format "IB RT" (15 bit)

Significant measured values

Measuring range 0 mA to 20 mA / 0 V to 10 V

Input data word (two's complement)	**0 mA to 20mA** I_{Input}	**0 V to 10 V** U_{nput}
hex	mA	V
7FFF	≥ 19,999385	≥ 9,999695
7FFE	19,9987745	9,999939
4000	10,0	5,0
0001	0.6105 µA	305.0 µV
0000	≤ 0	≤ 0

Fig. 4-38: Measuring range 0 mA to 20 mA / 0 V to 10 V Format "IB RT"

Measuring range -20 mA to +20 mA / -10 V to +10 V

Input data word (two's complement)	-20 mA to 20mA I_{Input}	-10 V to 10 V U_{nput}
hex	**mA**	**V**
7FFF	≥ +19,999389	≥ +9,999939
7FF7	+19,998779	+9,99939
4000	+10,0	+5,0
0001	+0.61035 µA	+305.0 µV
0000	0	0
FFFF	-0.61035 µA	-305.0 µV
8001	-19,999389	-9,99939
8000	≤ -20,0	≤ -10,0

Fig. 4-39: Measuring range -20 mA to +20 mA / -10 V to +10 V Format "IB RT"

Measuring range 4 to 20 mA

Input data word (two's complement)	4 mA to 20mA I_{Input}
hex	**mA**
7FFF	19,9995116
7FFE	19,9990232
4000	12,0
0001	0.4884 µA
0000	4,0
0000	3.2 to 4.0
7FFF	< 3,2

Fig. 4-40: Measuring range 4 mA to 20 mA format "IB RT"

Format "Standardized Representation"

The data are represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

In this format, the data are standardized on the measured range and represented to show the respective value without conversion. In this format, a bit has a value of 1 mV or 1 µA.

This format supports extended diagnosis. All values > 8000 hex signal an error. The error codes are listed in Fig. 4-28.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

55641008

55641008.eps

L: VZ Sign
AW Analog value

Fig. 4-41: Representation of measured value in the format "Standardized representation" (15 bit)

Significant Measured Values

Note: Because of the standardization of representation, not all potential codes are used. Additionally, some codes are used for diagnostic functions. Accordingly, the resolution is not 15 bit, but mathematically exact 13.287713 bit.

Measuring range 0 V to 10 V/ Measuring range 0 mA to 20 mA

Input data word (two's complement)		**0 V to 10 V U input**
hex	**dec**	**V**
8001	Over-range	> +10,837
2A55	10837	+10,837
2710	10000	+10,0
0001	1	+0,001
0000	0	≤0

Input data word (two's complement)		**0 mA to 20 mA I input**
hex	**dec**	**mA**
8001	Over-range	> +21,674
54AA	21674	+21,674
4E20	20000	+20,0
0001	1	+0,001
0000	0	≤0

Fig. 4-42: Measuring range 0 V to 10 V/ Measuring range 0 mA to 20 mA format "Standardized representation"

Measuring range -10 V to +10 V/ Measuring range -20 mA to +20 mA

Input data word (two's complement)		-10 V to 10 V U input
hex	**dec**	**V**
8001	Over-range	> +10,837
2A55	10837	+10,837
2710	10000	+10,0
0001	1	+0,001
0000	0	0
FFFF	-1	0,001
D8F0	-10000	-10,0
D5A6	10837	-10,837
8080	Figure is fallen below range	< -10,837

Input data word (two's complement)		-20 mA to 20 mA I input
hex	**dec**	**mA**
8001	Over-range	> +21,674
54AA	21674	+21,674
4E20	20000	+20,0
0001	1	+0,001
0000	0	0
FFFF	-1	-0,001
B1E0	-20000	-20,0
A656	-21674	-21,674
8080	Figure is fallen below range	< -21,674

Fig. 4-43: Measuring range -10 V to +10 V/ Measuring range -20 mA to +20 mA format "Standardized representation"

Input data word (two's complement)	4 mA to 20mA I_{Input}	
hex	**dec**	**mA**
8001	Over-range	> 21,339
43BB	17339	21,339
3E80	16000	20,0
0001	1	4,001
0000	0	4.0 to 3.2
8002	Wire breakage	< 3,2

Fig. 4-44: Measuring range 4mA to 20 mA Format "Standardized representation"

Example

Representation of a measured value in the various data formats.

Measuring range: 0 mA to 20 mA

Measured value 10 mA

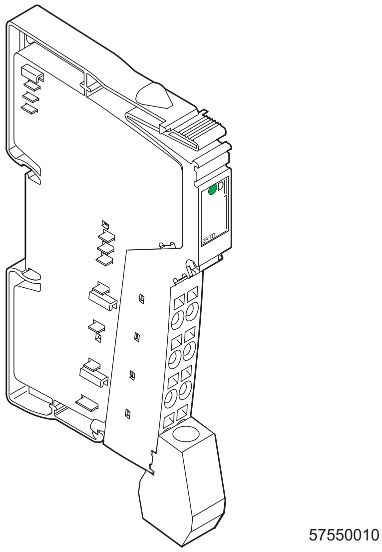
Input data word:

Format	Hex value	Dec value	Measured value
IB IL	3A98	15 000	10 mA
IB ST	4000	16 384	10 mA
IB RT	4000	16 384	10 mA
Standardized representation	2710	10 000	10 mA

Fig. 4-45: Input data word format "Standardized representation"

5 R-IB IL 24 TEMP 2 RTD (2 Temperatures Inputs)

5.1 General Notes



57550010.eps

Fig. 5-1: Terminal R-IB IL 24 TEMP 2 RTD with plugged-in connector

The terminal R-IB IL TEMP 2 RTD is provided for application within a RECO Inline station.

With this terminal, a two-channel input module for resistive temperature sensors is at your disposal. This terminal supports platinum and nickel sensors according to the DIN standard and the SAMA regulation. Additionally, the sensors CU10, CU50, CU53 as well as KTY81 and KTY84 are supported.

The measured temperature is represented via 16-bit values in two BUS data words (one word per channel).

Features

- Two inputs for resistive temperature sensors
- Configuration of the channels via BUS
- The measured values can be represented in three different formats
- Connection of the sensors in 2-, 3-, and 4-wire method

Note: The connector is not included in the scope of delivery of the terminal. Please order the connector according to the ordering information.

Indicator Elements

Position of the Diagnostic Indicators

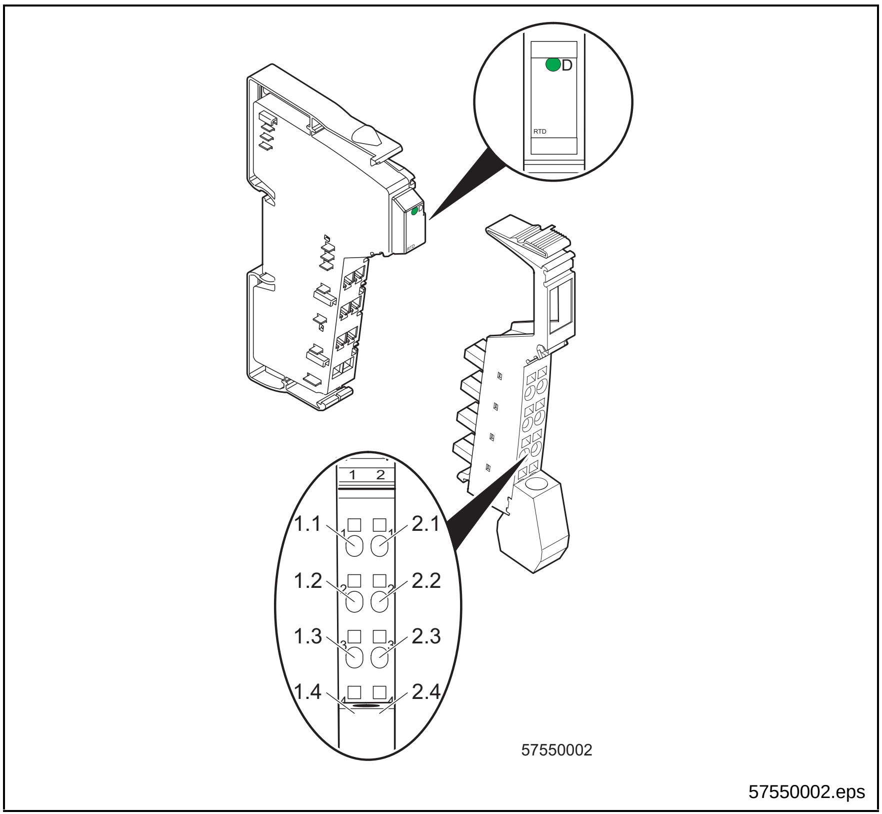


Fig. 5-2: Position of the diagnostic indicators R-IB IL 24 TEMP 2 RTD

Meaning of the Diagnostic Indicators

Identification	Color	Meaning
D	Green	Bus diagnosis

Fig. 5-3: Meaning of the diagnostic indicators R-IB 24 TEMP 2 RTD

5.2 Installation Instruction

Note: Please consider in your project planning that no isolating voltage is specified between the analog inputs and the bus. As a result, for example for detection of a thermistor, the user must make available signals with **safe isolation** as required.

A high current through the voltage jumper U_M and U_S results in heating of the voltage jumper, and thus in an increase of the temperature inside the terminals. To keep the current through the voltage jumper of the analog terminals as low as possible, please observe the following instruction:

ATTENTION

Set up all analog terminals with a main circuit of their own!

⇒ If this is impossible in your concrete case and you have to set up analog terminals in a main circuit together with other terminals, place the analog terminals behind all other terminals at the end of the main circuit.

5.3 Technical Data

General data		
Housing dimensions	12,2 x 120 x 71.5 mm without connector (W x H x D)	
Weight	46 g (without connector)	
Type of sensor connection	2-, 3-, and 4-wire method	
Type of operation	Process data operation with 2 words	
Permissible temperature	Operation Storage/transport	-25°C to +55 °C -25 °C to +85 °C
Air humidity	Operation Storage/transport	75 % on average, 85 % occasionally 75 % on average, 85 % occasionally
Air pressure	Operation Storage/transport	80 kPa to 106 kPa (up to 2000 m above MSL) 76 kPa to 106 kPa (up to 3000 m above MSL)
Degree of protection	IP20 according to IEC 60529	
Protection class	Class 3, according to VDE 0106, IEC 60536	

Fig. 5-4: General technical data R-IB IL 24 TEMP 2 RTD

Interface local bus	
Local bus interface	Data routing

Fig. 5-5: Technical data local bus R-IB IL 24 TEMP 2 RTD

Performance balance	
Logic voltage U_L	7.5 V
Current input from U_L	43 mA typical
Peripheral supply voltage U_{ANA}	24 V DC
Current input at U_{ANA}	11 mA typical
Total power input	590 mW (typical)

Fig. 5-6: Performance balance R-IB IL TEMP 2 RTD

Supply of module electronics and the periphery via the bus terminal/power terminal	
Connection method	Voltage routing

Fig. 5-7: Supply of module electronics and the periphery via the bus terminal/power terminal

Analog inputs	
Number	Two inputs for resistive temperature sensors
Connection type of the signals	2, 3, or 4-wire, shielded sensor line
Usable sensor types	Pt, Ni, Cu, KTY
Characteristic curve standards	According to DIN / according to SAMA
Conversion time of the A/D transformer	Typically 120 µs
Process data update	Dependent on the connection technology
Both channels in 2-wire method	20 ms
One channel in 2-wire method / one channel in 4-wire method	20 ms
Both channels in 3-wire method	32 ms

Fig. 5-8: Analog inputs R-IB IL 24 TEMP 2 RTD

Protective devices	
None	

Fig. 5-9: Protective devices R-IB IL TEMP 2 RTD

Error messages to the higher-level control or computer system	
Failure of the internal voltage supply	Yes
Logic voltage U_L fails or is fallen below value	Yes, peripheral error message to the bus terminal

Fig. 5-10: Error messages to the higher-level control or computer system

Error messages on process data	
Peripheral / application error	Yes

Fig. 5-11: Error messages on process data

5.4 Connections

Position of the Terminals

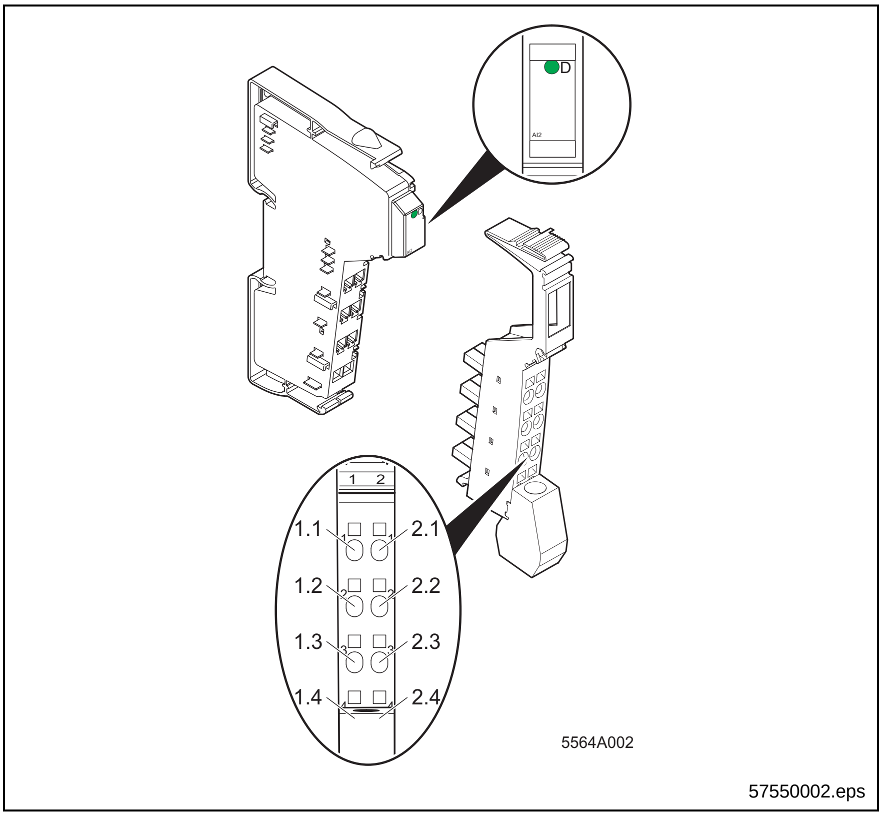


Fig. 5-12: Position of the terminals R-IB IL 24 TEMP 2 RTD

Terminal Assignment

Terminal Assignment with 2-/3-Wire Connection

Terminal	Signal	Remark
1.1	+I1	RTD Sensor 1
1.2	+I1	Constant-current excitation
1.3	-U1	Measuring input sensor 1
2.1	+I2	RTD Sensor 2
2.2	+I2	Constant-current excitation
2.3	-U2	Measuring input sensor 2
1.4, 2.4	Shield	Shield connection (channel 1 and 2)

Fig. 5-13: Terminal assignment with 2-/3-wire connection

Terminal Assignment with 4-Wire Connection to Channel 1 and 2-Wire Connection to Channel 2

Terminal	Signal	Remark
1.1	+I1	RTD Sensor 1
1.2	+I1	Constant-current excitation
1.3	-U1	Measuring input sensor 1
2.3	+U1	Measuring input sensor 2
2.1	+I2	RTD Sensor 2
2.2	+I2	Constant-current excitation
1.4, 2.4	Shield	Shield connection (channel 1 and 2)

Fig. 5-14: Terminal assignment with 4-wire connection to channel 1 and 2-wire connection to channel 2

Note: In 4-wire method, a sensor can only be connected to channel 1.

Internal Block Diagram

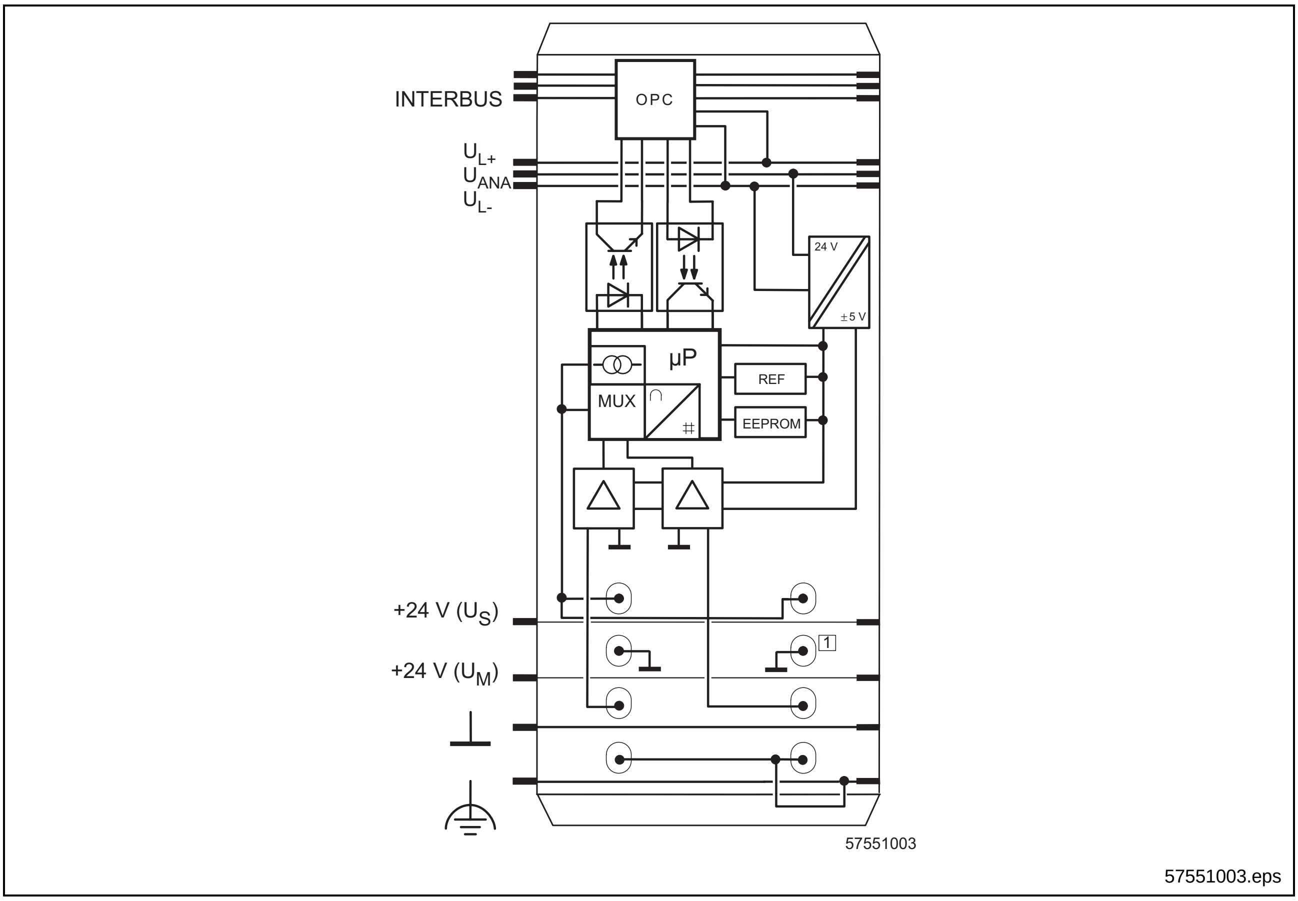


Fig. 5-15: Internal circuits of terminal points R-IB IL 24 AI 2/SF

Symbol Description

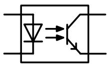
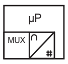
Symbol	Description
OPC	Protocol chip (bus logic including voltage treatment)
	Optocoupler
	DC/DC converter with galvanic isolation
	Microprocessor with multiplexer and analog-digital-transformer
REF	Reference voltage
EEPROM	Electrically erasable, re-programmable ROM
	Amplifier

Fig. 5-16: Symbol description

Notes on Connection

Connection of the Thermo Elements

Note: **Always** connect the variable temperature multipliers with twisted-pair and shielded lines.

Connection of the Shield System

The connection of the shield system is described in the examples for connections (Fig. 5-17).

Note: Connect the shield system at the terminal via the shield connection clip.

Via the clip, the shield is directly connected to FE at the terminal side. No additional protective circuits are required.

Insulate the shield system at the sensor.

Connection of a Sensor in 4-Wire Method

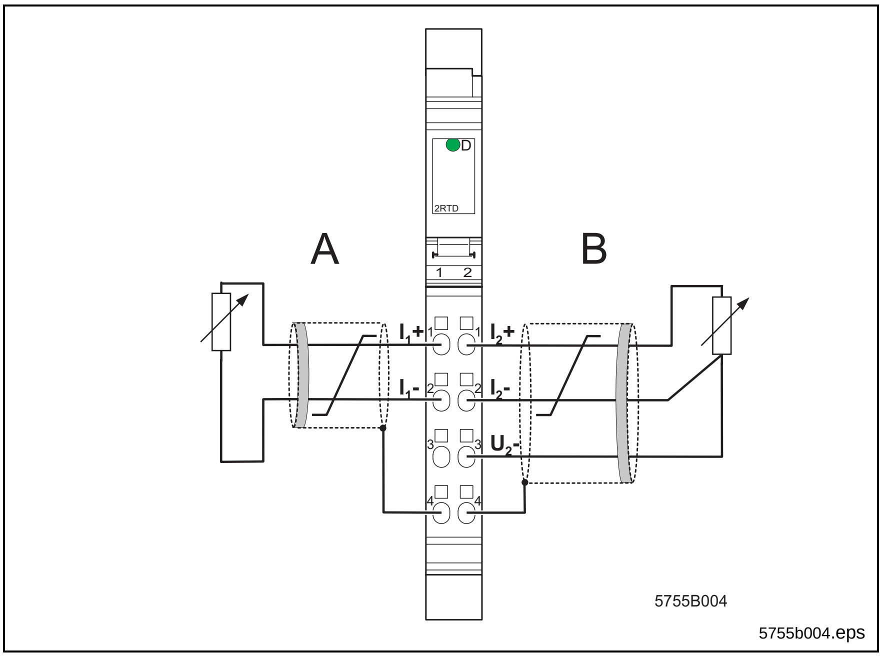
Note: In 4-wire method, a sensor can only be connected to channel 1. In this case, the sensor at channel 2 can only b e connected in 2-wire method!

Examples for Connection

Note: When connecting the shield to the terminal, you must insulate the shield on the sensor side (shown in gray in Fig. 5-17 and Fig. 5-18).

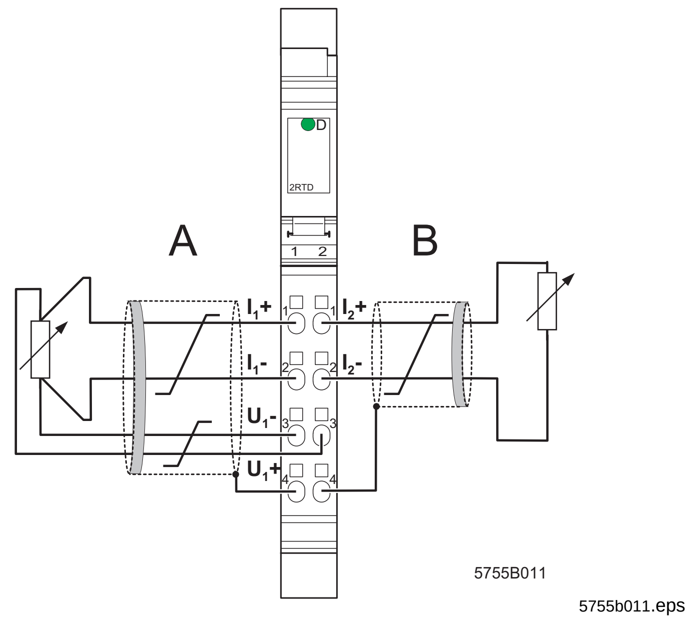
Use the connector with the shield connection to connect the sensors. In Fig. 5-17, the connection is represented in a diagrammatic view (without the shield connection).

Connection of Passive Sensors



L: A Channel 1; 2-wire method
B Channel 2; 3-wire method

Fig. 5-17: Connection of passive sensors in 2- and 3-wire method with shield connection



L: A Channel 1; 4-wire method
B Channel 2; 2-wire method

Fig. 5-18: Connection of passive sensors in 4- and 2-wire method with shield connection

Programming Data

ID code	$07F_{hex}$ (127_{dez})
Length code	02_{hex}
Input address space	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

Fig. 5-19: Programming data R-IB IL 24 TEMP 2 RTD

5.5 Process Data Words

Process Data Output Words for Configuration of the Terminal

"Word bit" vision	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Assignment	Con-figura-tion		Type of connec-tion		R_0				Resolu-tion		Format		Sensor type			

Fig. 5-20: Assignment of the process data output words for configuration of the terminal Word 0

"Word bit" vision	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 2	Assignment	Con-figura-tion		Type of con-nection		R_0				Resolu-tion		Format		Sensor type			

Fig. 5-21: Assignment of the process data output words for configuration of the terminal Word 1

Assignment of the Terminal Points to the Input Data Word

"Word bit" vision	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Terminal points channel 1	Signal	Terminal point 1.1 +I1-sensor 1															
	Signal reference	Terminal point 1.2 -I1 sensor 1								Terminal point 1.3 -U1 sensor 1							
	Shield (FE)	Terminal point 1.4															

Fig. 5-22: Assignment of the terminal points to the input data word 0

"Word bit" vision	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Terminal points channel 2	Signal	Terminal point 2.1 +I2 sensor 2															
	Signal reference	Terminal point 2.2 -I2 sensor 2								Terminal point 2.3 +U2 sensor 2							
	Shielding	Terminal point 2.4															

Fig. 5-23: Assignment of the terminal points to the input data word 1

Process Data Output Words

Via the two process data output words, you can configure the channels of the terminal.

For each channel, there are the following potential configurations, independent of the other channel:

Channel:

- Type of connection of the sensor
- Value of the reference resistor R_0
- Resolution setting
- Selection of a format to represent the measured values
- Sensor type setting

For the connection type, there is a dependency between the two channels. As soon as the 4-wire mode has been activated for channel 1, channel 2 can only be operated in 2-wire connection mode. 4-wire connection is only available for channel 1.

Any configuration errors are signaled by the corresponding error code, if the format IB Standard has been configures as the format for representation of the measured values.

The configuration setting is saved only in a volatile manner. It must be transferred in each BUS cycle.

After applying voltage (power up) to the Inline station, the message "Measured value invalid" (error code 8004_{hex})

will appear in the process data input words. After a maximum of 1 seconds, the preset configuration is taken over, and the first measured value is available.

Preset values:

Connection	3-wire method
R_0	100 Ω
Resolution	0.1 °C
Format	Format 1 (IB Standard)
Sensor type	PT 100 (DIN)

On change of configuration, the respective channel is re-initialized. In the process data output words, the message "Measured value invalid" (error code 8004_{hex}) will appear for a maximum of 100 ms.

If the configuration is invalid, the message "Configuration invalid" (error code 8004_{hex}) will appear.

Note: Please note: extended diagnosis is only possible if the format IB Standard has been configured as the format for representation of the measured value. As this format is pre-set on the terminal, it will be available immediately after application of voltage.

One process data output word is available for configuring each channel.

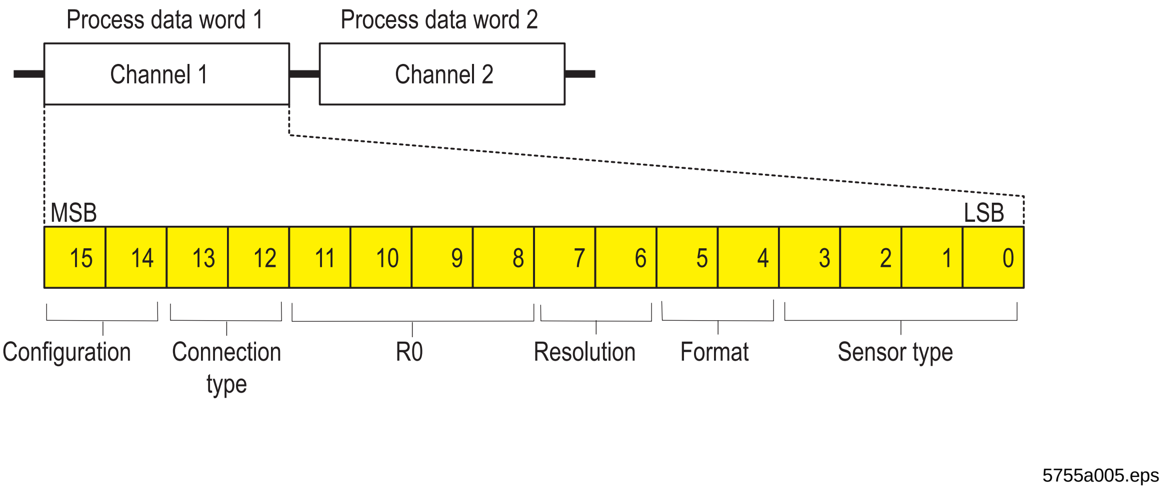


Fig. 5-24: Process data output words

Bit 15 and bit 14

To configure the terminal and/or a certain channel, set bit 15 of the respective output word to 1. If bit 15 = 0, the preset configuration is active. Presently, bit 14 is insignificant; accordingly, it is set to 0.

Bit 13 and bit 12

Code		**Type of connection:**
dec.	**bin.**	
0	**00**	**3-wire**
1	01	2-wire
2	10	4-wire (only channel 1)
3	11	Reserved

Fig. 5-25: Process data output words bit 13 and bit 12

Bit 11 to bit 8

Code		**R_0 [Ω]**
dec.	**bin.**	
0	**0000**	**100**
1	0001	10
2	0010	20
3	0011	30
4	0100	50
5	0101	120
6	0110	150
7	0111	200

Code		**R_0 [Ω]**
dec.	**bin.**	
8	**1000**	**240**
9	1001	300
10	1010	400
11	1011	500
12	1100	1000
13	1101	1500
14	1110	2000
15	1111	3000 (settable)

Fig. 5-26: Process data output words bit 11 to bit 8

Bit 7 and bit 6

Code		Resolution with sensor type			
dec.	**bin.**	**0 to 10**	**13**	**14**	**15**
0	**00**	**0.1 °C**	**1 %**	**0,1 Ω**	**1 Ω**
1	01	0.01 °C	0,1 %	0,01Ω	0,1Ω
2	10	-17.72 °C	Reserved	Reserved	Reserved
3	11	-17.77 °C			

Fig. 5-27: Process data output words bit 7 and bit 6

Bit 5 and bit 4

Code		Format
dec.	**bin.**	
0	**00**	**Format 1: IB Standard** **(15 bit +sign with extended diagnosis)** compatible to ST format
1	01	Format 2 (12 bit + sign + 3 diagnosis bits)
2	10	Format 3 (15 bit + sign)
3	11	Reserved

Fig. 5-28: Process data output words bit 5 and bit 4

Bit 3 to bit 0

Code		Sensor type
dec.	**bin.**	
0	**0000**	**Pt DIN**
1	0001	Pt SAMA
2	0010	Ni DIN
3	0011	Ni SAMA
4	0100	Cu10
5	0101	Cu50
6	0110	Cu53
7	0111	Ni 1000 (Landis & Gyr)

Code		Sensor type
dec.	**bin.**	
8	**1000**	Ni 500 (Viessmann)
9	1001	KTY 81-110
10	1010	KTY 84
11	1011	Reserved
12	1100	Reserved
13	1101	Potentiometer [%]
14	1110	Linear R: 0 to 400 Ω
15	1111	Linear R: 0 to 4000 Ω

Fig. 5-29: Process data output words bit 3 to bit 0

Process Data Input Words

For each channel, the measured values are transferred via the process data input words to the interface module or to the computer.

To represent the input data, three formats are available; see Fig. 5-30.

For details on the format, please refer to the paragraph "Formats for Representation of the Measured Values".

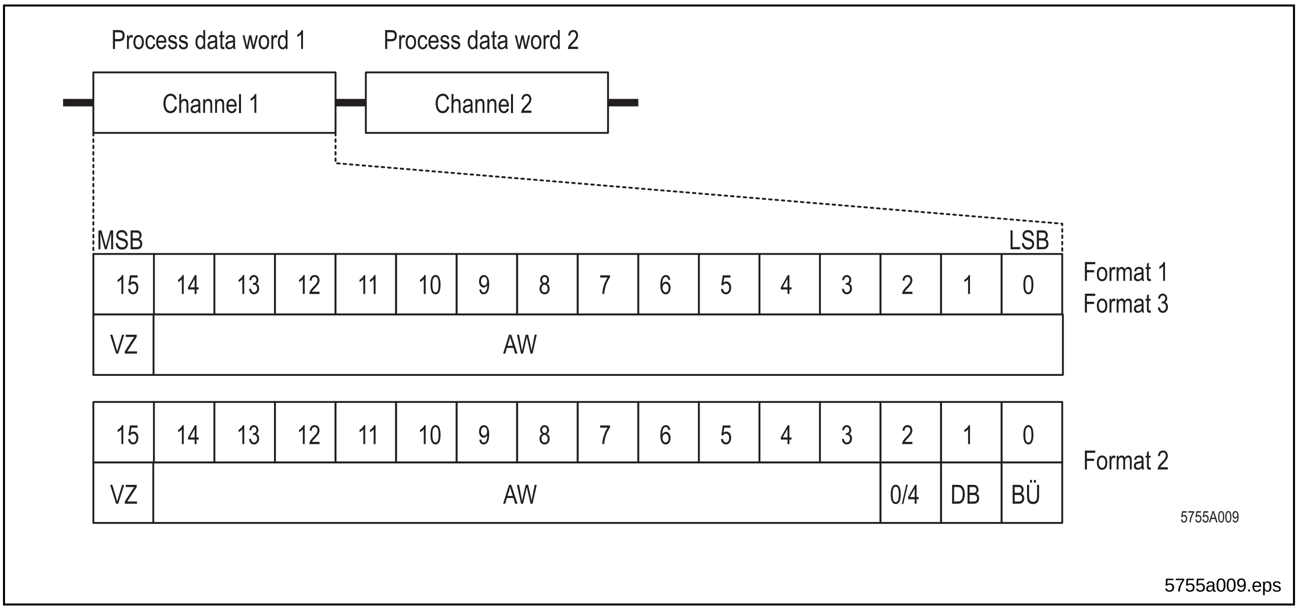


Fig. 5-30: Series of process data input words ii the BUS ring and representation of the bits of the first process data input word in the various formats

Legend:

MSB Most significant bit

LSB Least significant bit

VZ Sign

AW Analog value

0 Reserved

DB Wire breakage/short-circuit

BÜ Over-range

Error Codes

The process data format 1 "IB Standard" supports the extended diagnosis. The following error codes can occur:

Code (hex)	Failure:
8001	Out of measuring range (figure exceeds range)
8002	Wire breakage or short-circuit (available only in temperature range)
8004	Measured value invalid/no valid measured value available
8010	Invalid configuration
8040	Terminal defect
8080	Out of measuring range (figure remains under range)

Fig. 5-31: Error codes process data format 1 "IB Standard"

5.6 Recognition of Wire Breakage/Short-circuit

Wire breakage is recognized according to the following table:

Defects	Temperature measuring range			Resistance measuring range		
sensor line	2-wire	3-wire	4-wire	2-wire	3-wire	4-wire
+I	Yes	Yes	Yes	Yes	Yes	No
-I	Yes	Yes	Yes	Yes	Yes	No
+U	–	–	Yes	–	–	Yes
-U	–	Yes	Yes	–	Yes	Yes

Fig. 5-32: Recognition of wire breakage/short-circuit

Legend:

Yes Wire breakage/short circuit is recognized.

– With this connection method, the line is not connected.

No No wire breakage/short-circuit is recognized as the value is a valid measured value.

5.7 Formats for Representation of the Measured Values

Format 1: IB Standard (Default Setting)

The measured value is represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

This format supports extended diagnosis. Values > 8000_{hex} signal error. The error codes are listed in Fig. 5-31.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

55641008

55641008.eps

L: VZ Sign

AW Analog value

Fig. 5-33: Representation of measured value in format 1 (IB Standard; 15 bit)

Typical Analog Values in Dependence on the Resolution

Sensor type (bit 3 to 0)		0 to 10	13	14	15
Resolution (bit 7 and 6)		00_{bin} / 10_{bin}	00_{bin}	00_{bin}	00_{bin}
Process data (= analog value)		0.1 °C / -17.72 °C [°C] / [°F]	1 % [%]	0,1 Ω [Ω]	1 Ω [Ω]
hex	dec				
8002	–	Wire breakage	–	–	–
8001	–	Figure exceeds measuring range	–	400	4000
2710	10000	1000,0	–	–	–
0FA0	4000	400,0	4000 (40 x R_0)	400	4000
00A0	10	1,0	10 (0.10 x R_0)	1,0	1
0001	1	0,1	1 (0,01 x R_0)	0,1	1
0000	0	0	0	0	0
FFFF	-1	-0,1	–	–	–

Fig. 5-34: Typical analog values in dependence on the resolution of format 1 (part 1)

Sensor type (bit 3 to 0)		0 to 10	13	14	15
Resolution (bit 7 and 6)		**00_{bin} / 10_{bin}**	**00_{bin}**	**00_{bin}**	**00_{bin}**
Process data (= analog value)		**0.1 °C / -17.72 °C [°C] / [°F]**	**1 % [%]**	**0,1 Ω [Ω]**	**1 Ω [Ω]**
hex	**dec**				
FC18	-1000	-100,0	–	–	–
8080		Figure remains under measuring range	–	–	–
8002		Short circuit	–	–	–

Fig. 5-35: Typical analog values in dependence on the resolution of format 1 (part 2)

Sensor type (bit 3 to 0)		0 to 10	13	14	15
Resolution (bit 7 and 6)		**01_{bin} / 11_{bin}**	**01_{bin}**	**01_{bin}**	**01_{bin}**
Process data (= analog value)		**0.01 °C / 0.01 °F [°C] / [°F]**	**0,1 % [%]**	**0,01 Ω [Ω]**	**0,1 Ω [Ω]**
hex	**dec**				
8002	–	Wire breakage	–	–	–
8001	–	> 325,12 Figure exceeds measuring range	–	325,12	3251,2
2710	10000	100,0	1000,0 (10 x R_0)	100,00	1000,0
03E8	4000	10,00	100,0 (10 x R_0)	10,00	100
0001	1	0,1	0,1 (0,01 x R_0)	0,01	0,1
0000	0	0	0	0	0
FFFF	-1	-0,01	–	–	–
D8F0	-10000	-100,00	–	–	–
8080		Figure exceeds measuring range	–	–	–
8002		Short circuit	–	–	–

Fig. 5-36: Typical analog values in dependence on the resolution of format 3 (part 1)

Note: If the measured value is outside of the representation range of the process data, the error message "Figure exceeds measuring range" or "Figure remains under measuring range" will appear.

Format 2

You can select this format for each channel via bit 5 and 4 (bit combination 01_{bin}) of the respective process data output word.

The measured value is represented in the bits 14 to 3. The remaining 4 bits are available as sign and error bits.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW												0	DB	BÜ

55200060

55200060.eps

L:
VZ Sign
AW Analog value
0 Reserved
DB Wire breakage/short-circuit
BÜ Over-range

Fig. 5-37: Representation of measured value in Format 2 (12 bit)

Typical Analog Values in Dependence on the Resolution

Sensor type (bit 3 to 0)		**RTD sensor (0 to 13)**	
Resolution (bit 7 and 6)		**00_{bin} / 10_{bin}**	**01_{bin} / 11_{bin}**
Process data (= analog value)		**0.1 °C / -17.72 °C [°C] / [°F]**	**0.01 °C / 0.01 °F [°C] / [°F]**
hex	**dec**		
xxxx xxxx xxxx $xxx1_{bin}$	–	Figure exceeds measuring range (AW = positive end value from Fig. 5-44)	
2710	10000	1000,0	100,00
03E8	1000	100,0	10,00
0008	8	0,8	0,08
0000	0	0	0
FFF8	-8	-0,8	-0,08
FC18	-1000	-100,0	-10,00
xxxx xxxx xxxx $xxx1_{bin}$		Figure exceeds measuring range (AW = positive upper range value from Fig. 5-44)	
xxxx xxxx xxxx $xx1x_{bin}$		Figure exceeds measuring range (AW = positive upper range value from Fig. 5-44)	

Fig. 5-38: Typical analog values in dependence on the resolution Format 2

Legend:

AW Analog value

x Can take the values 0 or 1

Note: If the measured value is beyond the range of representation of the process data, bit 0 is set to 1.

With wire breakage/short circuit, bit 1 is set to 1.

Format 3

You can select this format for each channel via bit 5 and 4 (bit combination 10_{bin}) of the respective process data output word.

The measured value is represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

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L: VZ Sign
AW Analog value

Fig. 5-39: Representation of measured value in Format 3 (15 bit)

Typical Analog Values in Dependence on the Resolution

Sensor type (bit 3 to 0)		**RTD sensor (0 to 10)**	**Linear resistance (15)**
Resolution (bit 7 and 6)		**00_{bin} / 10_{bin}**	**00_{bin}**
Process data (= analog value)		**0.1 °C / -17.72 °C [°C] / [°F]**	**1 Ω [Ω]**
hex	**dec**		
7FFF	32767	–	> 2048
Upper limit* +1 LSB		Figure exceeds measuring range	–
7D00	32000	–	2000
2710	10000	1000,0	625
0001	1	0,1	0,0625
0000	0	0	0
FFFF	-1	-1,0	–
D8F0	-10000	-100,0	–
Lower limit* -1 LSB		Figure remains under measuring range	–
Lower limit* -2 LSB		Wire breakage/short-circuit	–

Fig. 5-40: Typical analog values in dependence on the resolution of format 3 (part 1)

* For the limits, please see Fig. 5-44 on page 5-21.

Sensor type (bit 3 to 0)		RTD sensor (0 to 10)	Linear resistance (15)
Resolution (bit 7 and 6)		01_{bin} / 11_{bin}	01_{bin}
Process data (= analog value)		0.01 °C / 0.01 °F [°C] / [°F]	0,1 Ω [Ω]
hex	dec		
7FFF	32767	–	> 4096
Upper limit* +1 LSB		Figure exceeds measuring range	–
7D00	32000	320,00	4000
2710	10000	100,0	1250
0001	1	0,1	0,125
0000	0	0	0
FFFF	-1	-1,0	–
D8F0	-10000	-100,0	–
Lower limit* -1 LSB		Figure remains under measuring range	–
Lower limit* -2 LSB		Wire breakage/short-circuit	–

Fig. 5-41: Typical analog values in dependence on the resolution of format 3 (part 2)

* For the limits, please see Fig. 5-44 on page 5-21.

5.8 Measuring Ranges

Measuring Ranges in Dependence on Resolution (Format IB Standard)

Resolution	Temperature sensors
00	-273 °C to +3276,8 °C resolution:: 0.1 °C
01	-273 °C to +327.68 °C resolution: 0.01 °C
10	-459 °F to +1,802.67 °C resolution: -17.72 °C
11	-459 °F to +327.68 °F resolution: -17.77 °C

Fig. 5-42: Measuring ranges in dependence on resolution (Format IB Standard)

Note: For the conversion of temperatures in °C to °F, the following formula can be used:

$$T[°F] = T[°C] x \frac{9}{5} + 32$$

Fig. 5-43: Conversion of temperature values in °C to °F

With

T [°F] Temperature in °F

T [°C] Temperature in °C

Input Measuring Ranges

No.	Input	Sensor type	Measuring range (supported by software)	
			Lower limit	Upper limit
0	Temperature sensors	Pt R_0 10Ω to 3000 Ω according to DIN	-200 °C	+850 °C
1		Pt R_0 10Ω to 3000 Ω according to SAMA	-200 °C	+850 °C
2		Ni R_0 10Ω to 3000 Ω according to DIN	-60 °C	+180 °C
3		Ni R_0 10Ω to 3000 Ω according to SAMA	-60 °C	+180 °C
4		Cu10	-70 °C	+500 °C
5		Cu50	-50 °C	+200 °C
6		Cu53	-50 °C	+180 °C
7		Ni 1000 L&G	-50 °C	+160 °C
8		Ni 500 (Viessmann)	-60 °C	+250 °C
9		KTY81-110	-55 °C	+150 °C
10		KTY81	-40 °C	+300 °C
11	Reserved			
12				
13	Relative potentiometer range		0 %	4 kΩ / R_0 x 100 % (maximum 400%)
14	Linear resistance measuring range		0 Ω	400 Ω
15			0 Ω	4000 Ω

Fig. 5-44: Input measuring ranges Format IB Standard

Note: The number (no.) corresponds to the code of the sensor type in bit 3 to bit 0 of the process data output word.

5.9 Measuring Errors

Systematic Measuring Errors with Temperature Measuring by Means of Resistance Thermometers

On measuring temperatures by means of resistance thermometers, systematic measuring errors are frequently the cause for corrupted measuring results.

Basically, there are three possible methods to connect a sensor: 2, 3, and 4-wire method.

4-Wire Method

Metrologically, the 4-wire method is the most exact measuring method (see Fig. 5-45).

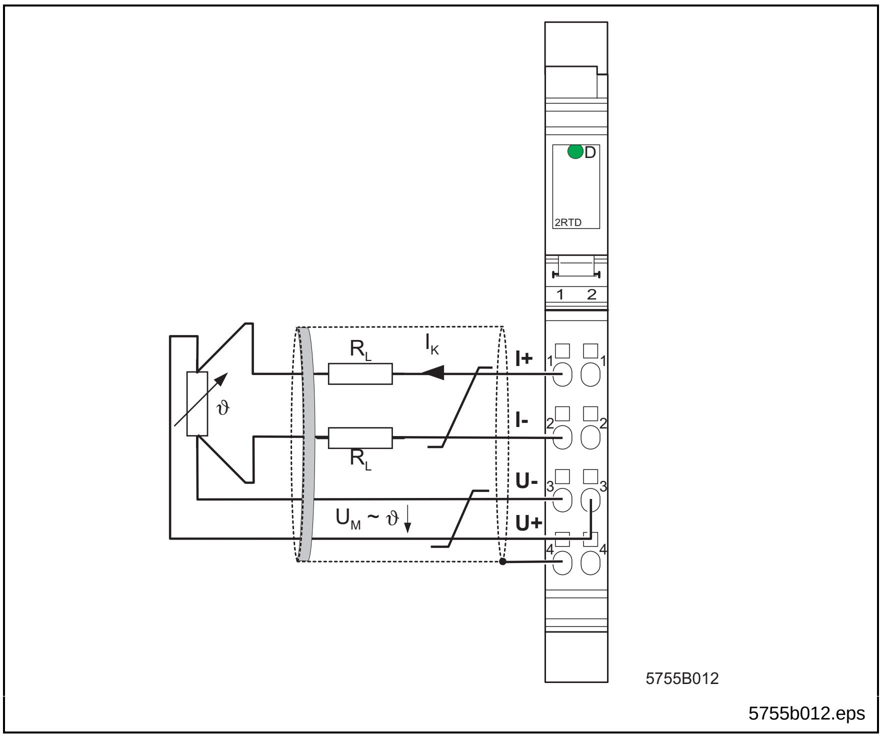

Fig. 5-45: Connection of resistance thermometers in 4-wire method

With the 4-wire method, a constant current is sent through the sensor via the lines I+ and I-. By means of the two other lines U+ and U-, the voltage proportional to the temperature is picked off at the sensor and measured. In this, the measurement is not at all influenced by the line resistances.

3-Wire Method

With the 3-wire method, the influence of the line resistance on the measuring result is eliminated or minimized in the terminal by multiple measuring of the voltage in proportion to the temperature and corresponding calculations. The result quality is approximately as good as with the 4-wire method in Fig. 5-45. However, the 4-wire method brings better results in an environment with disturbing influences.

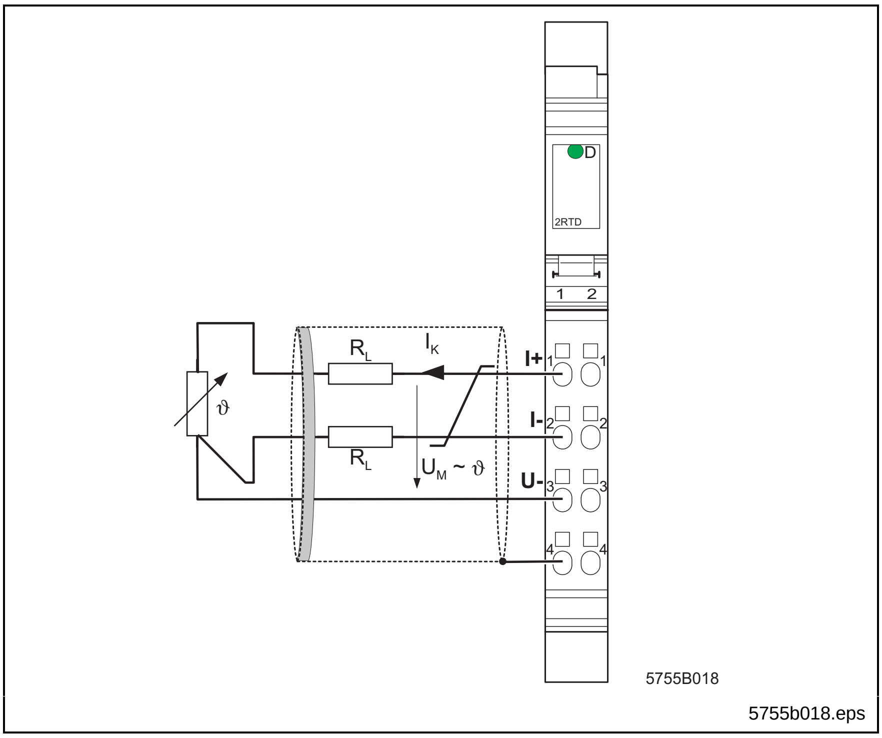

Fig. 5-46: Connection of resistance thermometers in 3-wire method

2-Wire Method

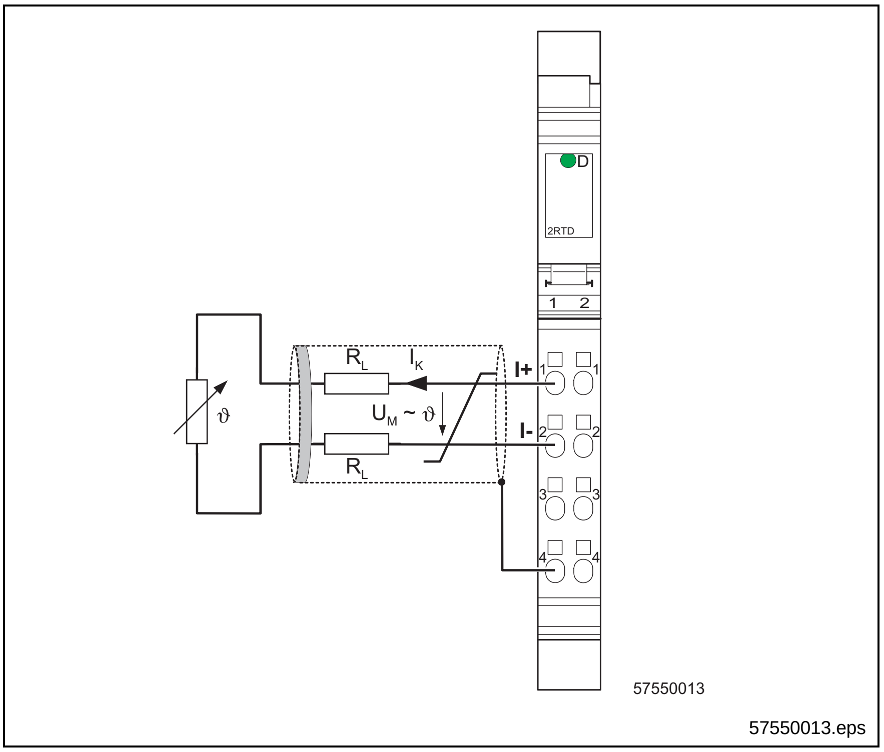

Fig. 5-47: Connection of resistance thermometers in 2-wire method

The 2-wire method is the most cost-effective type of connection.

Here, no lines U+ and U- are required. The voltage in proportion to the temperature is not measured directly at the sensor and additionally corrupted by the two line resistances R_L (see Fig. 5-38).

By any occurring measuring errors, the measurement as a whole can be rendered useless (see diagrams in Fig. 5-48 to Fig. 5-50). However, these diagrams also show the places in the measuring set-up where action can be taken to minimize these errors.

Systematic Errors in Temperature Measurement by Means of the 2-Wire Method

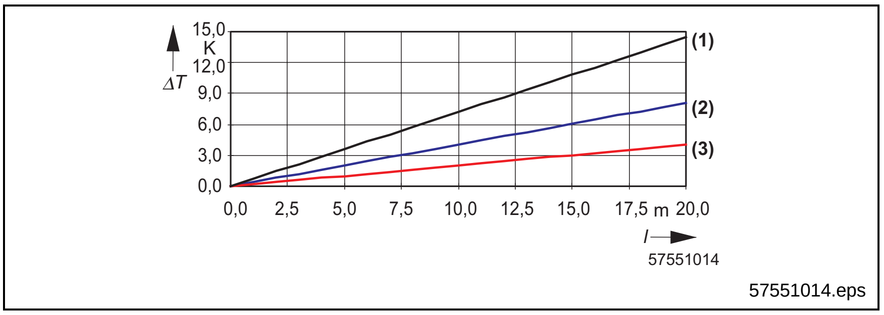

Fig. 5-48: Systematic temperature measuring error ΔT in dependence on line length l

Curves in dependence on line cross-section A

(1) Temperature measuring error for A = 0.14 mm^2

(2) Temperature measuring error for A = 0.25 mm^2

(3) Temperature measuring error for A = 0.50 mm^2

Measuring error valid for:

Copper line χ = 57 m/Ωmm^2 , T_U = 25 °C and PT-100 sensor

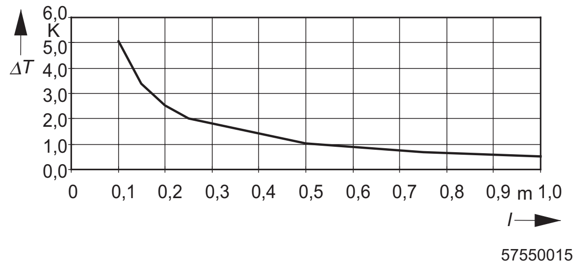

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Fig. 5-49: Systematic temperature measuring error ΔT in dependence on the line cross-section A

Measuring error valid for:

Copper line χ = 57 m/Ωmm^2 , T_U = 25 °C, l = 5 m and PT-100 sensor

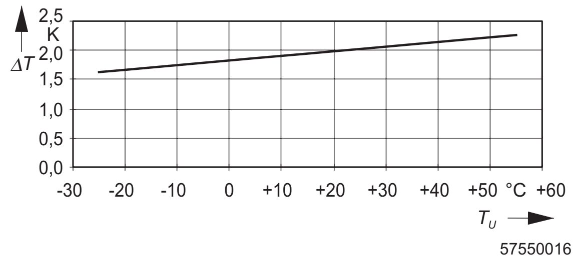

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Fig. 5-50: Systematic temperature measuring error ΔT in dependence on the line temperature T_U

Measuring error valid for:

Copper line χ = 57 m/Ωmm^2 , A = 0,25 mm^2, l = 5 m and PT-100 sensor

From all diagrams, the increase of the line resistance is visible as cause of the measuring error.

Accordingly, the application of PT-1000 detecting elements proves to be a most significant improvement. Because of the temperature co-efficient α which is ten times higher (α =0,385 Ω/K with PT100 compared to α=3,85 Ω/K with PT1000), the influence of the line resistance on the measurement is reduced by the factor 10. All errors in the above diagrams would be reduced by the factor 10.

Fig. 5-48 clearly shows the influence of the line length on the line resistance and thus to the measuring error. As a consequence, sensor lines are to be kept as short as possible.

Fig. 5-49 shows the influence of the line cross-section to the line resistance. It is evident that lines with a cross-section of under 0.5 mm^2 cause an exponential increase of the error.

Fig. 5-50 shows the influence of the ambient temperature on the line resistance.

This parameter is relatively insignificant and cannot be greatly influenced; here, it is only mentioned for the sake of completeness.

The equation for calculating the line resistance is as follows:

$$R_L = R_{L20} x\left(1 + 0{,}0043 \frac{1}{K} x T_U\right)$$

$$R_L = \frac{l}{\chi x A} x\left(1 + 0{,}0043 \frac{1}{K} x T_U\right)$$

Fig. 5-51: Calculation of the line resistance

With

R_L	Line resistance in Ω
R_{L20}	Line resistance at 20 °C in Ω
l	Line length in m
χ	Specific electric resistance of copper in Ωmm^2 /m
A	Line cross-section in mm^2
0,0043 1/K	Temperature coefficient for copper
T_U	Ambient temperature (line temperature) in °C

As there are two line resistance values in the measuring arrangement (connecting and return wire), the value must be doubled.

With the average temperature coefficient α (α =0,385 Ω/K with PT100, compared to α=3,85 Ω/K with PT1000), you'll find the absolute measuring error in Kelvin [K] for platinum sensors according to DIN.

5.10 Tolerance and Temperature Behavior

Typical Measuring Tolerances at 25°C

Temperature sensors	α at 100 °C	2-wire method		3-wire method		4-wire method	
		Relative [%]	**Absolute**	**Relative [%]**	**Absolute**	**Relative [%]**	**Absolute**
PT 100	0,385 Ω/K	±0.03 + x	±0.26 K + x	±0,03	±0.26 K	±0,02	±0,2 K
PT 1000	3,85 Ω/K	±0.04 + x	±0.31 K + x	±0,04	±0.31 K	±0,03	±0.26 K
Ni 100	0,617 Ω/K	±0.09 + x	±0.16 K + x	±0,09	±0.16 K	±0,07	±0.12 K
Ni 1000	6,17 Ω/K	±0.11 + x	±0,2 K + x	±0,11	±0,2 K	±0,09	±0.16 K
Cu 50	0,213 Ω/K	±0.24 + x	±0.47 K + x	±0,24	±0.47 K	±0,18	±0.35 K
Ni 1000 L&G	5,6 Ω/K	±0.13 + x	±0.21 K + x	±0,13	±0.21 K	±0,11	±0.18 K
Ni 500 Viessmann	2,8 Ω/K	±0.17 + x	±0.43 K + x	±0,17	±0.43 K	±0,14	±0.36 K
KTY 81-110	10,7 Ω/K	±0.07 + x	±0.11 K + x	±0,07	±0.11 K	±0,06	±0.09 K
KTY 84	6,2 Ω/K	±0.06 + x	±0.19 K + x	±0,06	±0.19 K	±0,05	±0.16 K
Linear resis-tance							
0 Ω up to 400 Ω		±0.025 + x	±100 mΩ+ x	±0,025	±100 mΩ	±0,019	±75 mΩ
0 Ω up to 4 kΩ		±0.03 + x	±1,2 Ω + x	±0,03	±1,2 Ω	±0,025	±1 Ω

Fig. 5-52: Typical measuring tolerances at 25°C

Legend:

α Mean sensitivity for calculation of the tolerance data.

χ Additional error caused by connection in 2-wire method (see "Systematic errors in temperature measuring by means of 2-wire method")

Maximum Measuring Tolerances at 25°C

Temperature sensors	α at 100 °C	2-wire method		3-wire method		4-wire method	
		Relative [%]	Absolute	Relative [%]	Absolute	Relative [%]	Absolute
PT 100	0,385 Ω/K	±0.12 + x	±1.04 K + x	±0,12	±1.04 K	±0,10	±0.83 K
PT 1000	3,85 Ω/K	±0.15 + x	±1.3 K + x	±0,15	±1.3 K	±0,12	±1.04 K
Ni 100	0,617 Ω/K	±0.36 + x	±0.16 K + x	±0,36	±0.65 K	±0,29	±0.52 K
Ni 1000	6,17 Ω/K	±0.45 + x	±0.81 K + x	±0,45	±0.81 K	±0,36	±0.65 K
Cu 50	0,213 Ω/K	±0.47 + x	±0.94 K + x	±0,47	±0.94 K	±0,38	±0.75 K
Ni 1000 L&G	5,6 Ω/K	±0.56 + x	±0.89 K + x	±0,56	±0.89 K	±0,44	±0.71 K
Ni 500 Viessmann	2,8 Ω/K	±0.72 + x	±1.79 K + x	±0,72	±1.79 K	±0,57	±1.43 K
KTY 81-110	10,7 Ω/K	±0.31 + x	±0.47 K + x	±0,31	±0.47 K	±0,25	±0.37 K
KTY 84	6,2 Ω/K	±0.27 + x	±0.81 K + x	±0,27	±0.81 K	±0,22	±0.65 K
Linear resistance							
0 Ω up to 400 Ω		±0.10 + x	±400 mΩ+ x	±0,10	±400 mΩ	±0,08	±320 mΩ
0 Ω up to 4 kΩ		±0.13 + x	±5 Ω + x	±0,13	±5 Ω	±0,10	±4 Ω

Fig. 5-53: Maximum measuring tolerances at 25°C

Legend:

α Mean sensitivity for calculation of the tolerance data.

χ Additional error caused by connection in 2-wire method (see "Systematic errors in temperature measuring by means of 2-wire method")

Temperature Behavior at –25°C to +55°C

	Typical	Maximum
2, 3, and 4-wire method	±12 ppm/K	±45 ppm/K

Fig. 5-54: Temperature behavior at –25°C to +55°C

6 R-IB IL 24 AO 1/SF (1 Analog Output)

6.1 General Notes

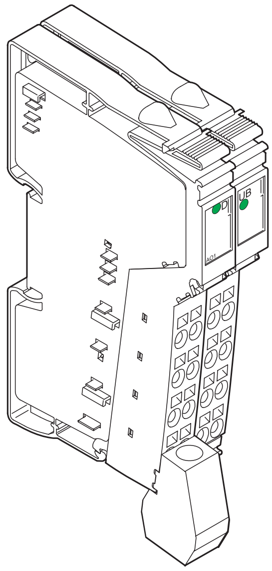

Fig. 6-1: Terminal R-IB IL 1 AO 1/SF with plugged-in connector

By means of this terminal, analog voltage and current signals are put out. The signals are provided with a resolution of 16 bit.

Features

- Connection of the actuators in 2-wire method with shield connection
- Two current ranges, one voltage range
- 0 mA to 20 mA, 4 mA to 20 mA
  0 V to 10 V
- Process data update including transformation period of the digital-analog transformer < 1 ms

DANGER

Only one output may be assigned on the terminal! To connect the connector of the actuator to this output, use the connector with the shield connection.

Note: The connector is not included in the scope of delivery of the terminal. Please order the connector according to the ordering information.

Indicator Elements

Position of the Diagnostic Indicators

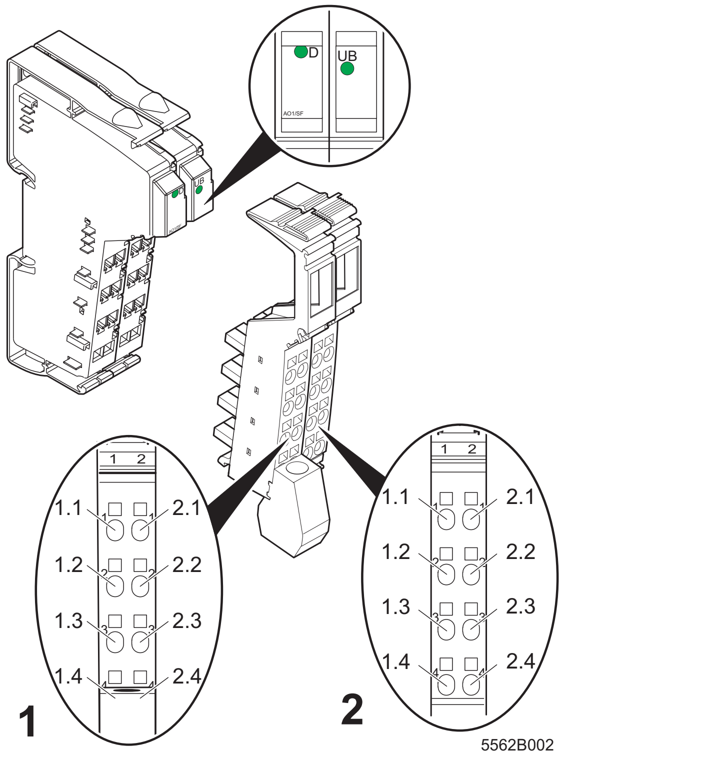

Fig. 6-2: Position of the diagnostic indicators R-IB IL 24 AO1/SF

Meaning of the Diagnostic Indicators

Identification	Color	Meaning
D	Green	Bus
UB	Green	Peripheral voltage for analog terminals available (current step)

Fig. 6-3: Meaning of the diagnostic indicators R-IB IL 24 AI 2/SF

6.2 Installation Instruction

A high current through the voltage jumper U_M and U_S results in heating of the voltage jumpers, and thus in an increase of the temperature inside the terminals. To keep the current through the voltage jumpers of the analog terminals as low as possible, please observe the following instruction:

- Set up all analog terminals with a main circuit of their own!
- If this is impossible in your concrete case and you have to set up analog terminals in a main circuit together with other terminals, place the analog terminals behind all other terminals at the end of the main circuit.

In this context, please note the derating curve in chapter 8.3.

6.3 Technical Data

General data		
Housing dimensions	24.4 x 120 x 71.5 mm without connector (W x H x D)	
Weight	90 g (without connector), 100 g (including connector)	
Connection methods of the actuators	2-wire method	
Type of operation	Process data operation with 1 word	
Permissible temperature	Operation Storage/transport	-25°C to +55 °C -25 °C to +85 °C
Air humidity	Operation Storage/transport	75 % on average, 85 % occasionally 75 % on average, 85 % occasionally
Air pressure	Operation Storage/transport	80 kPa to 106 kPa (up to 2000 m above MSL) 76 kPa to 106 kPa (up to 3000 m above MSL)
Degree of protection	IP20 according to IEC 60529	
Protection class	Class 3, according to VDE 0106, IEC 60536	

Fig. 6-4: General technical Data R-IB IL 24 AO 1/SF

Information deviating from the common technical data according to the User Manual DOK-CONTRL-IB-IL*IBSSYS	
Mechanical requirements	
Shock test according to EN 60068-2-27;IEC 60068-2-27	Load 15g over 11 ms, half sinusoidal wave, three shocks per room direction and orientation Load 25g over 6 ms, half sinusoidal wave, three shocks per room direction and orientation

Fig. 6-5: Information deviating from the common technical data

Interface local bus	
Local bus interface	Data routing

Fig. 6-6: Technical Data local bus R-IB IL 24 AO 1/SF

Performance balance	
Logic voltage U_L	7.5 V
Current input from U_L	Typically approx. 30 mA; maximum 40 mA
Peripheral supply voltage U_{ANA}	24 V DC
Current input at U_{ANA}	Typically approx. 50 mA; maximum 65 mA
Total power input	Approx. 1.425 W (typical)

Fig. 6-7: Performance balance R-IB IL 24 AI 2/SF

Supply of module electronics and the periphery via the bus terminal/power terminal	
Connection method	Voltage routing

Fig. 6-8: Supply of module electronics and the periphery via the bus terminal/power terminal

Analog output	
Number	1; configures automatically in dependence on the terminal point used
Signals/resolution in the process data word (quantization) Voltage 0 V tos +10 V Current 0 to 20 mA 4 to 20 mA	 0 to 9,99985 V 0,153 µV/LSB 0 to 19,9997 mA 0,305 µA/LSB 4 to 19,99976 mA 0,244 µA/LSB
Representation of measured value	16 bit straight binary
Basic error in current range	Typically ±0,05 %
Output load Voltage output Current output	 Minimum 2 kΩ Maximum 500 Ω
Process data update including transformation period of the digital-analog transformer	1 INTERBUS cycle (depending on bus configuration); < 1 ms
Slew rate (> 99 % of the upper range value)	< 10 µs

Fig. 6-9: Analog output R-IB IL 24 AO 1/SF

Tolerance and temperature behavior of the voltage output **(The data on tolerance refer to the upper output range value of 10 V.)**		
	Typical	**Maximum**
Tolerance at 23°C		
Total offset voltage	±0,03 %	±0,05 %
Gain error	±0,010 %	±0,15 %
Differential non-linearity	±0,0012 %	±0,003 %
Total tolerance at 23°C	**±0,15 %**	**±0,25 %**
Temperature behavior at –25°C to +55°C		
Offset voltage drift T_{KVO}	±10 ppm/K	±65 ppm/K
Amplification drift T_{KG}	±30 ppm/K	±35 ppm/K
Total voltage drift $T_{Kges} = T_{KVO} + T_{KG}$	±40 ppm/K	±100 ppm/K
Total tolerance of the voltage output **(-25 °C to 55 °C)** **Offset + amplification + linearity + drift error**	**±0,30 %**	**±0,60 %**

Tolerance and temperature behavior of the current output (The error data refer to the upper output range value of 20 mA).		
	Typical	**Maximum**
Offset error at 23°C		
Offset current I_{OS}	±0,05 %	±0,15 %
Gain error	±0,09 %	±0,25 %
Differential non-linearity	±0,0012 %	±0,003 %
Total tolerance at 23°C	**±0,15 %**	**±0,25 %**
Temperature behavior at –25°C to +55°C		
Offset current drift T_{KIO}	±25 ppm/K	±65 ppm/K
Amplification drift T_{KG}	±10 ppm/K	±35 ppm/K
Total voltage drift $T_{Kges} = T_{KIO} + T_{KG}$	±35 ppm/K	±100 ppm/K
Total tolerance of the voltage output (-25 °C to 55 °C) Offset + amplification + linearity + drift error	**±0,20 %**	**±0,35 %**

Fig. 6-10: Tolerance and temperature behavior R-IB IL 24 AO 1/SF

Additional tolerances under the influence of electromagnetic fields		
Type of electromagnetic interference	**Criterion**	**typical relative deviation from the upper limit of effective range**
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3 / IEC 61000-4-3	A	< 1 %
Fast transient disturbances (burst) supply 2 kV, output 1 kV according to EN 61000-4-4 / IEC 61000-4-4	B	< 1 %
Mains-borne disturbances Class 3 (test voltage 10 V) according to 61000-4-6 / IEC 61000-4-6	A	< 6 %

Fig. 6-11: Additional tolerances under the influence of electromagnetic fields R-IB IL 24 AO1/SF

Protective devices	
None	

Fig. 6-12: Protective devices R-IB IL 24 AO 1/SF

Error messages to the higher-level control or computer system	
Logic voltage U_L fails or is fallen below value	Yes, peripheral error message to the bus terminal

Fig. 6-13: Error messages to the higher-level control or computer system

6.4 Connections

Position of the Terminals

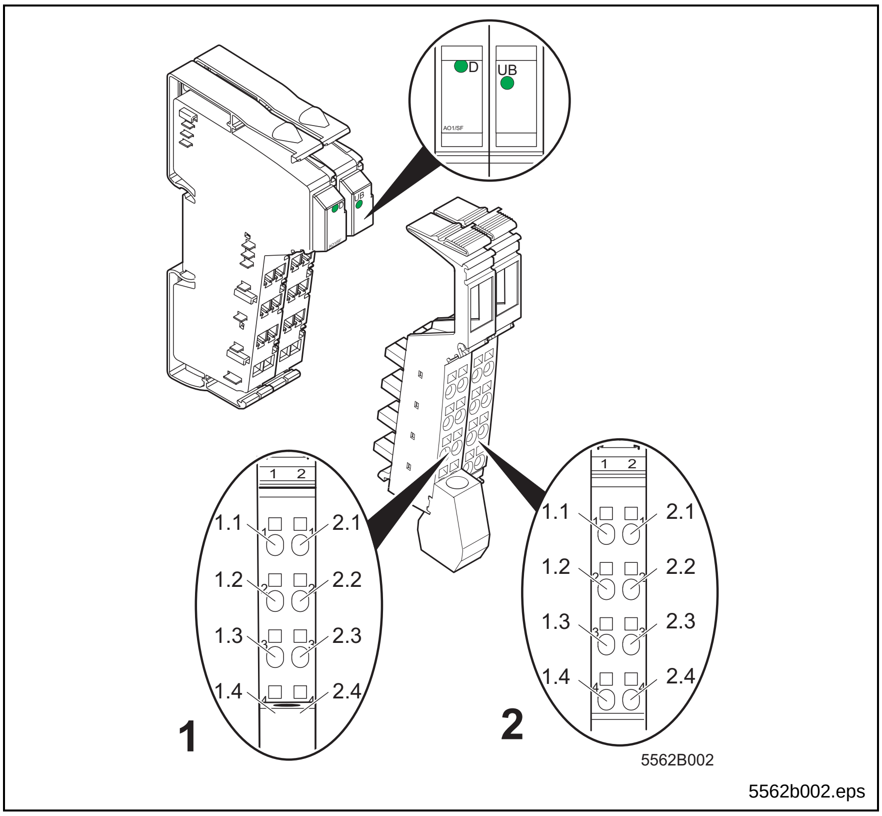

Fig. 6-14: Position of the terminals R-IB IL 24 AO 1/SF

Terminal Assignment

Connector	Terminal point	Signal	Assignment
1	1.1	U	Voltage output 0 V to 10 V
	2.1		Not assigned
2	1.1	I	Current output 0 mA to 20 mA
	2.1	I	Current output 4 mA to 20 mA
1 and 2	1.2, 2.2	–	Not assigned
	1.3, 2.3	GND	Ground
	1.4, 2.4	Shield	Shield connection

Fig. 6-15: Terminal assignment R-IB IL 24 AO 1/SF

Internal Block Diagram

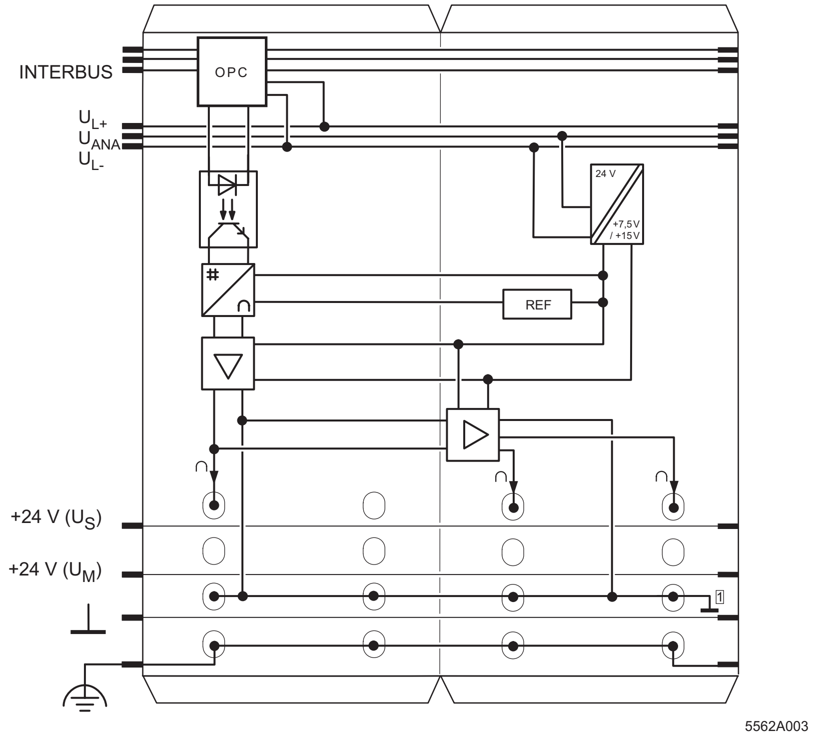

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Fig. 6-16: Internal circuits of terminal points R-IB IL 24 AO 1/SF

Symbol Description

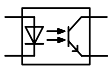
Symbol	Description
	Protocol chip (bus logic including voltage treatment)
	Optocoupler
	DC/DC converter with galvanic isolation
	Reference voltage
	Amplifier
	Digital-analog converter
	Analog output
	Analog ground, electrically isolated from the ground of the voltage jumper

Fig. 6-17: Symbol description

Notes on Connection

Note: **Always** connect the actuator with twisted-pair and shielded lines.

Assign the shield system at the terminal to PE on one side. For this purpose, cut back the shield at the module at the cable and connect it to the terminal by means of the shield connection clip. Via the clip, the shield is directly connected to FE at the module side.

Note: With line lengths of more than 10 m in an environment with disturbing influences, it is recommended to connect the shield at the actuator to the FE potential additionally by means of an RC element. Typically, the capacitor C should have a value of 1 nF to 15 nF, and the resistor R a minimum value of 10 MΩ .

For connection of the actuator, please use the connector set of the aluminum oxide CNT.

In Fig. 6-18 and Fig. 6-19, the appearance of the module depending on the output used is shown on the top left.

Examples for Connection

Note: Use the connector with the shield connection to connect the sensors. In Fig. 6-18 and Fig. 6-19, the connection is represented in a diagrammatic view (without the shield connection).

Voltage Measurement

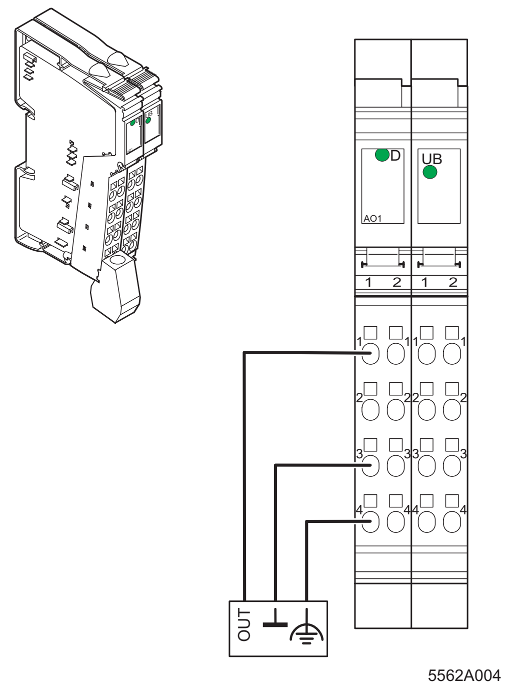


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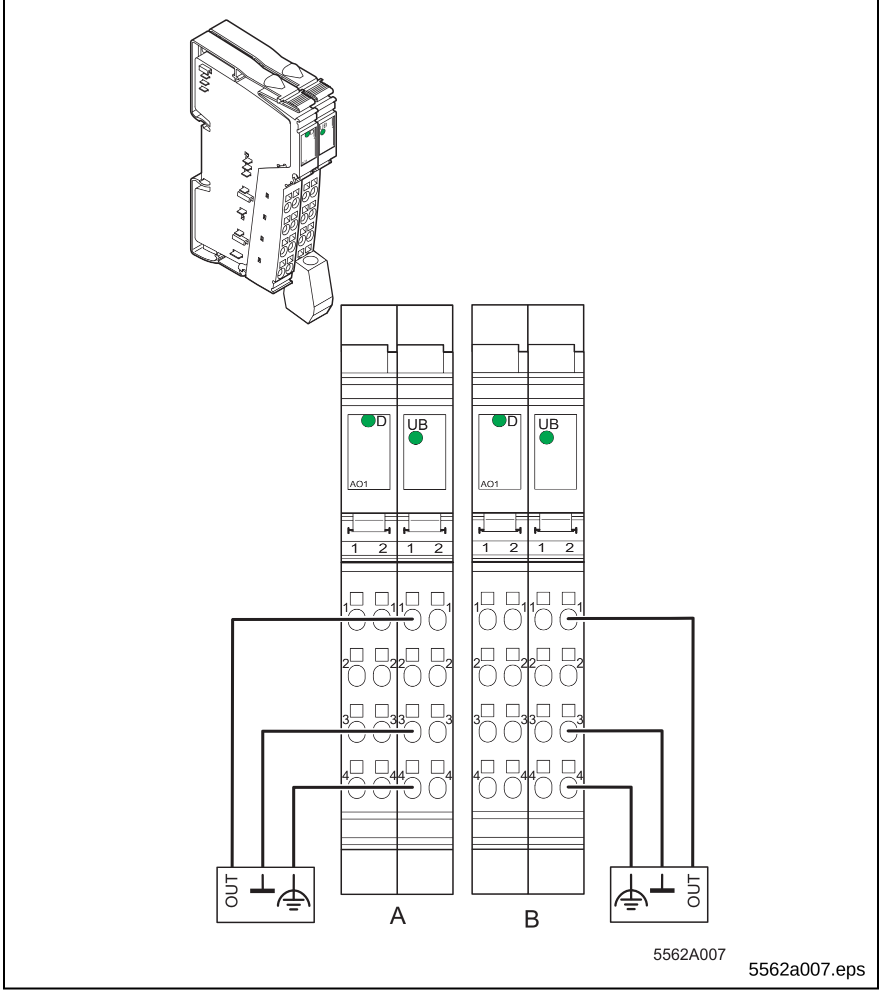
Fig. 6-18: Connection of an actuator at the voltage output 0 V to 10 V in 2-wire method with shield connection

Rexroth Indramat

Current Measurement



L: A Actuator at current output 0 mA to 20 mA
B Actuator at current output 4 mA to 20 mA

Fig. 6-19: Connection of an actuator to the current outputs in 2-wire method with shield connection

Programming Data

ID code	$07D_{hex}$ (127_{dez})
Length code	01_{hex}
Input address space	0 bytes
Output address area	2 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	2 bytes

Fig. 6-20: Programming data R-IB IL 24 AO 1/SF R-IB IL 24 AO 1/SF

6.5 Process Data Words

Note: The process data input word is not used.

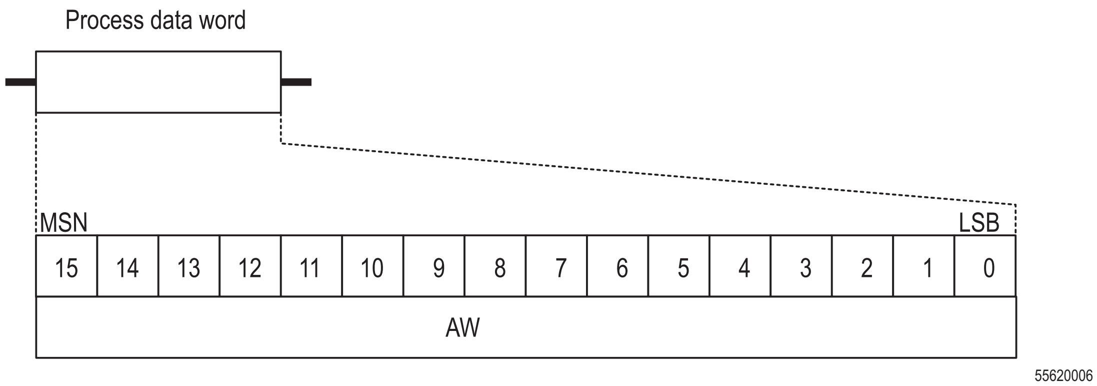
Assignment of the Terminal Points to the Process Data Output Word

INTERBUS reference	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Terminal point slot 1	Signal	Terminal point 1.1 Voltage output															
	Signal reference	Terminal point 1.3, 2.3															
	Shield (FE)	Terminal point 1.4, 2.4															
Terminal point slot 2	Signal	Terminal point 1.1 Current output 0 to 20 mA terminal point 2.1: Current output 4 to 20 mA															
	Signal reference	Terminal point 1.3, 2.3															
	Shield (FE)	Terminal point 1.4, 2.4															

Fig. 6-21: Assignment of the terminal points to the process data output word

Process Data Output Word

Via the process data output word, the output value is preset in each cycle.



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L: AW Analog value
MSB Most Significant Bit
LSB Less Significant Bit

Fig. 6-22: Process data output word

All output values are represented in 16 bit.

Please see the following tables for significant preset values in the process data word.

Abbreviations in the following tables:

QS Quantizing level(s)
ABE Upper output range value
MSB Most significant bit
LSB Less significant bit

Process data word for the voltage output 0 V to 10 V (example)																	
Voltage output 0 V to 10 V	**Analog value in volt**	**Process data word**															
		hex	binary (complement on two)														
			MSB														LSB
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
10 V minus 1 QS	9,99985	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10 V minus 2 QS	9,99969	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ABE	5,0000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 QS	+2,667 mV	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Zero	0,0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 6-23: Process data word for the voltage output 0 V to 10 V (example)

Process data word for the current output 0 mA to 20 mA (example)																		
Current output 0 mA to 20 mA	**Analog value in mA**	**Process data word**																
		hex	binary (complement on two)															
			MSB														LSB
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20 mA minus 1 QS	19,9997	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20 mA minus 2 QS	19,9994	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ABE	10,000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 QS	0.305 µA	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Zero	0,0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 6-24: Process data word for the current output 0 mA to 20 mA (example)

Process data word for the current output 4 mA to 20 mA (example)																	
Current output 4 mA to 20 mA	**Analog value in mA**	**Process data word**															
		hex	binary (complement on two)														
			MSB														LSB
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20 mA minus 1 QS	19,9998	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20 mA minus 2 QS	19,9995	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ABE	12,000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 mA plus 1 QS	4,000244	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Start of output range	4,0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 6-25: Process data word for the current output 4 mA to 20 mA (example)

Behavior of the Voltage or Current Output

Note: In project planning of your system, please consider the behavior of the output in error case!

Switching operation/ condition of supply voltage	**Framework condition**	**Process data word (hexadecimal)**	**Behavior/status of the analog voltage/current output**
U_{ANA} from 0 V to 24 V	U_L = 0 V	xxxx	0 V / 0 mA / 4 mA
U_{ANA} from 24 V to 0 V	U_L = 7.5 V	xxxx	0 V / 0 mA / 0 mA
Bus in stop	U_{ANA} = 0 V	xxxx	0 V / 0 mA / 0 mA
Bus in stop	U_{ANA} = 24 V	xxxx	0 V / 0 mA / 4 mA or hold last value

Fig. 6-26: Output behavior of the voltage or current output

Legend:

U_{ANA} Analog supply voltage of the terminal

U_L Supply voltage of the module electronics (logics supply)

xxxx Any value from 0000_{hex} to $FFFF_{hex}$

Note: The behavior or status of the output depends on which output is used.

Reaction of the Voltage or Current Output to a Control Command of the BUS Interface Module

Command	**Condition after switching operation**		
	BUS OUT Process data word (hexadecimal)	**Analog output**	
		U_{out}	**I_{out}**
STOP	Hold last value	Hold last value	Hold last value
ALARM STOP (Reset)	Hold last value	Hold last value	Hold last value

Fig. 6-27: Reaction of the voltage or current output to a control command of the BUS interface module

7 R-IB IL 24 AO 2/U/BP (2 Analog Voltage Outputs)

7.1 General Notes

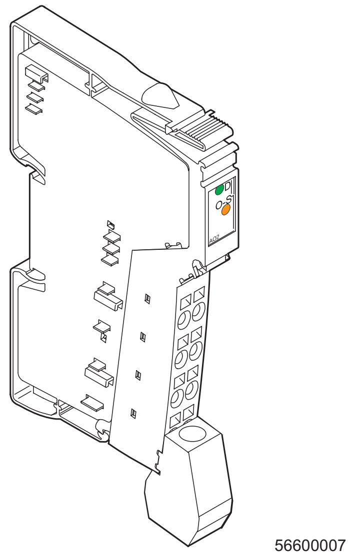

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Fig. 7-1: Terminal R-IB IL 24 AO 2/U/BP with plugged-in connector

The terminal is provided for application within an INTERBUS Inline station. It serves to put out analog voltage signals.

Features

- Two analog signal outputs
- Connection of the actuators in 2-wire method with shield connection
- Voltage ranges
  -10 V to +10 V (13 bit resolution), and
  0 V to +10 V (12 bit resolution),
- The output value can be given in two formats (IB IL and IB ST)
- Parameterizable behavior of the outputs in case of an error
- Process data update period including transformation period of the digital-analog transformer < 1 ms
- Excellent output driver properties; accordingly also suitable for long actuator lines.
- Diagnostic indicators

Note: The connector is not included in the scope of delivery of the terminal. Please order the connector according to the ordering information.

Indicator Elements

Position of the Diagnostic Indicators

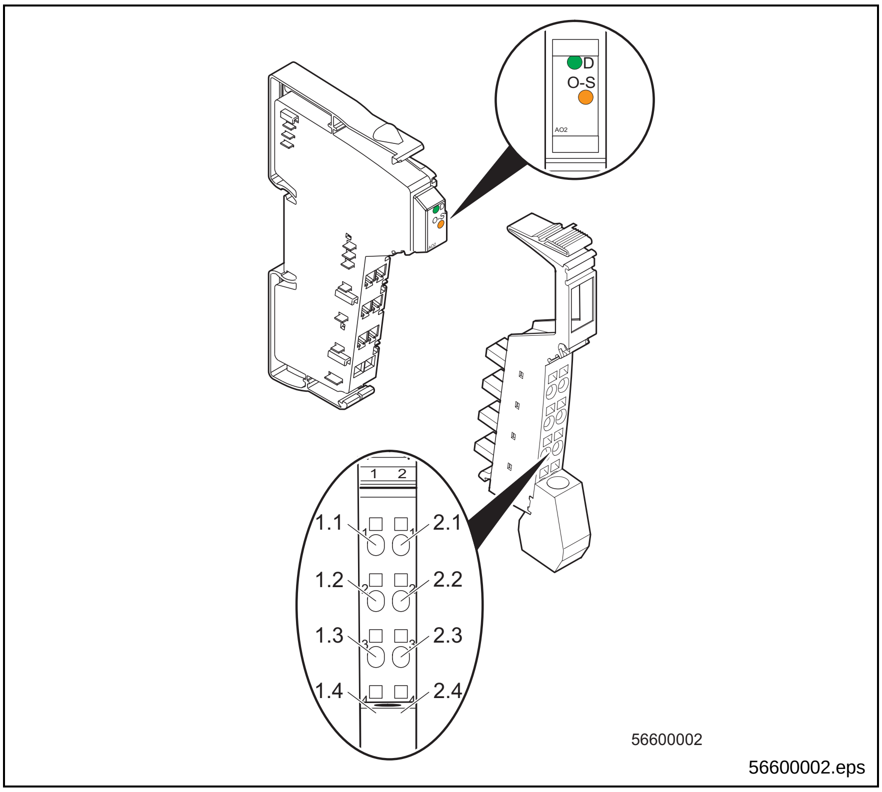


Fig. 7-2: Position of the diagnostic indicators R-IB IL 24 AO 2/U/BP

Meaning of the Diagnostic Indicators

Identification	Color	Meaning
D	Green	Bus diagnosis
OS	Orange	Parameterized in the original delivery condition

Fig. 7-3: Meaning of the diagnostic indicators R-IB IL 24 AO 2/U/BP

7.2 Installation Instruction

A high current through the voltage jumper U_M and U_S results in heating of the voltage jumpers, and thus in an increase of the temperature inside the terminals. To keep the current through the voltage jumpers of the analog terminals as low as possible, please observe the following instructions:

- Set up all analog terminals with a main circuit of their own!
- If this is impossible in your concrete case and you have to set up analog terminals in a main circuit together with other terminals, place the analog terminals behind all other terminals at the end of the main circuit.
- In this context, please note the derating curve in chapter 8.4.

7.3 Technical Data

General data		
Housing dimensions	12,2 x 120 x 71.5 mm without connector (W x H x D)	
Weight	48 g (without connector)	
Connection methods of the actuators	2-wire method	
Type of operation	Process data operation with 2 words	
Permissible temperature	Operation Storage/transport	-25°C to +55 °C -25 °C to +85 °C
Air humidity	Operation Storage/transport	75 % on average, 85 % occasionally 75 % on average, 85 % occasionally
Air pressure	Operation Storage/transport	80 kPa to 106 kPa (up to 2000 m above MSL) 76 kPa to 106 kPa (up to 3000 m above MSL)
Degree of protection	IP20 according to IEC 60529	
Protection class	Class 3, according to VDE 0106, IEC 60536	

Fig. 7-4: General technical data R-IB IL 24 AO 2/U/BP

Interface local bus	
Local bus interface	Data routing

Fig. 7-5: Technical data local bus R-IB IL 24 AO 2/U/BP

Performance balance	
Logic voltage U_L	7.5 V
Current input from U_L	Typically approx. 33 mA; maximum 40 mA
Peripheral supply voltage U_{ANA}	24 V DC
Current input at U_{ANA} Idling (R_L > 10 MΩ) Full load (R_L > 2 MΩ)	 Typically approx. 18 mA; maximum 28 mA Typically approx. 25 mA; maximum 35 mA
Total power input Idling (R_L > 10 MΩ) Full load (R_L > 2 MΩ)	 Typically 0,68 W Typically 0.85 W

Fig. 7-6: Performance balance R-IB IL 24 AO 2/U/BP

Supply of module electronics and the periphery via the bus terminal/power terminal	
Connection method	Potential routing

Fig. 7-7: Supply of module electronics and the periphery via the bus terminal/power terminal

Analog outputs	
Number	2
Connection type of the signals	2-wire method, single-ended
Signals/resolution in the process data word (quantization) Voltage -10 V to +10 V Voltage 0 V to +10 V	 333,33 µV/LSB 333,33 µV/LSB
Representation of output value -10 V to +10 V 0 V to +10 V	 16 bit complement on two 16 bit complement on two
Smallest DAC quantization level -10 V to +10 V 0 V to +10 V	 2,667 mV (13 bit) 2,667 mV (12 bit)
Basic error	±0,02 % typical of the upper output range value
Output load	2Ω minimum
Process data update period including transformation period of the digital-analog transformer	1 BUS cycle(dependent on the bus configuration); < 1 ms
Slew rate 10 % to 90 % of the end value 0 % to > 99 % of the end value	 Typically 15 µs Typically 31 µs
Slew rate (-9,0 V to + 9,0 V) idling with resistive load R_L = 2 kΩ with resistive/capacitative load R_L = 2 kΩ/ C_L = 10 nF with resistive/capacitative load R_L = 2 kΩ/ C_L = 220 nF	 Typically 0,35 V/µs Typically 0,24 V/µs Typically 0,24 V/µs Typically 0,09 V/µs
Transient protection of the analog outputs	Yes

Fig. 7-8: Analog outputs R-IB IL 24 AO 2/U/BP

Tolerance and temperature behavior (Absolute tolerance data) **(The data on tolerance refer to the upper output range value of 10 V.)**		
	Typical	**Maximum**
Tolerance at 23°C		
Total offset voltage	±0,5 mV	±4.0 mV
Gain error	±2.5 mV	±6.0 mV
Differential non-linearity	±1.3 mV	±3.9 mV
Total tolerance at 23°C	**±4.3 mV**	**±13.9 mV**
Temperature behavior at –25°C to +55°C		
Offset voltage drift T_{KVO}	±2.1 mV	±5.0 mV
Amplification drift T_{KG}	±9.2 mV	±20.0 mV
Total voltage drift $T_{Kges} = T_{KVO} + T_{KG}$	±11.3 mV	±25.0 mV
Total tolerance of the voltage inputs **(-25 °C bis 55 °C)** **Offset + amplification + linearity + drift error**	**±15.6 mV**	**±38.9 mV**
Tolerance and temperature behavior (Relative tolerance data) **(The data on tolerance refer to the upper output range value of 10 V.)**		
	Typical	**Maximum**
Tolerance at 23°C		
Total offset voltage	±0,005 %	±0,027 %
Gain error	±0,025 %	±0,060 %
Differential non-linearity	±0,0013 %	±0,027 %
Total tolerance at 23°C	**±0,09 %**	**±0,14 %**
Offset voltage drift T_{KVO}	±4 ppm/K	±10 ppm/K
Amplification drift T_{KG}	±18 ppm/K	±40 ppm/K
Total voltage drift $T_{Kges} = T_{KVO} + T_{KG}$	±23 ppm/K	±50 ppm/K
Total tolerance of the voltage inputs **(-25 °C bis 55 °C)** **Offset + amplification + linearity + drift error**	**±0,16 %**	**±0,39 %**

Fig. 7-9: Tolerance and temperature behavior R-IB IL 24 AO 2/U/BP

Additional tolerances under the influence of electromagnetic fields		
Type of electromagnetic interference	**Typical deviations from the upper output range value**	
	relative	**absolute**
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3 / IEC 61000-4-3	< ±0,2 %	< ±20 mV
Mains-borne disturbances Class 3 (test voltage 10 V) according to EN 61000-4-6 / IEC 61000-4-6	< ±2,8 %	< ±280 mV

Fig. 7-10: Additional tolerances under the influence of electromagnetic fields R-IB IL 24 AO 2/U/BP

Protective devices	
Transient protection of the analog outputs	Yes

Fig. 7-11: Protection devices R-IB IL 24 AO 2/U/BP

Error messages to the higher-level control or computer system	
Logic voltage U_L fails or is fallen below value	Yes, peripheral error message to the bus terminal

Fig. 7-12: Error messages to the higher-level control or computer system

7.4 Connections

Position of the Terminals

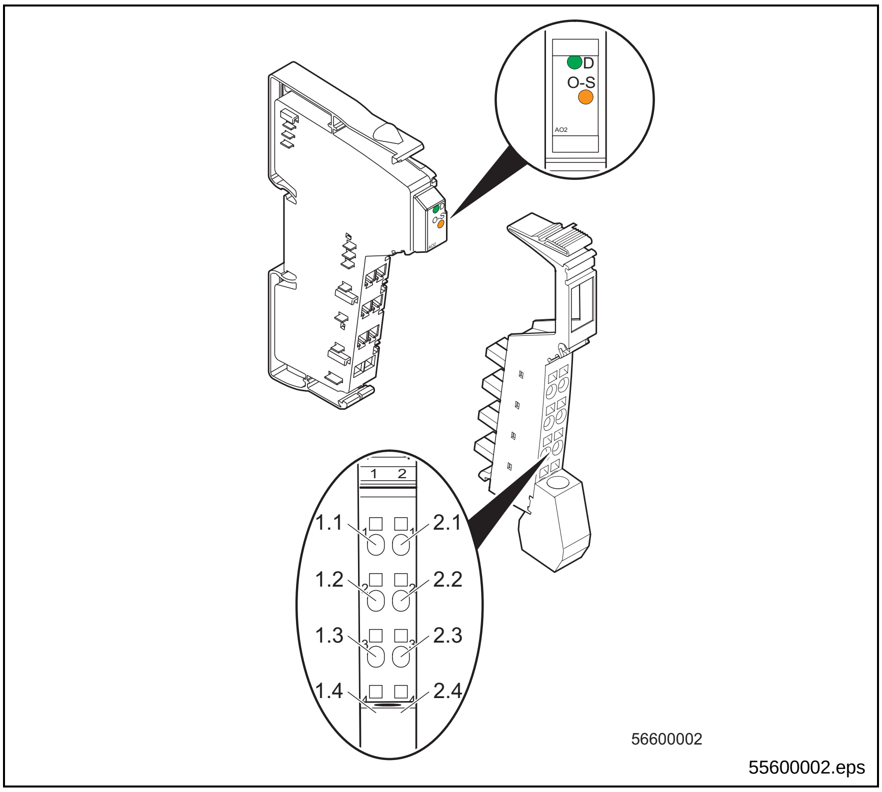


Fig. 7-13: Position of the terminals R-IB IL 24 AO 2/U/BP

Terminal Assignment

Terminal point	Signal	Assignment
1.1	U 1	Voltage output 1
2.1	U 2	Voltage output 2
1.2, 2.2	–	Not assigned
1.3, 2.3	AGND	Ground of the voltage outputs
1.4, 2.4	Shield	Shield connection

Fig. 7-14: Terminal assignment R-IB IL 24 AO 2/U/BP

Internal Block Diagram

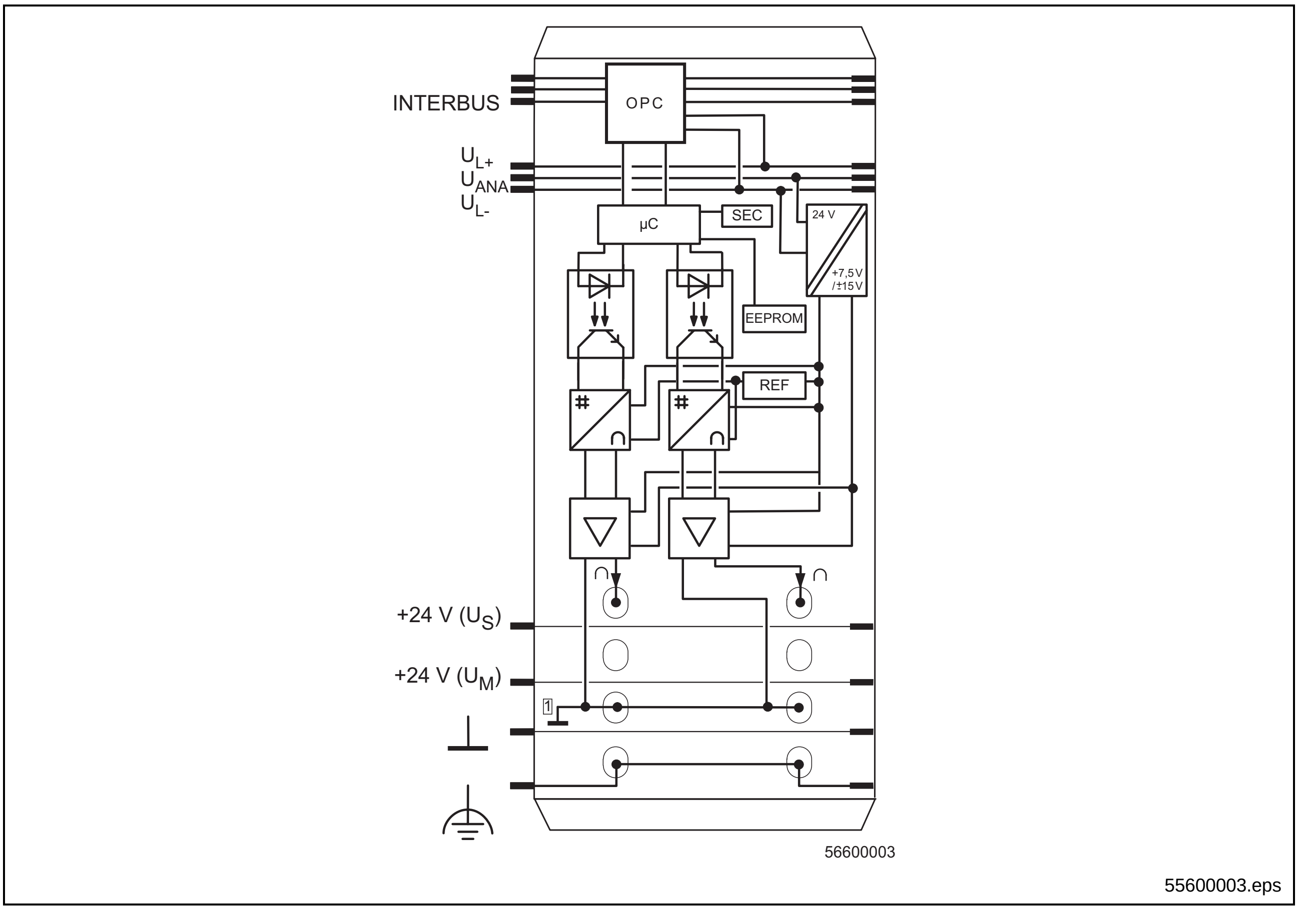


Fig. 7-15: Internal circuits of terminal points R-IB IL 24 AO 2/U/BP

Symbol Description

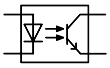
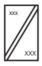
Symbol	Description
OPC	Protocol chip (bus logic including voltage treatment)
	Optocoupler
µP	Micro processor
SEC	Protective circuit (security)
EEPROM	Electrically erasable, re-programmable ROM
	DC/DC converter with galvanic isolation
REF	Reference voltage
	Amplifier
	Digital-analog converter
	Analog output
	Analog ground, electrically isolated from the ground of the voltage jumper

Fig. 7-16: Symbol description

Notes on Connection

You can connect analog actuators with a line length of **<10 m** unshielded twisted-pair lines

Always connect analog actuators with a line length of **>10m** with twisted-pair and shielded lines.

Assign the shield system at the terminal to PE on one side. For this purpose, cut back the shield at the terminal at the cable and connect it to the terminal by means of the shield connection clip (with strain relief). Via the clip, the shield is directly connected to FE at the terminal side.

When connecting a shielded actuator line in the peripheral connector, make sure that the braided screen is 15 mm longer than the strain relief. Connect the actuator lines according to the Chapter "Connection of shielded lines by means of the shield connector".

Examples for Connection

Note: Use the connector with the shield connection to connect the actuators. In Fig. 7-17 the connection is represented in a diagrammatic view (without the shield connection).

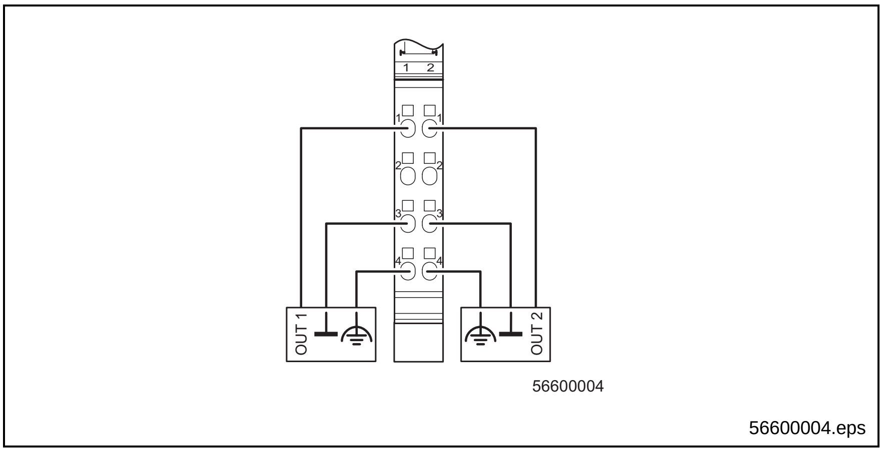


Fig. 7-17: Connection of two voltage actuators in 2-wire method with shield connection

Programming Data

ID code	$05B_{hex}$ (91_{dez})
Length code	02_{hex}
Process data channel	32 bits
Input address space	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

Fig. 7-18: Programming data R-IB IL 24 AO 2/U/BP R-IB IL 24 AO 2/U/BP

7.5 Connecting a Shielded Line via the Shield Connector

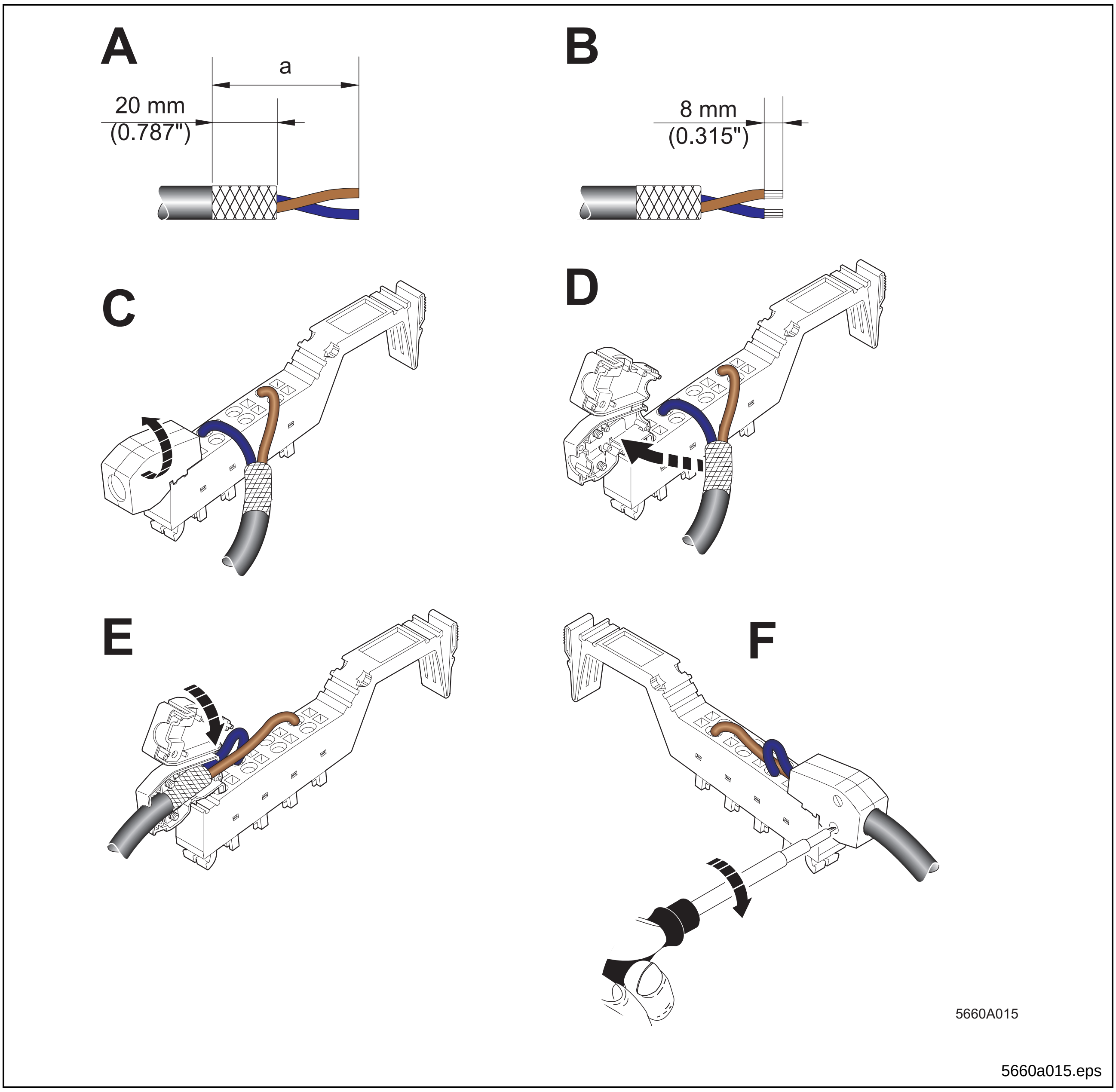


Fig. 7-19: Connecting the shield by means of the shield connector

Typically, the diameter of the actuator lines is so large that the line cannot be inserted into the strain relief of the shield connection with the outer sheath and the applied shield. Accordingly, the process for connecting these lines differs from the process described in the project planning manual. **The modifications compared to the project planning manual are printed bold.**

When connecting the lines according to Fig. 7-19, please proceed as follows:

Stripping the lines

- Strip the outer sheath of the line to the desired length (a). The desired length (a) depends on the position where you connect the cores and on whether you intend to lay the cores between the connection point and shield connection in a generous or a tight arrangement.
- Shorten the braided screen to **20 mm**. (A)
- **Do not** place the braided screen around the outer sheath. (B)
- Remove the protective foil.
- Strip the cores for 8 mm. (B)

Note: Inline wiring is provided without connector sleeves. However, connector sleeves may be used, if desired. In this case, the connector sleeves must be properly crimped.

Wiring of the connectors (according to the user's manual)

- Push a screw driver so far into the operating vertical raceway of the corresponding terminal point that you are able to put the conductor into the opening of the spring. Rexroth Indramat recommends the screwdriver SZF 1-0,6X3,5 (in preparation).
- Insert the conductor. Pull the screwdriver out of the opening. This fixes the conductor.

For connector assignment, please refer to Fig. 7-14 on pages 7-6.

Connecting the shield

- Open the shield connector (see user manual). (C)
- Insert the shield clip in the shield connection according to the line thickness (see user manual).
- Lay the line into the shield connection. (D)

When doing so, push the outer sheath of the line up to the shield clip. Under the shield clip, there must be the cores with the braided screen. The braided screen must project beyond the shield clip by approx. 15 mm.

- Close the shield connector. (E)
- Tighten the screws on the shield connector using a screwdriver. (F)

7.6 Process Data Words

Assignment of the Terminal Points to the Process Data Output Words

"Word bit" vision	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment	Format IB IL	VZ	Output value channel 1														
Assignment	Format IB ST	VZ	Output value channel 1												0	0	0
Terminal points	Signal	Terminal point 1.1 Voltage output 1															
	Signal reference	Terminal point 1.3															
	Shield (FE)	Terminal point 1.4															

Fig. 7-20: Assignment of the terminal points to the process data output word Word 0

"Word bit" vision	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment	Format IB IL	VZ	Output value channel 2														
Assignment	Format IB ST	VZ	Output value channel 2												0	0	0
Terminal points	Signal	Terminal point 2.1 Voltage output 2															
	Signal reference	Terminal point 2.3															
	Shield (FE)	Terminal point 2.4															

Fig. 7-21: Assignment of the terminal points to the process data output word Word 1

Legend:

VZ Sign

0 Bits 2 to 0 are not relevant in the format "IB ST". Assign "0" to these bits.

Assignment of the Process Data Input Words

"Word bit" vision	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment		VZ	Mirrored output value channel 1												F	B	H

Fig. 7-22: Assignment of the process data input words Word 0

"Word bit" vision	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
"Byte bit" vision	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment		VZ	Mirrored output value channel 2												F	B	H

Fig. 7-23: Assignment of the process data input words Word 1

Legend:

VZ Sign

F Format of the output data

B Voltage range

H Hold/Reset

Process Data Output Words

Via the process data output words, the output values are preset in each cycle.

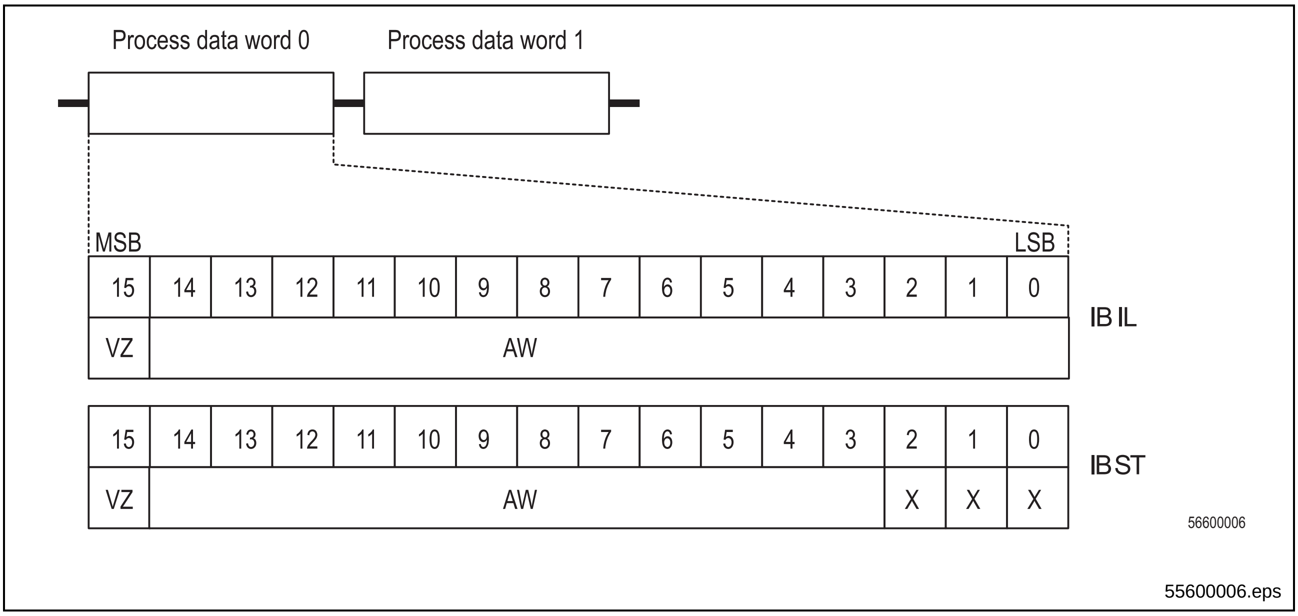


Fig. 7-24: Process data output words in the formats IB IL and IB ST

Legend:

VZ Sign

AW Output value

X Non-relevant bit

MSB Most significant bit

LSB Less Significant Bit

Note: Set the non-relevant bits to 0.

Process Data Input Words

In the process data input words, the bits 15 to 3 of the process data output values are mirrored.

Bit 15 is always the sign bit. Bits 2 to 0 are available as status bits. They contain information on the parameterized behavior of the terminal.

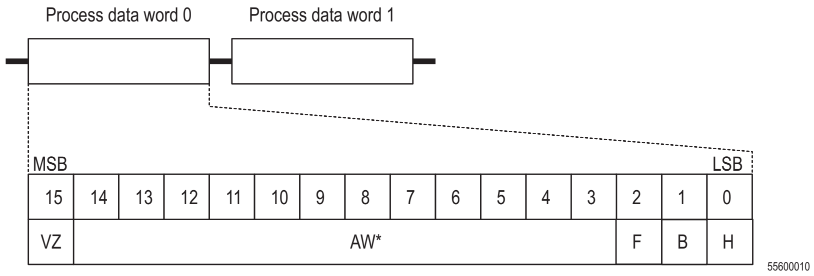


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Fig. 7-25: Process data input words

Legend:

VZ	Sign
AW	Mirrored output value
F	Format of the output data
B	Voltage range
H	Hold/Reset
MSB	Most significant bit
LSB	Less significant bit

The bits 2 to 0 have the following meaning:

Bit	**Identification**	**Meaning**	**Bit x = 0**	**Bit x = 1**
2	F	Format of the output data	IL	ST
1	B	Voltage range	-10 V to +10 V	0 V to +10 V
0	H	Hold/Reset	Hold 0	0

Fig. 7-26: Meaning of the bits with process data input words

7.7 Formats for Representation of the Measured Values

Note: The format of terminal R-IB IL AO 2/U/BP is compatible with the input terminal R-IB IL AI 2/SF. Accordingly, these terminals can be used in multiplexer systems (e.g. IB IL MUX).

The format "IB IL" is preset on the terminal (default). To operate the terminal also in the ST data formats used up to now, the representation of output values can be switched over to the format "IB ST".

Format "IB IL"

The output value is represented in the bits 14 to 0. An additional bit (bit 15) is available as sign bit.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW														

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L: VZ Sign
AW Output value

Fig. 7-27: Representation of output value in the format "IB IL" (15 bit + sign)

Significant Output Values in the Format "IB IL"

The terminal R-IB 24 AO 2 /U/BP has two analog output channels that can emit voltages from –10 V to + 10 V with a resolution of 13 bit.

Output range -10 V to + 10 V.

Output data word (two's complement)		**-10 V to +10 V U_{output}**	**Remark**
hex	**dec**	**V**	
7FFF	32767	+10,837	
7F00	32512	+10,837	
7F00	32512	+10,837	
7530	30000	+10,0	
0008	8	+2,667 mV	Smallest DAC quantization level
0001	1	+333,33 µV	Process data resolution
0000	0	0	
FFF8	-8	-2,667 mV	
8AD0	-30000	-10,0	
8100	-32512	-10,837	
<8100	*special treatment:*		
8001	-32767	+10,837	(over-range)
8080	-32640	- 10,837	(figure is fallen below range)
80xx	(others)	Hold last value	

Fig. 7-28: Significant output values in the format "IB IL" output range –10 V to +10 V

For the output range 0 V to 10 V, only the upper range is used (see Fig. 7-24 on page 7-14). Thus, the resolution for this range is limited to 12 bit.

Note: The bits 2 to 0 are not always regarded as "non-relevant bits". For the operation with the field multiplexer, error messages as well as information on figures that are above or fallen below the range must be evaluated accordingly. When the figures are above the range (8001_{hex}), 10,837 V are emitted, and 0 V when the are fallen below the range (8080_{hex}).

In case of an error code ($1000\ 0000\ 0xxx\ xxx0_{bin}$), the digital-analog converter continues to put out the last valid value.

Output range 0 V to + 10 V.

Output data word (two's complement)		**0 V to +10 V U_{output}**	**Remark**
hex	**dec**	**V**	
≤7FFF	32512	+10,837	
>7500	32512	+10,837	
7500	32512	+10,837	
7530	30000	+10,0	
0008	8	+2,667 mV	Smallest DAC quantization level
0001	1	+333,33 µV	Process data resolution
0000	0	0	
<8100	*special treatment:*		
8001	-32767	+10,837	(over-range)
8080	-32640	0	(figure is fallen below range)
80xx	(others)	Hold last value	

Fig. 7-29: Significant output values in the format "IB IL" output range 0 V to +10 V 12 bit

Note: The range $80xx_{hex}$ is reserved exclusively for error and event codes.

Format "IB ST"

The output value is represented in the bits 14 to 3. Bit 15 is available as a sign bit.

Bits 2 to 0 are not relevant.

This format corresponds to the data format used on the ST modules.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW												X	X	X

56600011

56600011.eps

Fig. 7-30: Representation of output value in the format "IB ST" (12 bit + sign)

Legend:

VZ Sign

AW Output value

X Non-relevant bit (set this bit to 0).

Note: The bits 2 to 0 are not always regarded as "non-relevant bits". The values $7FF9_{hex}$ and/or 8001_{hex} are recognized as exceeding respectively fallen below the range, interpreted as $7FF8_{hex}$ or 8008_{hex}, and treated like normal process data in the following. Thus, MUX compatibility is guaranteed. The only exception are the error codes (with ST, only wire breakage). With this error code (xxxx xxxx xxxx $xx1x_{bin}$), the last value is kept.

Significant Output Values in the Format "IB ST"

Output range 0 V to 10 V.

Output data word (two's complement)	0 V to 10 V U_{output}
hex	**V**
> 7FF8	9,9975
7FF8	9,9975
4000	5,0
0008	0,002441
< 0000	0

Fig. 7-31: Significant output values in the format "IB ST" output range 0 V to 10 V

Output range -10 V to + 10 V.

Output data word (two's complement)	-10 V to 10 V U_{output}
hex	**V**
> 7FF8	9,9975
7FF8	9,9975
0008	0,002441
0000	0
FFF8	-0,002441
8008	-9,9975
< 8008	-9,9975

Fig. 7-32: Significant output values in the format "IB ST" output range -10 V to 10 V

7.8 Output Behavior

Output Behavior in the Healthy Range (Standard Operation)

In standard operation, the output range and the data format on connection of voltage (power up) is read from the EEPROM of the terminal (non-volatile).

As an alternative, these settings as well as the behavior of the terminal in case of an error can be parameterized as volatile.

This parameterization can be set during operation by way of a process data sequence.

Output Behavior in Case of an Error

In case of an error, the outputs will behave as preset in the EEPROM (non-volatile) or as parameterized subsequently (volatile). This is to say, the outputs hold the last value (HOLD, default settings), or the are reset to zero (RESET, parameterizable).

Output Behavior of the Voltage Output

Note: In project planning of your system, please consider the behavior of the output in case of an error!

Switching operation/condition of supply voltage	Framework condition	Process data word (hexadecimal)	Behavior/status of the analog output
U_{ANA} from 0 V to 24 V	U_L = 0 V	xxxx	0 V
U_{ANA} from 24 V to 0 V	U_L = 0 V	xxxx	0 V
Bus in stop	U_{ANA} = 0 V	xxxx	0 V
Bus in stop	U_{ANA} = 24 V	xxxx	Hold last value
Bus reset (e.g. interruption of remote bus line)		xxxx	Hold last value (default setting) or 0 V (parameterizable)

Fig. 7-33: Output behavior of the voltage output

Legend:

U_{ANA} Analog supply voltage of the terminal

U_L Supply voltage of the module electronics (logics supply)

xxxx Any value from 0000_{hex} to $FFFF_{hex}$

Reaction of the Voltage or Current Output to a Control Command of the BUS Interface Module

Command	Condition after switching operation	
	BUS OUT Process data word (hexadecimal)	Analog output U_{out}
STOP	xxxx	Hold last value
ALARM STOP (Reset)	xxxx	Hold last value (default setting) or 0 V (parameterizable)

Fig. 7-34: Reaction of the voltage output to a control command of the BUS interface module

7.9 Input Behavior

For analysis of the input behavior, standard operation and parameterization mode are differentiated. The input behavior in parameterization mode is described in the section "Parameterization".

In **healthy standard operation**, the output data, following transfer to DAC, are mirrored as "Acknowledgement" in the input words in bit 15 to bit 3

Bit 2 to bit 0 are available as status bits and are used for indication and readback of the behavior of the terminal preset in the respective case.

As the terminal IB IL AO 2/U/BP evaluates as data bits only bit 15 to bit 3 in data format IB IL as well as in format IB ST, only these 13 bits are mirrored in the input data word (please observe the remarks on error codes and figures exceeding and fallen below the range.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW*												F	B	H

56600014

56600014.eps

Fig. 7-35: Input data in the formats "IB IL" and "IB ST"

Legend:

VZ	Sign		
AW	Mirrored output value		
F	Data format	0: IB IL	1: IB ST
B	Output range	0: -10 V to +10 V	0 V to 10 V
H	Hold/Reset	0: Hold	1: Reset

If the terminal has recognized an **error**, it is signaled by means of an error code in the first process data input word. For possible error codes, please see the following table.

Error Codes

Output data word (two's complement) hex	Cause	Remedy
8010	This code can only occur in the parameterization mode and can have two causes:	
	1 Configuration is being done	Continue configuration
	In the 2. parameterization step, the following code will appear in the first input word after transmission of the code 8055 hex: **In this position, it does not signal any error!**	
	2 Invalid configuration	Check parameterization
8020	Voltage at DAC remains under the permissible value ⇒ **periphery error is triggered**	Check feed-in of voltage at the bus terminal; check safe contact of the voltage jumpers; Replace terminal
8040	Terminal defect	Replace terminal

Fig. 7-36: Error codes R-IB IL 24 AO 2/U/BP

Note: The error codes overwrite the status bits (bit 2 to 0) with "0". Thus, a clear differentiation from the valid process data is possible in data format IB ST as well.

7.10 Parameterzation

The parameters of the terminal on delivery and as configurable via the process data are determined as follows:

Data format	Behavior of the outputs in case of an error	Output range
Condition on delivery		
IB IL	Outputs hold the last value (Hold)	-10 V to +10 V
Process data		
IB ST	Outputs are reset to 0 (Reset)	0 V to +10 V

Fig. 7-37: Parameterization on delivery and via the process data

To parameterize the terminal, you must change into parameterization mode. For this purpose, transfer the codes 8033_{hex} and 8055_{hex} one after the other in the first process data output word.

Note: To avoid any unintentional change into parameterization mode, it is advisable in standard operation to set to 0 the bits 2 to 0 when transferring process data.

Steps for Parameterization of the Terminal

1. step:	**Transfer of the code 8033 $_{hex}$ in the first process data output word.**
	In the bits 15 to 3 of the first process data input word, this code is acknowledged like standard process data. With each subsequent code unlike 8055$_{hex}$ in the first process data word, the system does not leave standard operation and interprets the code as process data.
2. step:	**Transfer of the code 8055 $_{hex}$ in the first process data output word.**
	The acknowledgement is given in the first input word by means of the code 8010$_{hex}$. In this case, this code does not signal any error but shows that subsequently (in step 3), a configuration word is expected. With each following code unlike 80xx $_{hex}$ in the first process data word, the system leaves the parameterization mode.
3. step:	**Transfer of the parameterization code: 1000 0000 1000 $p_3p_2p_1$ 1$_{bin}$.**
	Here, p x are the parameters of the terminal: p_3 : Data format (0: IB IL; 1: IB ST) p_2: Output range (0: -10 V to +10 V; 1: 0 V to 10 V) p_1: Reset behavior (0: Hold; 1: Reset) Acceptance of the value is confirmed in the bits 15 to 3 of the first input word by mirroring of the code. If an invalid configuration is given, the code 8010$_{hex}$ will appear in the first input data word. Here, it signals the error "Invalid configuration". This step can be repeated as often as desired. By transferring any code unlike 80xx $_{hex}$ in the first process data word, the parameterization mode is left without the parameterization taking effect.
4. step:	**In this step, you can decide whether the parameterization is to be stored in the EEPROM in a volatile (dynamic) or non-volatile (static) mode.**
	Volatile parameterization: After power-up, this setting is no longer available. In the following operation, the settings from the EEPROM are used. **Transfer of the codes 8077$_{hex}$** **Non-volatile parameterization:** The parameterization is stored in the EEPROM. After power-up, this parameterization is used from the EEPROM. **Transfer of the codes 8099$_{hex}$** After writing of 8077$_{hex}$ or 8099$_{hex}$, parameterization will take effect, and the parameterization mode is exited. This is signaled in the first input word by mirroring the code 8077 $_{hex}$ or 8099$_{hex}$ - Here, these values merely function as acknowledgement. The next process data is treated again as usual.

Fig. 7-38: Steps for Parameterization of the Terminal

Note: If parameterization was interrupted, a re-start at Step 1 is necessary to change back into parameterization mode. The orange LED "O-S" on the terminal signals if the original configuration is used, or if the current configuration deviates from the configuration status on delivery of the terminal. The LED is lighted when the delivery status has been parameterized.

8 Electrical Isolation

8.1 R-IB IL 24 AI 2/SF

DANGER

As a prerequisite for the electrical isolation of the logics level from the I/O area, the bus terminal of the station and the sensors connected to the analog input terminal described here must be supplied from isolated power supply units. The supply devices must not be connected in the 24 V area!

Common Potentials

24-V main voltage, 24-V segment voltage, and GND lie on the same potential. FE is a potential area of its own.

Isolated Potentials

The following table shows the potentials of a combination of bus terminal, power terminal and I/O terminal:

Test section	Test voltage
5 V supply of incoming remote bus /7.5 V supply (bus logics)	500 V AC 50 Hz: 1 min.
5 V supply of next remote bus / 7.5 V supply (bus logics)	
7.5 V supply (bus logics) / 24 V supply U_{ANA} / peripheral system	
7.5 V supply (bus logics) / 24 V supply U_{ANA} / functional earth	
24 V supply (peripheral system) / functional earth	

Fig. 8-1: Potentials R-IB IL 24 AI 2/SF

Electrical Isolation

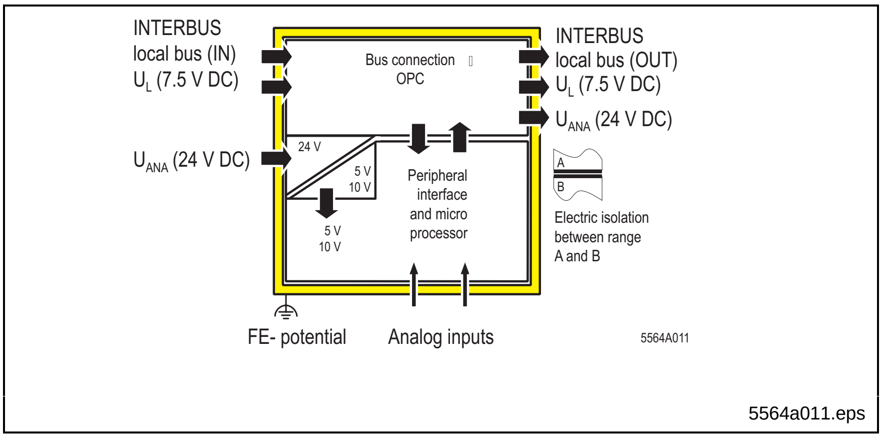

Fig. 8-2: Electrical isolation of the individual function areas

Rexroth Indramat

8.2 R-IB IL 24 TEMP 2 RTD

DANGER

As a prerequisite for the electrical isolation of the logics level from the I/O area, the bus terminal of the station and the sensors connected to the analog input terminal described here must be supplied from isolated power supply units. The supply devices must not be connected in the 24 V area!

Common Potentials

24-V main voltage, 24-V segment voltage, and GND lie on the same potential. FE is a potential area of its own.

Isolated Potentials

See the following table for all the potentials in the terminal IB IL TEMP 2 RTD:

Test section	Test voltage
7.5 V supply (bus logics) / 24 V supply U_{ANA} / peripheral system	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logics) / 24 V supply U_{ANA} / functional earth	
24 V supply (peripheral system) / functional earth	

Fig. 8-3: Potentials R-IB IL 24 AI 2/SF

Electrical Isolation

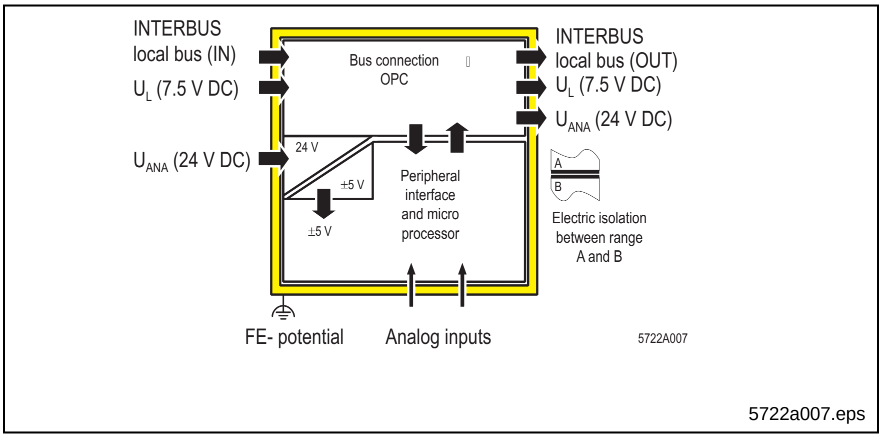

Fig. 8-4: Electrical isolation of the individual function areas

8.3 R-IB IL 24 AO 1/SF

Derating

Permissible Ambient Temperature in Dependence on the Current on the Voltage Jumpers U_M and U_S (Total Current)

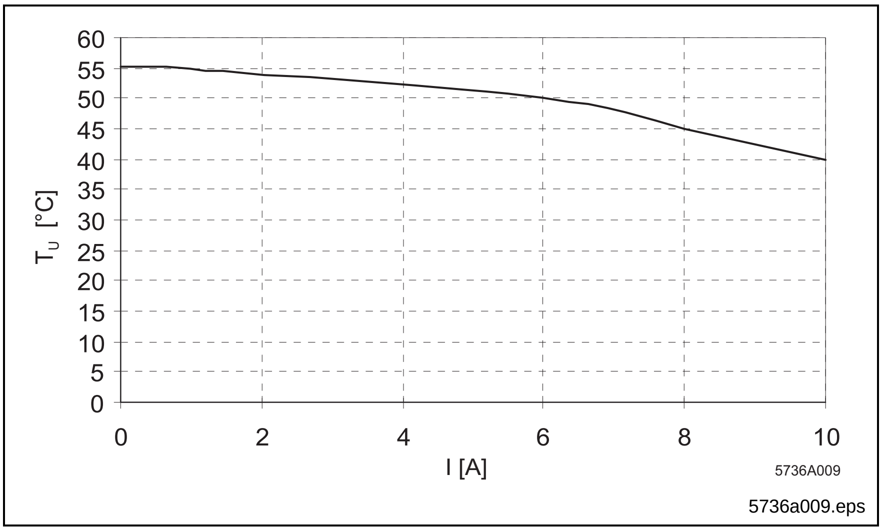

Fig. 8-5: Permissible ambient temperature in dependence on the current on the voltage jumpers U_M and U_S (total current)

T_U [°C]	Ambient temperature in °C
I [A]	Current through the voltage jumpers U_M and U_S in A

Electrical Isolation

Note: The DC/DC converter provides for electrical isolation of the logics level from the peripheral area.

Common Potentials

24-V main voltage, 24-V segment voltage, and GND lie on the same potential. FE is a potential area of its own.

Isolated Potentials

The following table shows the potentials of a combination of bus terminal, power terminal and I/O terminal:

Test section	Test voltage
7.5 V supply (bus logics) / 24 V supply U_{ANA} / peripheral system	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logics) / 24 V supply U_{ANA} / functional earth	
24 V supply (peripheral system) / functional earth	

Fig. 8-6: Potentials R-IB IL 24 AO 1/SF

Electrical Isolation

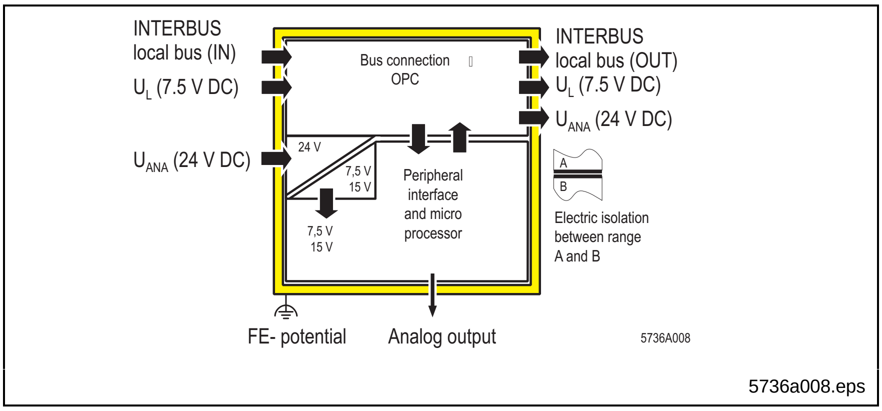

Fig. 8-7: Electrical isolation of the individual function areas

8.4 R-IB IL 24 AO 2/U/BP

Derating

Permissible Ambient Temperature in Dependence on the Current on the Voltage Jumpers U_M and U_S (Total Current)

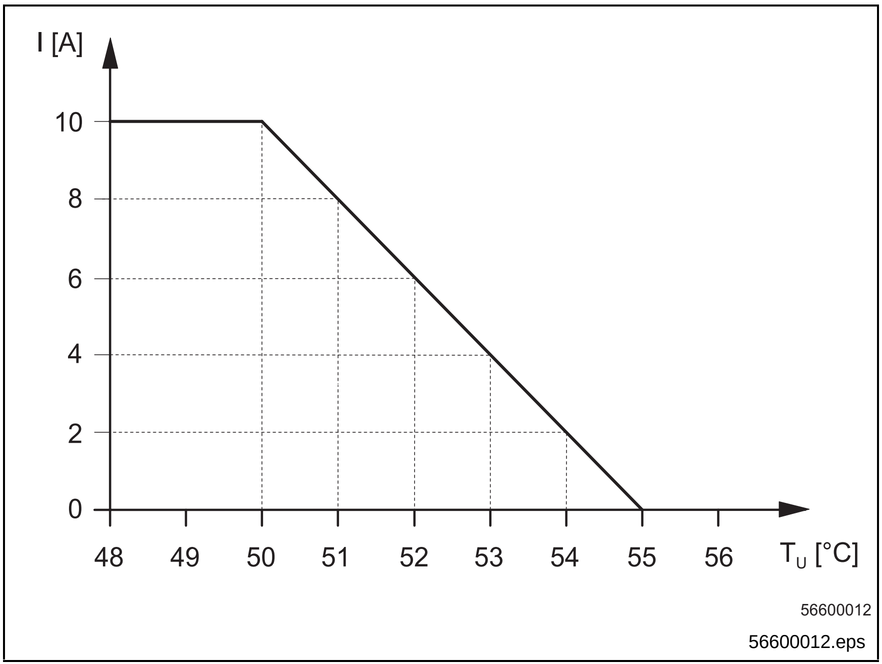

Fig. 8-8: Permissible ambient temperature in dependence on the current on the voltage jumpers U_M and U_S (total current)

From T_U = +50 °C, derating of 2 A/K will start.

T_U [°C]	Ambient temperature in °C
I [A]	Current through the voltage jumpers U_M and U_S in A

Electrical Isolation

Note: The DC/DC converter provides for electrical isolation of the logics level from the peripheral area.

Common Potentials

24-V main voltage, 24-V segment voltage, and GND lie on the same potential. FE is a potential area of its own.

Isolated Potentials

The following table shows the potentials of a combination of bus terminal, power terminal and I/O terminal:

Test section	Test voltage
7.5 V supply (bus logics) / 24 V supply U_{ANA} / peripheral system	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logics) / 24 V supply U_{ANA} / functional earth	
24 V supply (peripheral system) / functional earth	

Fig. 8-9: Potentials R-IB IL 24 AO 2/U/BP

Electrical Isolation

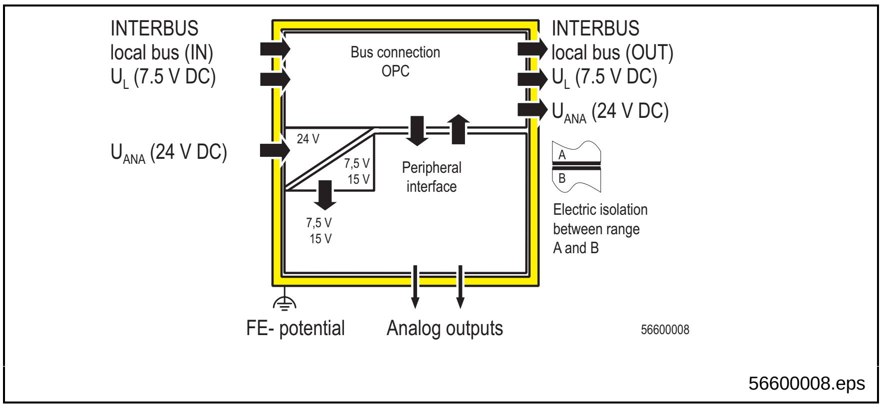

Fig. 8-10: Electrical isolation of the individual function areas

9 Ordering Information

9.1 Ordering Designation

Note: With all modules, the connectors are not part of the scope of delivery. They must be ordered separately.

Description	Short type (ordering designation)	Material number
Terminal with two analog input channels	R-IB IL 24 AI 2/SF	289306
Terminal with two resistive temperature sensor inputs For complete fitting of the terminal, you'll need a connector with a shield connection.	R-IB IL TEMP 2 RTD	289305
Terminal with an analog output to put out voltage or optionally current signals	R-IB IL 24 AO 1/SF	289303
Terminal with two analog voltage output channels	R-IB IL 24 AO 2/U/BP	289381
Connector with six connections in tension spring technology and with shield connection (light gray, unprinted); content of package: 5 pieces	R-IB IL SCN-6 SHIELD	289331
Connector set AO content of package: 10 pieces	R-IB IL AO/CNT-PLSET	289339
User manual "Project Planning and Installation of the Product Family RECO-Inline" with INTERBUS-S bus coupler	DOK-CONTRL-R-IL*IBSSYS	289594
User manual "Project Planning and Installation of the Product Family RECO-Inline" with PROFIBUS-S bus coupler	DOK-CONTRL-R-IL*PBSSYS	289596

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