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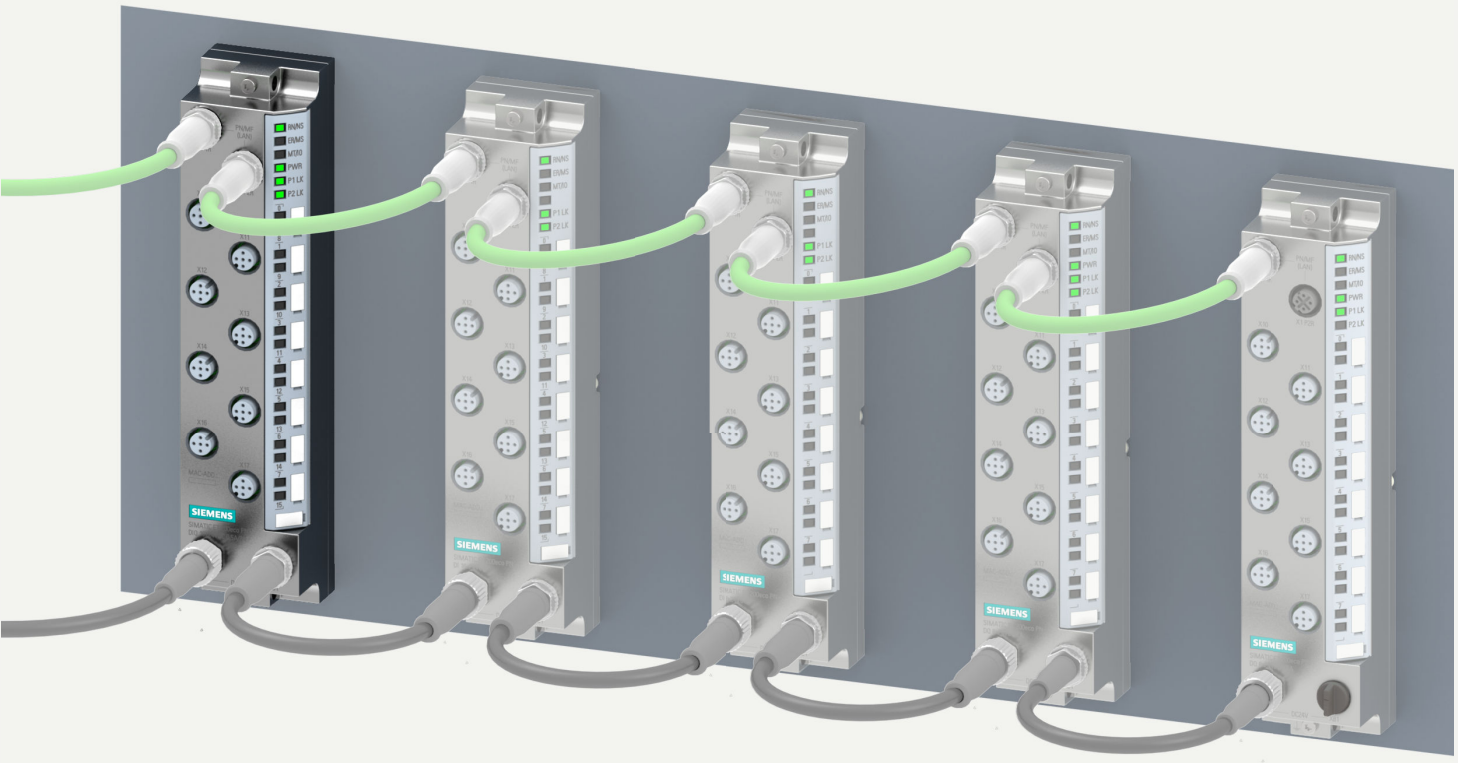

Edition 12/2022

Equipment Manual

SIMATIC

ET 200eco PN M12-L

I/O device analog inputs
AI 8xRTD/TC M12-L 8xM12
(6ES7144-6JF00-0BB0)

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SIMATIC

ET 200eco PN
Analog Inputs AI 8xRTD/TC M12-L 8xM12 (6ES7144-6JF00-0BB0)

Equipment Manual

12/2022
A5E51738148-AB

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Preface

Purpose of the documentation

This equipment manual supplements the ET 200eco PN M12-L Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/109778292) system manual. Functions that relate in general to the distributed I/O devices ET 200eco PN M12-L are described in this system manual.

The MultiFieldbus (https://support.industry.siemens.com/cs/ww/en/view/109773209) Function Manual describes general MultiFieldbus functions. This equipment manual describes the specific adaptations for this I/O device.

The information provided in this equipment manual and in the system manual and the function manuals supports you in commissioning the ET 200eco PN M12-L distributed I/O devices.

Changes compared to the previous version

This manual contains the following changes/additions compared to the previous version:

- Update of the Status and fault displays section
- Updating the Address Space section
- Update of the section Technical specifications (Page 96)

Conventions

Also observe notes marked as follows:

NOTE

A note contains important information:

- On the product described in the documentation
- On handling the product
- On the part of the documentation to which particular attention is paid

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Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/cert).

Table of contents

Guide to ET 200eco PN M12-L

1

1.1 Information classes ET 200eco PN M12-L

The documentation for the SIMATIC ET 200eco PN M12-L distributed I/O system is arranged into three areas.

This arrangement enables you to access the specific content you require.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/de/en/view/109742718).

Basic information

The System Manual describes in detail the configuration, installation, wiring and commissioning of the SIMATIC ET 200eco PN M12-L distributed I/O system.

The STEP 7 online help supports you in the configuration and programming.

Examples:

- ET 200eco PN M12-L System Manual
- Online help in the TIA Portal

Device information

Equipment manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

Examples:

- I/O Device Digital Inputs Equipment Manuals
- I/O Device Digital Inputs Equipment Manuals
- I/O Device Digital Inputs/Outputs Equipment Manuals
- IO-Link Master I/O Device Communication Module Equipment Manual
- I/O Device Analog Inputs Equipment Manual

General information

The function manuals contain detailed descriptions on general topics relating to the SIMATIC ET 200eco PN M12-L distributed I/O system.
Examples:

- Function Manual Diagnostics
- Function Manual Communication
- PROFINET Function Manual
- Function Manual Designing Interference-free Controllers
- IO-Link System Function Manual
- MultiFieldbus Function Manual

1.2 Basic tools

The tools described below support you in all steps: from planning, over commissioning, all the way to analysis of your system.

TIA Selection Tool

The TIA Selection Tool tool supports you in the selection, configuration, and ordering of devices for Totally Integrated Automation (TIA).
As successor of the SIMATIC Selection Tools , the TIA Selection Tool assembles the already known configurators for automation technology into a single tool.
With the TIA Selection Tool , you can generate a complete order list from your product selection or product configuration.
You can find the TIA Selection Tool on the Internet.
(https://support.industry.siemens.com/cs/ww/en/view/109767888)

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities on various SIMATIC S7 stations as bulk operations independent of TIA Portal.
The SIMATIC Automation Tool offers a wide range of functions:

- Scanning of a PROFINET/Ethernet system network and identification of all connected CPUs
- Assignment of addresses (IP, subnet, Gateway) and device name (PROFINET device) to a CPU
- Transfer of the date and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- RUN/STOP mode switchover
- CPU localization through LED flashing
- Reading out of CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Firmware update of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet.
(https://support.industry.siemens.com/cs/ww/en/view/98161300)

PRONETA

SIEMENS PRONETA (PROFINET network analysis) is a commissioning and diagnostic tool for PROFINET networks. PRONETA Basic has two core functions:

- In the network analysis, you get an overview of the PROFINET topology. Compare a real configuration with a reference installation or make simple parameter changes, e.g. to the names and IP addresses of the devices.
- The "IO test" is a simple and rapid test of the wiring and the module configuration of a plant, including documentation of the test results.

You can find SIEMENS PRONETA Basic on the Internet:
(https://support.industry.siemens.com/cs/ww/en/view/67460624)

SIEMENS PRONETA Professional is a licensed product that offers you additional functions. It offers you simple asset management in PROFINET networks and supports operators of automation systems in automatic data collection/acquisition of the components used through various functions:

- The user interface (API) offers an access point to the automation cell to automate the scan functions using MQTT or a command line.
- With PROFIenergy diagnostics, you can quickly detect the current pause mode or the readiness for operation of devices that support PROFIenergy and change these as needed.
- The data record wizard supports PROFINET developers in reading and writing acyclic PROFINET data records quickly and easily without PLC and engineering.

You can find SIEMENS PRONETA Professional on the Internet.
(https://www.siemens.com/proneta-professional)

SINETPLAN

SINETPLAN, the Siemens Network Planner, supports you in planning automation systems and networks based on PROFINET. The tool facilitates professional and predictive dimensioning of your PROFINET installation as early as in the planning stage. In addition, SINETPLAN supports you during network optimization and helps you to exploit network resources optimally and to plan reserves. This helps to prevent problems in commissioning or failures during productive operation even in advance of a planned operation. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning through importing and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long term and the optimal use of resources

You can find SINETPLAN on the Internet
(https://new.siemens.com/global/en/products/automation/industrial-communication/profinet/sinetplan.html).

1.3 MultiFieldbus Configuration Tool (MFCT)

MultiFieldbus Configuration Tool

MultiFieldbus Configuration Tool (MFCT) is a PC-based software and supports the configuration of MultiFieldbus- and DALI-devices. In addition, the MFCT offers convenient options for mass firmware updates of ET 200 devices with MultiFieldbus- support and reading service data for many other Siemens devices.

Functional scope of the MFCT

- MultiFieldbus configuration:
  Engineering, configuration and diagnostics of MultiFieldbus-devices, provision of the required project files (project, UDT-, CSV- and EDS-file), transfer/export of the files to device and/or data memory.
- DALI configuration:
  Device selection and online configuration of DALI devices.
- TM FAST:
  Generation and download of FPGA-UPD- and FPGA-DB-files.
- Maintenance:
  Topology scan of a Ethernet network, reading of service data, parameter assignment and firmware update.
- Settings:
  Language switching German / English, network scanner speed, setting of the network adapter, installation of GSDML-and EDS-files.

System/installation requirements for MFCT

The MFCT runs under Microsoft Windows and does not require installation or administrator rights.

For MFCT you must also install the following software:

- Microsoft .NET Framework 4.8 (You can find an Offline Installer on the Internet. (https://support.microsoft.com/en-us/topic/microsoft-net-framework-4-8-offline-installer-for-windows-9d23f658-3b97-68ab-d013-aa3c3e7495e0))
- NPcap from directory "Misc"
- PG/PC interface from directory "Misc"
- Microsoft C++ Redistributable for x86-systems (you can find the installation data for download on the Internet. (https://aka.ms/vs/15/release/vc_redist.x86.exe))

The download of the tool and further information as well as documentation on the individual functions of the MFCT can be found on the Internet.
(https://support.industry.siemens.com/cs/de/en/view/109773881)

1.4 SIMATIC Technical Documentation

Additional SIMATIC documents will complete your information. You can find these documents and their use at the following links and QR codes.

The Industry Online Support gives you the option to get information on all topics. Application examples support you in solving your automation tasks.

Overview of the SIMATIC Technical Documentation

Here you will find an overview of the SIMATIC documentation available in Siemens Industry Online Support:

Industry Online Support International (https://support.industry.siemens.com/cs/ww/en/view/109742705)

Watch this short video to find out where you can find the overview directly in Siemens Industry Online Support and how to use Siemens Industry Online Support on your mobile device:

Quick introduction to the technical documentation of automation products per video (https://support.industry.siemens.com/cs/us/en/view/109780491)

YouTube video: Siemens Automation Products - Technical Documentation at a Glance (https://youtu.be/TwLSxxRQQsA)

mySupport

With "mySupport" you can get the most out of your Industry Online Support.

Registration	You must register once to use the full functionality of "mySupport". After registration, you can create filters, favorites and tabs in your personal workspace.
Support requests	Your data is already filled out in support requests, and you can get an overview of your current requests at any time.
Documentation	In the Documentation area you can build your personal library.
Favorites	You can use the "Add to mySupport favorites" to flag especially interesting or frequently needed content. Under "Favorites", you will find a list of your flagged entries.
Recently viewed articles	The most recently viewed pages in mySupport are available under "Recently viewed articles".
CAx data	The CAx data area gives you access to the latest product data for your CAx or CAe system. You configure your own download package with a few clicks: • Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files • Manuals, characteristics, operating manuals, certificates • Product master data

You can find "mySupport" on the Internet. (https://support.industry.siemens.com/My/ww/en)

Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus on individual products.

You can find the application examples on the Internet.
(https://support.industry.siemens.com/cs/ww/en/ps/ae)

Product overview

2

2.1 Properties

Article number

6ES7144-6JF00-0BB0

View of the I/O device

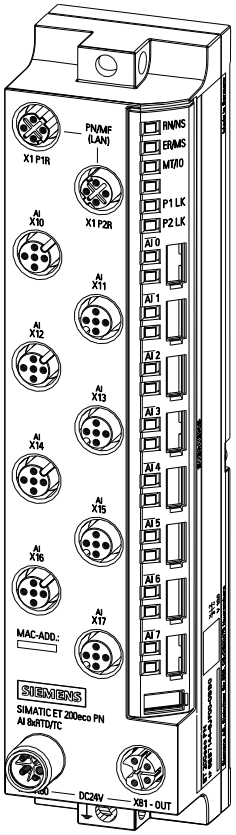


Figure 2-1 View of the I/O device AI 8xRTD/TC M12-L 8xM12

Properties

The I/O device has the following technical properties:

- Using the MultiFieldbus function, it connects the ET 200eco PN M12-L distributed I/O system with one of the following bus protocols:
  - PROFINET IO
  - EtherNet/IP
  - Modbus TCP
- 8 analog inputs
- M12 sockets for connection of sensors
- Measurement type can be set for each channel:
  - Voltage measurement: ±80 mV
  - Resistance measurement: 0-150 Ω, 0-300 Ω, 0-600 Ω, 0-3 kΩ, 0-6 kΩ
  - Thermal resistance measurement: Ni100, Ni120, Ni200, Ni500, Ni1000, Pt100, Pt200, Pt500, Pt1000 (2/3/4-wire connection)
  - Thermocouple measurement: Type B, C, E, J, K, L, N, R, S, T, U
- Connection for isolated/non-isolated thermocouples
- Resolution 16-bit
- Accuracy according to AMS2750F
- Smoothing
- Interference voltage suppression
- 24 V DC supply voltage
- Integrated switch with 2 ports
- Configurable diagnostics can be set for each channel
- Hardware interrupt on limit violation can be set per channel (2 low and 2 high limits each per channel)
- Various options to compensate for the reference junction temperature
- Dimensions 45 x 200 mm

The I/O device supports the following functions:

- Firmware update
- Identification and maintenance data I&M0 to I&M3
- Value status (Quality Information)
- Module Shared Input (MSI)
- Reaction-free shutdown of standard modules

NOTE

Process values during startup

As long as no parameters have been received by the I/O module, the I/O module returns the process value $7FFF_H$.

Accessories

The following components are included in the I/O device package:

- Identification labels

Other components

The following component can be ordered as spare part:

- Identification labels

The following components can be ordered as accessories:

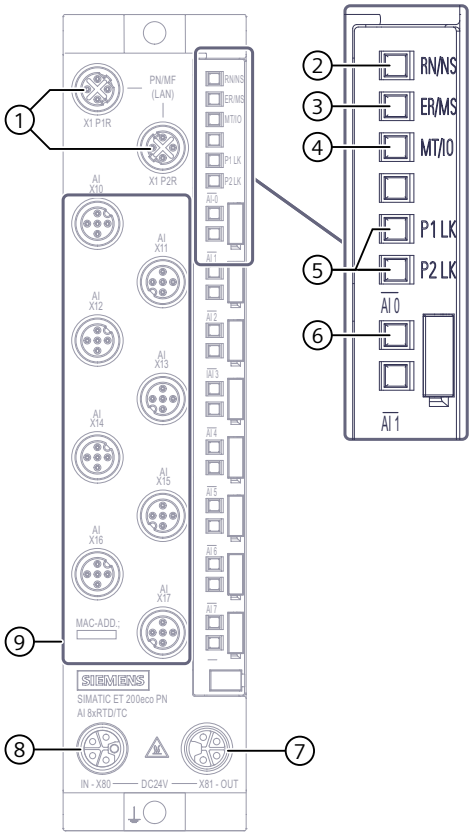
- Mounting rail
- Connectors and cables
- M12 sealing cap

See also

You can find more information on the accessories in the ET 200eco PN M12-L distributed I/O system (https://support.industry.siemens.com/cs/ww/en/view/109778292) system manual.

2.2 Operator controls and display elements

The figure below shows the operator controls and display elements of the AI 8xRTD/TC M12-L 8xM12 I/O device.



① PN/MF (LAN): Sockets for connecting the MultiFieldbus
② RN/NS: RUN/network status LED
③ ER/MS: ERROR/module status LED

④ MT/IO: MAINT/IO status LED
⑤ P1 LK/P2 LK: LINK port status LEDs
⑥ LED displays 0 to 7 for channel status/channel error
⑦ X81: Socket for loop-through of the supply and load voltage
⑧ X80: Connector for infeed of supply and load voltage
⑨ X10 to X17: Sockets for the input signal

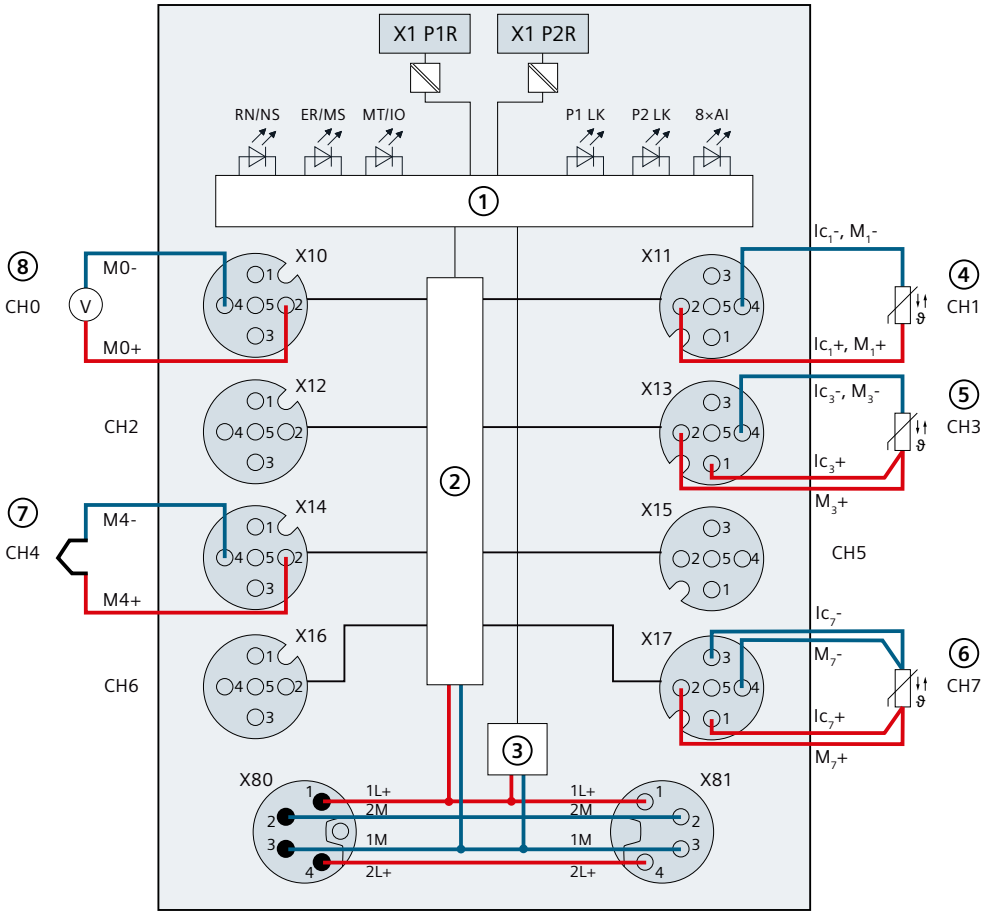
Figure 2-2 Operator controls and display elements

Wiring

3

3.1 Terminal and block diagram

The example in the following figure shows the pin assignment for the measurement types.



①	Bus interface with integrated 2-port switch	1L+	Supply voltage 1L+ (non-switched)
②	AI circuit	1M	Ground 1M (non-switched)
③	Internal supply voltage	2L+	Load voltage 2L+ (switched)
④	RTD/R 2-wire connection	2M	Ground 2M (switched)
⑤	RTD/R 3-wire connection	M_n+	Measuring input positive, channel n
⑥	RTD/R 4-wire connection	M_{n-}	Measuring input negative, channel n
⑦	Thermocouple measurement	Ic_n+, Ic_n-	Current output, current feed, RTD/R channel n
⑧	Voltage measurement	RN/NS	RUN/network status LED
X10 to X17	Channels 0 to 7	ER/MS	ERROR/module status LED

X80	Infeed of supply and load voltage	MT/IO	MAINT/IO status LED
X81	Loop-through of supply and load voltage	P1 LK	Link port 1 LED
X1 P1R	MultiFieldbus interface X1 port 1	P2 LK	Link port 2 LED
X1 P2R	MultiFieldbus interface X1 port 2	AI	Channel status/channel error LEDs

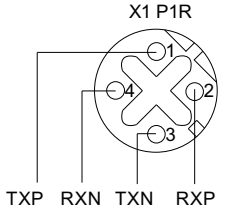
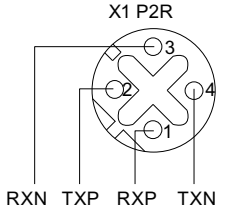
Figure 3-1 Terminal and block diagram

3.2 Pin assignment

Pin assignment MultiFieldbus connector

The following table shows the pin assignment of the MultiFieldbus connector.

Table 3-1 Pin assignment of the MultiFieldbus connector, port 1 and 2

Pin	Assignment of the core color of the PROFINET cable	Assignment	Front view of the connectors
Assignment X1 P1R			
1	Yellow	TXP	
2	White	RXP	
3	Orange	TXN	
4	Blue	RXN	
Thread		Functional earth FE	
Assignment X1 P2R			
1	Yellow	RXP	
2	White	TXP	
3	Orange	RXN	
4	Blue	TXN	
Thread		Functional earth FE	

Pin assignment of the sockets for analog inputs

The table below shows the pin assignment of the 8 sockets for the connection of the analog inputs.

Table 3-2 Pin assignment for thermocouple measurement and voltage measurement

Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (thermocouple)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
1	Reserved		

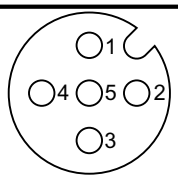
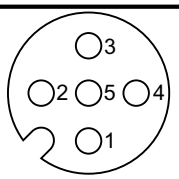
Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (thermocouple)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
2	Measuring input M_0+: Connector X10 Measuring input M_1+: Connector X11 Measuring input M_2+: Connector X12 Measuring input M_3+: Connector X13 Measuring input M_4+: Connector X14 Measuring input M_5+: Connector X15 Measuring input M_6+: Connector X16 Measuring input M_7+: Connector X17		
3	Reserved		
4	Measuring input M_0-: Connector X10 Measuring input M_1-: Connector X11 Measuring input M_2-: Connector X12 Measuring input M_3-: Connector X13 Measuring input M_4-: Connector X14 Measuring input M_5-: Connector X15 Measuring input M_6-: Connector X16 Measuring input M_7-: Connector X17		
5	Functional earth FE		

Table 3-3 Pin assignment for analog inputs (RTD/R 2-wire connection)

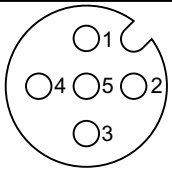
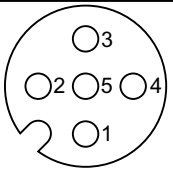
Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (RTD/R-2-wire connection)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
1	Reserved		
2	Measurement cable Ic_0+,M_0+: Connector X10 Measurement cable Ic_1+,M_1+: Connector X11 Measurement cable Ic_2+,M_2+: Connector X12 Measurement cable Ic_3+,M_3+: Connector X13 Measurement cable Ic_4+,M_4+: Connector X14 Measurement cable Ic_5+,M_5+: Connector X15 Measurement cable Ic_6+,M_6+: Connector X16 Measurement cable Ic_7+,M_7+: Connector X17		
3	Reserved		
4	Measurement cable Ic_0-,M_0-: Connector X10 Measurement cable Ic_1-,M_1-: Connector X11 Measurement cable Ic_2-,M_2-: Connector X12 Measurement cable Ic_3-,M_3-: Connector X13 Measurement cable Ic_4-,M_4-: Connector X14 Measurement cable Ic_5-,M_5-: Connector X15 Measurement cable Ic_6-,M_6-: Connector X16 Measurement cable Ic_7-,M_7-: Connector X17		
5	Functional earth FE		

Table 3-4 Pin assignment for analog inputs (RTD/R 3-wire connection)

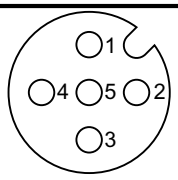
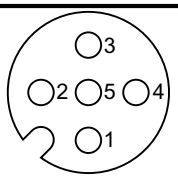
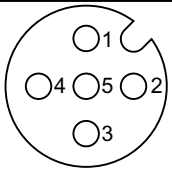
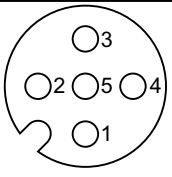
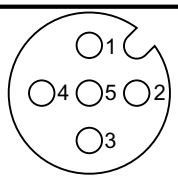
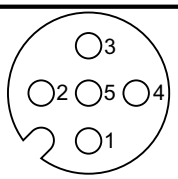
Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (RTD/R-3-wire connection)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
1	Constant current cable Ic_0+: Connector X10 Constant current cable Ic_1+: Connector X11 Constant current cable Ic_2+: Connector X12 Constant current cable Ic_3+: Connector X13 Constant current cable Ic_4+: Connector X14 Constant current cable Ic_5+: Connector X15 Constant current cable Ic_6+: Connector X16 Constant current cable Ic_7+: Connector X17		
2	Measurement cable M_0+: Connector X10 Measurement cable M_1+: Connector X11 Measurement cable M_2+: Connector X12 Measurement cable M_3+: Connector X13 Measurement cable M_4+: Connector X14 Measurement cable M_5+: Connector X15 Measurement cable M_6+: Connector X16 Measurement cable M_7+: Connector X17		
3	Reserved		
4	Measurement cable Ic_0-,M_0-: Connector X10 Measurement cable Ic_1-,M_1-: Connector X11 Measurement cable Ic_2-,M_2-: Connector X12 Measurement cable Ic_3-,M_3-: Connector X13 Measurement cable Ic_4-,M_4-: Connector X14 Measurement cable Ic_5-,M_5-: Connector X15 Measurement cable Ic_6-,M_6-: Connector X16 Measurement cable Ic_7-,M_7-: Connector X17		
5	Functional earth FE		

Table 3-5 Pin assignment for analog inputs (RTD/R 4-wire connection)

Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (RTD/R-4-wire connection)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
1	Constant current cable Ic_0+: Connector X10 Constant current cable Ic_1+: Connector X11 Constant current cable Ic_2+: Connector X12 Constant current cable Ic_3+: Connector X13 Constant current cable Ic_4+: Connector X14 Constant current cable Ic_5+: Connector X15 Constant current cable Ic_6+: Connector X16 Constant current cable Ic_7+: Connector X17		

Pin	Assignment	Front view of the sockets	
	X10 to X17 – sockets for analog inputs (RTD/R-4-wire connection)	**X10, X12, X14, X16**	**X11, X13, X15, X17**
2	Measurement cable M_0+: Connector X10 Measurement cable M_1+: Connector X11 Measurement cable M_2+: Connector X12 Measurement cable M_3+: Connector X13 Measurement cable M_4+: Connector X14 Measurement cable M_5+: Connector X15 Measurement cable M_6+: Connector X16 Measurement cable M_7+: Connector X17		
3	Constant current cable Ic_0-: Connector X10 Constant current cable Ic_1-: Connector X11 Constant current cable Ic_2-: Connector X12 Constant current cable Ic_3-: Connector X13 Constant current cable Ic_4-: Connector X14 Constant current cable Ic_5-: Connector X15 Constant current cable Ic_6-: Connector X16 Constant current cable Ic_7-: Connector X17		
4	Measurement cable M_0-: Connector X10 Measurement cable M_1-: Connector X11 Measurement cable M_2-: Connector X12 Measurement cable M_3-: Connector X13 Measurement cable M_4-: Connector X14 Measurement cable M_5-: Connector X15 Measurement cable M_6-: Connector X16 Measurement cable M_7-: Connector X17		
5	Functional earth FE		

NOTE

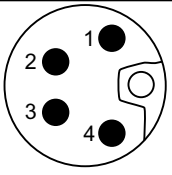
Coupler plug for RTD measurement

For RTD measurements, use a coupler plug with gold-plated contacts. Other materials can create contact resistance that can result in incorrect measured values.

Pin assignment of the connector for infeed of the supply voltage (M12 L-coded)

The table below shows the pin assignment of the M12 L-coded connector for infeed of the supply voltage.

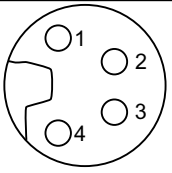
Table 3-6 Pin assignment of the supply voltage connector

Pin	Assignment of the core color of the power cable	Assignment	Front view of the connector
		X80 - connector (POWER input)	
1	Brown	Supply voltage 1L+ (non-switched)	
2	White	Ground 2M (switched)	
3	Blue	Ground 1M (non-switched)	
4	Black	Load voltage 2L+ (switched)	

Pin assignment of the socket for loop-through of the supply voltage (M12 L-coded)

The table below shows the pin assignment of the M12 L-coded socket for loop-through of the supply voltage.

Table 3-7 Pin assignment of the supply voltage socket

Pin	Assignment of the core color of the power cable	Assignment X81 - socket (POWER output)	Front view of the socket
1	Brown	Supply voltage 1L+ (non-switched)	
2	White	Ground 2M (switched)	
3	Blue	Ground 1M (non-switched)	
4	Black	Load voltage 2L+ (switched)	

PROFINET IO

4

4.1 Parameters/address space

4.1.1 Measurement types and measuring ranges

The table below indicates which measuring range and temperature coefficient is configurable.

Table 4-1 Measurement type and measuring ranges

Measurement type	Measuring range	Temperature coefficient	Resolution
Deactivated	–	–	–
Voltage	+/- 80 mV	–	Max. 16-bit incl. sign
Resistance	• 0 ... 150 Ω • 0 ... 300 Ω • 0 ... 600 Ω • 0 ... 3 kΩ • 0 ... 6 kΩ	–	Max. 15-bit
• Thermal resistor (2-wire connection) • Thermal resistor (3-wire connection) • Thermal resistor (4-wire connection)	Climatic range/standard range • Pt 100 • Pt 200 • Pt 500 • Pt 1000	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.00392 • Pt 0.003850	Max. 16-bit incl. sign
	Climatic range/standard range • Ni 100 • Ni 120 • Ni 200 • Ni 500 • Ni 1000	• Ni 0.00618 • Ni 0.006720	Max. 16-bit incl. sign
Thermocouple	Type: B, C, E, J, K, L, N, R, S, T, U	–	Max. 16-bit incl. sign

4.1.2 Parameters

Parameters of the I/O device analog input AI 8xRTD/TC M12-L 8xM12

When parameterizing the I/O device with STEP 7, you define the properties of the I/O device using various parameters. The following table lists the configurable parameters for distributed operation on the PROFINET IO.

NOTICE
Consistency of the encoders and parameters The analog inputs are preset to a thermal resistor (4-wire connection) Pt 100 standard range. Make sure that the connected encoders and the selected parameters match.

Parameters and default settings of the analog input I/O device

The table below shows the PROFINET IO parameters for the analog input I/O device AI 8xRTD/TC M12-L 8xM12 for configuration with the GSD file.

Table 4-2 Configurable parameters and their default settings (GSD)

Parameter	Value range	Default	Effective range with configuration software e.g. STEP 7 (TIA Portal)
Diagnostics: Low voltage 1L+	• Deactivated • Activated	Deactivated	Channel
Activation of outlier suppression	• Deactivated • Activated	Activated	Channel
Diagnostics: Reference junction	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Overflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Underflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Wire break detection and alarm	• Deactivated • Activated	Deactivated	Channel

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range	Default	Effective range with configuration software e.g. STEP 7 (TIA Portal)
Measurement type/Measuring range	• Deactivated	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	• Voltage ±80 mV		
	Resistance (2-, 3-, 4-wire connection) • 150 Ω • 300 Ω • 600 Ω • 3 kΩ • 6 kΩ		
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 climatic range • Pt 200 climatic range • Pt 500 climatic range • Pt 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 standard range • Pt 200 standard range • Pt 500 standard range • Pt 1000 standard range		
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 climatic range • Ni 120 climatic range • Ni 200 climatic range • Ni 500 climatic range • Ni 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 standard range • Ni 120 standard range • Ni 200 standard range • Ni 500 standard range • Ni 1000 standard range		

[1] Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

[2] By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

[3] For 2-wire connection only

[4-1] The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range		Default		Effective range with configuration software e.g. STEP 7 (TIA Portal)
Measurement type/Measuring range	Thermocouple • Type B • Type N • Type E • Type R • Type S • Type J • Type L • Type T • Type K • Type U • Type C		Thermal resistor (4-wire connection) Pt 100 standard range		Channel
Temperature coefficient	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.003920 • Pt 0.003850 • Ni 0.00618 • Ni 0.006720		Pt 0.00385055		Channel
Temperature unit	• Degrees Celsius • Degrees Fahrenheit • Kelvin		Degrees Celsius		Channel
Reference junction	• Fixed reference temperature • Dynamic reference temperature • Internal reference temperature • Off		Off		Channel
Fixed reference temperature	Degrees Celsius	-1450 ... 1550[4]	0[4]	0.0 °C	Channel
	Degrees Fahrenheit	-2290 ... 3110[4]	320[4]	32.0 °F	Channel
	Kelvin	1282 ... 3276[4]	2372[4]	273.2 K	Channel
Smoothing	• None • Weak • Medium • Strong		None		Channel
Interference frequency suppression	• 60 Hz (50 ms) • 50 Hz (60 ms)[1] • 16.7 Hz (180 ms) • 60 Hz (16.7 ms)[2] • 50 Hz (20 ms)[1 2] • 16.7 Hz (60 ms)[2] • None		50 Hz (20 ms)[1]		Channel

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range		Default		Effective range with configuration software e.g. STEP 7 (TIA Portal)
Scalable measuring range	• Deactivated • Activated		Deactivated		Channel
Measuring range resolution	• 2 decimal places • 3 decimal places		2 decimal places		Channel
Measuring range center	Degrees Celsius	-270 ... 1372[4]	0[4]	0 °C	Channel
	Degrees Fahrenheit	-454 ... 2501[4]	0[4]	0 °F	Channel
	Kelvin	4 ... 1645[4]	4[4]	4 K	Channel
Conductor resistance[3]	0 ... 50000 mΩ		0		Channel
Hardware interrupt: High limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: High limit 2	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 2	• Deactivated • Activated		Deactivated		Channel
High limit 1	The value range depends on the measurement type. The value range (min./max.) permitted for the measurement type is listed here (Page 115).		8500[4]		Channel
Low limit 1			-2000[4]		Channel
High limit 2			8500[4]		Channel
Low limit 2			-2000[4]		Channel

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

NOTE

Unused channels

"Deactivate" unused inputs in the parameter assignment to improve the cycle time of the I/O device.

A deactivated input always returns the value $7FFF_H$.

"Fixed reference temperature" parameter for thermocouples

The parameter "Fixed reference temperature" can only be set if you selected = "Fixed reference temperature" for the "Reference junction" parameter.

The value range for the "Reference temperature" for thermocouples can be found here (Page 115).

Data record 128

You can reconfigure the parameters with the data record 128 in RUN. When you change the parameters with data record 128, the parameters are not saved retentively.
An explanation of data record 128 is available in the section Structure of data record 128 for I/O device parameter assignment (Page 115).

4.1.3 Explanation of the parameters

Diagnostics: Low voltage 1L+

Enabling of the diagnostics for insufficient supply voltage 1L+.
Diagnostics: Low voltage 1L+ triggers the "Undervoltage" maintenance event. You can find more information in the section Maintenance events (Page 48).

Outlier suppression

The outlier suppression suppresses interference pulses in the analog input device which have been caused, for example, by switching processes in the system.
The last measured values are statistically analyzed (box plot).
Limits within which a new measured value is expected are derived from the distribution (scatter) of the measured values. When the distribution of the measured values changes, these limits adapt dynamically. New measured values that lie outside the determined limits are suppressed. This means the last value is retained.
Faults are suppressed up to a length of three module cycles. On the other hand, actual jumps in the input signal are delayed by the same time.

Diagnostics: Reference junction

Enabling of the Diagnostics Reference junction.
With dynamic reference temperature compensation, the I/O device receives the reference temperature via parameter data record 192. If the reference temperature is not receive cyclically within 5 minutes, the Diagnostics Reference junction trips.

Diagnostics: Overflow

Enable of the Diagnostics Overflow.
If the measured value exceeds the overrange, the Diagnostics Overflow trips.

Diagnostics: Underflow

Enabling of the Diagnostics Underflow.
If the measured value falls below the underrange, the Diagnostics Underflow trips.

Diagnostics: Wire break detection and alarm

Activation of wire break detection and enabling of diagnostics.

NOTE

Wire break diagnostics

With analog input channels, wire break diagnostics is not possible for the measurement type voltage ± 80 mV.

NOTE

Effect on the value status

When the parameter is deactivated, wire break detection is switched off. A wire break does not then affect the value status.

If the diagnostics: wire break is disabled, other diagnostic messages may occur in the event of a wire break in the cabling. This depends on which other diagnostics are enabled or disabled. The following table shows the diagnostic messages per channel that may occur for a wire break.

Table 4-3 Diagnostic messages for a wire break

Diagnostics: Wire break	Diagnostics: Overflow	Diagnostics: Underflow	Event	Process data	Diagnostics alarm per channel
Activated	Deactivated	Deactivated	Wire break	0x7FFF	Wire break
Deactivated	Deactivated	Activated	Wire break	0x7FFF	-
Deactivated	Activated	Deactivated	Wire break	0x7FFF	High limit violated
Deactivated	Activated	Activated	Wire break	0x7FFF	High limit violated
Deactivated	Deactivated	Deactivated	Wire break	0x7FFF	-

Measurement type/Measuring range

You use this parameter to set the measurement type or the measuring range for acquiring the measured values.

NOTE

Unused channels

"Deactivate" unused channels in the parameter assignment to improve the cycle time of the I/O device.

A deactivated channel always returns the value $7FFF_H$.

Temperature coefficient (for RTD)

The temperature coefficient depends on the chemical composition of the material. In Europe, only one value is used per sensor type (default value).

The correction factor for the temperature coefficient (α value) specifies how much the resistance of a certain material changes when the temperature is raised by 1 °C.

The further values facilitate sensor-specific setting of the temperature coefficient and enhance accuracy.

Temperature unit

You can use this parameter to set the temperature unit with which you want to measure the temperature.

Reference junction

If the measuring point is subjected to a different temperature than the reference junction (free ends of the thermocouple at the connection point), a thermal voltage arises between the free ends. The level of the thermal voltage depends:

- On the temperature difference between the measuring point and the free ends
- On the type of material combination of the thermocouple

Since a temperature difference is always detected with a thermocouple, the temperature of the reference junction has to be determined in order to determine the temperature of the measuring point.

The possible compensation types that can be configured via the "Reference junction" parameter are set out in the table below.

Table 4-4 Configurable compensation types for the "Reference junction" parameter

Compensation type	Explanation
Fixed reference temperature	**Properties** With this type of compensation, the reference junction temperature is stored as a fixed value. The default value is 0 °C. **Principle of operation** The reference junction temperature is specified in the "Fixed reference temperature" parameter. The possible value range is displayed in the table Structure of data record 128 for I/O device parameter assignment (Page 115). The configured reference junction temperature applies to all channels of the I/O device that you have selected for this type of compensation. The "Fixed reference temperature" unit depends on the configured "Temperature unit" parameter of the channel. **Wiring** Connect the thermocouples to terminals 2 and 4 from the reference junction with copper cables. If you record the reference junction temperature directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12, you can also connect the thermocouples directly or with compensating lines.

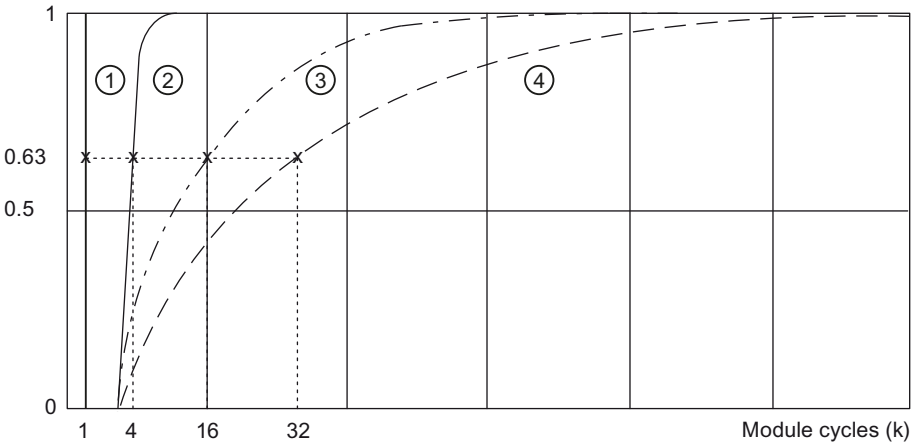
Compensation type	Explanation
Dynamic reference temperature	**Properties** With this compensation, the reference junction temperature can be measured via an external module on a different station. **Principle of operation** The reference junction temperature is transferred with the SFB 53 by means of data record 192 from the CPU to the AI 8xRTD/TC M12-L 8xM12 I/O device. Each channel that you select for this type of compensation can have its own reference junction temperature assigned to it via the user program. For more information, see section Structure of data record 192 for the dynamic reference temperature (Page 125). **Wiring** Connect the thermocouples to Terminals 2 and 4 from the reference junction with copper cables. If the reference junction temperature is recorded directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12 , you can also connect the thermocouples directly or with compensating lines.
Internal reference junction	**Properties** With this compensation type, the reference junction temperature is determined with an internal temperature sensor that is integrated in the AI 8xRTD/TC M12-L 8xM12 I/O device. Note: Take the reaction time to changes of the ambient temperature into account. **Principle of operation** The reference junction temperature is detected by an internal temperature sensor. All channels of the AI 8xRTD/TC M12-L 8xM12 that you select for this type of compensation will have the same reference junction temperature. **Wiring** Connect the thermocouples directly or with compensating lines to the AI 8xRTD/TC M12-L 8xM12.
No compensation	**Properties** With this compensation type, the reference junction temperature of the thermocouples is measured outside the AI 8xRTD/TC M12-L 8xM12 I/O device. You can, for example, connect a compensating box to the thermocouple for this purpose. **Principle of operation** The temperature of the reference junction for this type of compensation is specified as 0 °C. This can be achieved by using a compensating box. A separate compensating box is required for each thermocouple. **Wiring** Connect the compensating box with the AI 8xRTD/TC M12-L 8xM12 using copper cables. Note: Thermocouples of Type B do not require a compensating box up to a reference junction temperature of 50 °C.

Smoothing

The purpose of smoothing is to filter out interferences. The greater the smoothing factor, the better the filter effect. This is technically implemented in the form of a digital filter. The smoothing can be set in 4 levels. The smoothing factor k is equal to the number of module cycles. The time constant of the smoothing filter is the product of the smoothing factor k and the cycle time of the I/O device. The greater the smoothing, the greater the time constant of the filter.

Smoothing time = number of module cycles (k) x cycle time of the I/O device.

The following figure shows how many module cycles it takes for the smoothed analog value to approach 100%, depending on the configured smoothing. This is valid for all signal changes at the analog input.



① No smoothing (k = 1)
② Weak (k = 4)
③ Medium (k = 16)
④ Strong (k = 32)

Figure 4-1 Smoothing

Interference frequency suppression

This parameter suppresses the interference caused by the frequency of the AC voltage network used in the analog input I/O device.
The frequency of the AC voltage network can have a negative effect on measured values, particularly with measurements in the low voltage range and on thermocouples. For this parameter, the user defines the line frequency prevailing on their system.

Scalable measuring range

See the Scalable measuring range (Page 34) section.

Measuring range resolution

See the Scalable measuring range (Page 34) section.

Measuring range center

See the Scalable measuring range (Page 34) section.

Conductor resistance

The parameters are valid for the measurement types resistor and thermal resistor (2-wire connection).
The parameter is used to compensate the conductor resistance without interfering with the sensor wiring.

Hardware interrupt high/low limit 1 or 2

Enabling of a hardware interrupt when the high limit 1 or 2 or the low limit 1 or 2 is violated.
Requirement:

- An OB 4x must be assigned to the CPU/device.
- The fault-free signal (value status/QI = 1) is pending at the channel, meaning no diagnostics.

More information on the structure of hardware interrupts is available in the section Interrupts (Page 46).

High/low limit 1 or 2

Specify a threshold at which a hardware interrupt is triggered when it is exceeded or undershot.

Dependencies for the configuration

The parameter settings and I/O device are independent of each other. When configuring with the GSD file or with DS128, these dependencies must be observed. You can find these dependencies in the section Dependencies for the configuration (Page 114).

4.1.4 Scalable measuring range

4.1.4.1 Scalable measuring range

Function

The scalable measuring range is a limited section of a measuring range supported by the I/O device.

The scalable measuring range allows for a higher resolution of a configurable section.

- The function is enabled with the "Scalable measuring range" parameter.
- The "Measuring range resolution" parameter determines the resolution to 2 or 3 decimal places for a configurable section of the measuring range.
- The "Measuring range center" parameter determines the temperature around which the scalable measuring range is symmetrically spanned.

NOTE

The scalable measuring range is available for the temperature measuring ranges of thermal resistors (RTD) standard and thermocouples. The measuring ranges for voltage, resistor and thermal resistor climatic are not supported.

The scalable measuring range is valid for the following ranges:

- Nominal range
- Underrange
- Overrange

Value ranges

Table 4-5 Value ranges

Scalable measuring range	Measuring range resolution		Values hex.
	2 decimal places	3 decimal places	
Overflow	> 325.11	> 32.511	$7FFF_H$
High limit	325.11	32.511	$7EFF_H$
Measuring range center	0	0	0_H
Low limit	-325.12	-32.512	8100_H
Underflow	<-325.12	<-32.512	8000_H

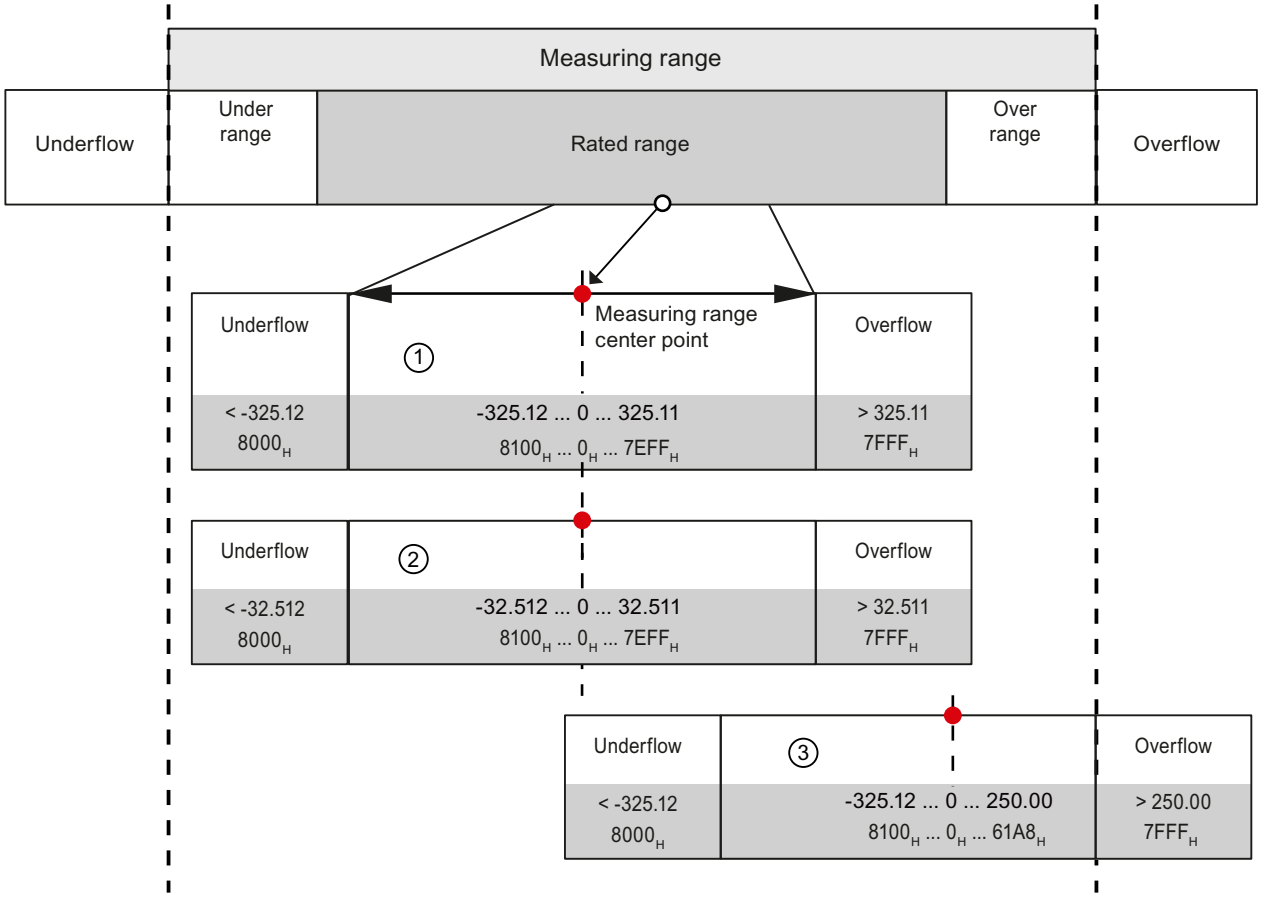
To obtain the absolute temperature, calculate the measuring range center in the user program (as offset) with the value of the user data of the scalable measuring range.
The measuring range center is always output in the user data as the value "0". The user data are correspondingly mapped to the bipolar input ranges in S7 format. Underflow / overflow is also formed in accordance with the limits of S7.

Rules

- The measuring range center must be within the nominal range of the underlying measuring range. The measuring range center is specified in integers.
- The scalable measuring range is spanned symmetrically over the measuring range center. Depending on the resolution, various value ranges result (①, ②).
- The scalable measuring range is limited by underflow and overflow of the underlying measuring range:
  - If the scalable measuring range falls below the limit, the scalable measuring range is cut off at the underflow.
  - When the scalable measuring range exceeds the limit (③), the scalable measuring range is cut off at the overflow.

Example

The following example illustrates the effect of scalable measuring ranges:



① Scalable measuring range with 2 decimal places in hexadecimal S7 format

② Scalable measuring range with 3 decimal places in hexadecimal S7 format

③ Scalable measuring range which is cut off at the overflow of the underlying measuring range ("Clipping")

Figure 4-2 Examples of scalable measuring ranges

Structure of data record 235

More information about the structure of data record 235 is available in section Structure of data record 235 for the scalable measuring range (Page 128).

4.1.4.2 Configuration

Requirement

You must select a valid temperature measuring range for configuration.

Configuration

The function is activated using the "Scalable measuring range" parameter.
The following figure shows an example of a configuration in STEP 7:

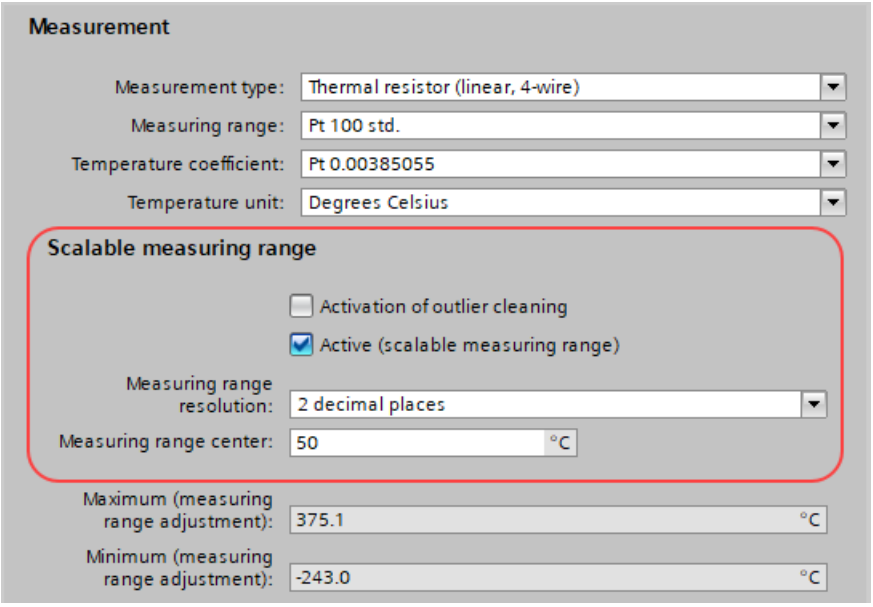


Figure 4-3 Configuration for the scalable measuring range

Reference

You will find more information on the configuration in the STEP 7 online help.

4.1.5 Address space

You can configure the AI 8xRTD/TC M12-L 8xM12 I/O device as needed. Depending on the configuration, additional/different addresses are assigned in the process images.

Configuration options of the AI 8xRTD/TC M12-L 8xM12 I/O device

You can configure the I/O device Analog Inputs like this:

- With STEP 7 (TIA Portal)
- With GSD file in any configuration software

When you configure the I/O device by means of the GSD file, the configurations are available under different short designations/device names in the device view of your configuration software.

The following configurations are possible:

Table 4-6 Configuration options

Configuration	Short designation/ device name in the GSD file (device view in the configuration software)	Configuration software, e.g., with STEP 7 (TIA Portal)	
		Integrated in hardware catalog STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) V11 or higher or STEP 7 V5.5 SP4 HF1 or higher
1 x 8-channel AI 8xRTD/TC	AI 8xRTD/TC	V17 or higher with HSP0369	X
1 x 8-channel AI 8xRTD/TC QI	AI 8xRTD/TC QI	V17 or higher with HSP0369	X
1 x 8-channel AI 8xRTD/TC MSI	AI 8xRTD/TC MSI	V17 or higher with HSP0369	X
2 x 4-channel AI 8xRTD/TC S	AI 8xRTD/TC S	V17 or higher with HSP0369	X

Address space for configuration as 1 x 8-channel AI 8xRTD/TC

The following figure shows the address space allocation for configuration as an 8-channel I/O device analog inputs without value status. The start address for the I/O device can be assigned freely. The addresses of the channels are derived from the start address.

Assignment in the process image input (PII)

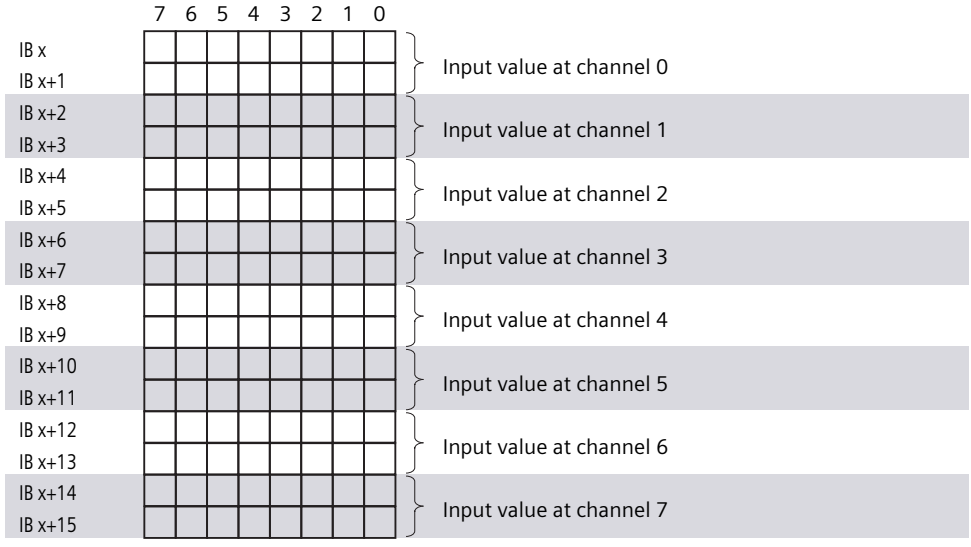


Figure 4-4 Address space for configuration as 1 x 8-channel AI 8xRTD/TC without value status

Value status (Quality Information, QI)

The value status is always returned with the following configuration options:

- AI 8xRTD/TC QI
- AI 8xRTD/TC MSI

Evaluating the value status

An additional byte is occupied in the input address space if you enable the value status for the I/O device. Bits 0 to 7 in this byte are assigned to a channel and return information about the validity of the analog input value.

Bit = 1: There is no error on the channel.

Bit = 0: Error on channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI

The following figure shows the address space allocation for the configuration as 8-channel I/O device analog inputs with value status.

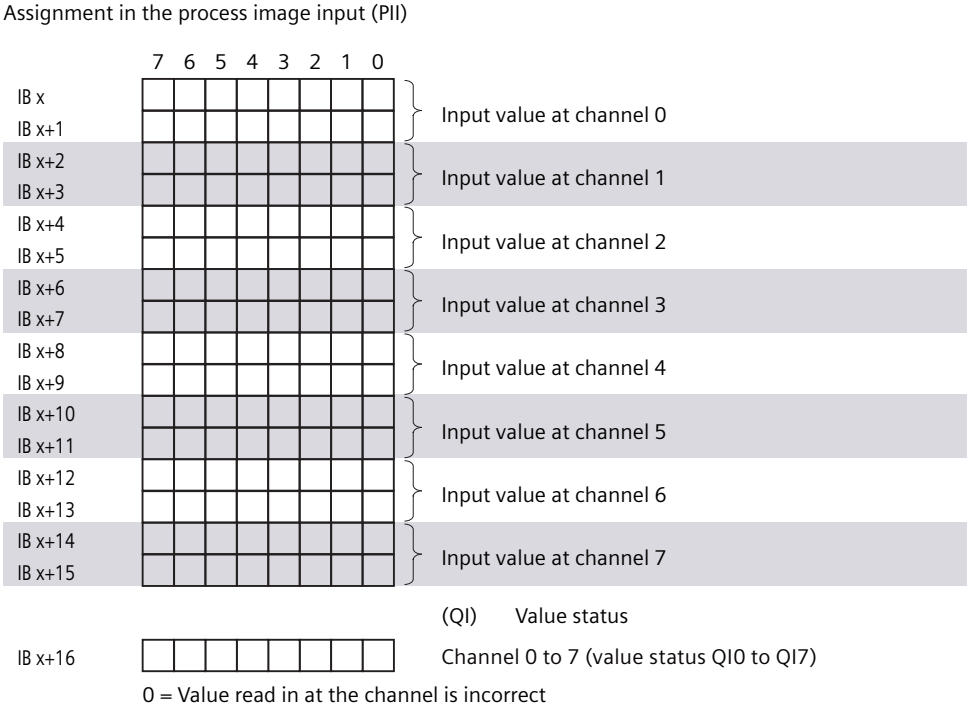


Figure 4-5 Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI with value status

NOTE

Value status with deactivated parameter "Diagnostics: Wire break detection and alarm"

When the parameter "Diagnostics: Wire break detection and alarm" is deactivated, the evaluation of the wire break is not mapped in the value status of the channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC MSI

With the configuration 1 x 8-channel AI 8xRTD/TC MSI, channels 0 to 7, including the value status of the I/O device, are copied into two submodules. Channels 0 to 7 are then available with identical values in various submodules. These submodules can be assigned to two IO controllers when used in a shared device.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule on which it occurs.

For the 1st Submodule (= basic submodule), the value status 0 indicates: The module detects that an error is pending at the channel and that the value is faulty.

For the 2nd Submodule (= MSI submodule) displays the value status 0:

- The value is faulty.
- The basic submodule is not yet assigned parameters (not ready).
- The connection between the IO controller and the basic submodule has been interrupted.
- The IO controller of the basic submodule is in STOP or POWER OFF state.

The following figure shows the assignment of the address space with submodules 1 and 2 and the value status.

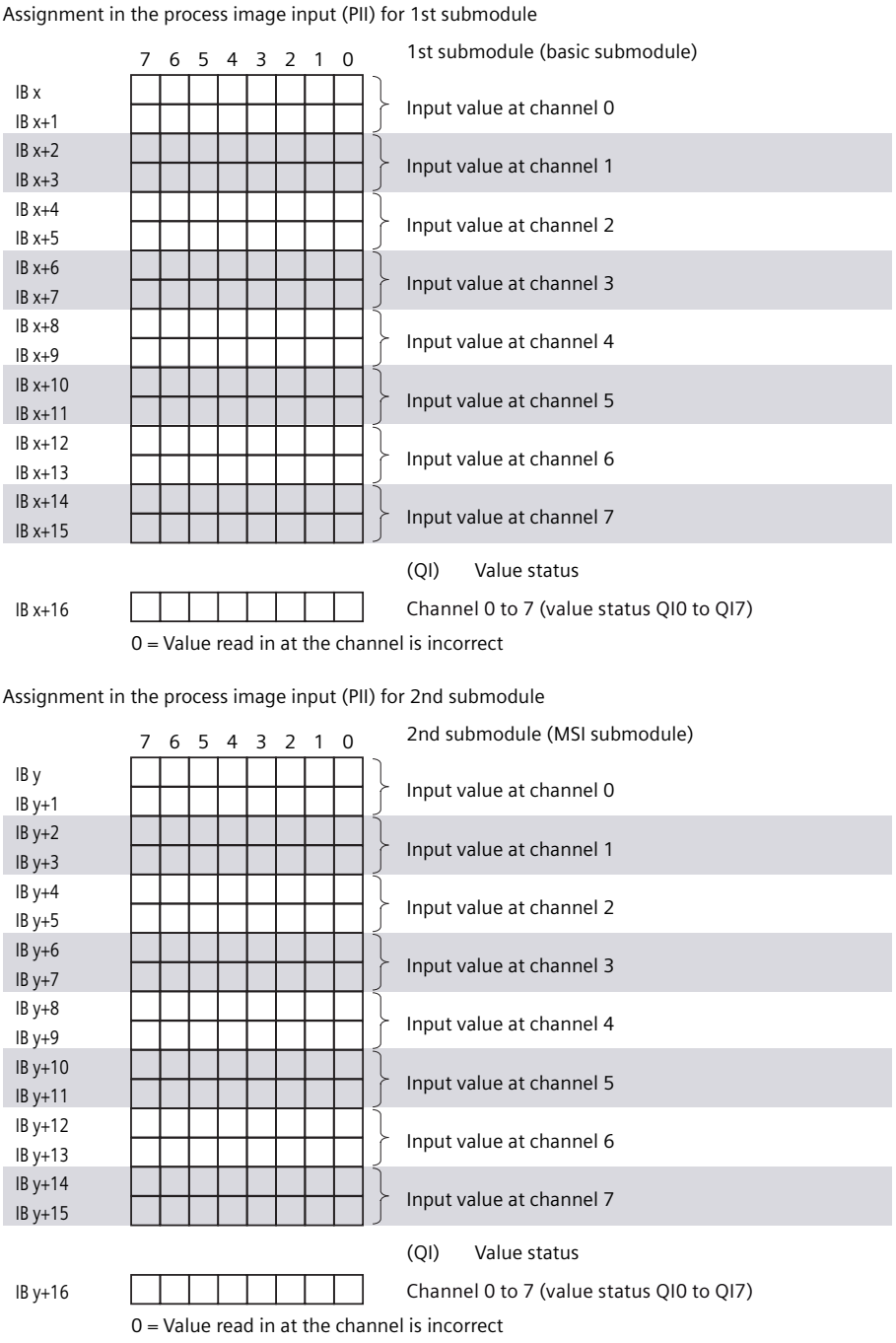


Figure 4-6 Address space for configuration as 1 x 8-channel AI 8xRTD/TC with value status

NOTE

Calibration not possible

When configured as a 1 x 8-channel AI 8xRTD/TC MSI, the "Calibrate" function is not possible.

Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

The following figure shows the address space allocation for configuration as a 2 x 4-channel I/O device analog inputs. The start addresses of the two submodules can be freely assigned.

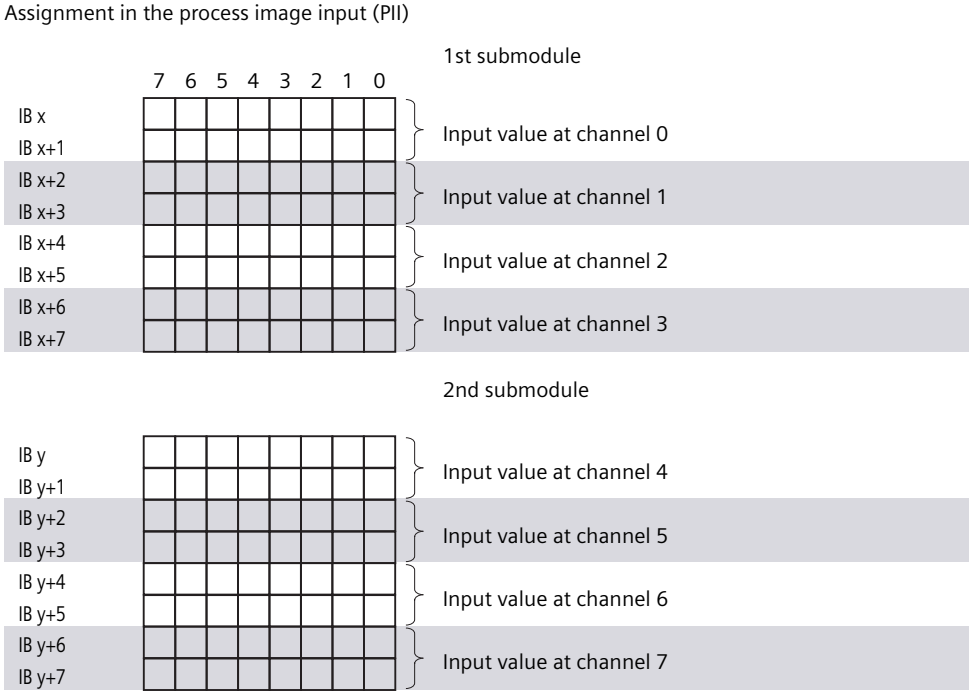


Figure 4-7 Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

NOTE

Calibration not possible

When configured as a 2 x 4-channel AI 8xRTD/TC S, the "Calibrate" function is not possible.

Reference

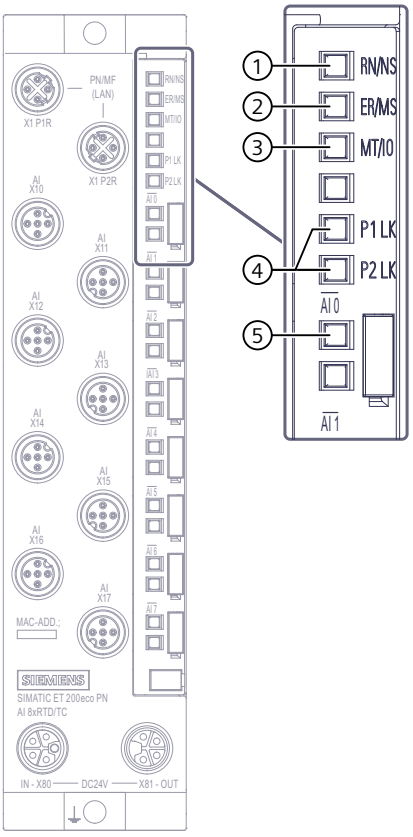
You can find information on the functionality **Module Shared Input/Module Shared Output (MSI/MSO)** in the STEP 7 online help or in the SIMATIC PROFINET with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/49948856) Function Manual.

4.2 Interrupts/diagnostic messages

4.2.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the I/O device AI 8xRTD/TC M12-L 8xM12.



① RN/NS: RUN/network status LED
② ER/MS: ERROR/module status LED
③ MT/IO: MAINT/IO status LED
④ P1 LK/P2 LK: LINK port status LEDs
⑤ LED displays 0 to 7 for channel status/channel error

Figure 4-8 LED displays

Meaning of the LEDs

The following tables set out the meaning of the status and error displays. Measures for dealing with diagnostics alarms can be found in the section Diagnostics alarms (Page 47).

Behavior of the LEDs RN/NS (RUN/network status), ER/MS (ERROR/module status) and MT/IO (MAINT/IO status) on PROFINET

Table 4-7 Error display of the LEDs

LEDs			Meaning	Solution
RN/ NS	ER/ MS	MT/ IO		
Off	Off	Off	Missing or insufficient supply voltage at the I/O device.	Check the supply voltage.
On	On	On	Test of LEDs during startup: The three LEDs light up simultaneously for approximately 0.25 s.	---
			The three LEDs light up simultaneously for approximately 2 s while "Reset to factory settings" is running.	---
Flash-ing	Off	Off	The ET 200eco PN is deactivated.	Activate the ET 200eco PN with the configuration software or via the user program.
			The ET 200eco PN is either not configured or incorrectly configured.	Configure the ET 200eco PN via the configuration software.
			The ET 200eco PN is starting up.	---
			The ET 200eco PN is being assigned parameters.	
			Loading firmware (when the firmware update is performed during startup, all LEDs retain their current status)	
On	Not relevant	Not relevant	The ET 200eco PN is currently exchanging data with the IO controller.	
Not relevant	Flash-ing	Not relevant	Module diagnostics is available	Evaluate the diagnostics and eliminate the error.
			The preset configuration does not match the actual configuration.	Check the configuration of the ET 200eco PN.
			Parameter error	Correct the errors in the parameter assignment.
Not relevant	Not relevant	On	Maintenance	Evaluate the maintenance events.
Flash-ing	Flash-ing	Flash-ing	The "Node flash test" is running (the P1 LK and P2 LK LEDs of the PROFINET interface are also flashing).	---
			Hardware or firmware defective. (The P1 LK and P2 LK LEDs of the PROFINET interface are **not** flashing).	Replace the ET 200eco PN I/O device.

P1 LK and P2 LK LEDs

Table 4-8 Error display of the P1 LK and P2 LK LEDs

LEDs		Meaning	Solution
P1 LK	P2 LK		
□ Off		There is **no** Ethernet connection between the communications interface of your IO device and a communication partner (e.g. IO controller).	Check whether the bus cable to the switch/communication partner is interrupted.
■ On		There is an Ethernet connection between the communications interface of your IO device and a communication partner (e.g. IO controller).	---
☼ Flashing		The "Node flash test" is running (the RN/NS, ER/MS and MT/IO LEDs also flash).	---
		Communications error: A physical connection exists, communication is not possible, however.	Check the PROFINET IO settings.

Channel status/channel error LED

Table 4-9 Status and error display of the channel status/channel error LED

LEDs	Meaning
Channel status/channel error	
□ Off	• Channel not configured • Channel deactivated
■ On	• Value is in the measuring range
■ On	• Channel diagnostics • Channel in calibration

4.2.2 Interrupts

The I/O device AI 8xRTD/TC M12-L 8xM12 analog input supports diagnostics interrupts and limit alarms.

Diagnostics interrupt

The I/O device generates a diagnostics interrupt for the following events:

- Channel temporarily not available
- Hardware interrupt lost
- Reference channel error
- Error
- Low limit violated
- High limit violated
- Wire break
- Parameter error

Maintenance interrupt

The I/O device generates a maintenance interrupt for the following event:

- Low voltage at 1L+

Hardware interrupt

If the fault-free signal (value status/QI = 1) is pending at the channel, meaning no diagnostic error interrupt, the I/O device generates a hardware interrupt for the following events:

- Violation of low limit 1
- Violation of high limit 1
- Violation of low limit 2
- Violation of high limit 2

4.2.3 Messages

4.2.3.1 Diagnostics alarms

A diagnostics alarm is output for each diagnostics event. On the I/O device AI 8xRTD/TC M12-L 8xM12 the LED ER/MS flashes red. You can read out the diagnostics alarms in the diagnostics buffer of the CPU, for example. You can evaluate the error codes with the user program.

Table 4-10 Diagnostics alarms, their meanings and corrective measures

Diagnostics alarm	Error code	Meaning	Corrective measures
Wire break	6_H	Fault in the external circuitry.	Check the external circuitry and correct the fault.
		Encoder faulty.	Replace the encoder.
		Interruption of cable between the I/O device and sensor.	Establish the connection.

1 = The message depends on the configured measuring range

2 = For resistor and thermal resistor measuring ranges with deactivated "Wire break" diagnostics, this is reported by the "Violation of high limit" diagnostics

Diagnostics alarm	Error code	Meaning	Corrective measures
Wire break	6_H	Channel not connected (open).	• Disable diagnostics • Connect the channel • Disable the channel
High limit violated[1]	7_H	Value is above the overrange.	Correct interplay between I/O device and sensor.
		Wire break[2]	See wire break.
Low limit violated[1]	8_H	Value is below underrange.	Correct interplay between I/O device and sensor.
Error	9_H	Internal module error has occurred	Replace the I/O device.
Parameter error	10_H	• I/O device cannot evaluate parameters for the channel • Incorrect parameter assignment	Correct the parameter assignment. (Wire break diagnostics set only with the permitted measuring ranges.)
Reference channel error (reference junction)	15_H	Data record 192 was not correctly cyclically received within 5 min.	Write DS 192
Hardware interrupt lost	16_H	The I/O device cannot trigger an interrupt because the previous interrupt was not acknowledged; possible configuring error.	• Change the interrupt handling on the CPU. Reassign the parameters to the I/O device, if necessary. • The error persists until the I/O device is assigned new parameters.
Channel temporarily not available	$1F_H$	Firmware update is currently in progress or has been canceled. The module does not read in process values in this state.	• Wait for firmware update. • Restart the firmware update.
		The channel is currently being calibrated.	• Complete calibration

1 = The message depends on the configured measuring range

2 = For resistor and thermal resistor measuring ranges with deactivated "Wire break" diagnostics, this is reported by the "Violation of high limit" diagnostics

4.2.3.2 Maintenance events

Triggering of a maintenance event

The PROFINET interfaces of the ET 200eco PN M12-L support the diagnostic concept and maintenance concept in PROFINET according to the IEC 61158-6-10 standard. The goal is to detect and remove potential problems as soon as possible.

The I/O device signals a maintenance event to the higher-level diagnostic system on the following event:

Table 4-11 Triggering of a maintenance event

Maintenance alarm	Error code	Event	Meaning
Maintenance demanded MT/IO LED is lit	2_H	Undervoltage	Supply voltage 1L+ is below the tolerance limit.

System alarms in STEP 7

The maintenance information is generated in STEP 7 with the following system alarms:

- Maintenance demanded - indicated for each port by a yellow wrench icon in the device view or in the hardware configuration.

You can find additional information in the STEP 7 online help.

4.2.3.3 Hardware interrupts

During a hardware interrupt, the CPU interrupts processing of the user program and processes the hardware interrupt organization block.
For detailed information on the event, refer to the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt info) and to the STEP 7 online help.
The information on which channel of the I/O device triggered the hardware interrupt is entered in the start information of the organization block. The figure below shows the assignment to the bits of the local data double word 8.

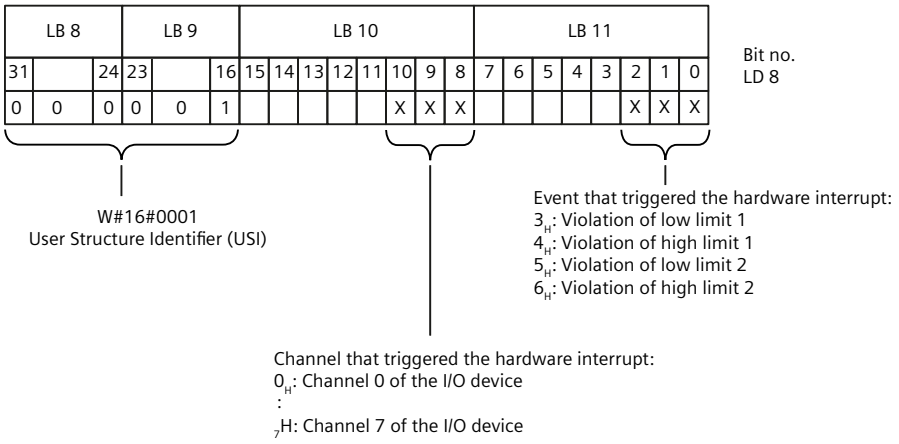


Figure 4-9 Start information of the organization block

EtherNet/IP

5

5.1 Functions/parameters/address space

5.1.1 Supported EtherNet/IP functions

Supported functions

The table below shows the functions that the I/O device supports with EtherNet/IP.

Supported functions	Remarks
I/O communication with scanner	FW 5.1.x or higher
Parameter assignment	FW 5.1.x or higher
Read diagnostics	FW 5.1.x or higher
Normative CIP objects	FW 5.1.x or higher
Reset to factory settings	FW 5.1.x or higher
Diagnostics bit in data status of cyclic I/O data per submodule	FW 5.1.x or higher
Shared device functions	FW 5.1.x or higher
EtherNet/IP basic service	FW 5.1.x or higher
Read events (hardware interrupts)	FW 5.1.x or higher
Data record interface	FW 5.1.x or higher

Supported diagnostics

The table below shows the diagnostics that the I/O device supports with EtherNet/IP.

Supported diagnostics	Remarks
Read diagnostics via CIP EtherNet/IP	FW 5.1.x or higher
Reading diagnostics with MFCT	FW 5.1.x or higher
Read hardware interrupt via CIP EtherNet/IP	FW 5.1.x or higher
PULL/PLUG event EtherNet/IP	Not supported
Read service data with MFCT	FW 5.1.x or higher

Supported CIP objects for EtherNet/IP

The table below shows the CIP objects that the I/O device supports with EtherNet/IP.

Supported CIP objects	Remarks
Identity object	FW 5.1.x or higher
Assembly object	FW 5.1.x or higher
Connection Manager object	FW 5.1.x or higher
TCP/IP Interface object	FW 5.1.x or higher
EtherNet Link object	FW 5.1.x or higher
LLDP Management object	FW 5.1.x or higher
LLDP Data Table object	Not supported
Param object	FW 5.1.x or higher

5.1.2 Measurement types and measuring ranges

The table below indicates which measuring range and temperature coefficient is configurable.

Table 5-1 Measurement type and measuring ranges

Measurement type	Measuring range	Temperature coefficient	Resolution
Deactivated	–	–	–
Voltage	+/- 80 mV	–	Max. 16-bit incl. sign
Resistance	• 0 ... 150 Ω • 0 ... 300 Ω • 0 ... 600 Ω • 0 ... 3 kΩ • 0 ... 6 kΩ	–	Max. 15-bit
• Thermal resistor (2-wire connection) • Thermal resistor (3-wire connection) • Thermal resistor (4-wire connection)	Climatic range/standard range • Pt 100 • Pt 200 • Pt 500 • Pt 1000	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.00392 • Pt 0.003850	Max. 16-bit incl. sign
	Climatic range/standard range • Ni 100 • Ni 120 • Ni 200 • Ni 500 • Ni 1000	• Ni 0.00618 • Ni 0.006720	Max. 16-bit incl. sign
Thermocouple	Type: B, C, E, J, K, L, N, R, S, T, U	–	Max. 16-bit incl. sign

5.1.3 Parameters

Parameters of the I/O device analog input AI 8xRTD/TC M12-L 8xM12

When you assign the parameters of the I/O device with MFCT, you can use various parameters to specify the module properties. The following table lists the configurable parameters for distributed operation.

NOTICE
Consistency of the encoders and parameters The analog inputs are preset to a thermal resistor (4-wire connection) Pt 100 standard range. Make sure that the connected encoders and the selected parameters match.

Parameters and default settings of the analog input I/O device

The table below shows the parameters for the I/O device analog input AI 8xRTD/TC M12-L 8xM12 for configuration with the GSD file.

Table 5-2 Configurable parameters and their default settings (GSD)

Parameter	Value range	Default	Effective range with configuration software e.g. MFCT
Diagnostics: Low voltage 1L+	• Deactivated • Activated	Deactivated	Channel
Activation of outlier suppression	• Deactivated • Activated	Activated	Channel
Diagnostics: Reference junction	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Overflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Underflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Wire break detection and alarm	• Deactivated • Activated	Deactivated	Channel

[1] Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

[2] By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

[3] For 2-wire connection only

[4-1] The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range	Default	Effective range with configuration software e.g. MFCT
Measurement type/Measuring range	• Deactivated	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	• Voltage ±80 mV		
	Resistance (2-, 3-, 4-wire connection) • 150 Ω • 300 Ω • 600 Ω • 3 kΩ • 6 kΩ		
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 climatic range • Pt 200 climatic range • Pt 500 climatic range • Pt 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 standard range • Pt 200 standard range • Pt 500 standard range • Pt 1000 standard range		
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 climatic range • Ni 120 climatic range • Ni 200 climatic range • Ni 500 climatic range • Ni 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 standard range • Ni 120 standard range • Ni 200 standard range • Ni 500 standard range • Ni 1000 standard range		

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range		Default		Effective range with configuration software e.g. MFCT
Measurement type/Measuring range	Thermocouple • Type B • Type N • Type E • Type R • Type S • Type J • Type L • Type T • Type K • Type U • Type C		Thermal resistor (4-wire connection) Pt 100 standard range		Channel
Temperature coefficient	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.003920 • Pt 0.003850 • Ni 0.00618 • Ni 0.006720		Pt 0.00385055		Channel
Temperature unit	• Degrees Celsius • Degrees Fahrenheit • Kelvin		Degrees Celsius		Channel
Reference junction	• Fixed reference temperature • Dynamic reference temperature • Internal reference temperature • Off		Off		Channel
Fixed reference temperature	Degrees Celsius	-1450 ... 1550[4]	0[4]	0.0 °C	Channel
	Degrees Fahrenheit	-2290 ... 3110[4]	320[4]	32.0 °F	Channel
	Kelvin	1282 ... 3276[4]	2372[4]	273.2 K	Channel
Smoothing	• None • Weak • Medium • Strong		None		Channel
Interference frequency suppression	• 60 Hz (50 ms) • 50 Hz (60 ms)[1] • 16.7 Hz (180 ms) • 60 Hz (16.7 ms)[2] • 50 Hz (20 ms)[1] [2] • 16.7 Hz (60 ms)[2] • None		50 Hz (20 ms)[1]		Channel

[1] Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

[2] By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

[3] For 2-wire connection only

[4-1] The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range		Default		Effective range with configuration software e.g. MFCT
Scalable measuring range	• Deactivated • Activated		Deactivated		Channel
Measuring range resolution	• 2 decimal places • 3 decimal places		2 decimal places		Channel
Measuring range center	Degrees Celsius	-270 ... 1372[4]	0	0 °C	Channel
	Degrees Fahrenheit	-454 ... 2501[4]	0	0 °F	Channel
	Kelvin	4 ... 1645[4]	4	4 K	Channel
Conductor resistance[3]	0 ... 50000 mΩ		0		Channel
Hardware interrupt: High limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: High limit 2	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 2	• Deactivated • Activated		Deactivated		Channel
High limit 1	The value range depends on the measurement type. The value range (min./max.) permitted for the measurement type is listed here (Page 115).		8500[4]		Channel
Low limit 1			-2000[4]		Channel
High limit 2			8500[4]		Channel
Low limit 2			-2000[4]		Channel

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

NOTE

Unused channels

"Disable" unused channels in the parameter assignment to improve the cycle time of the module.

A deactivated input always returns the value $7FFF_H$.

"Fixed reference temperature" parameter for thermocouples

The parameter "Fixed reference temperature" can only be set if you selected = "Fixed reference temperature" for the "Reference junction" parameter.

The value ranges for the "Reference temperature" for thermocouples can be found here (Page 115).

5.1.4 Explanation of the parameters

Diagnostics: Low voltage 1L+

Enabling of the diagnostics for insufficient supply voltage 1L+.

Outlier suppression

The outlier suppression suppresses interference pulses in the analog input device which have been caused, for example, by switching processes in the system.
The last measured values are statistically analyzed (box plot).
Limits within which a new measured value is expected are derived from the distribution (scatter) of the measured values. When the distribution of the measured values changes, these limits adapt dynamically. New measured values that lie outside the determined limits are suppressed. This means the last value is retained.
Faults are suppressed up to a length of three module cycles. On the other hand, actual jumps in the input signal are delayed by the same time.

Diagnostics: Reference junction

Enabling of the Diagnostics Reference junction.
With dynamic reference temperature compensation, the I/O device receives the reference temperature via parameter data record 192. If the reference temperature is not receive cyclically within 5 minutes, the Diagnostics Reference junction trips.

Diagnostics: Overflow

Enable of the Diagnostics Overflow.
If the measured value exceeds the overrange, the Diagnostics Overflow trips.

Diagnostics: Underflow

Enabling of the Diagnostics Underflow.
If the measured value falls below the underrange, the Diagnostics Underflow trips.

Diagnostics: Wire break detection and alarm

Activation of wire break detection and enabling of diagnostics.

NOTE

Wire break diagnostics

With analog input channels, wire break diagnostics is not possible for the measurement type voltage ± 80 mV.

NOTE

Effect on the value status

When the parameter is deactivated, wire break detection is switched off. A wire break does not then affect the value status.

If the diagnostics: wire break is disabled, other diagnostic messages may occur in the event of a wire break in the cabling. This depends on which other diagnostics are enabled or disabled. The following table shows the diagnostic messages per channel that may occur for a wire break.

Table 5-3 Diagnostic messages for a wire break

Diagnostics: Wire break	Diagnostics: Overflow	Diagnostics: Underflow	Event	Process data	Diagnostics alarm per channel
Activated	Deactivated	Deactivated	Wire break	0x7FFF	Wire break
Deactivated	Deactivated	Activated	Wire break	0x7FFF	-
Deactivated	Activated	Deactivated	Wire break	0x7FFF	High limit violated
Deactivated	Activated	Activated	Wire break	0x7FFF	High limit violated
Deactivated	Deactivated	Deactivated	Wire break	0x7FFF	-

Measurement type/Measuring range

You use this parameter to set the measurement type or the measuring range for acquiring the measured values.

NOTE

Unused channels

"Deactivate" unused channels in the parameter assignment to improve the cycle time of the I/O device.

A deactivated channel always returns the value $7FFF_H$.

Temperature coefficient (for RTD)

The temperature coefficient depends on the chemical composition of the material. In Europe, only one value is used per sensor type (default value).

The correction factor for the temperature coefficient (α value) specifies how much the resistance of a certain material changes when the temperature is raised by 1 °C.

The further values facilitate sensor-specific setting of the temperature coefficient and enhance accuracy.

Temperature unit

You can use this parameter to set the temperature unit with which you want to measure the temperature.

Reference junction

If the measuring point is subjected to a different temperature than the reference junction (free ends of the thermocouple at the connection point), a thermal voltage arises between the free ends. The level of the thermal voltage depends:

- On the temperature difference between the measuring point and the free ends
- On the type of material combination of the thermocouple

Since a temperature difference is always detected with a thermocouple, the temperature of the reference junction has to be determined in order to determine the temperature of the measuring point.

The possible compensation types that can be configured via the "Reference junction" parameter are set out in the table below.

Table 5-4 Configurable compensation types for the "Reference junction" parameter

Compensation type	Explanation
Fixed reference temperature	**Properties** With this type of compensation, the reference junction temperature is stored as a fixed value. The default value is 0 °C. **Principle of operation** The reference junction temperature is specified in the "Fixed reference temperature" parameter. The possible value range is displayed in the table Structure of data record 128 for I/O device parameter assignment (Page 115). The configured reference junction temperature applies to all channels of the I/O device that you have selected for this type of compensation. The "Fixed reference temperature" unit depends on the configured "Temperature unit" parameter of the channel. **Wiring** Connect the thermocouples to terminals 2 and 4 from the reference junction with copper cables. If you record the reference junction temperature directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12, you can also connect the thermocouples directly or with compensating lines.
Dynamic reference temperature	**Properties** With this compensation, the reference junction temperature can be measured via an external module on a different station. **Principle of operation** The reference junction temperature is transferred with the SFB 53 by means of data record 192 from the CPU to the AI 8xRTD/TC M12-L 8xM12 I/O device. Each channel that you select for this type of compensation can have its own reference junction temperature assigned to it via the user program. For more information, see section Structure of data record 192 for the dynamic reference temperature (Page 125). **Wiring** Connect the thermocouples to Terminals 2 and 4 from the reference junction with copper cables. If the reference junction temperature is recorded directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12 , you can also connect the thermocouples directly or with compensating lines.
Internal reference junction	**Properties** With this compensation type, the reference junction temperature is determined with an internal temperature sensor that is integrated in the AI 8xRTD/TC M12-L 8xM12 I/O device. Note: Take the reaction time to changes of the ambient temperature into account. **Principle of operation** The reference junction temperature is detected by an internal temperature sensor. All channels of the AI 8xRTD/TC M12-L 8xM12 that you select for this type of compensation will have the same reference junction temperature. **Wiring**

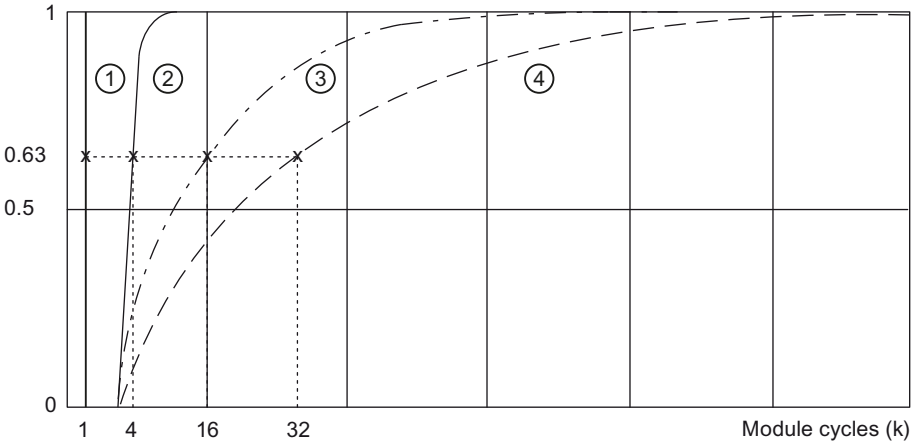
Compensation type	Explanation
	Connect the thermocouples directly or with compensating lines to the AI 8xRTD/TC M12-L 8xM12.
No compensation	**Properties** With this compensation type, the reference junction temperature of the thermocouples is measured outside the AI 8xRTD/TC M12-L 8xM12 I/O device. You can, for example, connect a compensating box to the thermocouple for this purpose. **Principle of operation** The temperature of the reference junction for this type of compensation is specified as 0 °C. This can be achieved by using a compensating box. A separate compensating box is required for each thermocouple. **Wiring** Connect the compensating box with the AI 8xRTD/TC M12-L 8xM12 using copper cables. Note: Thermocouples of Type B do not require a compensating box up to a reference junction temperature of 50 °C.

Smoothing

The purpose of smoothing is to filter out interferences. The greater the smoothing factor, the better the filter effect. This is technically implemented in the form of a digital filter. The smoothing can be set in 4 levels. The smoothing factor k is equal to the number of module cycles. The time constant of the smoothing filter is the product of the smoothing factor k and the cycle time of the I/O device. The greater the smoothing, the greater the time constant of the filter.

Smoothing time = number of module cycles (k) x cycle time of the I/O device.

The following figure shows how many module cycles it takes for the smoothed analog value to approach 100%, depending on the configured smoothing. This is valid for all signal changes at the analog input.



① No smoothing (k = 1)

② Weak (k = 4)

③ Medium (k = 16)

④ Strong (k = 32)

Figure 5-1 Smoothing

Interference frequency suppression

This parameter suppresses the interference caused by the frequency of the AC voltage network used in the analog input I/O device.
The frequency of the AC voltage network can have a negative effect on the measured values in low voltage ranges and on thermocouples. For this parameter, the user defines the line frequency prevailing on their system.

Scalable measuring range

See the Scalable measuring range (Page 61) section.

Measuring range resolution

See the Scalable measuring range (Page 61) section.

Measuring range center

See the Scalable measuring range (Page 61) section.

Conductor resistance

Parameters for the measurement types resistor and thermal resistor (2-wire connection).
The parameter is used to compensate the conductor resistance without interfering with the sensor wiring.

Hardware interrupt high/low limit 1 or 2

Enabling of a hardware interrupt when the high limit 1 or 2 or the low limit 1 or 2 is violated.
A hardware interrupt is only generated for the channel when there is a fault-free signal (value status/QI = 1). This means no diagnostics is pending for the channel. See also: Address space (Page 63)
More information on the structure of hardware interrupts is available in MultiFieldbus Function Manual (https://support.industry.siemens.com/cs/ww/en/view/109773209).

High/low limit 1 or 2

Specify a threshold at which a hardware interrupt is triggered when it is exceeded or undershot.

Dependencies for the configuration

The parameter settings and I/O device are independent of each other. When configuring with the GSD file or with DS128, these dependencies must be observed. You can find these dependencies in the section Dependencies for the configuration (Page 114).

5.1.5 Update time of the I/O data

You can estimate the typical update time for an I/O cycle as follows:

RPI timer (settable from 2 to 20 ms ± 10 %) default 10 ms
+ I/O processing (typically 1.4 ms, ± 1 ms jitter due to free-running cycles)
+ EM conversion (dependent on cycle time and parameter assignment of the module)

If necessary, you must take into account other influences caused by the EIP scanner and network components by adding them.

5.1.6 Scalable measuring range

Function

The scalable measuring range is a limited section of a measuring range supported by the I/O device.

The scalable measuring range allows for a higher resolution of a configurable section.

- The function is enabled with the "Scalable measuring range" parameter.
- The "Measuring range resolution" parameter determines the resolution to 2 or 3 decimal places for a configurable section of the measuring range.
- The "Measuring range center" parameter determines the temperature around which the scalable measuring range is symmetrically spanned.

NOTE

The scalable measuring range is available for the temperature measuring ranges of thermal resistors (RTD) standard and thermocouples. The measuring ranges for voltage, resistor and thermal resistor climatic are not supported.

The scalable measuring range is valid for the following ranges:

- Nominal range
- Underrange
- Overrange

Value ranges

Table 5-5 Value ranges

Scalable measuring range	Measuring range resolution		Values hex.
	2 decimal places	3 decimal places	
Overflow	> 325.11	> 32.511	$7FFF_H$
High limit	325.11	32.511	$7EFF_H$
Measuring range center	0	0	0_H
Low limit	-325.12	-32.512	8100_H
Underflow	<-325.12	<-32.512	8000_H

To obtain the absolute temperature, calculate the measuring range center in the user program (as offset) with the value of the user data of the scalable measuring range.

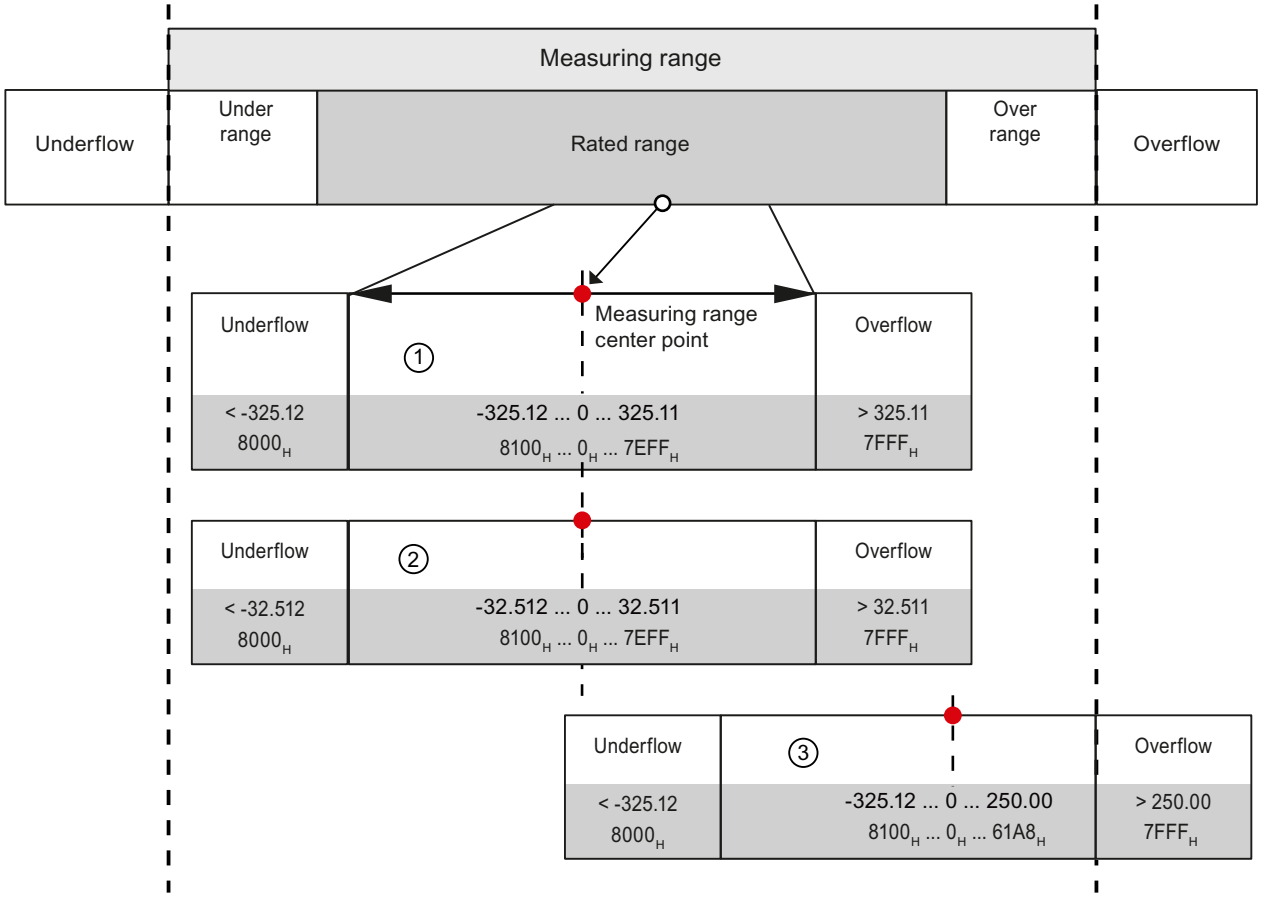
The measuring range center is always output in the user data as the value "0". The user data are correspondingly mapped to the bipolar input ranges in S7 format. Underflow / overflow is also formed in accordance with the limits of S7.

Rules

- The measuring range center must be within the nominal range of the underlying measuring range. The measuring range center is specified in integers.
- The scalable measuring range is spanned symmetrically over the measuring range center. Depending on the resolution, various value ranges result (①, ②).
- The scalable measuring range is limited by underflow and overflow of the underlying measuring range:
  - If the scalable measuring range falls below the limit, the scalable measuring range is cut off at the underflow.
  - When the scalable measuring range exceeds the limit (③), the scalable measuring range is cut off at the overflow.

Example

The following example illustrates the effect of scalable measuring ranges:



① Scalable measuring range with 2 decimal places in hexadecimal S7 format

② Scalable measuring range with 3 decimal places in hexadecimal S7 format

③ Scalable measuring range which is cut off at the overflow of the underlying measuring range ("Clipping")

Figure 5-2 Examples of scalable measuring ranges

Structure of data record 235

More information about the structure of data record 235 is available in section Structure of data record 235 for the scalable measuring range (Page 128).

5.1.7 Address space

You can configure the AI 8xRTD/TC M12-L 8xM12 I/O device as needed. Depending on the configuration, additional/different addresses are assigned in the process images.

Configuration options of the AI 8xRTD/TC M12-L 8xM12 I/O device

When configuring via GSD file, you will find the configurations under different short designations/device names in the MFCT device view.
The following configurations are possible:

Table 5-6 Configuration options

Configuration	Short designation/ device name in the GSD file (device view in the configuration software)	Configuration software, e.g. with MFCT
		GSD file in MFCT V1.4 SP1 or higher
1 x 8-channel AI 8xRTD/TC	AI 8xRTD/TC	X
1 x 8-channel AI 8xRTD/TC QI	AI 8xRTD/TC QI	X
1 x 8-channel AI 8xRTD/TC MSI	AI 8xRTD/TC MSI	X
2 x 4-channel AI 8xRTD/TC S	AI 8xRTD/TC S	X

Address space for configuration as 1 x 8-channel AI 8xRTD/TC

The following figure shows the address space allocation for configuration as an 8-channel I/O device analog inputs without value status. The addresses of the channels are derived from the start address.

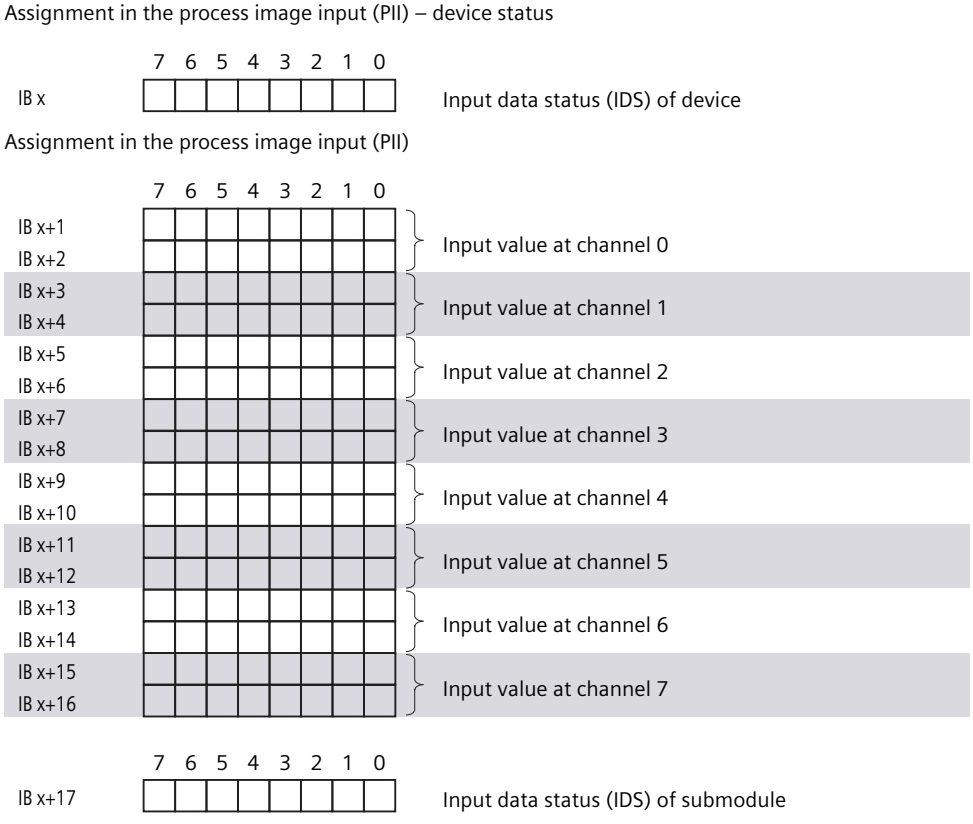


Figure 5-3 Address space for configuration as 1 x 8-channel AI 8xRTD/TC without value status

Value status (Quality Information, QI)

The value status is always returned with the following configuration options:

- AI 8xRTD/TC QI
- AI 8xRTD/TC MSI

Evaluating the value status

An additional byte is occupied in the input address space if you enable the value status for the I/O device. Bits 0 to 7 are assigned to a channel and provide information about the validity of the analog input value.

Bit = 1: There is no error on the channel.

Bit = 0: Error on channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI

The following figure shows the address space allocation for the configuration as 8-channel I/O device analog inputs with value status.

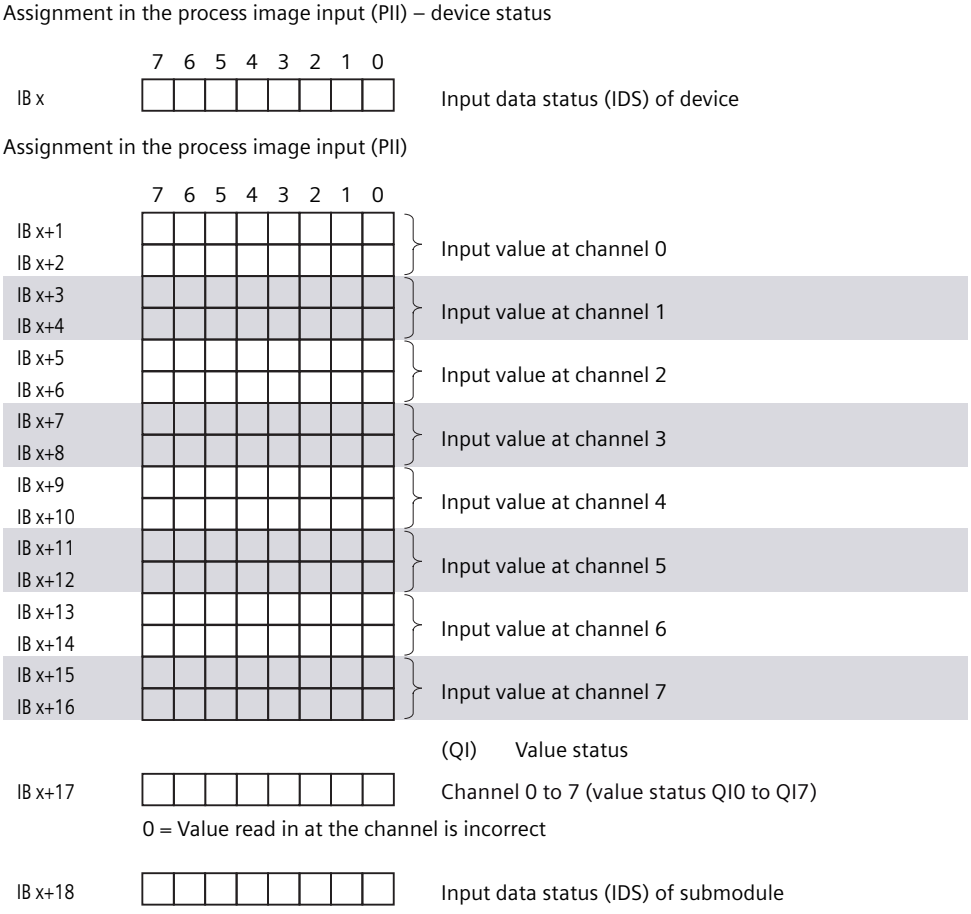


Figure 5-4 Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI with value status

NOTE

Value status with deactivated parameter "Diagnostics: Wire break detection and alarm"

When the parameter "Diagnostics: Wire break detection and alarm" is deactivated, the evaluation of the wire break is not mapped in the value status of the channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC MSI

With the configuration 1 x 8-channel AI 8xRTD/TC MSI, channels 0 to 7, including the value status of the I/O device, are copied into two submodules. Channels 0 to 7 are then available with identical values in various submodules. These submodules can be assigned to two IO controllers when used in a shared device.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule on which it occurs.

For the 1st Submodule (= basic submodule), the value status 0 indicates: The module detects that an error is pending at the channel and that the value is faulty.
For the 2nd Submodule (= MSI submodule) displays the value status 0:

- The value is faulty.
- The basic submodule is not yet assigned parameters (not ready).
- The connection between the IO controller and the basic submodule has been interrupted.
- The IO controller of the basic submodule is in STOP or POWER OFF state.

The following figure shows the assignment of the address space with submodules 1 and 2 and the value status.

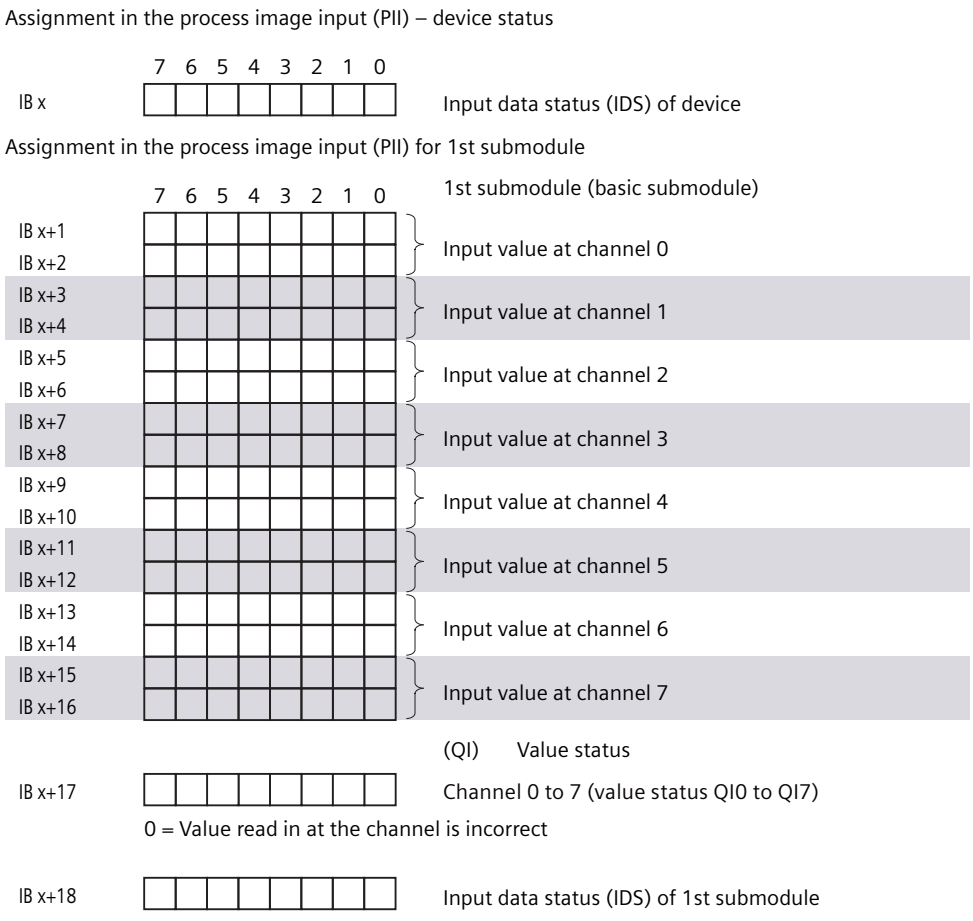


Figure 5-5 Address space for configuration as 1 x 8-channel AI 8xRTD/TC with value status (basic submodule)

Assignment in the process image input (PII) for 2nd submodule

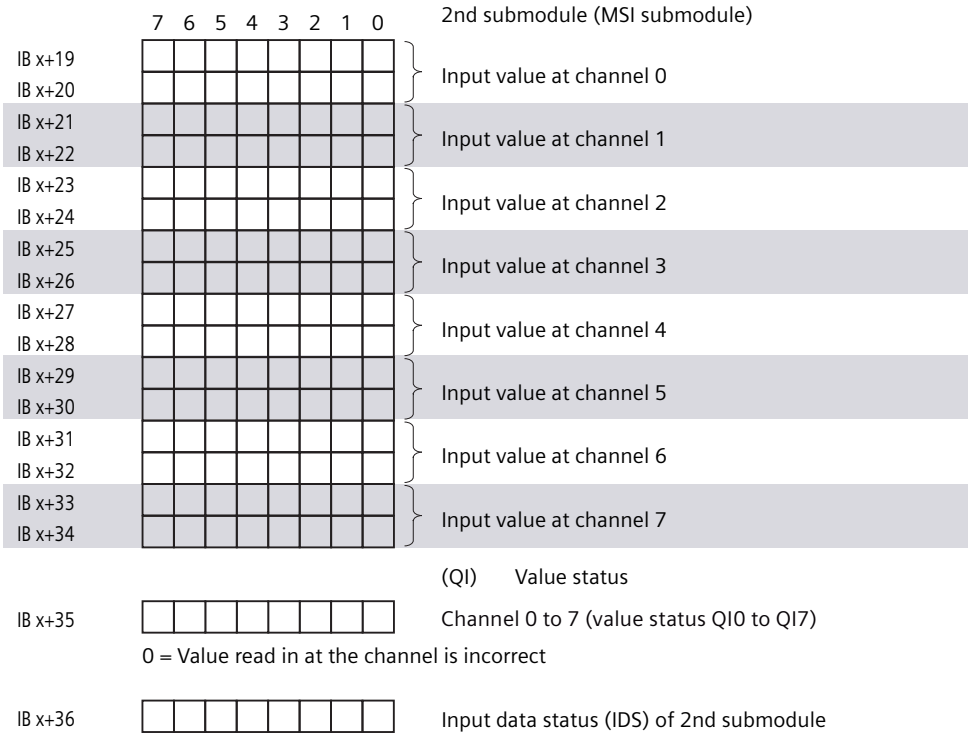


Figure 5-6 Address space for configuration as 1 x 8-channel AI 8xRTD/TC with value status (MSI submodule)

Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

The following figure shows the address space allocation for the configuration as 2 x 4-channel I/O device analog inputs without value status.

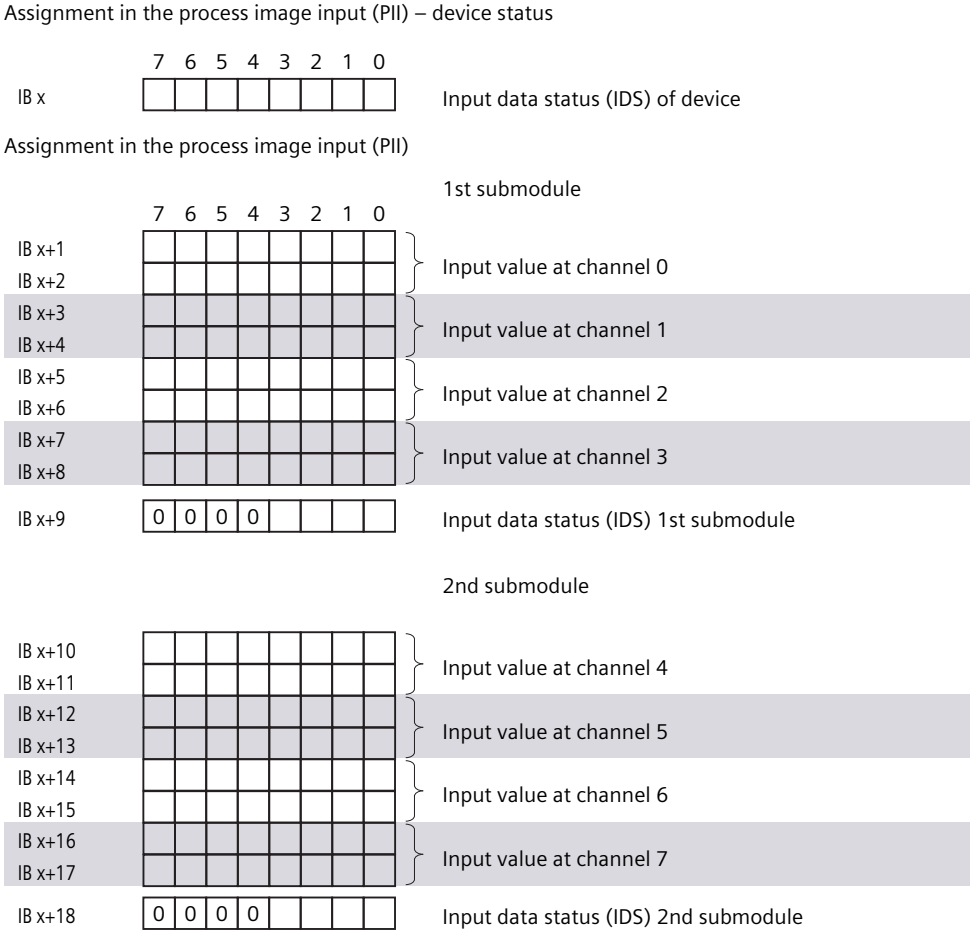


Figure 5-7 Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

Reference

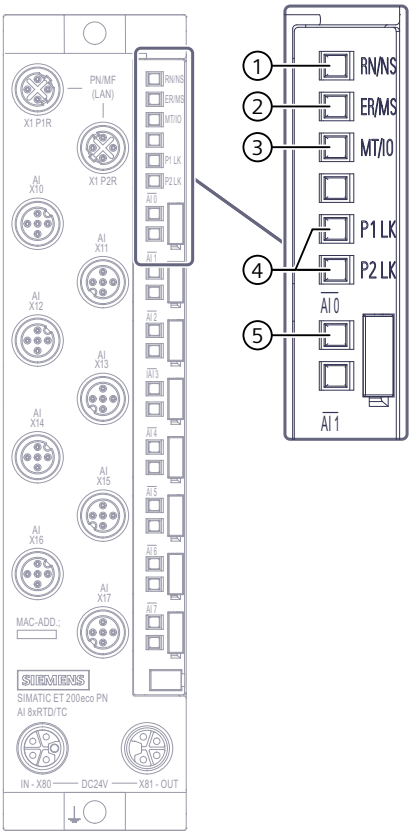
You can find information about the **Module Internal Shared Input/Shared Output (MSI/MSO)** functionality in the MultiFieldbus (https://support.industry.siemens.com/cs/ww/en/view/109773209) Function Manual or in the SIMATIC PROFINET with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/49948856) Function Manual.

5.2 Diagnostics

5.2.1 Status and error displays for EtherNet/IP

LED displays

The figure below shows the LED displays (status and error displays) of the I/O device AI 8xRTD/TC M12-L 8xM12.



① RN/NS: RUN/network status LED
② ER/MS: ERROR/module status LED
③ MT/IO: MAINT/IO status LED
④ P1 LK/P2 LK: LINK port status LEDs
⑤ LED displays 0 to 15 for channel status/channel error

Figure 5-8 LED displays

Behavior of the LEDs RN/NS (RUN/network status), ER/MS (ERROR/module status) and MT/IO (MAINT/IO status) on EtherNet/IP

The LEDs display the status with the **highest priority** if there are different LED states due to overlaid events. (0 = off, 1 = green flashing, 2 = green, 3 = yellow, 4 = red flashing, 5 = red)

The following table shows the meaning of the RN/NS, ER/MS LEDs and MT/IO LEDs for EtherNet/IP:

Table 5-7 Error display of the LEDs

LEDs			Meaning	Solution
RN/NS	ER/MS	MT/IO		
□ Off	□ Off	□ Off	Missing or insufficient supply voltage at the I/O device.	• Check the supply voltage.
☼ Flashing	Not relevant	Not relevant	I/O device on, no data exchange	
■ On	Not relevant	Not relevant	The ET 200eco PN is currently exchanging data with the scanner.	
☼ Flashing	Not relevant	Not relevant	EtherNet/IP connection interrupted	
■ On	■ On	■ On	The ET 200eco PN is currently exchanging data with at least one EtherNet/IP connection.	---
			I/O devices used by EtherNet/IP are in RUN mode.	---
Not relevant	□ Off	Not relevant	No valid MultiFieldbus project is loaded in the ET 200eco PN.	
Not relevant	☼ Flashing	Not relevant	No data exchange. A valid MultiFieldbus project is loaded in the ET 200eco PN.	
Not relevant	■ On	Not relevant	Data exchange via EtherNet/IP	
Not relevant	☼ Flashing	Not relevant	Errors in the configuration or parameter assignment.	
Not relevant	Not relevant	□ Off	The EtherNet/IP I/O devices are in STOP mode. No error	
Not relevant	Not relevant	■ On	The EtherNet/IP I/O devices are in RUN mode.	
Not relevant	Not relevant	■ On	Maintenance	Evaluate the maintenance events.
Not relevant	Not relevant	☼ Flashing	IO diagnostics or missing I/O device of slots used by EtherNet/IP	
☼ Flashing	☼ Flashing	☼ Flashing	Test of LEDs during startup: The three LEDs light up simultaneously for approximately 0.25 s in red. Then for approximately 0.25 s in green.	---
☼ Flashing	☼ Flashing	☼ Flashing	Hardware or firmware defective.	• You can read out the service data with MFCT.

LEDs			Meaning	Solution
RN/ NS	**ER/ MS**	**MT/ IO**		
☼ Flash-ing	☼ Flash-ing	☼ Flash-ing	The "Node flash test" is running (the P1 LK and P2 LK LEDs are also flash-ing).	

P1 LK and P2 LK LEDs

Table 5-8 Error display of the P1 LK and P2 LK LEDs

LEDs		Meaning	Solution
P1 LK	**P2 LK**		
□ Off		There is **no** Ethernet connection between the communications interface of your IO device and a communication partner (e.g. scanner).	Check whether the bus cable to the switch/communication partner is interrup-ted.
■ On		There is an Ethernet connection between the communications interface of your IO device and a communication partner (e.g. scanner).	---
☼ Flashing		The "Node flash test" is running (the RN/NS, ER/MS and MT/IO LEDs also flash).	---

Channel status/channel error LED

Table 5-9 Status and error display of the channel status/channel error LED

LEDs	Meaning
Channel status/channel error	
□ Off	• Channel not configured • Channel deactivated
■ On	Value is in the measuring range
■ On	Channel diagnostics

Modbus TCP

6

6.1 Functions/parameters/address space

6.1.1 Supported Modbus TCP functions

Supported functions

The table below shows the functions that the I/O device supports with Modbus TCP.

Supported functions	RegLayoutVersion	Remarks
I/O communication with Modbus client	V1.0	FW 5.1.x or higher
Free user registers (e.g. for coordination of the redundancy)	V1.0	FW 5.1.x or higher
Device information	V1.0	FW 5.1.x or higher
Module configuration status register	≥ V1.1	FW 5.1.x or higher
Diagnostics bit in data status of cyclic I/O data per submodule	V1.0	FW 5.1.x or higher
Shared device functions	V1.0	FW 5.1.x or higher
Reading events (hardware interrupts)	V1.0	FW 5.1.x or higher
Data record interface	≥ V1.1	FW 5.1.x or higher

Supported diagnostics

The table below shows the diagnostics that the I/O device supports with Modbus TCP.

Supported diagnostics	Remarks
Reading diagnostics with MFCT	FW 5.1.x or higher
Reading hardware interrupts via event interface	FW 5.1.x or higher
PULL/PLUG event Modbus TCP	Not supported
Read service data with MFCT	FW 5.1.x or higher

6.1.2 Measurement types and measuring ranges

The table below indicates which measuring range and temperature coefficient is configurable.

Table 6-1 Measurement type and measuring ranges

Measurement type	Measuring range	Temperature coefficient	Resolution
Deactivated	–	–	–

Measurement type	Measuring range	Temperature coefficient	Resolution
Voltage	+/- 80 mV	–	Max. 16-bit incl. sign
Resistance	• 0 ... 150 Ω • 0 ... 300 Ω • 0 ... 600 Ω • 0 ... 3 kΩ • 0 ... 6 kΩ	–	Max. 15-bit
• Thermal resistor (2-wire connection) • Thermal resistor (3-wire connection) • Thermal resistor (4-wire connection)	Climatic range/standard range • Pt 100 • Pt 200 • Pt 500 • Pt 1000	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.00392 • Pt 0.003850	Max. 16-bit incl. sign
	Climatic range/standard range • Ni 100 • Ni 120 • Ni 200 • Ni 500 • Ni 1000	• Ni 0.00618 • Ni 0.006720	Max. 16-bit incl. sign
Thermocouple	Type: B, C, E, J, K, L, N, R, S, T, U	–	Max. 16-bit incl. sign

6.1.3 Parameters

Parameters of the I/O device analog input AI 8xRTD/TC M12-L 8xM12

When you assign the parameters of the I/O device with MFCT, you can use various parameters to specify the module properties. The following table lists the configurable parameters for distributed operation.

NOTICE
Consistency of the encoders and parameters The analog inputs are preset to a thermal resistor (4-wire connection) Pt 100 standard range. Make sure that the connected encoders and the selected parameters match.

Parameters and default settings of the analog input I/O device

The table below shows the parameters for the I/O device analog input AI 8xRTD/TC M12-L 8xM12 for configuration with the GSD file.

Table 6-2 Configurable parameters and their default settings (GSD)

Parameter	Value range	Default	Effective range with configuration software e.g. MFCT
Diagnostics: Low voltage 1L+	• Deactivated • Activated	Deactivated	Channel
Activation of outlier suppression	• Deactivated • Activated	Activated	Channel
Diagnostics: Reference junction	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Overflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Underflow	• Deactivated • Activated	Deactivated	Channel
Diagnostics: Wire break detection and alarm	• Deactivated • Activated	Deactivated	Channel
Measurement type/Measuring range	• Deactivated	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	• Voltage ±80 mV		
	Resistance (2-, 3-, 4-wire connection) • 150 Ω • 300 Ω • 600 Ω • 3 kΩ • 6 kΩ		
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 climatic range • Pt 200 climatic range • Pt 500 climatic range • Pt 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Pt 100 standard range • Pt 200 standard range • Pt 500 standard range • Pt 1000 standard range		

[1] Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

[2] By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

[3] For 2-wire connection only

[4-1] The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range	Default	Effective range with configuration software e.g. MFCT
Measurement type/Measuring range	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 climatic range • Ni 120 climatic range • Ni 200 climatic range • Ni 500 climatic range • Ni 1000 climatic range	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
	Thermal resistor (2-, 3-, 4-wire connection) • Ni 100 standard range • Ni 120 standard range • Ni 200 standard range • Ni 500 standard range • Ni 1000 standard range		
Measurement type/Measuring range	Thermocouple • Type B • Type N • Type E • Type R • Type S • Type J • Type L • Type T • Type K • Type U • Type C	Thermal resistor (4-wire connection) Pt 100 standard range	Channel
Temperature coefficient	• Pt 0.00385055 • Pt 0.003916 • Pt 0.003902 • Pt 0.003920 • Pt 0.003850 • Ni 0.00618 • Ni 0.006720	Pt 0.00385055	Channel
Temperature unit	• Degrees Celsius • Degrees Fahrenheit • Kelvin	Degrees Celsius	Channel
Reference junction	• Fixed reference temperature • Dynamic reference temperature • Internal reference temperature • Off	Off	Channel

[1] Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

[2] By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

[3] For 2-wire connection only

[4-1] The decimal value corresponds to the selected temperature unit ×10

Parameter	Value range		Default		Effective range with configuration software e.g. MFCT
Fixed reference temperature	Degrees Celsius	-1450 ... 1550[4]	0[4]	0.0 °C	Channel
	Degrees Fahrenheit	-2290 ... 3110[4]	320[4]	32.0 °F	Channel
	Kelvin	1282 ... 3276[4]	2372[4]	273.2 K	Channel
Smoothing	• None • Weak • Medium • Strong		None		Channel
Interference frequency suppression	• 60 Hz (50 ms) • 50 Hz (60 ms)[1] • 16.7 Hz (180 ms) • 60 Hz (16.7 ms)[2] • 50 Hz (20 ms)[1 2] • 16.7 Hz (60 ms)[2] • None		50 Hz (20 ms)[1]		Channel
Scalable measuring range	• Deactivated • Activated		Deactivated		Channel
Measuring range resolution	• 2 decimal places • 3 decimal places		2 decimal places		Channel
Measuring range center	Degrees Celsius	-270 ... 1372[4]	0	0 °C	Channel
	Degrees Fahrenheit	-454 ... 2501[4]	0	0 °F	Channel
	Kelvin	4 ... 1645[4]	4	4 K	Channel
Conductor resistance[3]	0 ... 50000 mΩ		0		Channel
Hardware interrupt: High limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 1	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: High limit 2	• Deactivated • Activated		Deactivated		Channel
Hardware interrupt: Low limit 2	• Deactivated • Activated		Deactivated		Channel
High limit 1	The value range depends on the measurement type. The value range (min./max.) permitted for the measurement type is listed here (Page 115).		8500[4]		Channel
Low limit 1			-2000[4]		Channel
High limit 2			8500[4]		Channel
Low limit 2			-2000[4]		Channel

1 Interference frequency suppression: At 50 Hz, the 400 Hz interfering signals are also automatically filtered out

2 By selecting this interference frequency suppression with shorter integration time, the attenuation of the interference frequency that can be achieved is reduced (see Technical specifications).

3 For 2-wire connection only

4-1 The decimal value corresponds to the selected temperature unit ×10

NOTE

Unused channels

"Disable" unused channels in the parameter assignment to improve the cycle time of the module.

A deactivated input always returns the value $7FFF_H$.

"Fixed reference temperature" parameter for thermocouples

The parameter "Fixed reference temperature" can only be set if you selected = "Fixed reference temperature" for the "Reference junction" parameter.

The value ranges for the "Reference temperature" for thermocouples can be found here (Page 115).

6.1.4 Explanation of the parameters

Diagnostics: Low voltage 1L+

Enabling of the diagnostics for insufficient supply voltage 1L+.

Outlier suppression

The outlier suppression suppresses interference pulses in the analog input device which have been caused, for example, by switching processes in the system.
The last measured values are statistically analyzed (box plot).
Limits within which a new measured value is expected are derived from the distribution (scatter) of the measured values. When the distribution of the measured values changes, these limits adapt dynamically. New measured values that lie outside the determined limits are suppressed. This means the last value is retained.
Faults are suppressed up to a length of three module cycles. On the other hand, actual jumps in the input signal are delayed by the same time.

Diagnostics: Reference junction

Enabling of the Diagnostics Reference junction.

With dynamic reference temperature compensation, the I/O device receives the reference temperature via parameter data record 192. If the reference temperature is not receive cyclically within 5 minutes, the Diagnostics Reference junction trips.

Diagnostics: Overflow

Enable of the Diagnostics Overflow.

If the measured value exceeds the overrange, the Diagnostics Overflow trips.

Diagnostics: Underflow

Enabling of the Diagnostics Underflow.
If the measured value falls below the underrange, the Diagnostics Underflow trips.

Diagnostics: Wire break detection and alarm

Activation of wire break detection and enabling of diagnostics.

NOTE

Wire break diagnostics

With analog input channels, wire break diagnostics is not possible for the measurement type voltage ± 80 mV.

NOTE

Effect on the value status

When the parameter is deactivated, wire break detection is switched off. A wire break does not then affect the value status.

If the diagnostics: wire break is disabled, other diagnostic messages may occur in the event of a wire break in the cabling. This depends on which other diagnostics are enabled or disabled. The following table shows the diagnostic messages per channel that may occur for a wire break.

Table 6-3 Diagnostic messages for a wire break

Diagnostics: Wire break	Diagnostics: Overflow	Diagnostics: Underflow	Event	Process data	Diagnostics alarm per channel
Activated	Deactivated	Deactivated	Wire break	0x7FFF	Wire break
Deactivated	Deactivated	Activated	Wire break	0x7FFF	-
Deactivated	Activated	Deactivated	Wire break	0x7FFF	High limit violated
Deactivated	Activated	Activated	Wire break	0x7FFF	High limit violated
Deactivated	Deactivated	Deactivated	Wire break	0x7FFF	-

Measurement type/Measuring range

You use this parameter to set the measurement type or the measuring range for acquiring the measured values.

NOTE

Unused channels

"Deactivate" unused channels in the parameter assignment to improve the cycle time of the I/O device.

A deactivated channel always returns the value $7FFF_H$.

Temperature coefficient (for RTD)

The temperature coefficient depends on the chemical composition of the material. In Europe, only one value is used per sensor type (default value).

The correction factor for the temperature coefficient (α value) specifies how much the resistance of a certain material changes when the temperature is raised by 1 °C.

The further values facilitate sensor-specific setting of the temperature coefficient and enhance accuracy.

Temperature unit

You can use this parameter to set the temperature unit with which you want to measure the temperature.

Reference junction

If the measuring point is subjected to a different temperature than the reference junction (free ends of the thermocouple at the connection point), a thermal voltage arises between the free ends. The level of the thermal voltage depends:

- On the temperature difference between the measuring point and the free ends
- On the type of material combination of the thermocouple

Since a temperature difference is always detected with a thermocouple, the temperature of the reference junction has to be determined in order to determine the temperature of the measuring point.

The possible compensation types that can be configured via the "Reference junction" parameter are set out in the table below.

Table 6-4 Configurable compensation types for the "Reference junction" parameter

Compensation type	Explanation
Fixed reference temperature	**Properties** With this type of compensation, the reference junction temperature is stored as a fixed value. The default value is 0 °C. **Principle of operation** The reference junction temperature is specified in the "Fixed reference temperature" parameter. The possible value range is displayed in the table Structure of data record 128 for I/O device parameter assignment (Page 115). The configured reference junction temperature applies to all channels of the I/O device that you have

Compensation type	Explanation
	selected for this type of compensation. The "Fixed reference temperature" unit depends on the configured "Temperature unit" parameter of the channel. **Wiring** Connect the thermocouples to terminals 2 and 4 from the reference junction with copper cables. If you record the reference junction temperature directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12, you can also connect the thermocouples directly or with compensating lines.
Dynamic reference temperature	**Properties** With this compensation, the reference junction temperature can be measured via an external module on a different station. **Principle of operation** The reference junction temperature is transferred with the SFB 53 by means of data record 192 from the CPU to the AI 8xRTD/TC M12-L 8xM12 I/O device. Each channel that you select for this type of compensation can have its own reference junction temperature assigned to it via the user program. For more information, see section Structure of data record 192 for the dynamic reference temperature (Page 125). **Wiring** Connect the thermocouples to Terminals 2 and 4 from the reference junction with copper cables. If the reference junction temperature is recorded directly at the M12 connector of the AI 8xRTD/TC M12-L 8xM12 , you can also connect the thermocouples directly or with compensating lines.
Internal reference junction	**Properties** With this compensation type, the reference junction temperature is determined with an internal temperature sensor that is integrated in the AI 8xRTD/TC M12-L 8xM12 I/O device. Note: Take the reaction time to changes of the ambient temperature into account. **Principle of operation** The reference junction temperature is detected by an internal temperature sensor. All channels of the AI 8xRTD/TC M12-L 8xM12 that you select for this type of compensation will have the same reference junction temperature. **Wiring** Connect the thermocouples directly or with compensating lines to the AI 8xRTD/TC M12-L 8xM12.
No compensation	**Properties** With this compensation type, the reference junction temperature of the thermocouples is measured outside the AI 8xRTD/TC M12-L 8xM12 I/O device. You can, for example, connect a compensating box to the thermocouple for this purpose. **Principle of operation** The temperature of the reference junction for this type of compensation is specified as 0 °C. This can be achieved by using a compensating box. A separate compensating box is required for each thermocouple. **Wiring** Connect the compensating box with the AI 8xRTD/TC M12-L 8xM12 using copper cables. Note: Thermocouples of Type B do not require a compensating box up to a reference junction temperature of 50 °C.

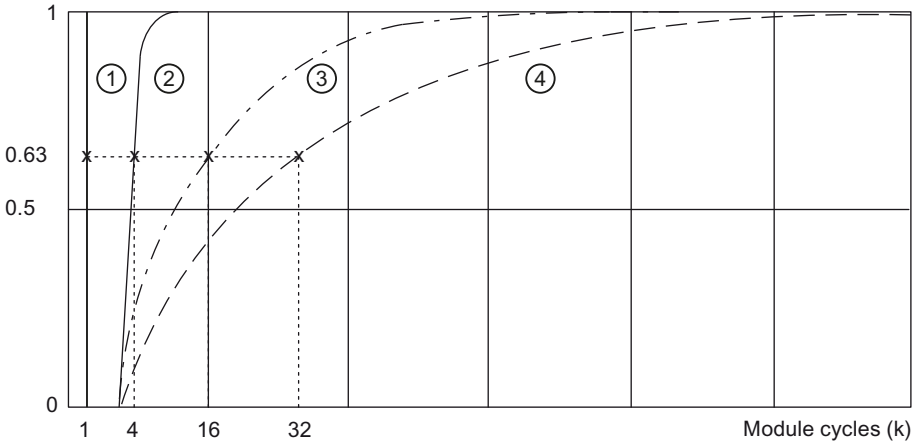
Smoothing

The purpose of smoothing is to filter out interferences. The greater the smoothing factor, the better the filter effect. This is technically implemented in the form of a digital filter. The smoothing can be set in 4 levels. The smoothing factor k is equal to the number of module cycles. The time constant of the smoothing filter is the product of the smoothing factor k and

the cycle time of the I/O device. The greater the smoothing, the greater the time constant of the filter.

Smoothing time = number of module cycles (k) x cycle time of the I/O device.

The following figure shows how many module cycles it takes for the smoothed analog value to approach 100%, depending on the configured smoothing. This is valid for all signal changes at the analog input.



① No smoothing (k = 1)
② Weak (k = 4)
③ Medium (k = 16)
④ Strong (k = 32)

Figure 6-1 Smoothing

Interference frequency suppression

This parameter suppresses the interference caused by the frequency of the AC voltage network used in the analog input I/O device.

The frequency of the AC voltage network can have a negative effect on the measured values in low voltage ranges and on thermocouples. For this parameter, the user defines the line frequency prevailing on their system.

Scalable measuring range

See the Scalable measuring range (Page 83) section.

Measuring range resolution

See the Scalable measuring range (Page 83) section.

Measuring range center

See the Scalable measuring range (Page 83) section.

Conductor resistance

Parameters for the measurement types resistor and thermal resistor (2-wire connection).
The parameter is used to compensate the conductor resistance without interfering with the sensor wiring.

Hardware interrupt high/low limit 1 or 2

Enabling of a hardware interrupt when the high limit 1 or 2 or the low limit 1 or 2 is violated.
A hardware interrupt is only generated for the channel when there is a fault-free signal (value status/QI = 1). This means no diagnostics is pending for the channel. See also: Address space (Page 86)
More information on the structure of hardware interrupts is available in MultiFieldbus Function Manual (https://support.industry.siemens.com/cs/ww/en/view/109773209).

High/low limit 1 or 2

Specify a threshold at which a hardware interrupt is triggered when it is exceeded or undershot.

Dependencies for the configuration

The parameter settings and I/O device are independent of each other. When configuring with the GSD file or with DS128, these dependencies must be observed. You can find these dependencies in the section Dependencies for the configuration (Page 114).

6.1.5 Update time of the I/O data

You can estimate the typical update time for an I/O cycle as follows:
Update time (can be set starting at 2 ms)
+ I/O processing (typically 1.4 ms, +/- 1 ms jitter due to free-running cycles)
+ EM conversion (dependent on cycle time and parameter assignment of the module)
If necessary, you must take into account other influences caused by the MTCP client and network components by adding them.

6.1.6 Scalable measuring range

Function

The scalable measuring range is a limited section of a measuring range supported by the I/O device.

The scalable measuring range allows for a higher resolution of a configurable section.

- The function is enabled with the "Scalable measuring range" parameter.
- The "Measuring range resolution" parameter determines the resolution to 2 or 3 decimal places for a configurable section of the measuring range.
- The "Measuring range center" parameter determines the temperature around which the scalable measuring range is symmetrically spanned.

NOTE

The scalable measuring range is available for the temperature measuring ranges of thermal resistors (RTD) standard and thermocouples. The measuring ranges for voltage, resistor and thermal resistor climatic are not supported.

The scalable measuring range is valid for the following ranges:

- Nominal range
- Underrange
- Overrange

Value ranges

Table 6-5 Value ranges

Scalable measuring range	Measuring range resolution		Values hex.
	2 decimal places	3 decimal places	
Overflow	> 325.11	> 32.511	$7FFF_H$
High limit	325.11	32.511	$7EFF_H$
Measuring range center	0	0	0_H
Low limit	-325.12	-32.512	8100_H
Underflow	<-325.12	<-32.512	8000_H

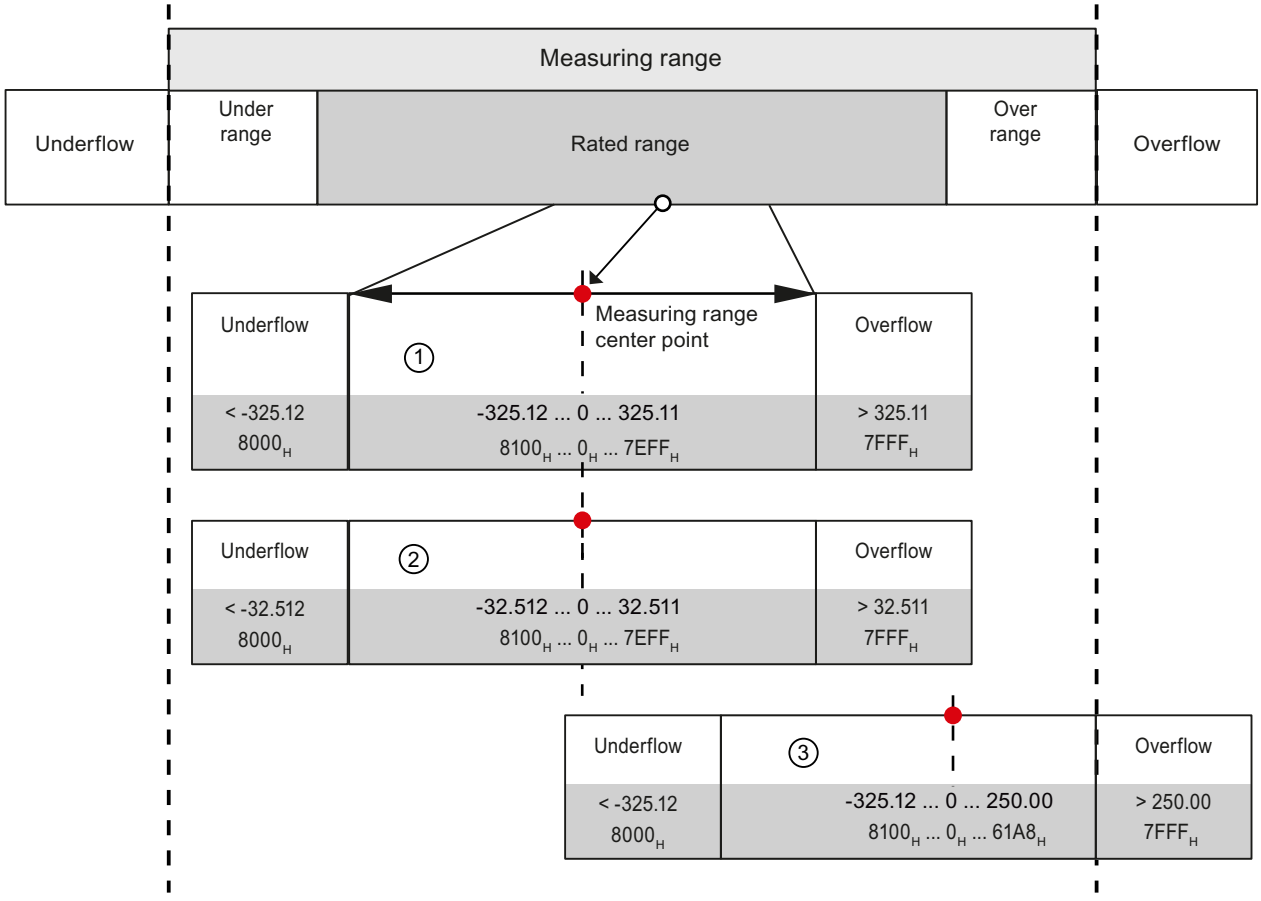
To obtain the absolute temperature, calculate the measuring range center in the user program (as offset) with the value of the user data of the scalable measuring range.
The measuring range center is always output in the user data as the value "0". The user data are correspondingly mapped to the bipolar input ranges in S7 format. Underflow / overflow is also formed in accordance with the limits of S7.

Rules

- The measuring range center must be within the nominal range of the underlying measuring range. The measuring range center is specified in integers.
- The scalable measuring range is spanned symmetrically over the measuring range center. Depending on the resolution, various value ranges result (①, ②).
- The scalable measuring range is limited by underflow and overflow of the underlying measuring range:
  - If the scalable measuring range falls below the limit, the scalable measuring range is cut off at the underflow.
  - When the scalable measuring range exceeds the limit (③), the scalable measuring range is cut off at the overflow.

Example

The following example illustrates the effect of scalable measuring ranges:



① Scalable measuring range with 2 decimal places in hexadecimal S7 format

② Scalable measuring range with 3 decimal places in hexadecimal S7 format

③ Scalable measuring range which is cut off at the overflow of the underlying measuring range ("Clipping")

Figure 6-2 Examples of scalable measuring ranges

Structure of data record 235

More information about the structure of data record 235 is available in section Structure of data record 235 for the scalable measuring range (Page 128).

6.1.7 Address space

You can configure the AI 8xRTD/TC M12-L 8xM12 I/O device as needed. Depending on the configuration, additional/different addresses are assigned in the process images.

Configuration options of the AI 8xRTD/TC M12-L 8xM12 I/O device

When configuring via GSD file, you will find the configurations under different short designations/device names in the MFCT device view.
The following configurations are possible:

Table 6-6 Configuration options

Configuration	Short designation/ device name in the GSD file (device view in the configuration software)	Configuration software, e.g. with MFCT
		GSD file in MFCT V1.4 SP1 or higher
1 x 8-channel AI 8xRTD/TC	AI 8xRTD/TC	X
1 x 8-channel AI 8xRTD/TC QI	AI 8xRTD/TC QI	X
1 x 8-channel AI 8xRTD/TC MSI	AI 8xRTD/TC MSI	X
2 x 4-channel AI 8xRTD/TC S	AI 8xRTD/TC S	X

Address space for configuration as 1 x 8-channel AI 8xRTD/TC

The following figure shows the address space allocation for configuration as an 8-channel I/O device analog inputs without value status. The addresses of the channels are derived from the start address.

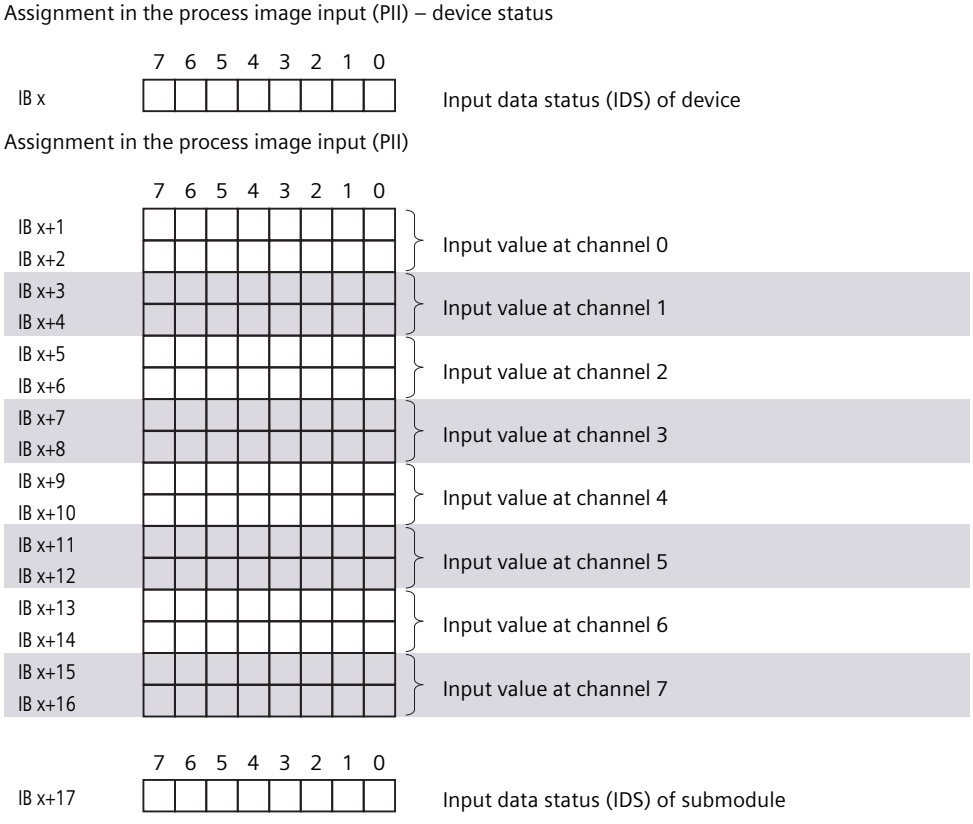


Figure 6-3 Address space for configuration as 1 x 8-channel AI 8xRTD/TC without value status

Value status (Quality Information, QI)

The value status is always returned with the following configuration options:

- AI 8xRTD/TC QI
- AI 8xRTD/TC MSI

Evaluating the value status

An additional byte is occupied in the input address space if you enable the value status for the I/O device. Bits 0 to 7 are assigned to a channel and provide information about the validity of the analog input value.

Bit = 1: There is no error on the channel.

Bit = 0: Error on channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI

The following figure shows the address space allocation for the configuration as 8-channel I/O device analog inputs with value status.

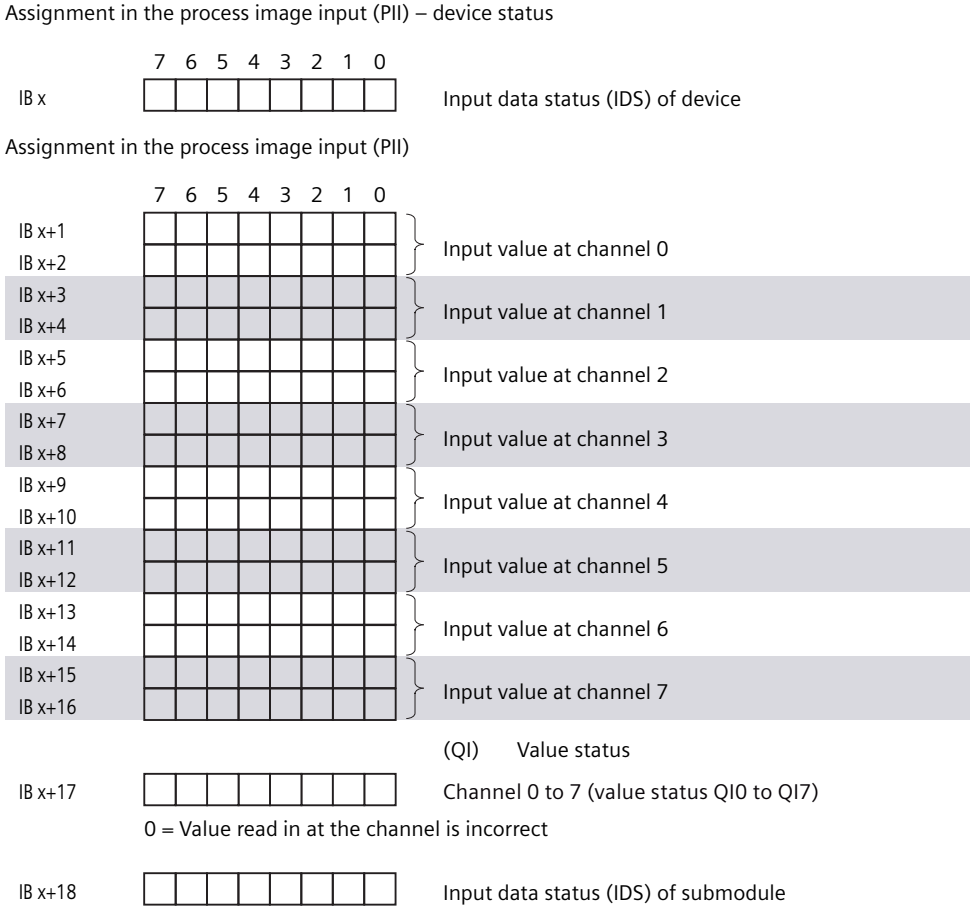


Figure 6-4 Address space for configuration as 1 x 8-channel AI 8xRTD/TC QI with value status

NOTE

Value status with deactivated parameter "Diagnostics: Wire break detection and alarm"

When the parameter "Diagnostics: Wire break detection and alarm" is deactivated, the evaluation of the wire break is not mapped in the value status of the channel.

Address space for configuration as 1 x 8-channel AI 8xRTD/TC MSI

With the configuration 1 x 8-channel AI 8xRTD/TC MSI, channels 0 to 7, including the value status of the I/O device, are copied into two submodules. Channels 0 to 7 are then available with identical values in various submodules. These submodules can be assigned to two IO controllers when used in a shared device.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule on which it occurs.

For the 1st Submodule (= basic submodule), the value status 0 indicates: The module detects that an error is pending at the channel and that the value is faulty.

For the 2nd Submodule (= MSI submodule) displays the value status 0:

- The value is faulty.
- The basic submodule is not yet assigned parameters (not ready).
- The connection between the IO controller and the basic submodule has been interrupted.
- The IO controller of the basic submodule is in STOP or POWER OFF state.

The following figure shows the assignment of the address space with submodules 1 and 2 and the value status.

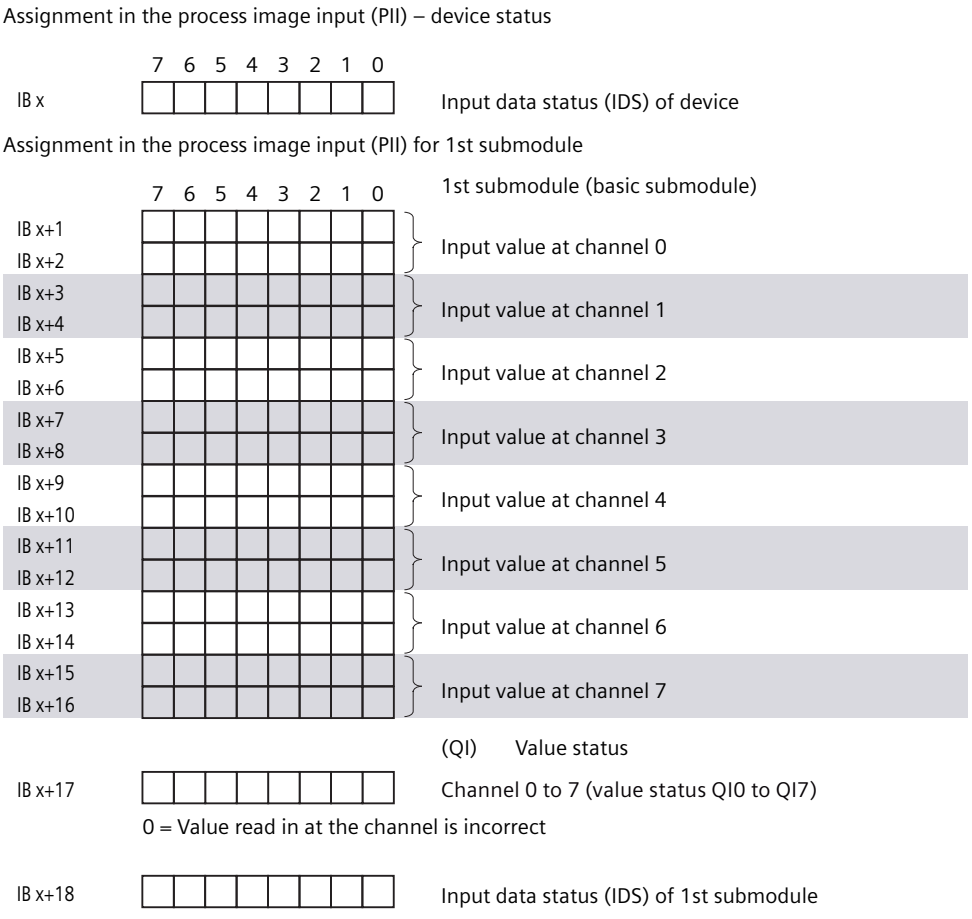


Figure 6-5 Address space for configuration as 1 x 8-channel AI 8xRTD/TC with value status (basic submodule)

Assignment in the process image input (PII) for 2nd submodule

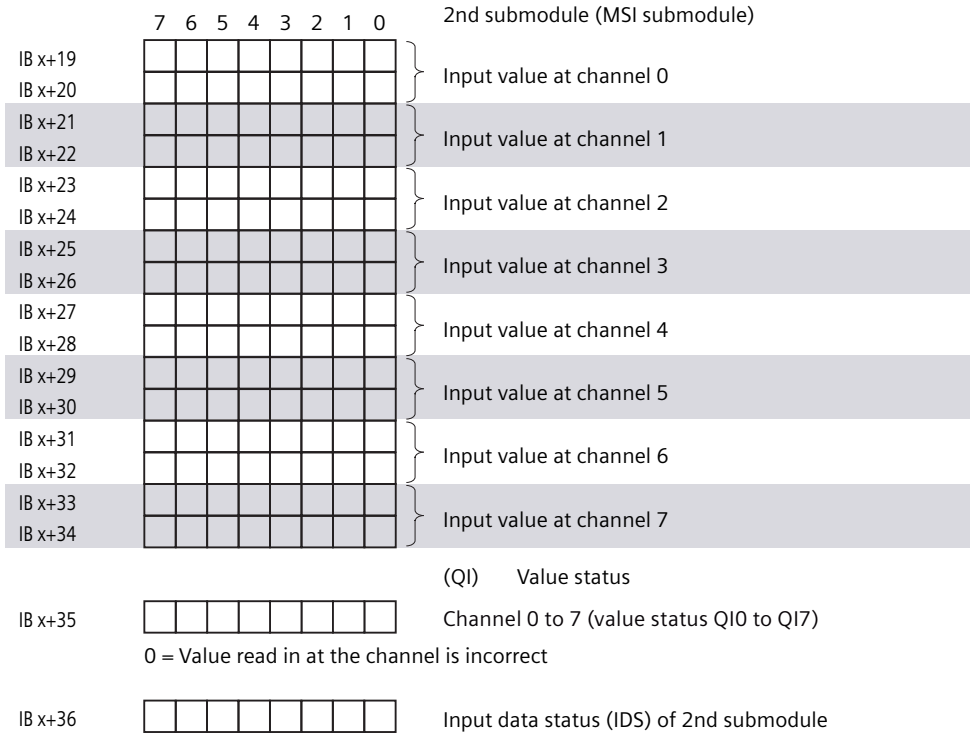


Figure 6-6 Address space for configuration as 1 x 8-channel AI 8xRTD/TC with value status (MSI submodule)

Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

The following figure shows the address space allocation for the configuration as 2 x 4-channel I/O device analog inputs without value status.

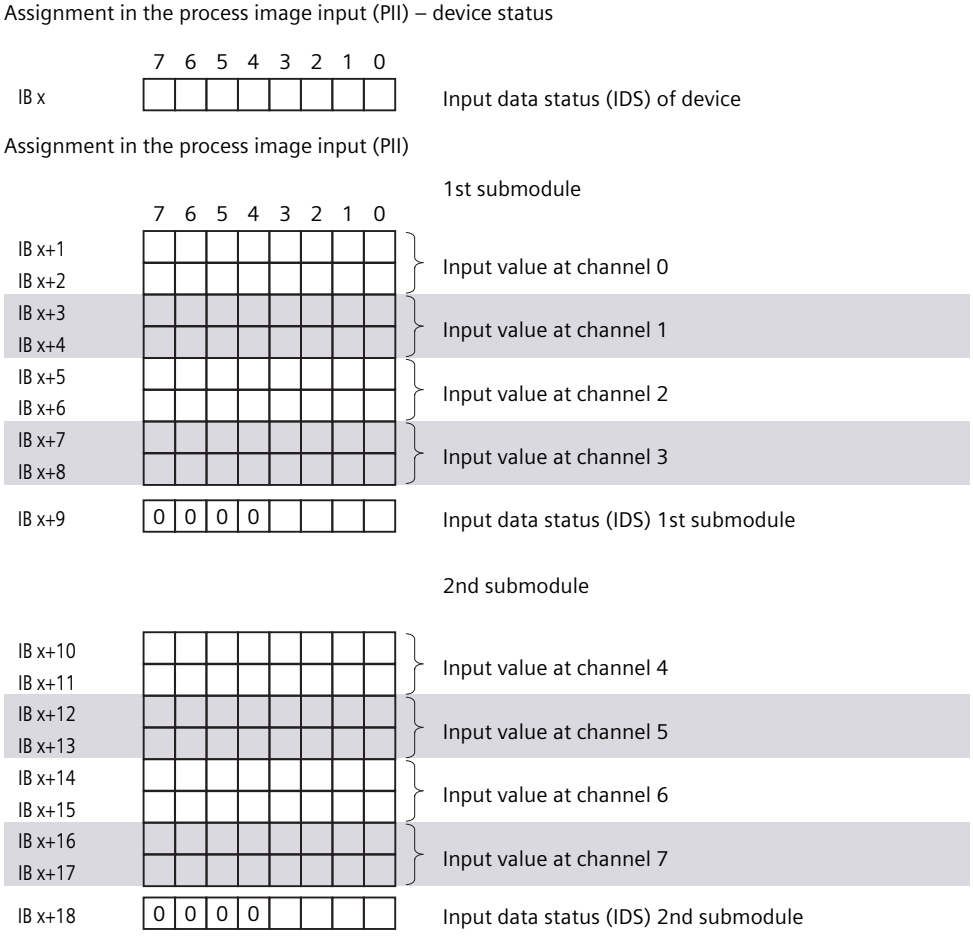


Figure 6-7 Address space for configuration as 2 x 4-channel AI 8xRTD/TC S

Reference

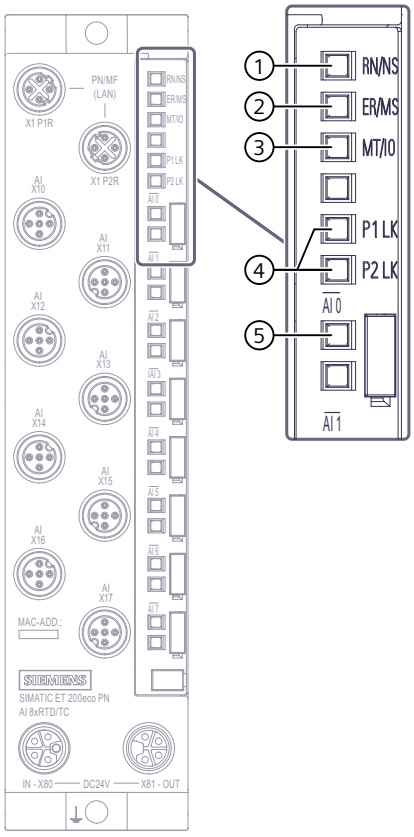
You can find information about the **Module Internal Shared Input/Shared Output (MSI/MSO)** functionality in the MultiFieldbus (https://support.industry.siemens.com/cs/ww/en/view/109773209) Function Manual or in the SIMATIC PROFINET with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/49948856) Function Manual.

6.2 Diagnostics

6.2.1 Status and error displays for Modbus TCP

LED displays

The figure below shows the LED displays (status and error displays) of the I/O device AI 8xRTD/TC M12-L 8xM12.



① RN/NS: RUN/network status LED
② ER/MS: ERROR/module status LED
③ MT/IO: MAINT/IO status LED
④ P1 LK/P2 LK: LINK port status LEDs
⑤ LED displays 0 to 15 for channel status/channel error

Figure 6-8 LED displays

Behavior of the LEDs RN/NS (RUN/network status), ER/MS (ERROR/module status) and MT/IO (MAINT/IO status) on modbus TCP

The LEDs display the status with the **highest priority** if there are different LED states due to overlaid events. (0 = off, 1 = green flashing, 2 = green, 3 = yellow, 4 = red flashing, 5 = red)

The following table shows the meaning of the RN/NS, ER/MS LEDs and MT/IO LEDs for Modbus TCP:

Table 6-7 Error display of the LEDs

LEDs			Meaning	Solution
RN/ NS	ER/ MS	MT/ IO		
□ Off	□ Off	□ Off	Missing or insufficient supply voltage at the I/O device.	• Check the supply voltage.
☼ Flash- ing	□ Off	□ Off	I/O device on, no data exchange	
■ On	□ Off	□ Off	The I/O device is exchanging data with any connection.	
☼ Flash- ing	☼ Flash- ing	□ Off	MultiFieldbus project is present in the I/O device, no data exchange	
■ On	■ On	□ Off	The I/O device exchanges data without errors via a modbus TCP connection	
■ On	☼ Flash- ing	□ Off	The I/O device exchanges data. An error has occurred in the I/O device.	Check the following: • Configuration • Parameter settings • PNIO diagnostics
☼ Flash- ing	☼ Flash- ing	□ Off	The I/O device does not exchange data. An error has occurred in the I/O device.	
☼ Flash- ing	☼ Flash- ing	□ Off	An existing connection to modbus TCP was terminated by a timeout	
☼ Flash- ing	☼ Flash- ing	□ Off	An existing connection to Modbus TCP was terminated by a timeout. Errors in the configuration or parameter assignment.	Check the following: • Configuration • Parameter assignment
☼ Flash- ing	☼ Flash- ing	☼ Flash- ing	Test of LEDs during startup: The three LEDs light up simultaneously for approximately 0.25 s in red. Then for approximately 0.25 s in green.	---
☼ Flash- ing	☼ Flash- ing	☼ Flash- ing	Hardware or firmware defective.	• You can read out the service data with MFCT.
☼ Flash- ing	☼ Flash- ing	☼ Flash- ing	The "Node flash test" is running (the P1 LK and P2 LK LEDs are also flashing).	

P1 LK and P2 LK LEDs

Table 6-8 Error display of the P1 LK and P2 LK LEDs

LEDs		Meaning	Solution
P1 LK	P2 LK		
☐ Off		There is **no** Ethernet connection between the communications interface of your IO device and a communication partner (e.g. scanner).	Check whether the bus cable to the switch/communication partner is interrupted.
■ On		There is an Ethernet connection between the communications interface of your IO device and a communication partner (e.g. scanner).	---
☼ Flashing		The "Node flash test" is running (the RN/NS, ER/MS and MT/IO LEDs also flash).	---

Channel status/channel error LED

Table 6-9 Status and error display of the channel status/channel error LED

LEDs	Meaning
Channel status/channel error	
☐ Off	• Channel not configured • Channel deactivated
■ On	Value is in the measuring range
■ On	Channel diagnostics

Technical specifications

7

Technical specifications of the I/O device analog input AI 8xRTD/TC M12-L 8xM12

The following table shows the technical specifications as of the issue date. You can find a data sheet including daily updated technical specifications on the Internet (https://support.industry.siemens.com/cs/ww/en/pv/6ES7144-6JF00-0BB0/td?dl=en).

Article number	6ES7144-6JF00-0BB0
General information	
HW functional status	FS01
Firmware version	V5.1.x
• FW update possible	Yes
Vendor identification (VendorID)	002AH
Device identifier (DeviceID)	0306H
Manufacturer ID according to ODVA (VendorID)	04E3H
Device ID according to ODVA (Product code)	0FAAH
Product function	
• I&M data	Yes; I&M0 to I&M3
• Isochronous mode	No
• Prioritized startup	Yes
• Measuring range scalable	Yes
Engineering with	
• STEP 7 TIA Portal configurable/integrated from version	STEP 7 V17 or higher with HSP 0369
• PROFINET from GSD version/GSD revision	GSDML V2.4.x
• Multi Fieldbus Configuration Tool (MFCT)	from V1.3 SP1
Operating mode	
• MSI	Yes
CiR - Configuration in RUN	
Calibration possible in RUN	Yes
Supply voltage	
power supply according to NEC Class 2 required	No
Load voltage 1L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
• Reverse polarity protection	Yes; against destruction

Article number	6ES7144-6JF00-0BB0
Input current	
Current consumption (rated value)	85 mA; without load
from load voltage 1L+ (unswitched voltage)	12 A; Maximum value
from load voltage 2L+, max.	12 A; Maximum value
Power loss	
Power loss, typ.	6.3 W
Address area	
Address space per module	
• Inputs	16 byte; + 1 byte for QI information
Hardware configuration	
Submodules	
• Number of configurable submodules, max.	2
Analog inputs	
Number of analog inputs	8
• For voltage measurement	8
• For resistance/resistance thermometer measurement	8
• For thermocouple measurement	8
permissible input voltage for voltage input (destruction limit), max.	24 V
Constant measurement current for resistance-type transmitter, typ.	0.7 mA
Cycle time (all channels), min.	Sum of the basic conversion times and additional processing times (depending on the parameterization of the active channels); for line compensation in case of a three-wire connection, an additional cycle is necessary
Technical unit for temperature measurement adjustable	Yes; Degrees Celsius / degrees Fahrenheit / Kelvin
Input ranges (rated values), voltages	
• -80 mV to +80 mV	Yes; 16 bit incl. sign
– Input resistance (-80 mV to +80 mV)	10 MΩ
Input ranges (rated values), thermocouples	
• Type B	Yes; 16 bit incl. sign
– Input resistance (Type B)	10 MΩ
• Type C	Yes; 16 bit incl. sign
– Input resistance (Type C)	10 MΩ
• Type E	Yes; 16 bit incl. sign
– Input resistance (Type E)	10 MΩ
• Type J	Yes; 16 bit incl. sign
– Input resistance (type J)	10 MΩ
• Type K	Yes; 16 bit incl. sign

Article number	6ES7144-6JF00-0BB0
– Input resistance (Type K)	10 MΩ
• Type L	Yes; 16 bit incl. sign
– Input resistance (Type L)	10 MΩ
• Type N	Yes; 16 bit incl. sign
– Input resistance (Type N)	10 MΩ
• Type R	Yes; 16 bit incl. sign
– Input resistance (Type R)	10 MΩ
• Type S	Yes; 16 bit incl. sign
– Input resistance (Type S)	10 MΩ
• Type T	Yes; 16 bit incl. sign
– Input resistance (Type T)	10 MΩ
• Type U	Yes; 16 bit incl. sign
– Input resistance (Type U)	10 MΩ
Input ranges (rated values), resistance thermometer	
• Ni 100	Yes; Standard/climate
– Input resistance (Ni 100)	10 MΩ
• Ni 1000	Yes; Standard/climate
– Input resistance (Ni 1000)	10 MΩ
• Ni 120	Yes; Standard/climate
– Input resistance (Ni 120)	10 MΩ
• Ni 200	Yes; Standard/climate
– Input resistance (Ni 200)	10 MΩ
• Ni 500	Yes; Standard/climate
– Input resistance (Ni 500)	10 MΩ
• Pt 100	Yes; Standard/climate
– Input resistance (Pt 100)	10 MΩ
• Pt 1000	Yes; Standard/climate
– Input resistance (Pt 1000)	10 MΩ
• Pt 200	Yes; Standard/climate
– Input resistance (Pt 200)	10 MΩ
• Pt 500	Yes; Standard/climate
– Input resistance (Pt 500)	10 MΩ
Input ranges (rated values), resistors	
• 0 to 150 ohms	Yes
– Input resistance (0 to 150 ohms)	10 MΩ
• 0 to 300 ohms	Yes

Article number	6ES7144-6JF00-0BB0
– Input resistance (0 to 300 ohms)	10 MΩ
• 0 to 600 ohms	Yes
– Input resistance (0 to 600 ohms)	10 MΩ
• 0 to 3000 ohms	Yes
– Input resistance (0 to 3000 ohms)	10 MΩ
• 0 to 6000 ohms	Yes
– Input resistance (0 to 6000 ohms)	10 MΩ
Thermocouple (TC)	
Temperature compensation	
– parameterizable	Yes
– internal temperature compensation	Yes
– external temperature compensation with compensations socket	Yes
– dynamic reference temperature value	Yes
– fixed reference temperature	Yes
Cable length	
• shielded, max.	30 m
Analog value generation for the inputs	
Analog value display	SIMATIC S7 format
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Integration time, parameterizable	Yes; channel by channel
• Integration time (ms)	0.84 / 16.7 (50) / 20 (60) / 60 (180)
• Basic conversion time, including integration time (ms)	4.50 / 21.5 (54) / 24 (64) / 64 (184)
– additional conversion time for wire-break monitoring	2 ms; for 3/4-wire transducer 4 ms
• Interference voltage suppression for interference frequency f1 in Hz	none / 60 / 50 / 16.7
Smoothing of measured values	
• parameterizable	Yes
• Step: None	Yes; 1x cycle time
• Step: low	Yes; 4x cycle time
• Step: Medium	Yes; 16x cycle time
• Step: High	Yes; 32x cycle time
Encoder	
Connection of signal encoders	

Article number	6ES7144-6JF00-0BB0
• for resistance measurement with two-wire connection	Yes
• for resistance measurement with three-wire connection	Yes
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.01 %; ±0.1 % for resistance thermometers and resistance
Temperature error (relative to input range), (+/-)	0.0009 %/K; ±0.005 % / K at thermocouple
Crosstalk between the inputs, max.	-70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.008 %
Temperature error of internal compensation	±1,5 °C
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.2 %
• Resistance, relative to input range, (+/-)	0.1 %; See deviations in the manual
• Resistance thermometer, relative to input range, (+/-)	0.1 %; See deviations in the manual
• Thermocouple, relative to input range, (+/-)	0.3 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.1 %
• Resistance, relative to input range, (+/-)	0.05 %; See deviations in the manual
• Resistance thermometer, relative to input range, (+/-)	0.05 %; See deviations in the manual
• Thermocouple, relative to input range, (+/-)	0.15 %
Interference voltage suppression for f = n x (f1 +/- 0.5 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	40 dB
Interfaces	
Number of PROFINET interfaces	1
1. Interface	
Interface type	PROFINET with 100 Mbit/s full duplex (100BASE-TX)
Interface types	
• M12 port	Yes; 2x M12, 4-pin, D-coded
• Number of ports	2
• integrated switch	Yes

Article number	6ES7144-6JF00-0BB0
Protocols	
• PROFINET IO Device	Yes
• Open IE communication	Yes
Interface types	
M12 port	
• Autonegotiation	Yes
• Autocrossing	Yes
• Transmission rate, max.	100 Mbit/s
Protocols	
Supports protocol for PROFINET IO	Yes
PROFIsafe	No
EtherNet/IP	Yes
Modbus TCP	Yes
PROFINET IO Device	
Services	
– IRT	Yes; 250 µs to 4 ms in 125 µs frame
– Prioritized startup	Yes
– Shared device	Yes
– Number of IO Controllers with shared device, max.	2
Redundancy mode	
• PROFINET system redundancy (S2)	Yes
– on S7-1500R/H	Yes
– on S7-400H	Yes
• PROFINET system redundancy (R1)	No
• H-Sync forwarding	Yes
Media redundancy	
– MRP	Yes
EtherNet/IP	
Services	
– CIP Implicit Messaging	Yes
– CIP Explicit Messaging	Yes
– CIP Safety	No
– Shared device	Yes; 2x EtherNet/IP Scanner
– Number of scanners with shared device, max.	2
Updating times	
– Requested Packet Interval (RPI)	2 ms
Redundancy mode	
– DLR (Device Level Ring)	No

Article number	6ES7144-6JF00-0BB0
Address area	
– Address space per module, max.	38 byte
– LargeForwardOpen (Class3)	No
Modbus TCP	
Services	
– read coils (code=1)	Yes
– read discrete inputs (code=2)	Yes
– Read Holding Registers (Code=3)	Yes
– write single coil (code=5)	Yes
– write multiple coils (code=15)	Yes
– Write Multiple Registers (Code=16)	Yes
– Parameter change by master	No
– Modbus TCP Security Protocol	No
Address space per station	
– Address space per station, max.	38 byte
– Access-consistent address space	2 byte
Updating time	
– I/O request interval	2 ms
Connections	
– Number of connections per slave	12
Open IE communication	
• TCP/IP	Yes; (only EtherNet/IP or Modbus TCP)
• SNMP	Yes
• LLDP	Yes
• ARP	Yes
Interrupts/diagnostics/status information	
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Maintenance interrupt	Yes; Parameterizable
• Limit value alarm	Yes; two upper and two lower limit values in each case
Diagnoses	
• Diagnostic information readable	Yes
• Monitoring the supply voltage	Yes
– parameterizable	Yes
• Wire-break	Yes; Not for ±80 mV
• Overflow/underflow	Yes
Diagnostics indication LED	
• RUN LED	Yes; green LED

Article number	6ES7144-6JF00-0BB0
• ERROR LED	Yes; red LED
• MAINT LED	Yes; Yellow LED
• NS LED	Yes; green/red LED
• MS LED	Yes; green/red LED
• IO LED	Yes; red/green/yellow LEDs
• Channel status display	Yes; green LED
• for channel diagnostics	Yes; red LED
• Connection display LINK TX/RX	Yes; green LED, only link
Potential separation	
between the load voltages	Yes
between Ethernet and electronics	Yes
Potential separation channels	
• between the channels	No
• between the channels and the power supply of the electronics	Yes
Isolation	
tested with	
• 24 V DC circuits	707 V DC (type test)
• Test voltage for interface, rms value [Vrms]	1 500 V; According to IEEE 802.3
Degree and class of protection	
IP degree of protection	IP65/67/69K
Standards, approvals, certificates	
Suitable for safety-related tripping of standard modules	Yes; From FS01
Suitable for applications according to AMS 2750	Yes; Declaration of Conformity, see online support entry 109757262
Suitable for applications according to CQI-9	Yes; based on AMS 2750 F
Highest safety class achievable for safety-related tripping of standard modules	
• Performance level according to ISO 13849-1	PL d
• Category according to ISO 13849-1	Cat. 3
• SIL acc. to IEC 62061	SIL 2
• remark on safety-oriented shutdown	https://support.industry.siemens.com/cs/de/en/view/39198632
Ambient conditions	
Ambient temperature during operation	
• min.	-40 °C
• max.	60 °C
Altitude during operation relating to sea level	

Article number	6ES7144-6JF00-0BB0
• Ambient air temperature-barometric pressure-altitude	Up to max. 5 000 m, at installation height > 2 000 m additional restrictions
connection method / header	
Design of electrical connection	4/5-pin M12 circular connectors
Design of electrical connection for the inputs and outputs	M12, 5-pin, A-coded
Design of electrical connection for supply voltage	M12, 4-pin, L-coded
Dimensions	
Width	45 mm
Height	200 mm
Depth	48 mm
Weights	
Weight, approx.	780 g

Operational error limits and basic error limits for thermocouples

The operational error limits and basic error limits for thermocouples apply starting at different temperatures. The following table shows the thermocouple type with the associated temperature as of which the error limit applies.

Thermocouple type	Temperature
Type T	-200 °C
Type K	-100 °C
Type B	+700 °C
Type N	-150 °C
Type E	-150 °C
Type R	+200 °C
Type S	+200 °C

Deviation of operational error limits and basic error limits

The parameter setting "Interference frequency suppression = None" results in the following operational error limits and basic error limits:

Value range	Resistance value	Operational limit	Basic error limit
Resistance (2-, 3-, 4-wire connection) • 6 kΩ	As of approx. 4 kΩ	>0.1%	>0.05%
Thermal resistor (2-, 3-, 4-wire connection)			

Dimension drawing

A

A.1 Dimension drawing

The figure below shows the dimension drawing of the AI 8xRTD/TC M12-L 8xM12 analog input I/O device in the front and side view.

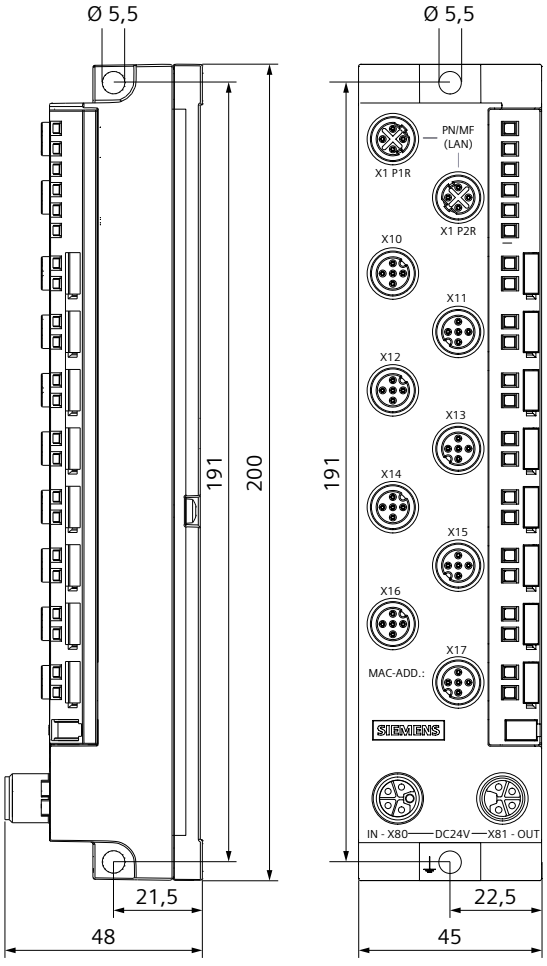


Figure A-1 Dimension drawing

Representation of analog values

B

B.1 Measured value resolution

This appendix shows the possible analog values for all measuring ranges.

Measured value resolution

The resolution of the analog values differs depending on the analog input I/O device and its parameter assignment.
Each analog value is written left aligned to the tags. The bits marked with "x" are set to "0".

NOTE

Temperature values

The digitized temperature values are the result of a conversion in the analog input I/O device. The following resolution therefore does not apply to temperature values.

Table B-1 Resolution of the analog values

Resolution in bits including sign	Values		Analog value	
	Decimal	Hexadecimal	High byte	Low byte
14	4	4_H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 1 x x
15	2	2_H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 1 x
16	1	1_H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

B.2 Representation of input ranges

In the following tables, you can find the digitized representation of the bipolar and unipolar input ranges. The resolution is 16 bits.

Table B-2 Bipolar input ranges

Dec. value	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	

Dec. value	Measured value in %	Data word																Range
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-27648	-100.000	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	
-27649	-100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	Underrange
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32768	<-117.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Table B-3 Unipolar input ranges

Dec. value	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Underrange
-4864	-17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
-32768	<-17.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

B.3 Representation of analog values in voltage measuring range

The table below lists the decimal and hexadecimal values (coding) of the voltage measuring range.

Table B-4 Voltage measuring range ± 80 mV

Values		Voltage measuring range	Range
Dec.	Hex.	± 80 mV	
32767	7FFF	> 94.1 mV	Overflow
32511	7EFF	94.1 mV	Overrange
27649	6C01		
27648	6C00	80 mV	Nominal range
20736	5100	60 mV	
1	1	2.89 µV	
0	0	0 mV	
-1	FFFF	-2.89 µV	

Values		Voltage measuring range	Range
Dec.	**Hex.**	**± 80 mV**	
-20736	AF00	-60 mV	Nominal range
-27648	9400	-80 mV	
-27649	93FF		Underrange
-32512	8100	-94.1 mV	
-32768	8000	< -94.1 mV	Underflow

B.4 Representation of analog values for resistance-based sensors

Resistance-based sensor

The following table lists the values (codings) of the resistance-based sensors.

Table B-5 Value ranges of the resistance-based sensors

Values		Resistance-based sensor range					Range
Dec.	**Hex.**	**150 Ω**	**300 Ω**	**600 Ω**	**3 kΩ**	**6 kΩ**	
32767	7FFF	>176.38 Ω	>352.77 Ω	>705.53 Ω	>3527.67 Ω	>7055.34 Ω	Overflow
32511	7EFF	176.38 Ω	352.77 Ω	705.53 Ω	3527.67 Ω	7055.34 Ω	Overrange
27649	6C01						
27648	6C00	150 Ω	300 Ω	600 Ω	3000 Ω	6000 Ω	Nominal range
20736	5100	112.5 Ω	225 Ω	450 Ω	2250 Ω	4500 Ω	
1	1	5.43 mΩ	10.85 mΩ	21.70 mΩ	108.51 mΩ	217.01 mΩ	
0	0	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	

NOTE

Negative value for 2-wire connection

A negative value is possible in these constellations:

- Configured conductor compensation > sum of conductor resistance and resistance
- Short-circuit on the input and configured conductor compensation

With a negative value, the value 8000_H is generated. The diagnostics alarm "Violation of low limit" is signaled for the channel in question.

B.5 Representation of analog values for thermal resistors

NOTE

A higher resolution can be configured for the measuring range for standard resistance thermometers, see section Scalable measuring range (Page 34).

The tables below list the decimal and hexadecimal values (coding) of the thermal resistors.

Table B-6 Thermal resistor Pt 100, Pt 200, Pt 500, Pt 1000 standard

Pt x00 Standard in °C (1 digit = 0.1 °C)	**Values**		**Pt x00 Standard in °F (1 digit = 0.1 °F)**	**Values**		**Pt x00 Standard in K (1 digit = 0.1 K)**	**Values**		**Range**
	Dec.	**Hex.**		**Dec.**	**Hex.**		**Dec.**	**Hex.**	
>1000.0	32767	7FFF	>1832.0	32767	7FFF	>1273.2	32767	7FFF	Overflow
1000.0 : 850.1	10000 : 8501	2710 : 2135	1832.0 : 1562.1	18320 : 15621	4790 : 3D05	1273.2 : 1123.3	12732 : 11233	31BC : 2BE1	Overrange
850.0 : -200.0	8500 : -2000	2134 : F830	1562.0 : -328.0	15620 : -3280	3D04 : F330	1123.2 : 73.2	11232 : 732	2BE0 : 2DC	Nominal range
-200.1 : -243.0	-2001 : -2430	F82F : F682	-328.1 : -405.4	-3281 : -4054	F32F : F02A	73.1 : 30.2	731 : 302	2DB : 12E	Underrange
<-243.0	-32768	8000	<-405.4	-32768	8000	<30.2	32768	8000	Underflow

Table B-7 Thermal resistor Pt 100, Pt 200, Pt 500, Pt 1000 Climatic

Pt x00 Climatic in °C (1 digit = 0.01 °C)	**Values**		**Pt x00 Climatic in °F (1 digit = 0.01 °F)**	**Values**		**Range**
	Dec.	**Hex.**		**Dec.**	**Hex.**	
>155.00	32767	7FFF	>311.00	32767	7FFF	Overflow
155.00 : 130.01	15500 : 13001	3C8C : 32C9	311.00 : 266.01	31100 : 26601	797C : 67E9	Overrange
130.00 : -120.00	13000 : -12000	32C8 : D120	266.00 : -184.00	26600 : -18400	67E8 : B820	Nominal range
-120.01 : -145.00	-12001 : -14500	D11F : C75C	-184.01 : -229.00	-18401 : -22900	B81F : A68C	Underrange
<-145.00	-32768	8000	<-229.00	-32768	8000	Underflow

Table B-8 Thermal resistor Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000 Standard

Ni x00 Standard in °C (1 digit = 0.1 °C)	**Values**		**Ni x00 Standard in °F (1 digit = 0.1 °F)**	**Values**		**Ni x00 Standard in K (1 digit = 0.1 K)**	**Values**		**Range**
	Dec.	**Hex.**		**Dec.**	**Hex.**		**Dec.**	**Hex.**	
> 295.0	32767	7FFF	> 563.0	32767	7FFF	> 568.2	32767	7FFF	Overflow
295.0 : 250.1	2950 : 2501	B86 : 9C5	563.0 : 482.1	5630 : 4821	15FE : 12D5	568.2 : 523.3	5682 : 5233	1632 : 1471	Overrange

Ni x00 Standard in °C (1 digit = 0.1 °C)	Values		Ni x00 Standard in °F (1 digit = 0.1 °F)	Values		Ni x00 Standard in K (1 digit = 0.1 K)	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
250.0 : -60.0	2500 : -600	9C4 : FDA8	482.0 : -76.0	4820 : -760	12D4 : FD08	523.2 : 213.2	5232 : 2132	1470 : 854	Nominal range
-60.1 : -105.0	-601 : -1050	FDA7 : FBE6	-76.1 : -157.0	-761 : -1570	FD07 : F9DE	213.1 : 168.2	2131 : 1682	853 : 692	Underrange
<-105.0	-32768	8000	<-157.0	-32768	8000	< 168.2	32768	8000	Underflow

Table B-9 Thermal resistor Ni 100 Ni 120 Ni 200 Ni 500 Ni 1000 Climatic

Ni x00 Climatic in °C (1 digit = 0.01 °C)	Values		Ni x00 Climatic in °F (1 digit = 0.01 °F)	Values		Range
	Dec.	Hex.		Dec.	Hex.	
>155.00	32767	7FFF	>311.00	32767	7FFF	Overflow
155.00 : 130.01	15500 : 13001	3C8C : 32C9	311.00 : 266.01	31100 : 26601	797C : 67E9	Overrange
130.00 : -60.00	13000 : -6000	32C8 : E890	266.00 : -76.00	26600 : -7600	67E8 : E250	Nominal range
-60.01 : -105.00	-6001 : -10500	E88F : D6FC	-76.01 : -157.00	-7601 : -15700	E24F : C2AC	Underrange
<-105.00	-32768	8000	<-157.00	-32768	8000	Underflow

B.6 Representation of analog values for thermocouples

NOTE

A higher resolution can be configured for the measuring range for the thermocouples, see section Scalable measuring range (Page 34).

The tables below list the decimal and hexadecimal values (coding) of the thermocouples.

Table B-10 Thermocouple type B

Type B in °C	Values		Type B in °F	Values		Type B in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2070.0	32767	7FFF	> 3276.6	32767	7FFF	> 2343.2	32767	7FFF	Overflow
2070.0 : 1820.1	20700 : 18201	50DC : 4719	3276.6 : 2786.6	32766 : 27866	7FFE : 6CDA	2343.2 : 2093.3	23432 : 20933	5B88 : 51C5	Overrange

Type B in °C	Values		Type B in °F	Values		Type B in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
1820.0 : 0.0	18200 : 0	4718 : 0000	2786.5 : 32.0	27865 : 320	6CD9 : 0140	2093.2 : 273.2	20932 : 2732	51C4 : 0AAC	Nominal range
-0.1 : -120.0	-1 : -1200	FFFF : FB50	31.9 : -184.0	319 : -1840	013F : F8D0	273.1 : 153.2	2731 : 1532	0AAB : 05FC	Underrange
< -120.0	-32768	8000	< -184.0	-32768	8000	< 153.2	-32768	8000	Underflow

Table B-11 Thermocouple type C

Type C in °C	Values		Type C in °F	Values		Type C in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2500.0	32767	7FFF	> 3276.6	32767	7FFF	> 2773.2	32767	7FFF	Overflow
2500.0 : 2315.1	25000 : 23151	61A8 : 5A6F	3276.6 : 2786.6	32766 : 27866	7FFE : 6CDA	2773.2 : 2588.3	27732 : 25883	6C54 : 651B	Overrange
2315.0 : 0.0	23150 : 0	5A6E : 0000	2786.5 : 32.0	27865 : 320	6CD9 : 0140	2588.2 : 273.2	25882 : 2732	651A : 0AAC	Nominal range
-0.1 : -120.0	-1 : -1200	FFFF : FB50	31.9 : -184.0	319 : -1840	013F : F8D0	273.1 : 153.2	2731 : 1532	0AAB : 05FC	Underrange
< -120.0	-32768	8000	< -184.0	-32768	8000	< 153.2	-32768	8000	Underflow

Table B-12 Thermocouple type E

Type E in °C	Values		Type E in °F	Values		Type E in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1200.0	32767	7FFF	> 2192.0	32767	7FFF	> 1473.2	32767	7FFF	Overflow
1200.0 : 1000.1	12000 : 10001	2EE0 : 2711	2192.0 : 1832.1	21920 : 18321	55A0 : 4791	1473.2 : 1273.3	14732 : 12733	398C : 31BD	Overrange
1000.0 : -270.0	10000 : -2700	2710 : F574	1832.0 : -454.0	18320 : -4540	4790 : EE44	1273.2 : 3.2	12732 : 32	31BC : 0020	Nominal range
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-13 Thermocouple type J

Type J in °C	Values		Type J in °F	Values		Type J in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1450.0	32767	7FFF	> 2642.0	32767	7FFF	> 1723.2	32767	7FFF	Overflow
1450.0 : 1200.1	14500 : 12001	38A4 : 2EE1	2642.0 : 2192.1	26420 : 21921	6734 : 55A1	1723.2 : 1473.3	17232 : 14733	4350 : 398D	Overrange
1200.0 : -210.0	12000 : -2100	2EE0 : F7CC	2192.0 : -346.0	21920 : -3460	55A0 : F27C	1473.2 : 63.2	14732 : 632	398C : 0278	Nominal range
< -210.0	-32768	8000	< -346.0	-32768	8000	< 63.2	-32768	8000	Underflow

Table B-14 Thermocouple type K

Type K in °C	Values		Type K in °F	Values		Type K in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1622.0	32767	7FFF	> 2951.6	32767	7FFF	> 1895.2	32767	7FFF	Overflow
1622.0 : 1372.1	16220 : 13721	3F5C : 3599	2951.6 : 2501.7	29516 : 25017	734C : 61B9	1895.2 : 1645.3	18952 : 16453	4A08 : 4045	Overrange
1372.0 : -270.0	13720 : -2700	3598 : F574	2501.6 : -454.0	25016 : -4540	61B8 : EE44	1645.2 : 3.2	16452 : 32	4044 : 0020	Nominal range
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-15 Thermocouple type L

Type L in °C	Values		Type L in °F	Values		Type L in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1150.0	32767	7FFF	> 2102.0	32767	7FFF	> 1423.2	32767	7FFF	Overflow
1150.0 : 900.1	11500 : 9001	2CEC : 2329	2102.0 : 1652.1	21020 : 16521	521C : 4089	1423.2 : 1173.3	14232 : 11733	3798 : 2DD5	Overrange
900.0 : -200.0	9000 : -2000	2328 : F830	1652.0 : -328.0	16520 : -3280	4088 : F330	1173.2 : 73.2	11732 : 732	2DD4 : 02DC	Nominal range
< -200.0	-32768	8000	< -328.0	-32768	8000	< 73.2	-32768	8000	Underflow

Table B-16 Thermocouple type N

Type N in °C	Values		Type N in °F	Values		Type N in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1550.0	32767	7FFF	> 2822.0	32767	7FFF	> 1823.2	32767	7FFF	Overflow
1550.0 : 1300.1	15500 : 13001	3C8C : 32C9	2822.0 : 2372.1	28220 : 23721	6E3C : 5CA9	1823.2 : 1573.3	18232 : 15733	4738 : 3D75	Overrange
1300.0 : -270.0	13000 : -2700	32C8 : F574	2372.0 : -454.0	23720 : -4540	5CA8 : EE44	1573.2 : 3.2	15732 : 32	3D74 : 0020	Nominal range
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-17 Thermocouples R and S

Types R, S in °C	Values		Types R, S in °F	Values		Types R, S in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2019.0	32767	7FFF	> 3276.6	32767	7FFF	> 2292.2	32767	7FFF	Overflow
2019.0 : 1769.1	20190 : 17691	4EDE : 451B	3276.6 : 3216.3	32766 : 32163	7FFE : 7DA3	2292.2 : 2042.3	22922 : 20423	598A : 4FC7	Overrange

Types R, S in °C	Values		Types R, S in °F	Values		Types R, S in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
1769.0 : -50.0	17690 : -500	451A : FE0C	3216.2 : -58.0	32162 : -580	7DA2 : FDBC	2042.2 : 223.2	20422 : 2232	4FC6 : 08B8	Nominal range
-50.1 : -170.0	-501 : -1700	FE0B : F95C	-58.1 : -274.0	-581 : -2740	FDBB : F54C	223.1 : 103.2	2231 : 1032	08B7 : 0408	Underrange
< -170.0	-32768	8000	< -274.0	-32768	8000	< 103.2	< 1032	8000	Underflow

Table B-18 Thermocouple type T

Type T in °C	Values		Type T in °F	Values		Type T in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 540.0	32767	7FFF	> 1004.0	32767	7FFF	> 813.2	32767	7FFF	Overflow
540.0 : 400.1	5400 : 4001	1518 : 0FA1	1004.0 : 752.1	10040 : 7521	2738 : 1D61	813.2 : 673.3	8132 : 6733	1FC4 : 1AAD	Overrange
400.0 : -270.0	4000 : -2700	0FA0 : F574	752.0 : -454.0	7520 : -4540	1D60 : EE44	673.2 : 3.2	6732 : 32	1AAC : 0020	Nominal range
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-19 Thermocouple type U

Type U in °C	Values		Type U in °F	Values		Type U in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 850.0	32767	7FFF	> 1562.0	32767	7FFF	> 1123.2	32767	7FFF	Overflow
850.0 : 600.1	8500 : 6001	2134 : 1771	1562.0 : 1112.1	15620 : 11121	2738.0 : 2B71	1123.2 : 873.3	11232 : 8733	2BE0 : 221D	Overrange
600.0 : -200.0	6000 : -2000	1770 : F830	1112.0 : -328.0	11120 : -3280	2B70 : F330	873.2 : 73.2	8732 : 732	221C : 02DC	Nominal range
< -200.0	-32768	8000	< -328.0	-32768	8000	< 73.2	-32768	8000	Underflow

Parameter data record

C

C.1 Dependencies for the configuration

The parameter settings are dependent on each other when configuring the I/O device. These dependencies must be considered when configuring with the latest HSP in STEP 7 TIA. When configuring with the GSD file or with data record 128, these dependencies must be observed.

Configuring with the GSD file or with data record 128, measurement type / measuring range

This table lists the properties and their dependencies on the measurement type and measuring range.

Table C-1 Dependencies of the measurement type / measuring range

Measurement type	Measuring range	Temperature unit	Temperature coefficient	Reference junction	Conductor resistance	Scalable measuring range	Measuring range resolution
Deactivated	*	*	*	*	*	*	*
Voltage	±80 mV	*	*	*	*	–	*
Resistor (2, 3, 4-wire connection)	150 Ω, 300 Ω, 600 Ω, 3 kΩ, 6 kΩ	*	*	*	x, with 2-wire connection	–	*
Thermal resistor (2, 3, 4-wire connection)	Pt100 Climatic Pt200 Climatic Pt500 Climatic Pt1000 Climatic	Degrees Celsius Degrees Fahrenheit	Pt 0.00385055 Pt 0.003916 Pt 0.003902 Pt 0.00392 Pt 0.00385	*	x, with 2-wire connection	x	x
	Pt100 Standard Pt200 Standard Pt500 Standard Pt1000 Standard	Degrees Celsius Degrees Fahrenheit Kelvin					
	Ni100 Climatic Ni120 Climatic Ni200 Climatic Ni500 Climatic Ni1000 Climatic	Degrees Celsius Degrees Fahrenheit	Ni 0.00618 Ni 0.00672				

x = property is allowed, – = property is **not allowed**, * = property is not relevant

[1] The unit of the reference temperature corresponds to the temperature unit set in the channel

Measurement type	Measuring range	Temperature unit	Temperature coefficient	Reference junction	Conductor resistance	Scalable measuring range	Measuring range resolution
Thermal resistor (2, 3, 4-wire connection)	Ni100 Standard Ni120 Standard Ni200 Standard Ni500 Standard Ni1000 Standard	Degrees Celsius Degrees Fahrenheit Kelvin	Ni 0.00618 Ni 0.00672	*	x, with 2-wire connection	x	x
Thermocouple	Type B, N, E, R, S, J, L, T, K, U, C	Degrees Celsius Degrees Fahrenheit Kelvin	*	Dynamic reference temperature Internal reference temperature No compensation	*	x	x
				Fixed reference temperature[1]			

x = property is allowed, – = property is **not allowed**, * = property is not relevant

1 The unit of the reference temperature corresponds to the temperature unit set in the channel

Configuring with the GSD file or data record 128, measurement type

This table lists the properties and their dependencies on the measurement type.

Table C-2 Dependencies on the measurement type

Measurement type	Measuring range center	Interference frequency suppression	Smoothing	High / Low limit	Diagnostics					
					Underflow	Overflow	Wire break	Low voltage 1L+	Reference junction	Outlier cleaning
Deactivated	*	*	*	*	*	*	*	*	*	*
Voltage	–	x	x	x	x	x	–	x	–	x
Resistor (2, 3, 4-wire connection)	–	x	x	x	x	x	x	x	–	x
Thermal resistor (2, 3, 4-wire connection)	x	x	x	x	x	x	x	x	–	x
Thermocouple	x	x	x	x	x	x	x	x	x[1]	x

x = property is allowed, – = property is **not allowed**, * = property is not relevant

1 Property is not relevant when "Fixed reference temperature" is used

C.2 Structure of data record 128 for I/O device parameter assignment

With data record 128, you can reconfigure the I/O device in your user program, regardless of your programming. This means that you can use all the functions of the I/O device even if you configured it with a GSD file.

Parameter assignment in the user program

You can reassign the parameters of the I/O device in RUN. For example, you can change the measuring ranges of individual channels in RUN without this having an effect on the other channels.

Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the I/O device using data record 128. The parameters set with STEP 7 are not changed in the CPU by this action. After a restart, the parameters set in STEP 7 are still valid.

Output parameter STATUS

If errors occur during the transfer of parameters with the "WRREC" instruction, the I/O device continues operation with the previously valid parameter assignment. The STATUS output parameter contains a corresponding error code.

The instruction "WRREC" and the error codes are described in the online help of STEP 7.

Structure of data record 128

The figure below shows the structure of data record 128.

On the left, you can see the structure of data record 128 when it is configured as an 1 x 8-channel I/O device.
On the right, you can see the structure of data record 128 when it is configured as a 2 x 4-channel I/O device.

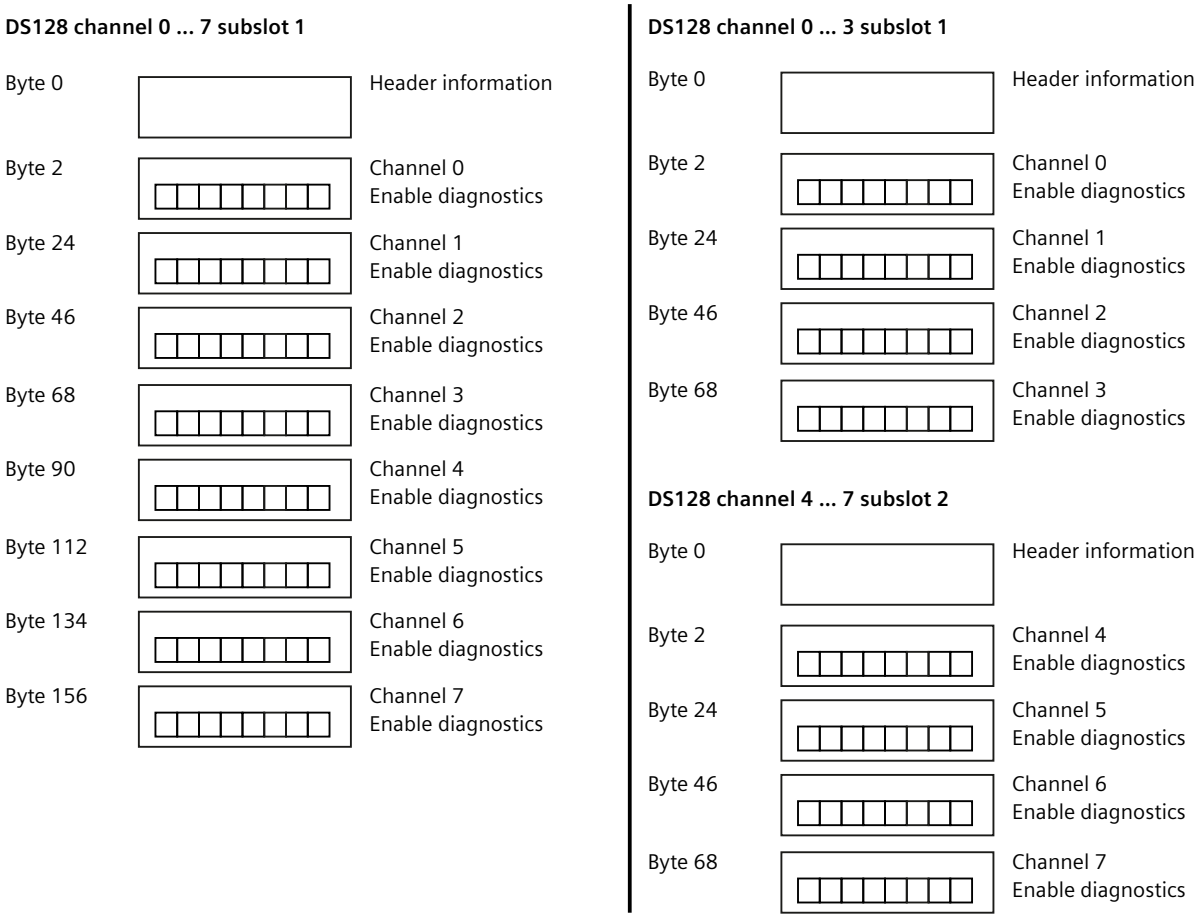


Figure C-1 Structure of data record 128

Header information

The figure below shows the structure of the header information.

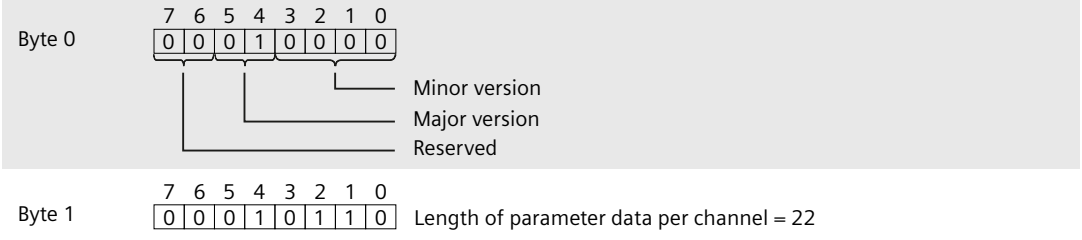
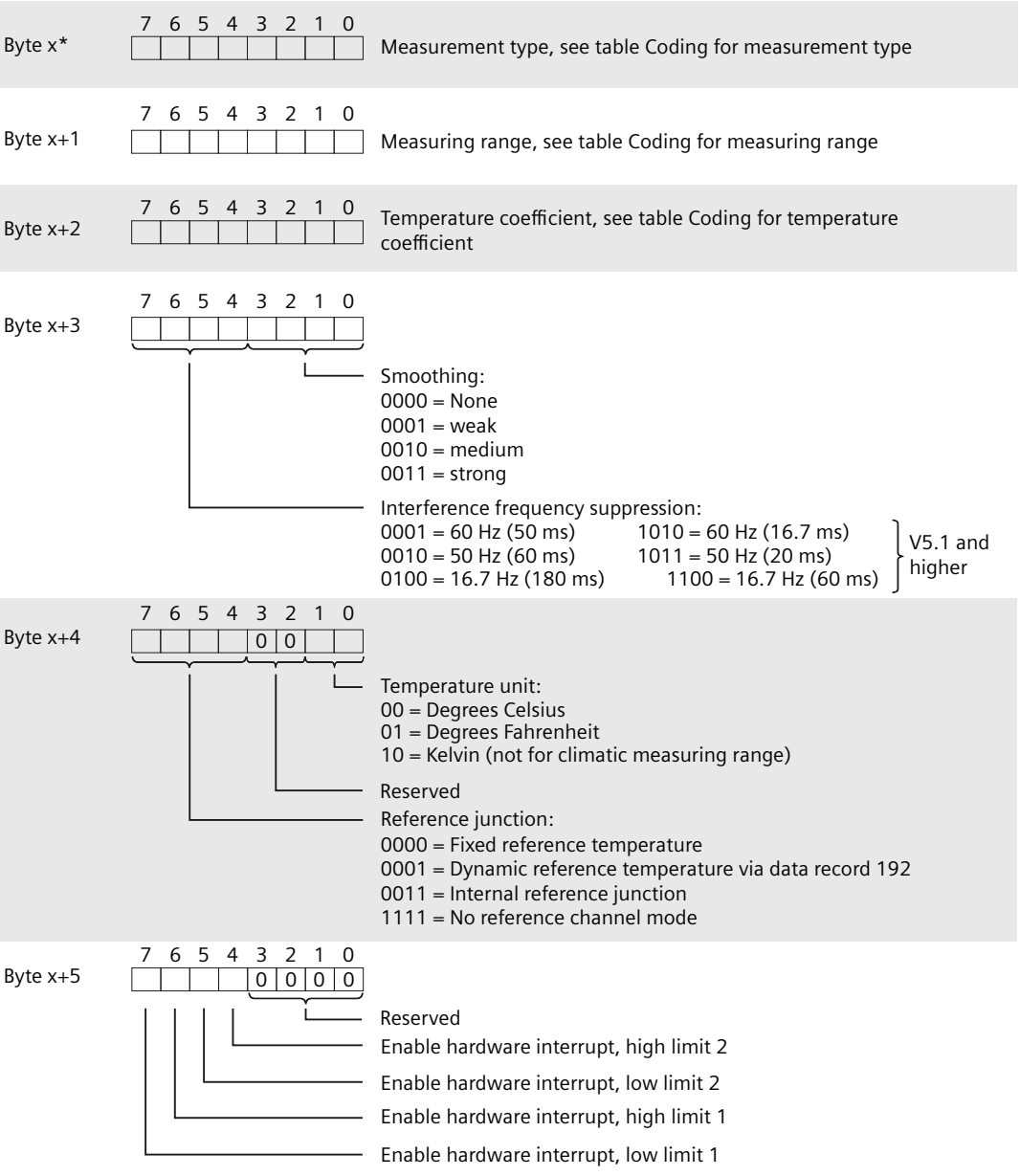


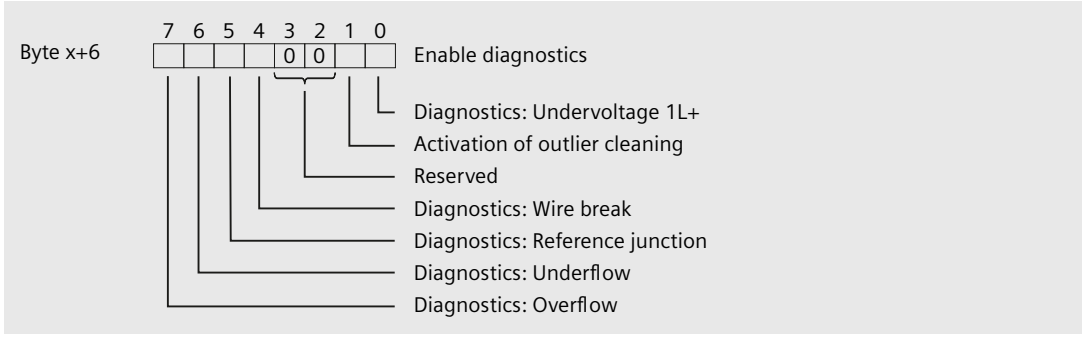
Figure C-2 Header information

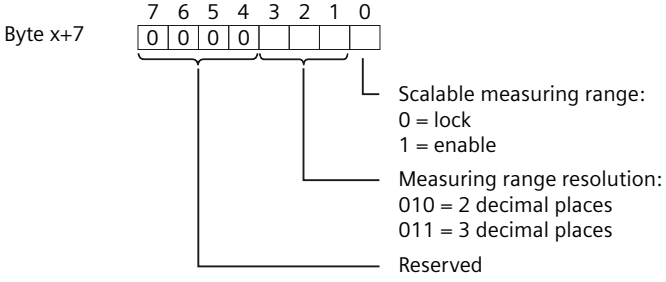
Parameters

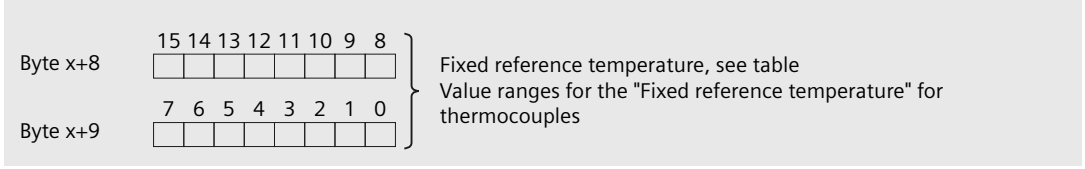
The following figure shows the structure of the parameters for a channel.
Activate a parameter by setting the corresponding bit to "1".

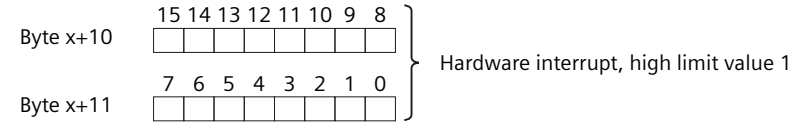
- Parameterization as 1 x 8-channel I/O device:
  * x = 2 + (channel number * 22); channel number = 0 to 7
- Parameterization as 2 x 4-channel I/O device:
  * x = 2 + (channel number * 22); channel number = 0 to 7

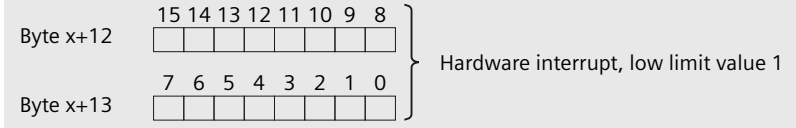


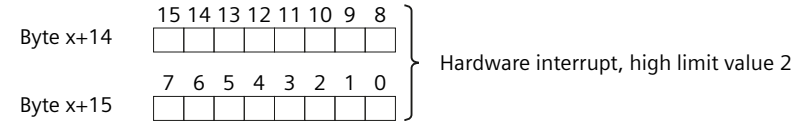

Byte x+6
7 6 5 4 3 2 1 0
0 0
Enable diagnostics
Diagnostics: Undervoltage 1L+
Activation of outlier cleaning
Reserved
Diagnostics: Wire break
Diagnostics: Reference junction
Diagnostics: Underflow
Diagnostics: Overflow

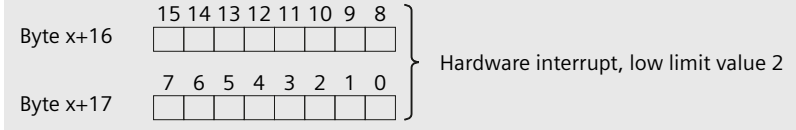

Byte x+7
7 6 5 4 3 2 1 0
0 0 0 0
Scalable measuring range:
0 = lock
1 = enable
Measuring range resolution:
010 = 2 decimal places
011 = 3 decimal places
Reserved


Byte x+8
15 14 13 12 11 10 9 8
Byte x+9
7 6 5 4 3 2 1 0
Fixed reference temperature, see table
Value ranges for the "Fixed reference temperature" for thermocouples


Byte x+10
15 14 13 12 11 10 9 8
Byte x+11
7 6 5 4 3 2 1 0
Hardware interrupt, high limit value 1


Byte x+12
15 14 13 12 11 10 9 8
Byte x+13
7 6 5 4 3 2 1 0
Hardware interrupt, low limit value 1


Byte x+14
15 14 13 12 11 10 9 8
Byte x+15
7 6 5 4 3 2 1 0
Hardware interrupt, high limit value 2


Byte x+16
15 14 13 12 11 10 9 8
Byte x+17
7 6 5 4 3 2 1 0
Hardware interrupt, low limit value 2

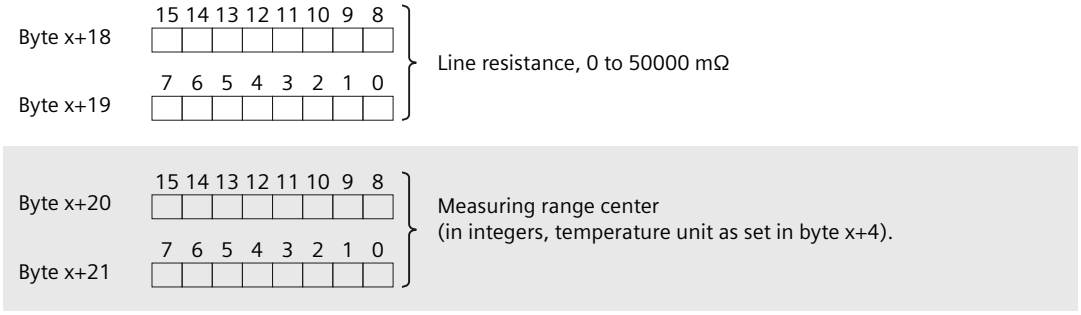


Figure C-3 Structure of byte x to x + 21

See also

Parameters (Page 24)

Coding for measurement types

The following table contains the coding for the measurement types of the analog input module. You must enter these codings at byte x (see previous figure).

Table C-3 Coding for measurement types

Measurement type	Coding
Deactivated	0000 0000
Voltage	0000 0001
Resistor, 4-wire connection	0000 0100
Resistor, 3-wire connection	0000 0101
Resistor, 2-wire connection	0000 0110
Thermal resistor, 4-wire connection	0000 0111
Thermal resistor, 3-wire connection	0000 1000
Thermal resistor, 2-wire connection	0000 1001
Thermocouple	0000 1010

Coding for measuring ranges

The following table contains the coding for the measuring ranges of the analog input module. You must enter these codings at byte x+1 (see previous figure).

Table C-4 Coding for measuring ranges

Measuring range	Coding
Voltage 80 mV	 0000 0010
Resistance 150 Ω 300 Ω 600 Ω 3 kΩ 6 kΩ	 0000 0001 0000 0010 0000 0011 0000 0100 0000 0101

Measuring range	Coding
Thermal resistor climatic	
Pt 100	0000 0000
Pt 200	0000 0111
Pt 500	0000 1000
Pt 1000	0000 1001
Thermal resistor standard	
Pt 100	0000 0010
Pt 200	0000 1011
Pt 500	0000 0100
Pt 1000	0000 0101
Thermal resistor climatic	
Ni 100	0000 0001
Ni 120	0000 1101
Ni 200	0001 0001
Ni 500	0001 0011
Ni 1000	0000 1010
Thermal resistor standard	
Ni 100	0000 0011
Ni 120	0000 1100
Ni 200	0001 0000
Ni 500	0001 0010
Ni 1000	0000 0110
Thermocouple	
Type B	0000 0000
Type N	0000 0001
Type E	0000 0010
Type R	0000 0011
Type S	0000 0100
Type J	0000 0101
Type L	0000 0110
Type T	0000 0111
Type K	0000 1000
Type U	0000 1001
Type C	0000 1010

Coding for temperature coefficient for temperature measurement

The following table contains the coding for the temperature coefficients of the analog input module. You must enter these codings at byte x+2 (see previous figure).

Table C-5 Coding for temperature coefficient for temperature measurement

Temperature coefficient	Coding
Pt 0.00385055	0000 0000
Pt 0.003916	0000 0001
Pt 0.003902	0000 0010
Pt 0.003920	0000 0011
Pt 0.003850	0000 0100
Ni 0.00618	0000 1000
Ni 0.006720	0000 1001

Limits for hardware interrupts

The table below shows the permitted value ranges of the hardware interrupts for the measurement type.

- The value in use is specified.
- The limits depend on the measurement type and the measuring range.
- The value for the overflow must be larger than the value for the underflow.

The conversion to the respective temperature unit is (1 digit = 0.1) for the standard range and (1 digit = 0.01) for the climate range, see section Measured value resolution (Page 106).

Table C-6 Value ranges of the hardware interrupts

Measurement type	Measuring range	Low limit	High limit	Unit
Voltage	± 80 mV	-94.071	94.068	mV
		-32511	32510	Decimal
Resistance	150 Ω	0.01	176.38	Ω
		1	32510	Decimal
	300 Ω	0.01	352.76	Ω
		1	32510	Decimal
	600 Ω	0.02	705.51	Ω
		1	32510	Decimal
	3 kΩ	0.11	3527.56	Ω
		1	32510	Decimal
	6 kΩ	0.22	7055.12	Ω
		1	32510	Decimal
Thermal resistor	Pt 100 Cl. Pt 200 Cl. Pt 500 Cl. Pt 1000 Cl.	-144.99	154.99	°C
		-14499	15499	Decimal
		-228.99	310.99	F
		-22899	31099	Decimal
Thermal resistor	Pt 100 Std. Pt 200 Std. Pt 500 Std. Pt 1000 Std.	-242.9	999.9	°C
		-2429	9999	Decimal
		-405.3	1831.9	F
		-4053	18319	Decimal
		30.3	1273.1	K
		303	12731	Decimal
Thermal resistor	Ni 100 Cl. Ni 120 Cl. Ni 200 Cl. Ni 500 Cl. Ni 1000 Cl.	-104.99	294.99	°C
		-10499	29499	Decimal
		-156.99	327.65	F
		-15699	32765	Decimal

Measurement type	Measuring range	Low limit	High limit	Unit
Thermal resistor	Ni 100 Std. Ni 120 Std. Ni 200 Std. Ni 500 Std. Ni 1000 Std.	-104.9	294.9	°C
		-1049	2949	Decimal
		-156.9	562.9	F
		-1569	5629	Decimal
		168.3	568.1	K
		1683	5681	Decimal
Thermocouple	Type B	-119.9	2069.9	°C
		-1199	20699	Decimal
		-183.9	3276.5	F
		-1839	32765	Decimal
		153.3	2343.1	K
		1533	23431	Decimal
Thermocouple	Type N	-269.9	1549.9	°C
		-2699	15499	Decimal
		-453.9	2821.9	F
		-4539	28219	Decimal
		3.3	1823.1	K
		33	18231	Decimal
Thermocouple	Type E	-269.9	1199.9	°C
		-2699	11999	Decimal
		-453.9	2191.9	F
		-4539	21919	Decimal
		3.3	1473.1	K
		33	14731	Decimal
Thermocouple	Types R, S	-169.9	2018.9	°C
		-1699	20189	Decimal
		-273.9	3276.5	F
		-2739	32765	Decimal
		103.3	2292.1	K
		1033	22921	Decimal
Thermocouple	Type J	-209.9	1449.9	°C
		-2099	14499	Decimal
		-345.9	2641.9	F
		-3459	26419	Decimal
		63.3	1723.1	K
		633	17231	Decimal

Measurement type	Measuring range	Low limit	High limit	Unit
Thermocouple	Type L	-199.9	1149.9	°C
		-1999	11499	Decimal
		-327.9	2101.9	F
		-3279	21019	Decimal
		73.3	1423.1	K
		733	14231	Decimal
Thermocouple	Type T	-269.9	539.9	°C
		-2699	5399	Decimal
		-453.9	1003.9	F
		-4539	10039	Decimal
		3.3	813.1	K
		33	8131	Decimal
Thermocouple	Type K	-269.9	1621.9	°C
		-2699	16219	Decimal
		-453.9	2951.5	F
		-4539	29515	Decimal
		3.3	1895.1	K
		33	18951	Decimal
Thermocouple	Type U	-199.9	849.9	°C
		-1999	8499	Decimal
		-327.9	1561.9	F
		-3279	15619	Decimal
		73.3	1123.1	K
		733	11231	Decimal
Thermocouple	Type C	-119.9	2499.9	°C
		-1199	24999	Decimal
		-183.9	3276.5	F
		-1839	32765	Decimal
		153.3	2773.1	K
		1533	27731	Decimal

"Fixed reference temperature" values for thermocouples

The following table shows the value ranges for the "Fixed reference temperature" for thermocouples.

Table C-7 Value ranges for the "Fixed reference temperature" for thermocouples

Temperature unit	Temperature		Decimal	
	Min.	Max.	Min.	Max.
Celsius	-145.0	155.0	-1450	1550
Fahrenheit	-229.0	311.0	-2290	3110
Kelvin	128.2	327.6	1282	3276

C.3 Structure of data record 192 for the dynamic reference temperature

The following descriptions relate to the instructions in PROFINET IO and STEP 7. If you are using a different user program or fieldbus, you must adapt the instructions accordingly.

The **WRREC** instruction is used to transfer the reference junction temperature via data record 192 to the I/O device.

The WRREC instruction is described in the online help for STEP 7 and in the MultiFieldbus Function Manual.

If you have set the "Dynamic reference temperature" value for the "Reference junction" parameter, the I/O module expects a new data record at least every 5 minutes. If the I/O module does not receive a new data record within this time, it generates the "Reference channel error" diagnostic message.

Assignment to the channel

The assignment of the data record 192 depends on the parameter assignment of the I/O device.

- Parameterization as 1 x 8-channel I/O device:
  - Data record 192 parameterizes channels 0 to 7
  - Data record 192 can be up to 18 bytes long
- Parameterization as 2 x 4-channel I/O device:
  - Data record 192 parameterizes channels 0 to 3 or channels 4 to 7.
  - Data record 192 can be up to 10 bytes long

Structure of data record 192 for dynamic reference temperature

The following figure shows the structure of data record 192 for a 1 x 8-channel I/O device.

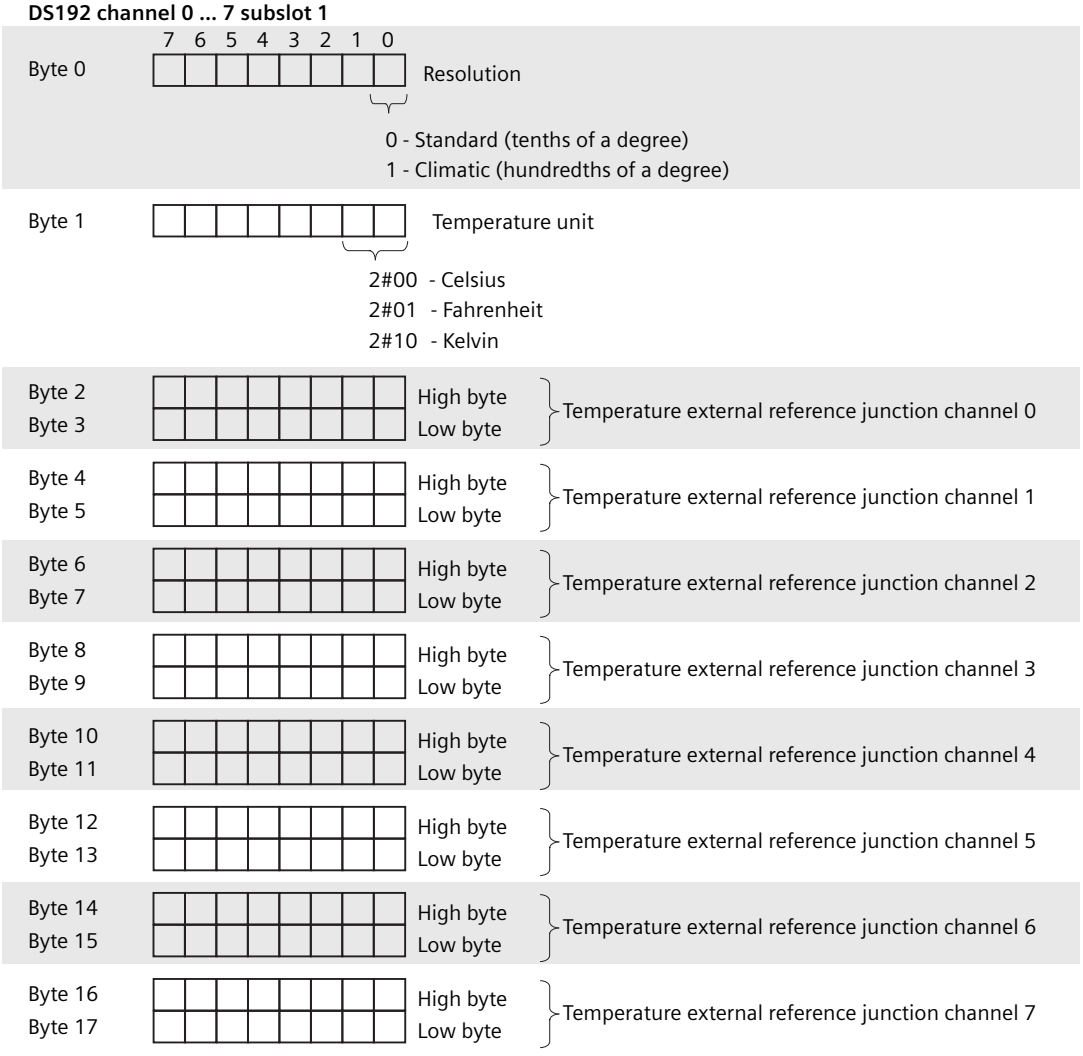


Figure C-4 Structure of data record 192 for 1 x 8 channels

The following figure shows the structure of data record 192 for a 2 x 4-channel I/O device.

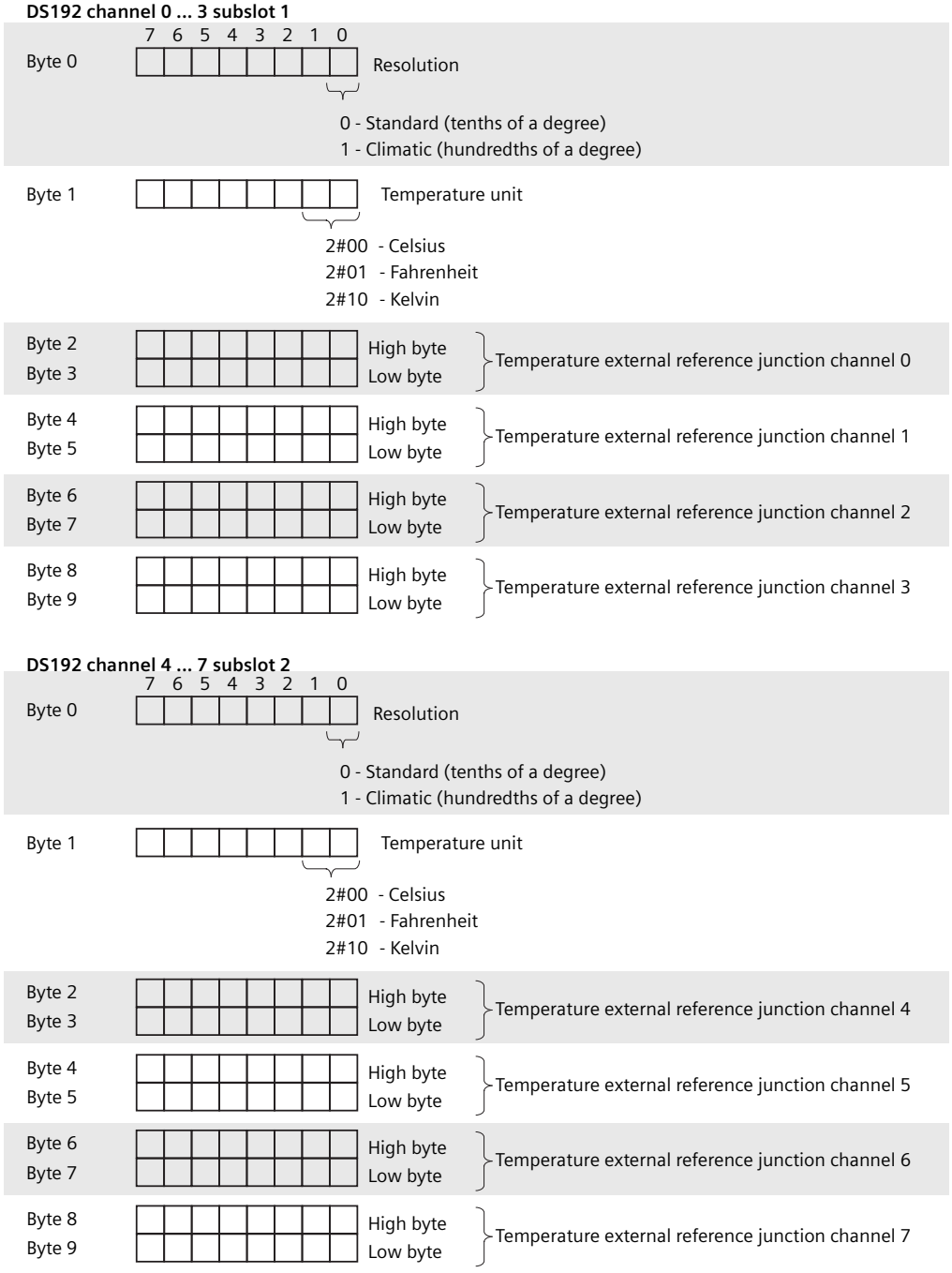


Figure C-5 Structure of data record 192 for 2 x 4 channels

Valid values for fixed temperature compensation

The selectable values must lie within the permitted value range. The resolution of the valid values for temperature compensation is a tenth of a degree

Table C-8 Valid values for temperature compensation via data record

Temperature unit	Decimal	Hexadecimal
Celsius (default)	-1450 ... 1550	$FA56_H$ ... $60E_H$
Fahrenheit (default)	-2290 ... 3110	$F70E_H$ ... $C26_H$
Kelvin (default)	1282 ... 3276	502_H ... CCC_H
Celsius (climatic)	-14500 ... 15500	$C75C_H$ ... $3C8C_H$
Fahrenheit (climatic)	-22900 ... 31100	$A68C_H$ ... $797C_H$
Kelvin (climatic)	12820 ... 32760	3214_H ... $7FF8_H$

NOTE

Thanks to the structure of the DS 192 data records, you can use a separate reference junction for each channel. The channels can also be combined via the user program in such a way that they use the same reference junction. Specify the same temperature value for all channels in the data records that work with the same reference junction temperature.

Additional information

You can find more information on compensation of the reference junction temperature via data record in the function manual SIMATIC analog value processing (https://support.industry.siemens.com/cs/ww/en/view/67989094).

C.4 Structure of data record 235 for the scalable measuring range

Evaluation in the user program

In the user program, you can evaluate the following using data record 235:

- The status of the scalable measuring range
- Limits of underflow/overflow of the scalable measuring range

Structure of data record 235

The figure below shows the structure of data record 235.
On the left, you can see the structure of data record 235 when it is configured as an 1 x 8-channel I/O device.
On the right, you can see the structure of data record 235 when it is configured as a 2 x 4-channel I/O device.

The following figure shows the allocation of the bytes for the parameterization as a 1 x 8-channel I/O device.

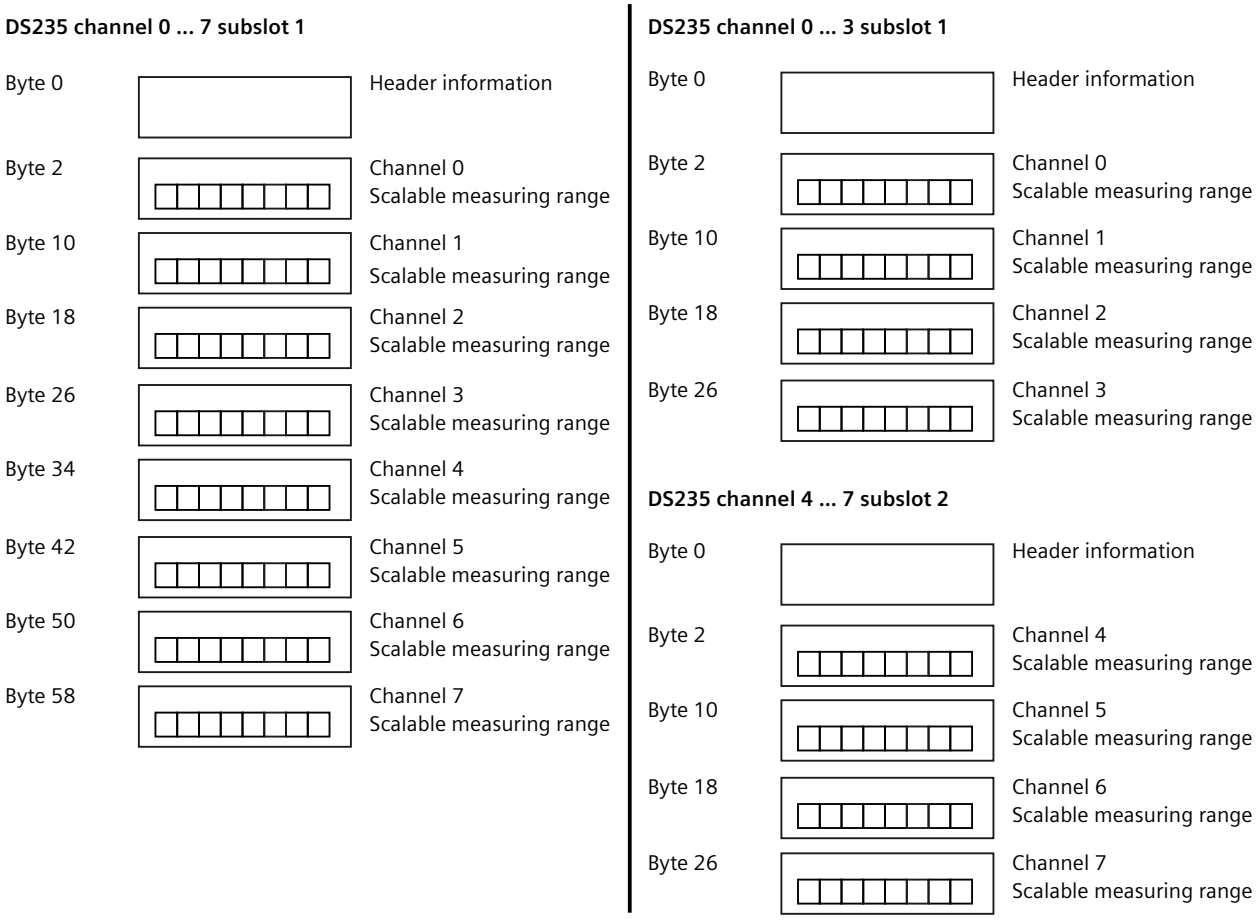


Figure C-6 Structure of data record 235

Header information

The figure below shows the structure of the header information.

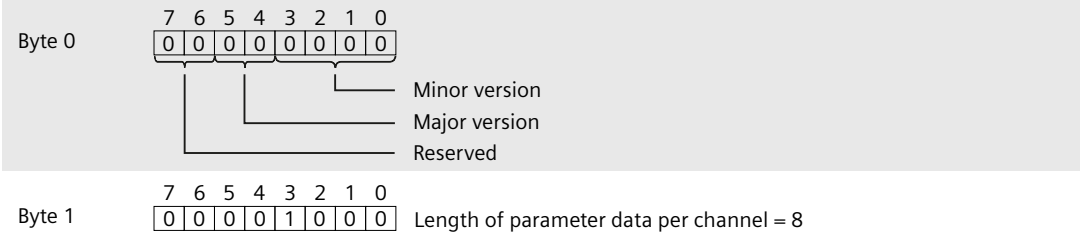


Figure C-7 Header information of data record 235

Parameters

The figure below shows the structure of the parameter.

If the corresponding bit is set to "1", the parameter is activated.
* x = 2 + (channel number x 8)

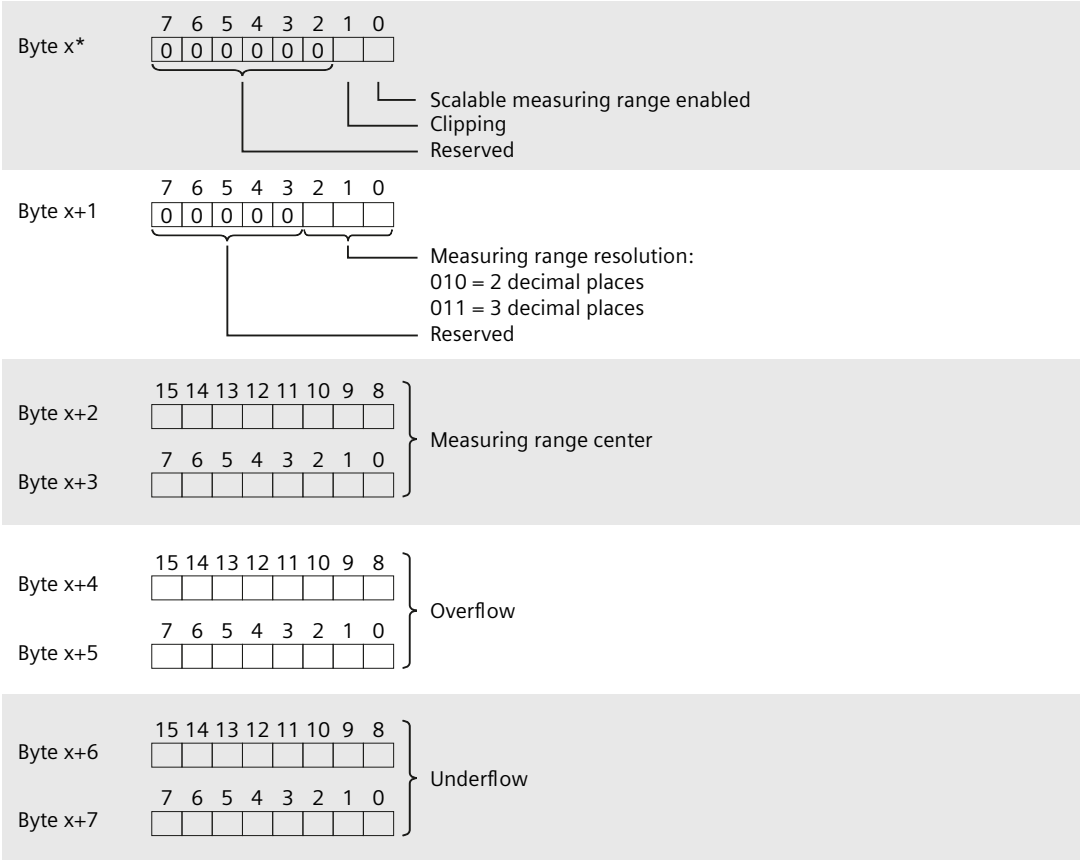


Figure C-8 Structure of data record 235 - channel parameter byte x to x+7

Description of the parameters

Table C-9 Description **of the parameters from data record 235**

Parameter	Description
Scalable measuring range enabled	1 = Function is active for this channel.
Clipping	1 = Scalable measuring range cut off at the overflow / underflow of the underlying measuring range (see Figure (Page 36-37)).
Resolution	2 or 3 decimal places
Measuring range center	Temperature in whole °C / °F / K ("working point" for the scaling)
Overflow/underflow	Limits of the scalable measuring range

Example

The following example shows the values for a thermal resistor Pt 100 Standard, °C:

Table C-10 Example of a thermal resistor Pt 100 Standard

Hex. value	Dec. value	Evaluation of data record 235
00_H	0	V0.0
08_H	8	8 bytes
03_H	3	Scalable measuring range active and clipped (clipping)
02_H	2	Resolution: 2 decimal places
$02EE_H$	750	Measuring range center: 750 °C
$61A8_H$	25000	Overflow (Maximum): 250.**00** + 750 = 1000.00 °C Scalable measuring range is clipped at the overflow.
8100_H	-32512	Underflow (Minimum): -325.**12** + 750 = 424.88 °C

See also

Scalable measuring range (Page 34)

C.5 Error transferring the data record

Error transferring the data record

The I/O device checks the values of the transferred data record. Only if the values were transferred without errors does the I/O device apply the values from the data record.

The "WRREC" instruction for writing data records returns corresponding error codes in the "STATUS" parameter when errors occur. For STEP 7 you will also find the parameter description in the STEP 7 online help.

The Error codes table shows the following:

- The specific error codes of the I/O device
- The meaning of the error code
- A suggestion for correcting the error
- The data records at which the error may occur

Table C-11 Error codes

Error code in STATUS parameter (hexadecimal)				Meaning	Solution	DS128	DS192	DS235
Byte 0	Byte 1	Byte 2	Byte 3					
DF	80	B0	xx	Number of the data record unknown.	Enter a valid number for the data record.	✓	✓	✓
DF	80	B1	xx	Length of the data record incorrect.	Enter a valid value for the data record length.	✓	✓	✓
DF	80	B2	xx	I/O device cannot be accessed:	Check the assigned values for the parameters of the "WRREC" instruction.	✓	✓	✓

Error code in STATUS parameter (hexadecimal)				Meaning	Solution	DS128	DS192	DS235
Byte 0	**Byte 1**	**Byte 2**	**Byte 3**					
DF	80	E0	xx	Wrong version or error in the header information.	Correct the version, length and number of parameter blocks.	✓	✓	✓
DF	80	E1	01	Reserved bit set	Check the parameters of the I/O device.	✓	✓	
DF	80	E1	02	Invalid diagnostics enable bit set for operating mode.	Check the parameters of the I/O device.	✓		
DF	80	E1	03	Invalid hardware interrupt enable bit set for operating mode.	Check the parameters of the I/O device.	✓		
DF	80	E1	04	Invalid value for hardware interrupt limit.	Check the parameters of the I/O device.	✓		
DF	80	E1	05	Invalid coding set for measuring range / measurement type.	Check the parameters of the I/O device.	✓		
DF	80	E1	08	Invalid coding set for interference frequency suppression / integration time.	Check the parameters of the I/O device.	✓		
DF	80	E1	09	Invalid coding for smoothing.	Check the parameters of the I/O device.	✓		
DF	80	E1	0F	Invalid parameter assignment of reference temperature set.	Check the parameters of the I/O device.	✓	✓	
DF	80	E1	10	Invalid measurement type set.	Check the parameters of the I/O device.	✓		
DF	80	E1	11	Invalid measuring range set.	Check the parameters of the I/O device.	✓		
DF	80	E1	20	Invalid temperature coefficient set.	Check the parameters of the I/O device.	✓		
DF	80	E1	21	Invalid temperature unit set.	Check the parameters of the I/O device.	✓	✓	
DF	80	E1	22	Invalid scalable measuring range or not permissible.	Check the parameters of the I/O device.	✓		
DF	80	E1	23	Invalid conductor resistance set.	Check the parameters of the I/O device.	✓		