

SIEMENS



Manual

SIMATIC

S7-1500 / ET 200MP

Analog Input Module AI 8xU/I/RTD/TC ST
(6ES7531-7KF00-0AB0)

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SIEMENS

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S7-1500/ET 200MP
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Warning notice system

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

Preface

Purpose of the documentation

This manual supplements the system manual S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/ww/en/view/59191792>).

Functions that relate in general to the systems are described in this system manual.

The information provided in this manual and in the system/function manuals supports you in commissioning the systems.

Changes compared to previous version

Compared to the previous version, this manual contains the following changes:

- New licensing conditions and copyright information of the Open Source Software
- New technical specifications

Conventions

The term "CPU" is used in this manual both for the CPUs of the S7-1500 automation system, as well as for interface modules of the ET 200MP distributed I/O system.

Please also observe notes marked as follows:

Note

A note contains important information on the product described in the documentation, on the handling of the product or on the section of the documentation to which particular attention should be paid.

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Open-source software is used in the firmware of the I/O modules. Open Source Software is provided free of charge. We are liable for the product described, including the open-source software contained in it, pursuant to the conditions applicable to the product. Siemens accepts no liability for the use of the open source software over and above the intended program sequence, or for any faults caused by modifications to the software.

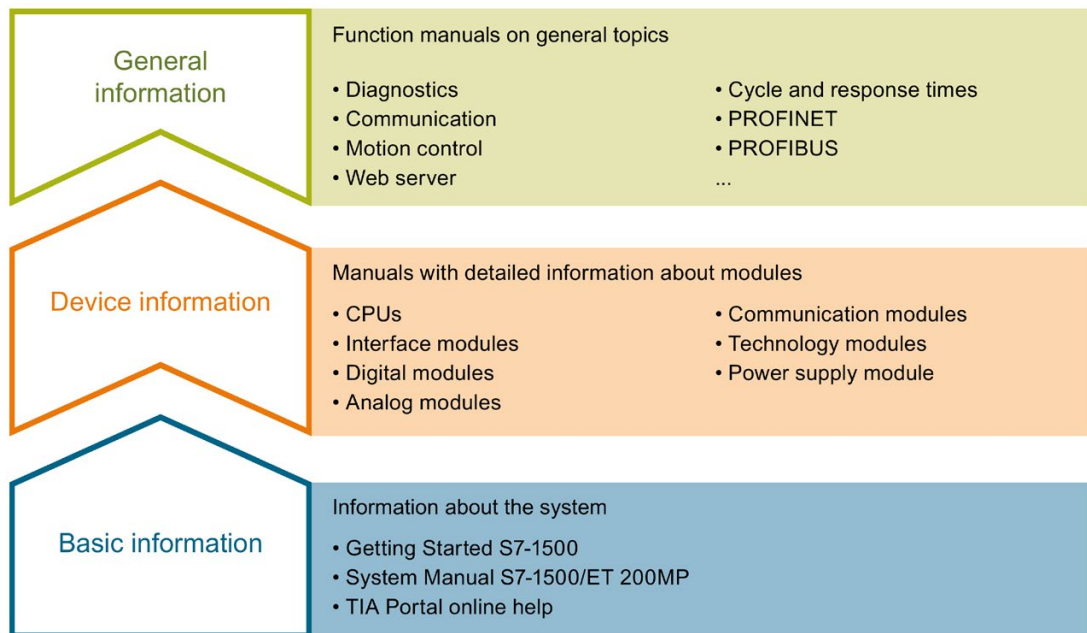
For legal reasons, we are obliged to publish the original text of the license conditions and copyright notices. Please read the information relating to this on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109757558>).

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Documentation guide

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP distributed I/O system is arranged into three areas. This arrangement enables you to access the specific content you require.



Basic information

The System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500 and ET 200MP systems. The STEP 7 online help supports you in the configuration and programming.

Device information

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

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, motion control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109742691>).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (<https://support.industry.siemens.com/cs/us/en/view/68052815>).

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/86140384>).

SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/86630375>).

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In "mySupport", you can save filters, favorites and tags, request CAx data and compile your personal library in the Documentation area. In addition, your data is already filled out in support requests and you can get an overview of your current requests at any time.

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"mySupport" - Documentation

In the Documentation area in "mySupport" you can combine entire manuals or only parts of these to your own manual.

You can export the manual as PDF file or in a format that can be edited later.

You can find "mySupport" - Documentation on the Internet (<http://support.industry.siemens.com/My/ww/en/documentation>).

"mySupport" - CAx data

In the CAx data area in "mySupport", you can access the current product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

- 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" - CAx data on the Internet (<http://support.industry.siemens.com/my/ww/en/CAxOnline>).

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 will find the application examples on the Internet (<https://support.industry.siemens.com/sc/ww/en/sc/2054>).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).

This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one 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 (<http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool>).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of the TIA Portal.

General function overview:

- Network browsing and creation of a table showing the accessible devices in the network.
- Flashing of device LEDs or HMI display to locate a device
- Downloading of addresses (IP, subnet, gateway) to a device
- Downloading the PROFINET name (station name) to a device
- Placing a CPU in RUN or STOP mode
- Setting the time in a CPU to the current time of your PG/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data from/to a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- Performing a CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to a device

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

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the PROFINET network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET network and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a system.

You can find SIEMENS PRONETA on the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/67460624>).

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 optimal exploitation of resources

You can find SINETPLAN on the Internet (<https://www.siemens.com/sinetplan>).

Product overview

2.1 Properties

Article number

6ES7531-7KF00-0AB0

View of the module

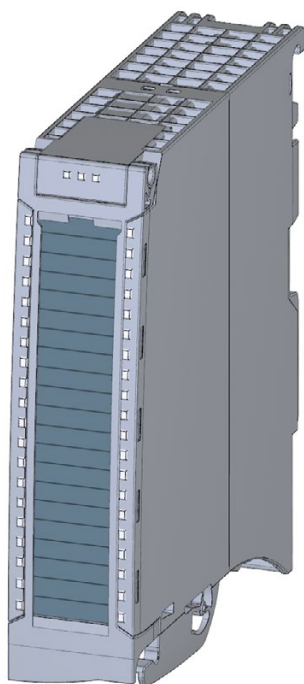


Figure 2-1 View of the AI 8xU/I/RTD/TC ST module

Properties

The module has the following technical properties:

- 8 analog inputs
- Voltage measurement type can be set per channel
- Current measurement type can be set per channel
- Measuring type resistance adjustable for channel 0, 2, 4 and 6
- Measuring type resistance thermometers (RTD) adjustable for channel 0, 2, 4 and 6
- Thermocouple (TC) measurement type can be set per channel
- Resolution 16 bits including sign
- Configurable diagnostics (per channel)
- Hardware interrupt on limit violation can be set per channel (two low and two high limits per channel)

The module supports the following functions:

Table 2- 1 Version dependencies of the module functions

Function	Firmware version of the module	Configuration software	
		STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) V12 or higher, or STEP 7 V5.5 SP3 or higher
Firmware update	V1.0.0 or higher	V12 or higher	X
Identification data I&M0 to I&M3	V1.0.0 or higher	V12 or higher	X
Parameter assignment in RUN	V1.0.0 or higher	V12 or higher	X
Isochronous mode	V1.0.0 or higher	V12 or higher	---
Calibration in runtime	V1.0.0 or higher	V12 or higher	X
Module-internal Shared Input (MSI)	V2.0.0 or higher	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
Configurable submodules / submodules for Shared Device	V2.0.0 or higher	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
Configurable after interface module IM 155-5 DP ST	V2.0.0 or higher	V13 or higher	X

You can configure the module with STEP 7 (TIA Portal) and with a GSD file.

Compatibility

The following table shows the compatibility of the modules and the dependencies between hardware functional status (FS) and firmware version (FW) used:

Hardware functional status	Firmware version	Note
FS01	V1.0.0 to V2.0.x	Upgrade to downgrade possible between V1.0.0 and V2.0.x
FS02	V1.0.0 to V2.0.x	
FS03	V2.1.0 to V2.1.x	Upgrade to downgrade possible between V2.1.0 and V2.1.x
FS04	V2.2.0 or higher	Upgrade and downgrade possible between V2.2.0 and higher

Accessories

The following accessories are supplied with the module and can also be ordered separately as spare parts:

- Shield bracket
- Shield terminal
- Power supply element
- Labeling strips
- U connector
- Universal front door

Other components

The following component can be ordered separately:

Front connectors, including potential jumpers and cable ties

You can find additional information on accessories in the system manual S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/ww/en/view/59191792>).

Wiring

This section contains the block diagram of the module and outlines various connection options.

You can find information on wiring the front connector, creating a cable shield, etc. in the Wiring section of the system manual S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/ww/en/view/59191792>).

You can find additional information on compensating the reference junction temperature in the function manual Analog value processing (<http://support.automation.siemens.com/WW/view/en/67989094>), the structure of a data record in the section Structure of a data record for dynamic reference temperature (Page 65).

Note

- You may use and combine the different wiring options for all channels.
 - Do not insert the potential jumpers supplied with the front connector.
-

Abbreviations used

Meaning of the abbreviations used in the following figures:

U_n+/U_n-	Voltage input channel n (voltage only)
M_n+/M_n-	Measuring input channel n
I_n+/I_n-	Current input channel n (current only)
$I_{c,n}+/I_{c,n-}$	Current output for RTD, channel n
U_{Vn}	Supply voltage at channel n for 2-wire transmitters (2WMT)
Comp+/Comp-	Compensation input
I_{Comp+}/I_{Comp-}	Current output for compensation
L+	Connection for supply voltage
M	Ground connection
M_{ANA}	Reference potential of the analog circuit

Pin assignment for the power supply element

The power supply element is plugged onto the front connector for powering the analog module. Wire the supply voltage to terminals 41 (L+) and 44 (M). You can use terminals 42 (L+) and 43 (M) to loop the potential to the next module.

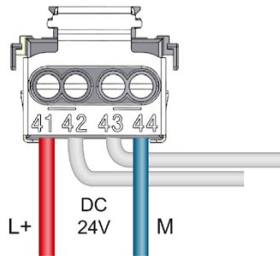
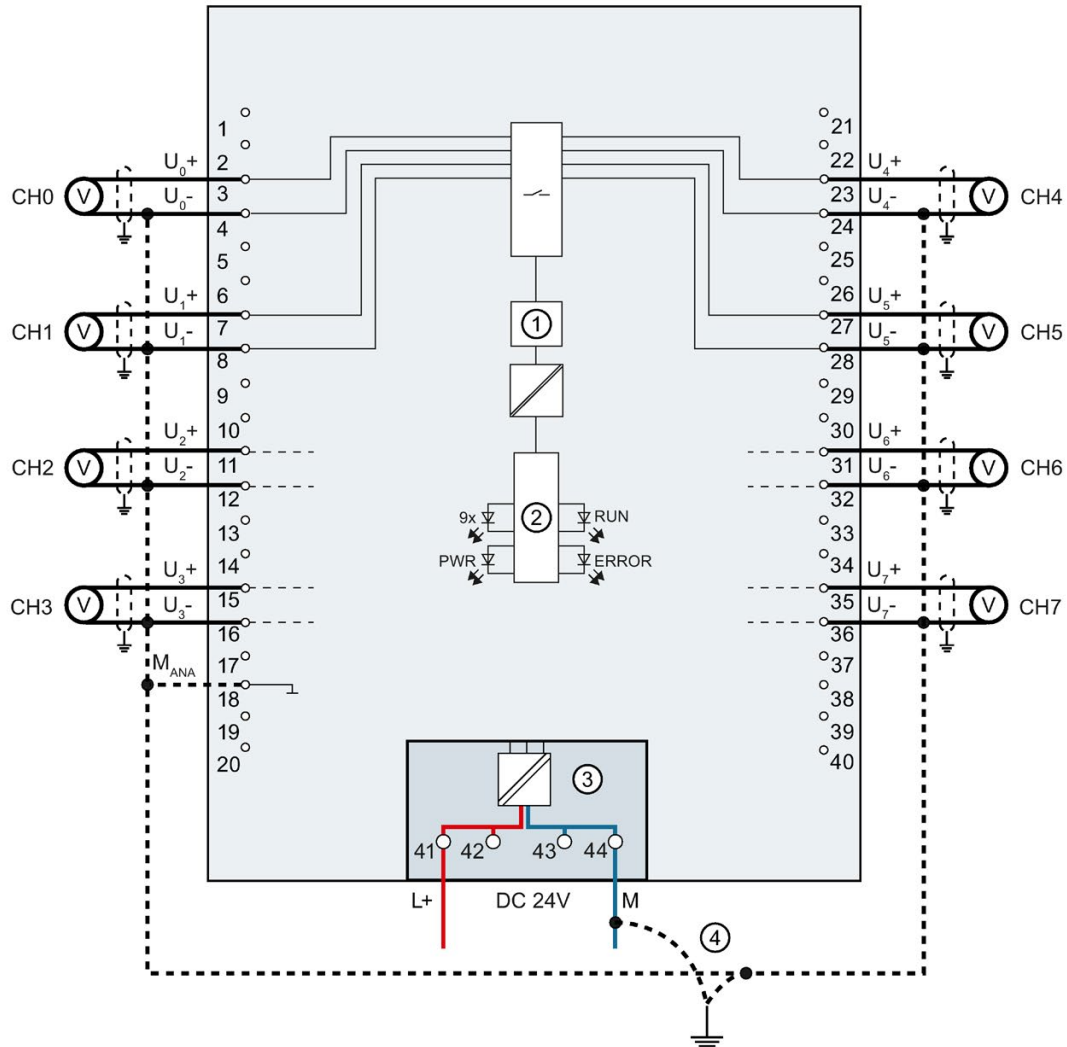


Figure 3-1 Power supply element wiring

Block diagram and pin assignment for voltage measurement

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



- | | | |
|---|-------|---|
| ① Analog-to-digital converter (ADC) | CHx | Channel or 9 x channel status (green/red) |
| ② Backplane bus interface | RUN | Status display LED (green) |
| ③ Supply voltage via power supply element | ERROR | Error display LED (red) |
| ④ Equipotential bonding cable (optional) | PWR | LED for power supply (green) |

Figure 3-2 Block diagram and pin assignment for voltage measurement

Connection: 4-wire transmitters for current measurement

The example in the following figure shows the pin assignment for current measurement with 4-wire transmitters.

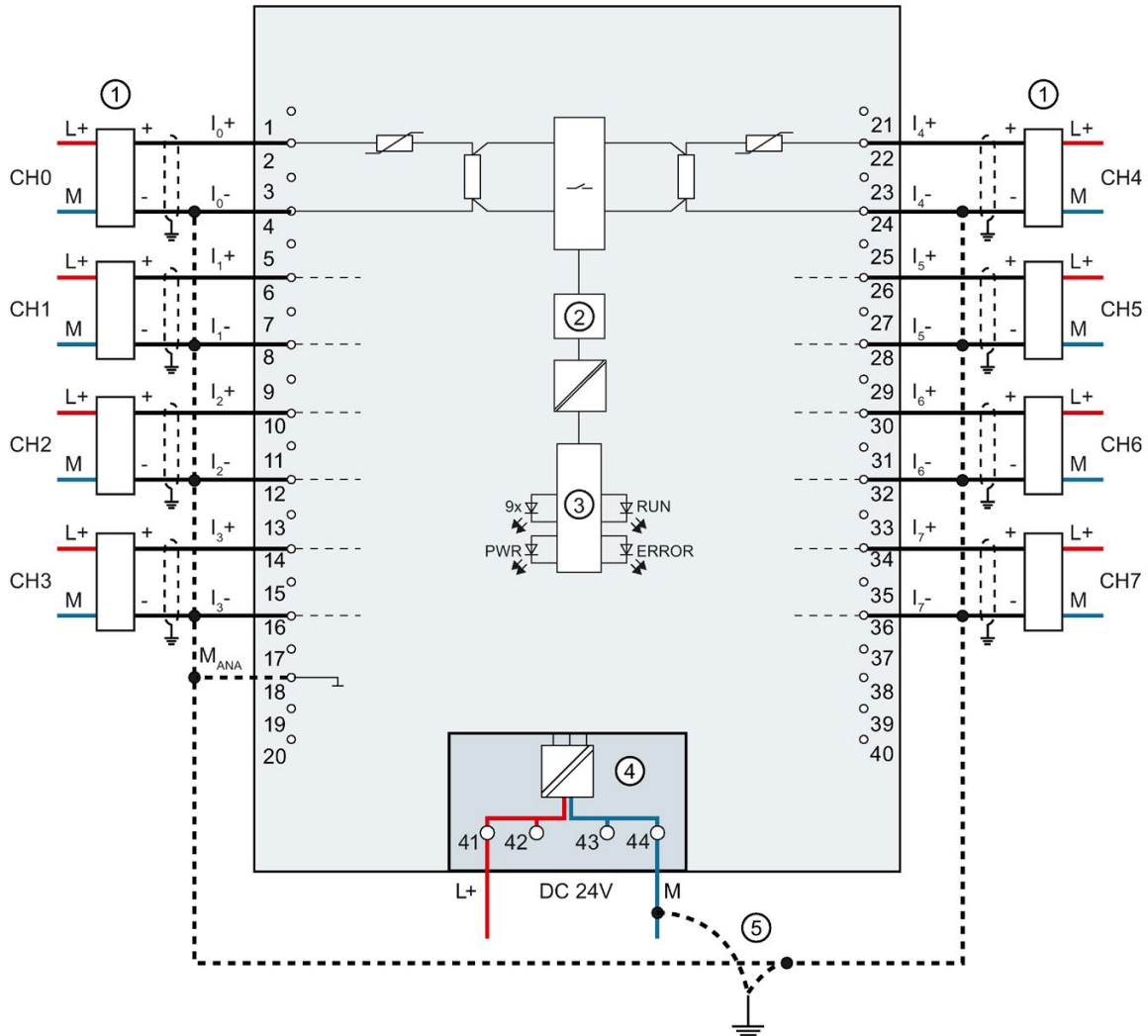
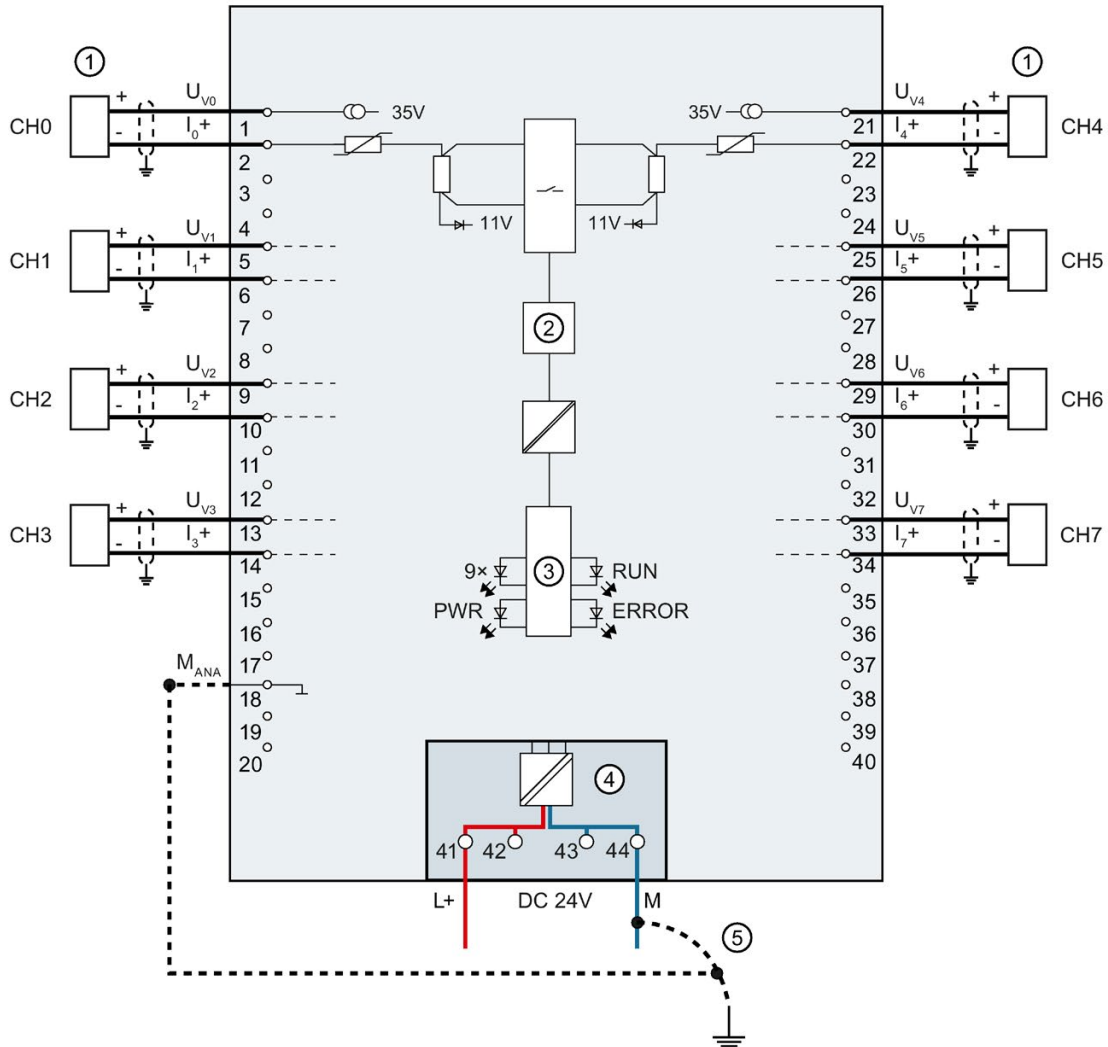


Figure 3-3 Block diagram and pin assignment for current measurement

Connection: 2-wire transmitters for current measurement

The example in the following figure shows the pin assignment for current measurement with 2-wire transmitters.

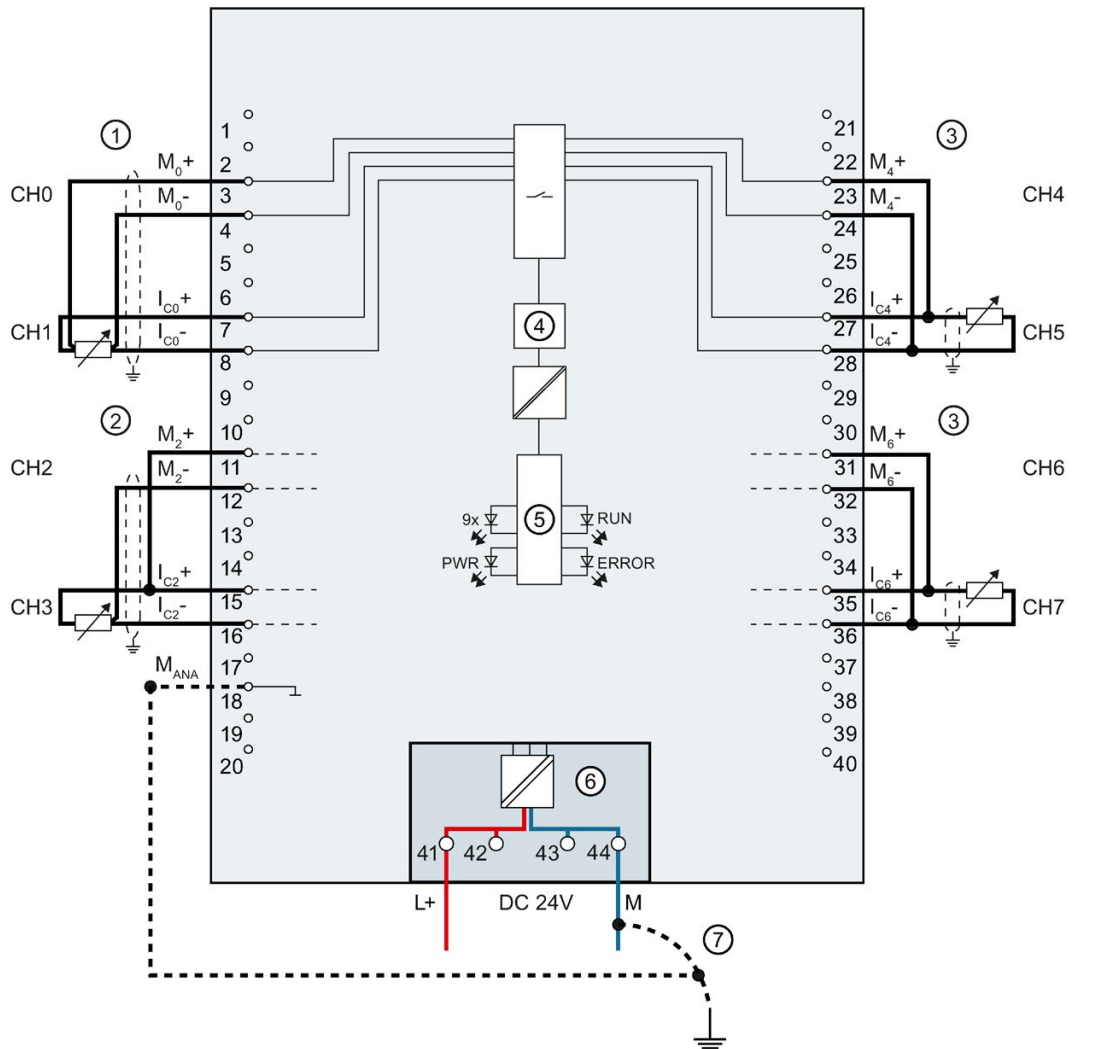


- | | | | |
|---|---|-------|---|
| ① | Wiring 2-wire transmitter | CHx | Channel or 9 x channel status (green/red) |
| ② | Analog-to-digital converter (ADC) | RUN | Status display LED (green) |
| ③ | Backplane bus interface | ERROR | Error display LED (red) |
| ④ | Supply voltage via power supply element | PWR | LED for power supply (green) |
| ⑤ | Equipotential bonding cable (optional) | | |

Figure 3-4 Block diagram and pin assignment for current measurement

Connection: 2-, 3- and 4-wire connection of resistance-based sensors or thermal resistors (RTD)

The example in the following figure shows the pin assignment for 2-, 3- and 4-wire connections of resistance-based sensors or thermal resistors.

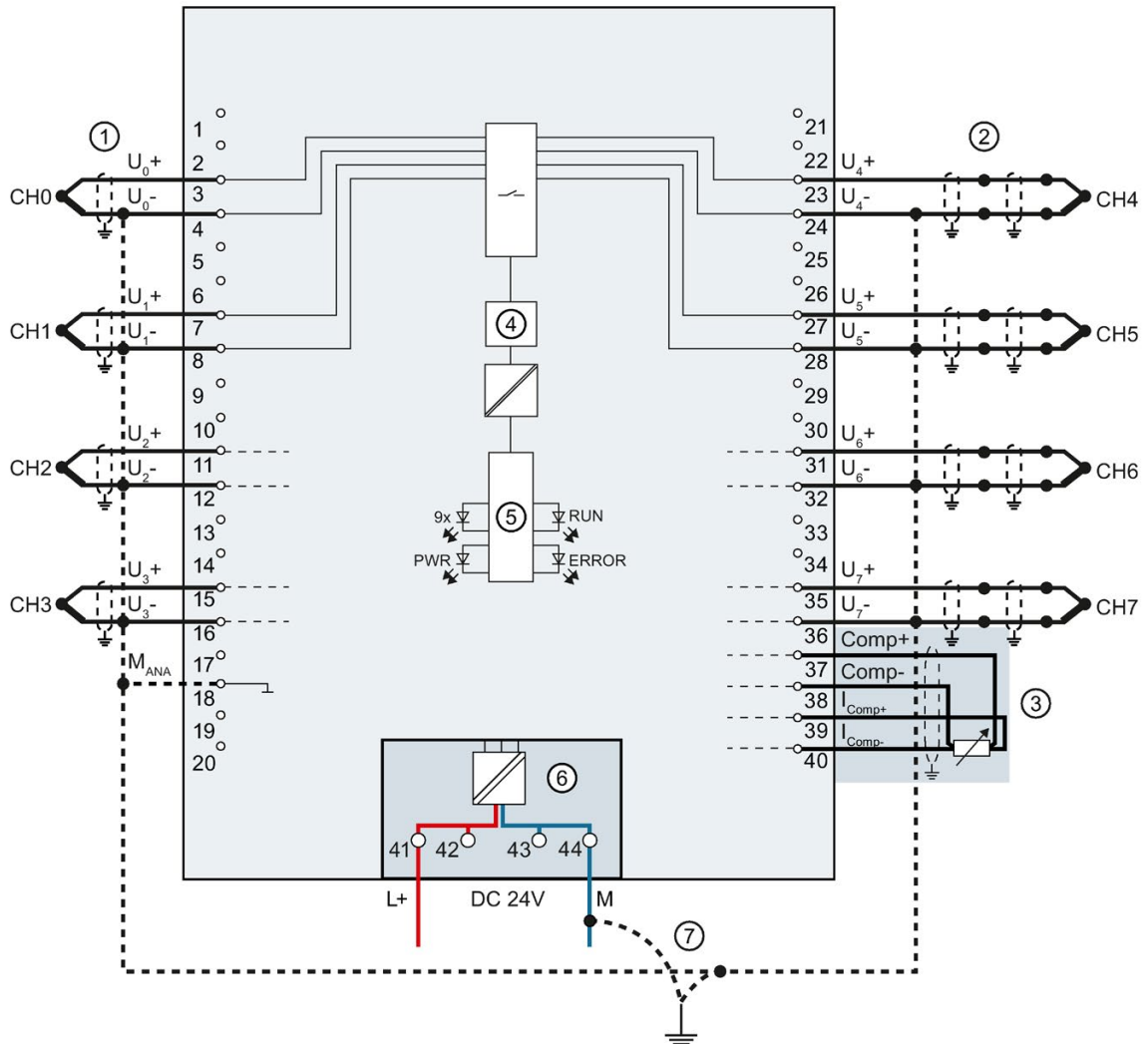


- | | | | |
|---|---|-------|---|
| ① | 4-wire connection | CHx | Channel or 9 x channel status (green/red) |
| ② | 3-wire connection | RUN | Status display LED (green) |
| ③ | 2-wire connection | ERROR | Error display LED (red) |
| ④ | Analog-to-digital converter (ADC) | PWR | LED for power supply (green) |
| ⑤ | Backplane bus interface | | |
| ⑥ | Supply voltage via power supply element | | |
| ⑦ | Equipotential bonding cable (optional) | | |

Figure 3-5 Block diagram and pin assignment for 2-, 3- and 4-wire connections

Connection: Non-grounded thermocouples for external/internal compensation and connection of a resistance thermometer (RTD) at the reference channel

The following figure shows an example of the pin assignment of non-grounded thermocouples for external/internal compensation and the connection of a resistance thermometer (RTD) at the reference channel.

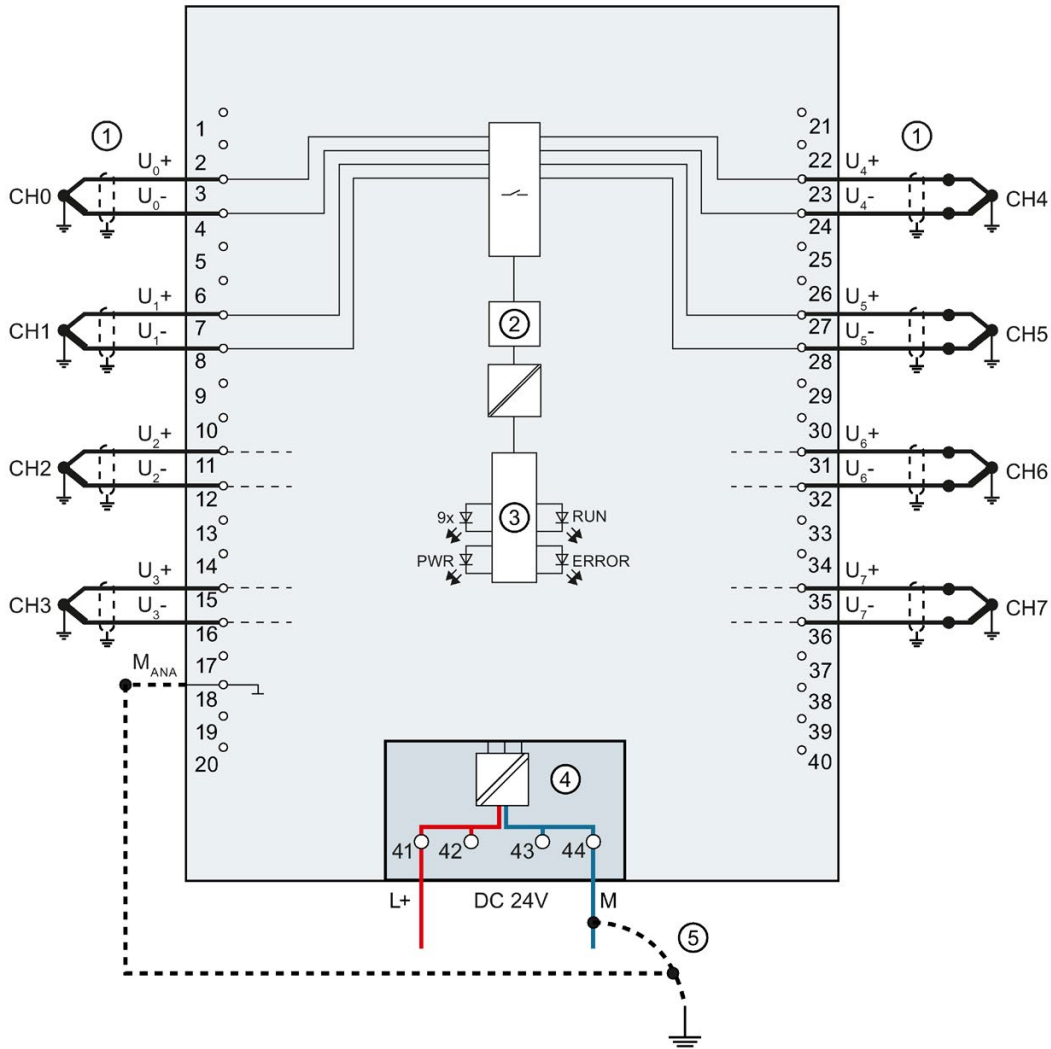


- | | | | |
|---|---|-------|---|
| ① | Wiring of a thermocouple (non-grounded) for internal compensation | CHx | Channel or 9 x channel status (green/red) |
| ② | Wiring of a thermocouple (non-grounded) for external compensation | RUN | Status display LED (green) |
| ③ | Wiring of a resistance thermometer (RTD) at the reference channel | ERROR | Error display LED (red) |
| ④ | Analogue-to-digital converter (ADC) | PWR | LED for power supply (green) |
| ⑤ | Backplane bus interface | | |
| ⑥ | Supply voltage via power supply element | | |
| ⑦ | Equipotential bonding cable (optional) | | |

Figure 3-6 Block diagram and pin assignment for non-grounded thermocouples and resistance thermometers

Connection: Grounded thermocouples for internal compensation

The following figure shows an example of the pin assignment for grounded thermocouples for internal compensation.



- | | | | |
|---|---|-------|---|
| ① | Wiring of a thermocouple (grounded) for internal compensation | CHx | Channel or 9 x channel status (green/red) |
| ② | Analog-to-digital converter (ADC) | RUN | Status display LED (green) |
| ③ | Backplane bus interface | ERROR | Error display LED (red) |
| ④ | Supply voltage via power supply element | PWR | LED for power supply (green) |
| ⑤ | Equipotential bonding cable (optional) | | |

Figure 3-7 Block diagram and pin assignment for grounded thermocouples

Parameters/address space

4.1 Measuring types and ranges

Introduction

The module is set to voltage measurement type with measuring range ± 10 V by default. You need to reassign the module parameters with STEP 7 if you want to use a different measurement type or range.

Deactivate the input if it is not going to be used. The module cycle time is shortened and the interference factors that lead to failure of the module (for example, triggering a hardware interrupt) are avoided.

The following table shows the measurement types and the respective measuring range.

Table 4- 1 Measurement types and measuring ranges

Measurement type	Measuring range	Representation of analog values
Voltage	± 50 mV ± 80 mV ± 250 mV ± 500 mV ± 1 V ± 2.5 V 1 V to 5 V ± 5 V ± 10 V	See Representation of analog values in voltage measuring ranges (Page 69)
Current 2WMT (2-wire transmitter)	4 mA to 20 mA	See Representation of analog values in the current measuring ranges (Page 71)
Current 4WMT (4-wire transmitter)	0 mA to 20 mA 4 mA to 20 mA ± 20 mA	
Resistor (2-wire connection)	PTC	See Representation of the analog values of resistance-based sensors/resistance thermometers (Page 72)
Resistor (3-wire connection)	150 Ω 300 Ω	
Resistor (4-wire connection)	600 Ω 6000 Ω	

4.1 Measuring types and ranges

Measurement type	Measuring range	Representation of analog values
Thermal resistor RTD (3-wire connection) (4-wire connection)	PT100 Standard/Climate PT200 Standard/Climate PT500 Standard/Climate PT1000 Standard/Climate Ni100 Standard/Climate Ni1000 Standard/Climate LG-Ni1000 Standard/Climatic	
Thermocouple (TC)	Type B Type E Type J Type K Type N Type R Type S Type T	See Representation of analog values for thermocouples (Page 75)
Disabled	-	-

The tables of the input ranges, overflow, underrange, etc. are available in the appendix Representation of analog values (Page 67).

Using PTC resistors

PTC resistors are suitable for temperature monitoring of electrical devices, such as motors, drives, and transformers.

Use Type A PTC resistors (PTC thermistor) in accordance with DIN/VDE 0660, part 302. In doing so, follow these steps:

1. Choose "Resistor (2-wire terminal)" and "PTC" in STEP 7.
2. Connect the PTC using 2-wire connection technology.

If you enable the "Underflow" diagnostics in STEP 7, it will be signaled for resistance values $<18 \Omega$. In this case, this diagnostic signifies "Short-circuit in the wiring".

The following figure shows the address space assignment for the AI 8xU//RTD/TC ST module with PTC resistors.

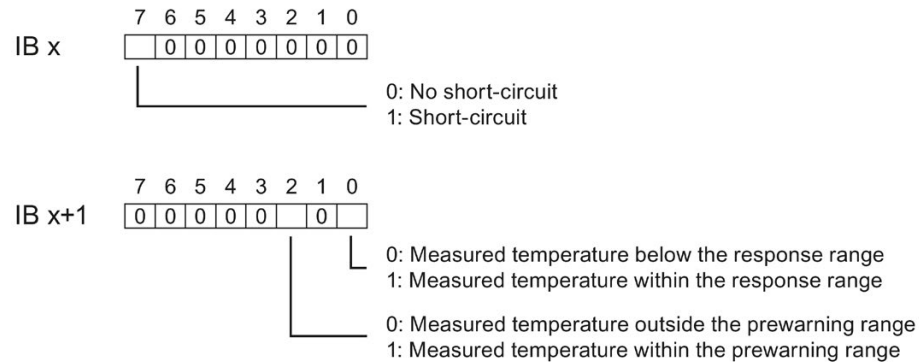


Figure 4-1 Address space for the AI 8xU//RTD/TC ST module with PTC resistors

The diagram below shows the temperature profile and the corresponding switching points.

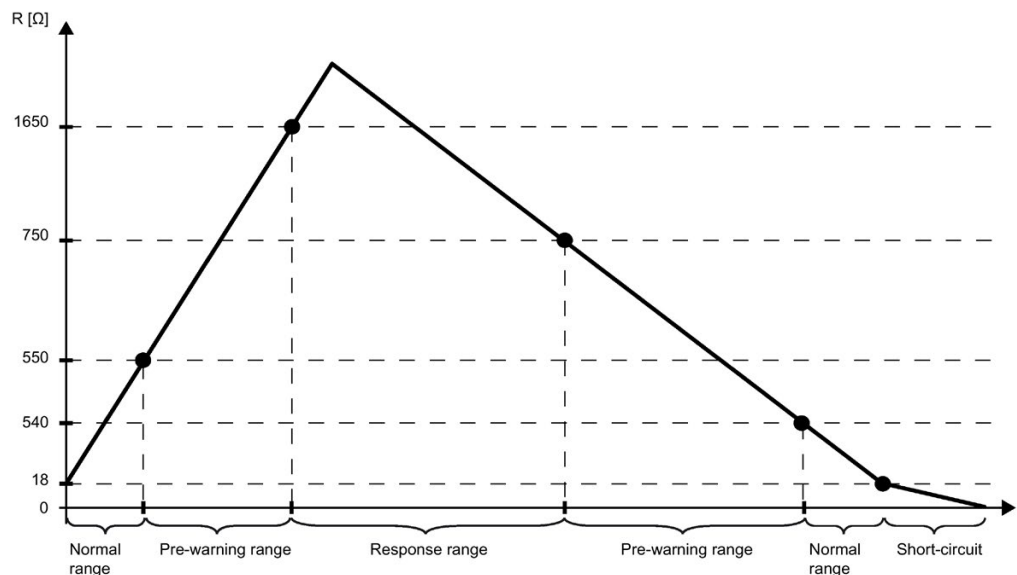


Figure 4-2 Temperature profile and the corresponding switching points

Measured value acquisition with PTC resistors

If faults occur (for example supply voltage L+ missing) that make it impossible to acquire measured values with PTC resistors, the corresponding channels (IR x/IR x+1) report overflow (7FFF_H). If the value status (QI) is enabled, the value 0 = incorrect is output in the corresponding bit.

4.2 Parameters

AI 8xU/I/RTD/TC ST parameters

When you assign the module parameters in STEP 7, you use various parameters to specify the module properties. The following table lists the configurable parameters. The effective range of the configurable parameters depends on the type of configuration. The following configurations are possible:

- Central operation with a S7-1500 CPU
- Distributed operation on PROFINET IO in an ET 200MP system
- Distributed operation on PROFIBUS DP in an ET 200MP system

When assigning parameters in the user program, use the WRREC instruction to transfer the parameters to the module by means of data records; refer to the section Parameter assignment and structure of the parameter data records (Page 54).

The following parameter settings for the channels are possible:

Table 4- 2 Configurable parameters and their defaults

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
Diagnostics					
• Missing supply voltage L+	Yes/No	No	Yes	Channel ³⁾	Module ⁴⁾
• Overflow	Yes/No	No	Yes	Channel	Module ⁴⁾
• Underflow	Yes/No	No	Yes	Channel	Module ⁴⁾
• Common mode error	Yes/No	No	Yes	Channel	Module ⁴⁾
• Reference channel error	Yes/No	No	Yes	Channel	Module ⁴⁾
• Wire break ¹⁾	Yes/No	No	Yes	Channel	Module ⁴⁾
• Current limit for wire break diagnostics ²⁾	1.185 mA or 3.6 mA	1.185 mA	Yes	Channel	--- ⁵⁾

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
Measuring					
• Measuring type	See chapter Measuring types and ranges (Page 21)	Voltage	Yes	Channel	Channel
• Measuring range		±10 V	Yes	Channel	Channel
• Temperature coefficient	Pt: 0.003851 Pt: 0.003902 Pt: 0.003916 Pt: 0.003920 Ni: 0.00618 Ni: 0.00672 LG-Ni: 0.005000	0.003851	Yes	Channel	Channel
• Temperature unit	<ul style="list-style-type: none"> • Kelvin (K) • Fahrenheit (°F) • Celsius (°C) 	°C	Yes	Channel	Module
• Interference frequency suppression	400 Hz 60 Hz 50 Hz 10 Hz	50 Hz	Yes	Channel	Module
• Smoothing	None/low/medium/high	None	Yes	Channel	Channel
• Reference junction for TC	<ul style="list-style-type: none"> • Fixed reference temperature • Dynamic reference temperature • Internal reference junction • Reference channel of the module 	Internal reference junction	Yes	Channel	Module ⁵⁾ <ul style="list-style-type: none"> • Dynamic reference temperature • Internal reference junction
• Fixed reference temperature	Temperature	25 °C	Yes	Channel	--- ⁵⁾

4.2 Parameters

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
Hardware interrupts					
• Hardware interrupt low limit 1	Yes/No	No	Yes	Channel	--- 5)
• Hardware interrupt high limit 1	Yes/No	No	Yes	Channel	--- 5)
• Hardware interrupt low limit 2	Yes/No	No	Yes	Channel	--- 5)
• Hardware interrupt high limit 2	Yes/No	No	Yes	Channel	--- 5)

1) Only for measurement type Resistance, Resistance Thermometer RTD: If "Wire break" diagnostics and "Value status" are deactivated, the module reports overflow or underflow (7FFF_n or 8000_n) in case of a wiring error. The alarm depends on whether the connected cables are faulty.

Recommendation: Activate the "Wire break" diagnostics. The active check for wire break reliably detects wiring errors and the module reports overflow (7FFF_H).

2) When "Wire break" diagnostics is disabled, the current limit of 1.185 mA applies to the value status. For measured values below 1.185 mA, the value status is always: 0 = fault.

3) If you enable diagnostics for multiple channels, you will receive an alarm surge on failure of the supply voltage because each enabled channel will detect this fault.

You can prevent this message burst by assigning the diagnostics function to one channel only.

4) You can set the effective range of the diagnostics for each channel in the user program with data records 0 to 7.

5) You can set the current limit for wire break diagnostics, the setting "Fixed reference temperature" and "Reference channel of the module" as well as the limits for hardware interrupts in the user program with data records 0 to 7.

Parameters of the reference channel

You cannot configure the reference channel with GSD file. You have to transfer the reference channel to the module with data record 8.

If you want to change the default settings, you have to transfer the parameters to the module with data record 8, see chapter Parameter assignment and structure of the parameter data records (Page 54).

The diagnostics "Common mode error" and "Reference channel error" cannot be configured for the reference channel.

4.3 Declaration of parameters

Missing supply voltage L+

Enabling of the diagnostics, with missing or too little supply voltage L+.

Overflow

Enabling of the diagnostics if the measured value violates the high limit.

Underflow

Enabling of the diagnostics when the measured value violates the low limit.

Common mode error

Enabling of diagnostics if the valid common mode voltage is exceeded.

Enable the Common mode error diagnostics when 2WMT is connected, for example, to check for a short circuit to M_{ANA} or a wire break. If you do not need the Common mode error diagnostics, disable the parameter.

Reference channel error

- Enable diagnostics for an error at the temperature compensation channel, e.g. wire break.
- Dynamic reference temperature compensation type is configured and no reference temperature has been transferred to the module yet.

Wire break

Enabling of the diagnostics if the module has no current flow or the current is too weak for the measurement at the corresponding configured input or the applied voltage is too low.

Current limit for wire break diagnostics

Threshold for reporting wire breaks. The value can be set to 1.185 mA or 3.6 mA, depending on the sensor used.

Temperature coefficient

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

The temperature coefficient (α value) indicates by how much the resistance of a specific material changes relatively if the temperature increases by 1 °C.

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

Interference frequency suppression

At analog input modules, this suppresses interference caused by the frequency of the AC network.

The frequency of the AC network may corrupt measurements, particularly in the low voltage ranges and when thermocouples are being used. For this parameter, the user defines the mains frequency prevailing on his system.

Smoothing

The individual measured values are smoothed using filtering. The smoothing can be set in 4 levels.

Smoothing time = number of module cycles (k) x cycle time of the module.

The following figure shows the number of module cycles after which the smoothed analog value is almost 100%, depending on the set smoothing. It is valid for each signal change at the analog input.

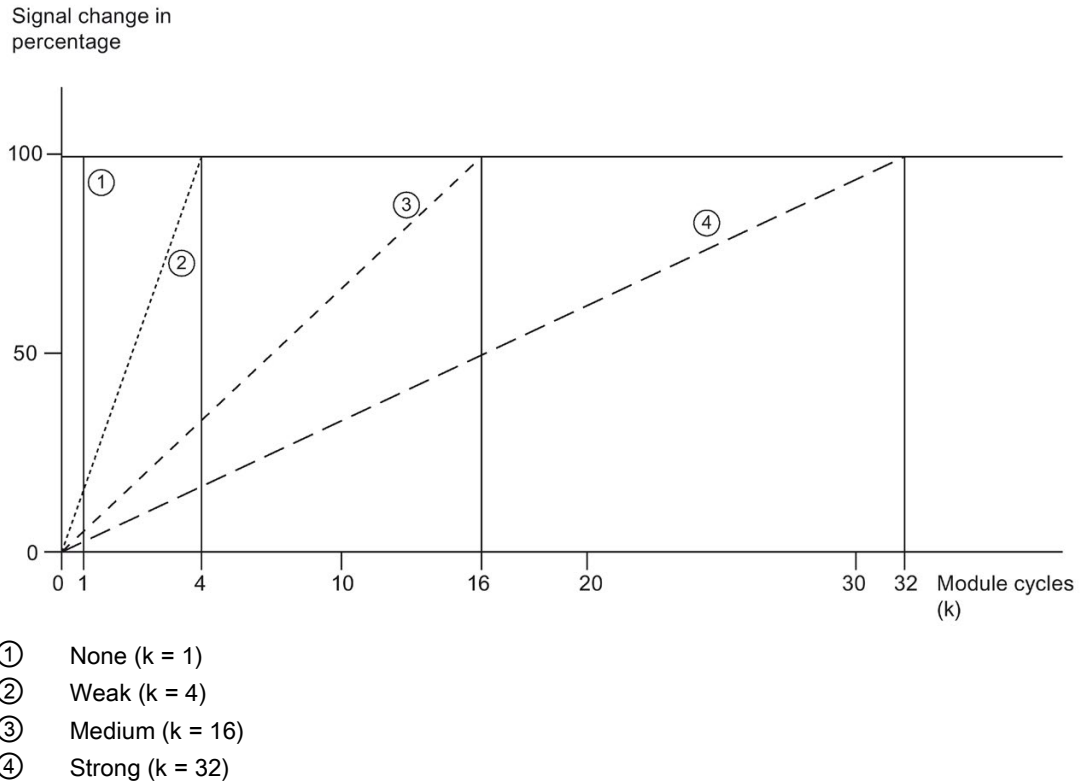


Figure 4-3 Smoothing with AI 8xU//RTD/TC ST

Reference junction for TC

The following settings can be configured for the reference junction parameter:

Table 4- 3 Possible parameter assignments for the reference junction parameter TC

Setting	Description
Fixed reference temperature	The reference junction temperature is configured and stored in the module as a fixed value.
Dynamic reference temperature	The reference junction temperature is transferred in the user program from the CPU to the module by data records 192 to 199 using the WRREC (SFB 53) instruction.
Internal reference junction	The reference junction temperature is determined using an integrated sensor of the module.
Reference channel of the module	The reference junction temperature is determined using an external resistance thermometer (RTD) at the reference channel (COMP) of the module.

Hardware interrupt 1 or 2

Enabling of a hardware interrupt at violation of high limit 1 or 2 or low limit 1 or 2.

Low limit 1 or 2

Specifies the low limit threshold that triggers hardware interrupt 1 or 2.

High limit 1 or 2

Specifies the high limit threshold that triggers hardware interrupt 1 or 2.

4.4 Address space

The module can be configured differently in STEP 7; see following table. Depending on the configuration, additional/different addresses are assigned in the process image of the inputs.

Configuration options of AI 8xU/I/RTD/TC ST

You can configure the module with STEP 7 (TIA Portal) or with a GSD file.

When you configure the module by means of the GSD file, the configurations are available under different abbreviations/module names.

The following configurations are possible:

Table 4- 4 Configuration options

Configuration	Short designation/ module name in the GSD file	Configuration software, e.g., with STEP 7 (TIA Portal)	
		Integrated in hardware catalog STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) V12 or higher or STEP 7 V5.5 SP3 or higher
1 x 8-channel without value status	AI 8xU/I/RTD/TC ST	V12 or higher	X
1 x 8-channel with value status	AI 8xU/I/RTD/TC ST QI	V12 or higher	X
8 x 1-channel without value status	AI 8xU/I/RTD/TC ST S	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
8 x 1-channel with value status	AI 8xU/I/RTD/TC ST S QI	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status for module-internal shared input with up to 4 submodules	AI 8xU/I/RTD/TC ST MSI	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)

Value status (Quality Information, QI)

The value status is always activated for the following module names:

- AI 8xU/I/RTD/TC ST QI
- AI 8xU/I/RTD/TC ST S QI
- AI 8xU/I/RTD/TC ST MSI

An additional bit is assigned to each channel for the value status. The value status bit indicates if the read in digital value is valid. (0 = value is incorrect).

Address space of AI 8xU/I/RTD/TC ST

The following figure shows the address space allocation for the configuration as 8-channel module. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"IB x" stands, for example, for the module start address input byte x.

Assignment in the process image input (PII)

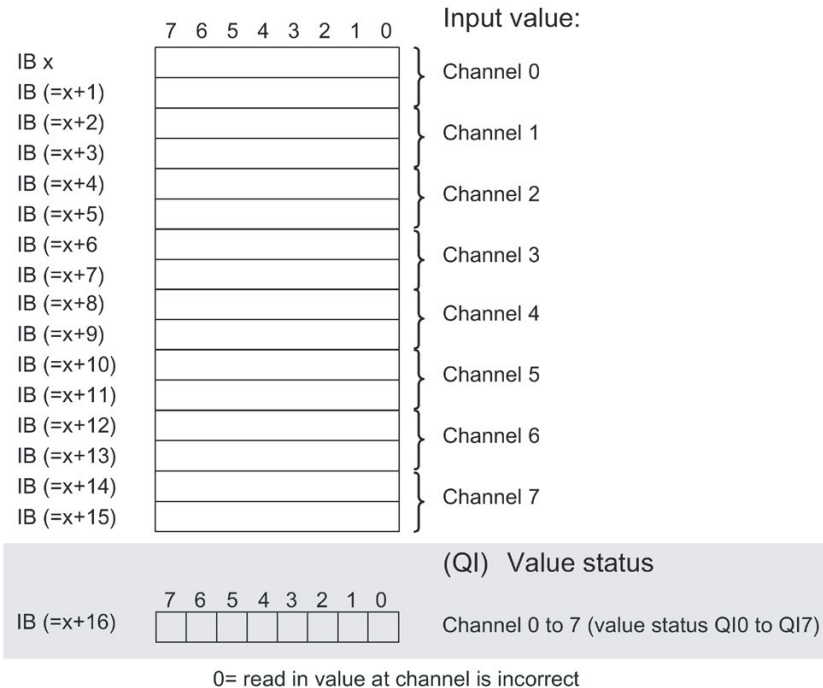


Figure 4-4 Address space for configuration as 1 x 8-channel AI 8xU/I/RTD/TC ST with value status

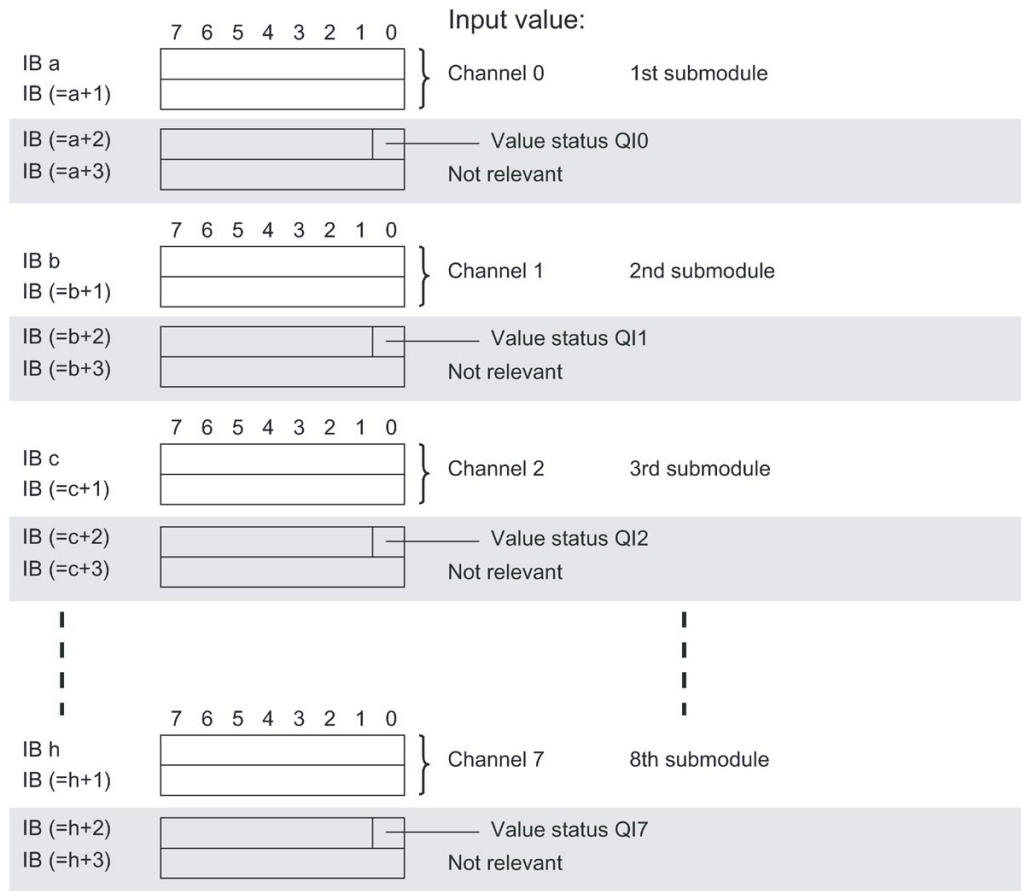
Address space for configuration as 8 x 1-channel AI 8xU/I/RTD/TC ST QI

For the configuration as a 8 x 1-channel module, the channels of the module are divided into multiple submodules. The submodules can be assigned to different IO controllers when the module is used in a shared device.

The number of usable IO controllers depends on the interface module used. Observe the information in the manual for the particular interface module.

Contrary to the 1 x 8-channel module configuration, each of the eight submodules has a freely assignable start address.

Assignment in the process image input (PII)



0= read in value at channel is incorrect

Figure 4-5 Address space for configuration as 8 x 1-channel AI 8xU/I/RTD/TC ST S QI with value status

Address space for configuration as 1 x 8-channel AI 8xU/I/RTD/TC ST MSI

The channels 0 to 7 of the module are copied in up to four submodules with configuration 1 x 8-channel module (Module-internal shared input, MSI). Channels 0 to 7 are then available with identical input values in different submodules. These submodules can be assigned to up to four IO controllers when the module is used in a shared device. Each IO controller has read access to the same channels.

The number of usable IO controllers depends on the interface module used. Please observe the information in the manual for the particular interface module.

Value status (Quality Information, QI)

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

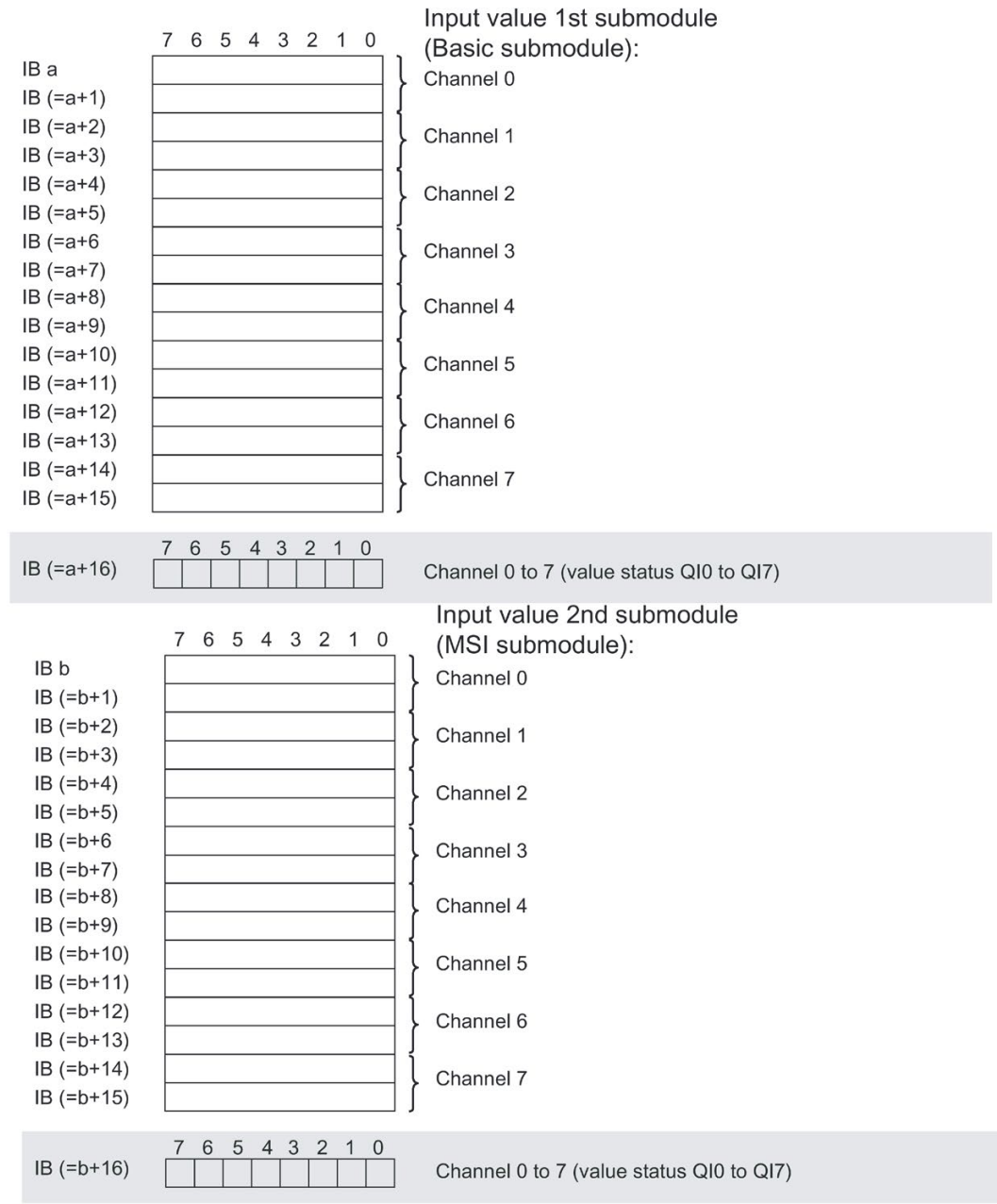
For the 1st submodule (= basic submodule), the value status 0 indicates that the value is incorrect.

For the 2nd to 4th submodule (=MSI submodule), the value status 0 indicates that the value is incorrect or the basic submodule has not yet been configured (not ready).

4.4 Address space

The figure below shows the assignment of the address space with submodules 1 and 2.

Assignment in the process image input (PII)



0= read in value at channel is incorrect

Figure 4-6 Address space for configuration as 1 x 8-channel AI 8xU//RTD/TC ST MSI with value status

The following figure shows the assignment of the address space with submodule 3 and 4.

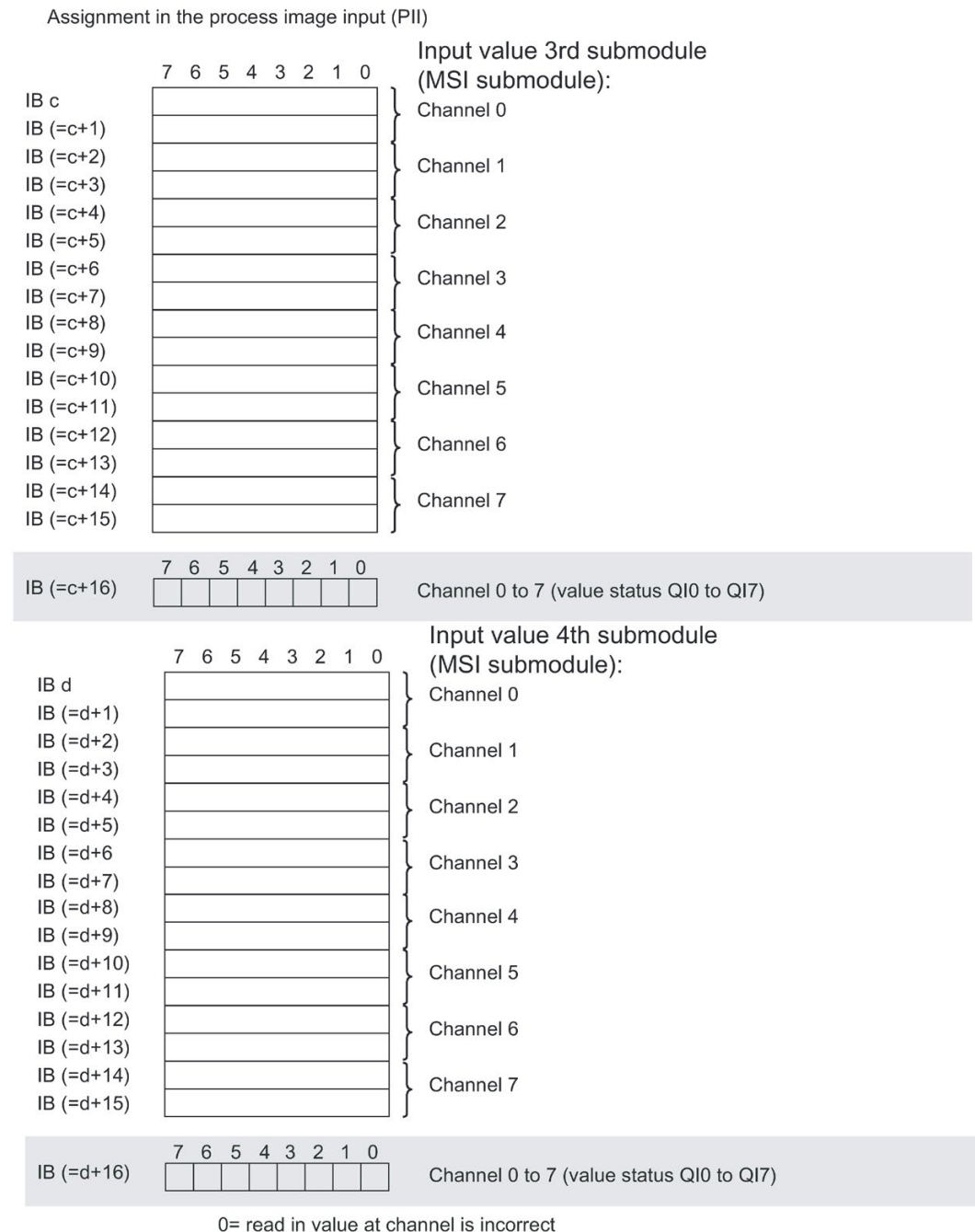


Figure 4-7 Address space for configuration as 1 x 8-channel AI 8xU/I/RTD/TC ST MSI with value status

Reference

You can find information on the Shared Input/Output (MSI/MSO) function in the section Module-Internal Shared Input/Output (MSI/MSO) of the PROFINET with STEP 7 V13 (<https://support.industry.siemens.com/cs/ww/en/view/49948856>) function manual.

Interrupts/diagnostics alarms

5.1 Status and error displays

LED displays

The following figure shows the LED displays (status and error displays) of AI 8xU/I/RTD/TC ST.

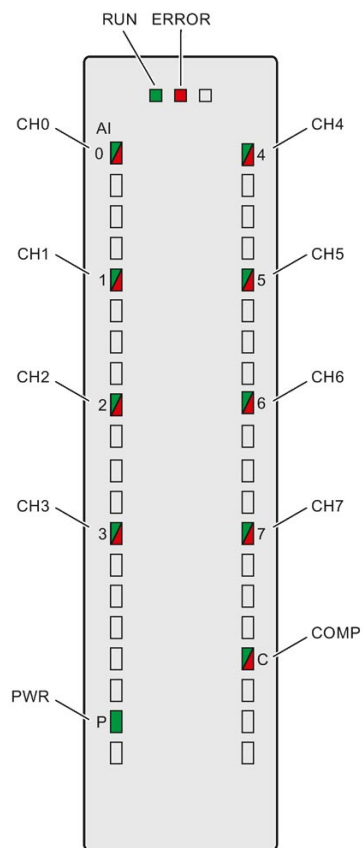


Figure 5-1 LED displays of the module AI 8xU/I/RTD/TC ST

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostic alarms can be found in section Diagnostic alarms.

RUN and ERROR LED

Table 5- 1 Status and error displays RUN and ERROR

LEDs		Meaning	Remedy
RUN	ERROR		
□ Off	□ Off	Voltage missing or too low at backplane bus.	<ul style="list-style-type: none"> Switch on the CPU and/or the system power supply modules. Verify that the U connectors are inserted. Check to see if too many modules are inserted.
☀ Flashes	□ Off	The module starts and flashes until the valid parameter assignment is set.	---
■ On	□ Off	Module is configured.	---
■ On	☀ Flashes	Indicates module errors (at least one error at one channel, e.g., wire break).	Evaluate the diagnostics data and eliminate the error (e.g., wire break).
☀ Flashes	☀ Flashes	Hardware defective.	Replace the module.

PWR LED

Table 5- 2 PWR status display

LED PWR	Meaning	Remedy
□ Off	Supply voltage L+ to module too low or missing	Check supply voltage L+.
■ On	Supply voltage L+ is present and OK.	---

CHx and COMP LED

Table 5- 3 CHx and COMP status indication

LED CHx/COMP	Meaning	Remedy
□ Off	Channel disabled	---
■ On	Channel configured and OK.	---
■ On	Channel is configured (channel error pending). Diagnostic alarm: e.g. wire break	Check the wiring. Disable diagnostics.

See also

Diagnostics alarms (Page 41)

5.2 Interrupts

Analog input module AI 8xU//RTD/TC ST supports the following diagnostic and hardware interrupts.

You can find detailed information on the event in the error organization block with the "RALRM" instruction (read additional interrupt info) and in the STEP 7 online help.

Diagnostic interrupt

The module generates a diagnostic interrupt at the following events:

- Missing supply voltage L+
- Wire break
- Overflow
- Underflow
- Common mode error
- Reference channel error
- Parameter assignment error

Hardware interrupt

The module generates a hardware interrupt at the following events:

- Low limit violated 1
- High limit violated 1
- Low limit violated 2
- Above high limit 2

The module channel that triggered the hardware interrupt is entered in the start information of the organization block. The diagram below shows the assignment to the bits of double word 8 in local data.

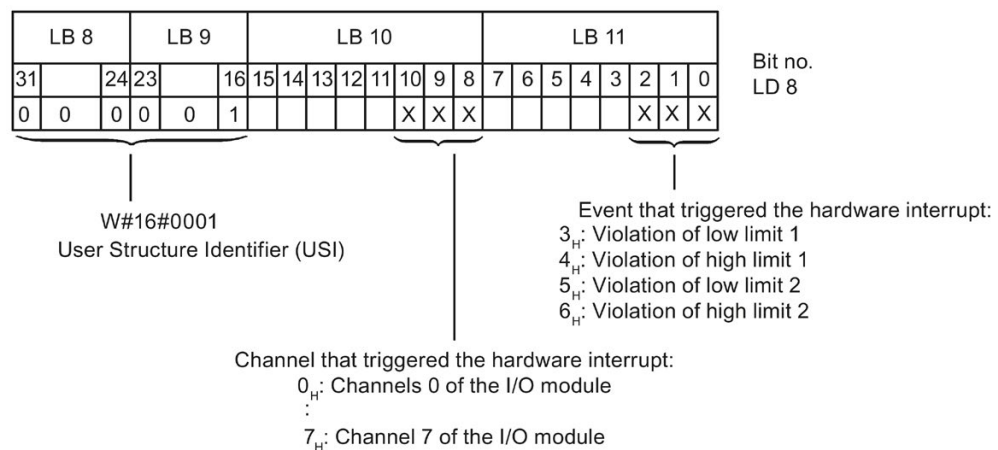


Figure 5-2 OB start information

Reaction when reaching limits 1 and 2 at the same time

If the two high limits 1 and 2 are reached at the same time, the module always signals the hardware interrupt for high limit 1 first. The configured value for high limit 2 is irrelevant. After processing the hardware interrupt for high limit 1, the module triggers the hardware interrupt for high limit 2.

The module has the same reaction when the low limits are reached at the same time. If the two low limits 1 and 2 are reached at the same time, the module always signals the hardware interrupt for low limit 1 first. After processing the hardware interrupt for low limit 1, the module triggers the hardware interrupt for low limit 2.

Structure of the additional interrupt information

Table 5- 4 Structure of USI = W#16#0001

Data block name	Contents	Remark	Bytes
USI (User Structure Identifier)	W#16#0001	Additional interrupt info for hardware interrupts of the I/O module	2
The channel that triggered the hardware interrupt follows.			
Channel	B#16#00 to B#16#n	Number of the event-triggering channel (n = number of module channels -1)	1
The event that triggered the hardware interrupt follows.			
Event	B#16#03	Low limit violated 1	1
	B#16#04	High limit violated 1	
	B#16#05	Low limit violated 2	
	B#16#06	Violation of high limit 2	

5.3 Diagnostics alarms

A diagnostics alarm is generated and the ERROR LED flashes on the module for each diagnostics event. The diagnostics alarms can be read out in the diagnostics buffer of the CPU, for example. You can evaluate the error codes with the user program.

If the module is operated distributed with PROFIBUS DP in an ET 200MP system, you have the option to read out diagnostics data with the instruction RDREC or RD_REC using data record 0 and 1. The structure of the data records is available on the Internet in the "Manual for interface module IM 155-5 DP ST (6ES7155-5BA00-0AB0)".

Table 5- 5 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarm	Error code	Meaning	Solution
Wire break	6 _H	Impedance of encoder circuit too high	Use a different encoder type or modify the wiring, for example, using cables with larger cross-section
		Wire break between the module and sensor	Connect the cable
		Channel not connected (open)	<ul style="list-style-type: none"> • Disable diagnostics • Connect the channel
Overflow	7 _H	Measuring range violated	Check the measuring range
Underflow	8 _H	Measuring range violated	Check the measuring range
Parameter assignment error	10 _H	<ul style="list-style-type: none"> • The module cannot evaluate parameters for the channel • Incorrect parameter assignment 	Correct the parameter assignment
Load voltage missing	11 _H	Supply voltage L+ of the module is missing	Connect supply voltage L+ to module/channel
Reference channel error	15 _H	Invalid reference temperature for the used TC channel with compensation	Check the resistance thermometer. For the compensation with data record, restore communication to the module/station.
Common mode error	118 _H	Valid common mode voltage exceeded Causes when a 2WT is connected, e.g.: <ul style="list-style-type: none"> • Wire break • Galvanic connection to M_{ANA} 	Check the wiring, e.g. sensor ground connections, use equipotential cables

Diagnostics alarms with value status (QI)

If you configure the module with value status (QI), the module always checks all errors even if the respective diagnostics is not enabled. But the module cancels the inspection as soon as it detects the first error, regardless if the respective diagnostics has been enabled or not. The result may be that enabled diagnostics may not be displayed.

Example: You have enabled "Underflow" diagnostics, but the module detects the "Wire break" diagnostics first and aborts after this error message. The "Underflow" diagnostics is not detected.

Recommendation: To ensure that all errors can be diagnosed reliably, select all check boxes under "Diagnostics".

Technical specifications

Technical specifications of the AI 8xU/I/RTD/TC ST

The following table shows the technical specifications as of 08/2018. You will find a data sheet including daily updated technical specifications on the Internet (<https://support.industry.siemens.com/cs/ww/en/pv/6ES7531-7KF00-0AB0/td?dl=en>).

Article number	6ES7531-7KF00-0AB0
General information	
Product type designation	AI 8xU/I/RTD/TC ST
HW functional status	FS04
Firmware version	V2.0.0
<ul style="list-style-type: none"> FW update possible 	Yes
Product function	
<ul style="list-style-type: none"> I&M data 	Yes; I&M0 to I&M3
<ul style="list-style-type: none"> Measuring range scalable 	No
<ul style="list-style-type: none"> Scalable measured values 	No
<ul style="list-style-type: none"> Adjustment of measuring range 	No
Engineering with	
<ul style="list-style-type: none"> STEP 7 TIA Portal configurable/integrated as of version 	V12 / V12
<ul style="list-style-type: none"> STEP 7 configurable/integrated as of version 	V5.5 SP3 / -
<ul style="list-style-type: none"> PROFIBUS as of GSD version/GSD revision 	V1.0 / V5.1
<ul style="list-style-type: none"> PROFINET as of GSD version/GSD revision 	V2.3 / -
Operating mode	
<ul style="list-style-type: none"> Oversampling 	No
<ul style="list-style-type: none"> MSI 	Yes
CiR – Configuration in RUN	
Reparameterization possible in RUN	Yes
Calibration possible in RUN	Yes
Supply voltage	
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

Article number	6ES7531-7KF00-0AB0
Input current	
Current consumption, max.	240 mA; with 24 V DC supply
Encoder supply	
24 V encoder supply	
<ul style="list-style-type: none"> Short-circuit protection Output current, max. 	<p>Yes</p> <p>20 mA; Max. 47 mA per channel for a duration < 10 s</p>
Power	
Power available from the backplane bus	0.7 W
Power loss	
Power loss, typ.	2.7 W
Analog inputs	
Number of analog inputs	8
<ul style="list-style-type: none"> For current measurement For voltage measurement For resistance/resistance thermometer measurement For thermocouple measurement 	<p>8</p> <p>8</p> <p>8</p> <p>4</p> <p>8</p>
permissible input voltage for voltage input (destruction limit), max.	28.8 V
permissible input current for current input (destruction limit), max.	40 mA
Constant measurement current for resistance-type transmitter, typ.	150 Ohm, 300 Ohm, 600 Ohm, Pt100, Pt200, Ni100: 1.25 mA; 6 000 Ohm, Pt500, Pt1000, Ni1000, LG-Ni1000: 0.625 mA; PTC: 0.472 mA
Technical unit for temperature measurement adjustable	Yes; °C/°F/K

Article number	6ES7531-7KF00-0AB0
Input ranges (rated values), voltages	
• 0 to +5 V	No
• 0 to +10 V	No
• 1 V to 5 V	Yes
• Input resistance (1 V to 5 V)	100 k Ω
• -1 V to +1 V	Yes
• Input resistance (-1 V to +1 V)	10 M Ω
• -10 V to +10 V	Yes
• Input resistance (-10 V to +10 V)	100 k Ω
• -2.5 V to +2.5 V	Yes
• Input resistance (-2.5 V to +2.5 V)	10 M Ω
• -25 mV to +25 mV	No
• -250 mV to +250 mV	Yes
• Input resistance (-250 mV to +250 mV)	10 M Ω
• -5 V to +5 V	Yes
• Input resistance (-5 V to +5 V)	100 k Ω
• -50 mV to +50 mV	Yes
• Input resistance (-50 mV to +50 mV)	10 M Ω
• -500 mV to +500 mV	Yes
• Input resistance (-500 mV to +500 mV)	10 M Ω
• -80 mV to +80 mV	Yes
• Input resistance (-80 mV to +80 mV)	10 M Ω
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
• Input resistance (0 to 20 mA)	25 Ω ; Plus approx. 42 ohms for overvoltage protection by PTC
• -20 mA to +20 mA	Yes
• Input resistance (-20 mA to +20 mA)	25 Ω ; Plus approx. 42 ohms for overvoltage protection by PTC
• 4 mA to 20 mA	Yes
• Input resistance (4 mA to 20 mA)	25 Ω ; Plus approx. 42 ohms for overvoltage protection by PTC

Article number	6ES7531-7KF00-0AB0
Input ranges (rated values), thermocouples	
• Type B	Yes
• Input resistance (Type B)	10 MΩ
• Type C	No
• Type E	Yes
• Input resistance (Type E)	10 MΩ
• Type J	Yes
• Input resistance (type J)	10 MΩ
• Type K	Yes
• Input resistance (Type K)	10 MΩ
• Type L	No
• Type N	Yes
• Input resistance (Type N)	10 MΩ
• Type R	Yes
• Input resistance (Type R)	10 MΩ
• Type S	Yes
• Input resistance (Type S)	10 MΩ
• Type T	Yes
• Input resistance (Type T)	10 MΩ
• Type TXK/TXK(L) to GOST	No

Article number	6ES7531-7KF00-0AB0
Input ranges (rated values), resistance thermometer	
• Cu 10	No
• Cu 10 according to GOST	No
• Cu 50	No
• Cu 50 according to GOST	No
• Cu 100	No
• Cu 100 according to GOST	No
• Ni 10	No
• Ni 10 according to GOST	No
• Ni 100	Yes; Standard/climate
• Input resistance (Ni 100)	10 MΩ
• Ni 100 according to GOST	No
• Ni 1000	Yes; Standard/climate
• Input resistance (Ni 1000)	10 MΩ
• Ni 1000 according to GOST	No
• LG-Ni 1000	Yes; Standard/climate
• Input resistance (LG-Ni 1000)	10 MΩ
• Ni 120	No
• Ni 120 according to GOST	No
• Ni 200 according to GOST	No
• Ni 500	No
• Ni 500 according to GOST	No
• Pt 10	No
• Pt 10 according to GOST	No
• Pt 50	No
• Pt 50 according to GOST	No
• Pt 100	Yes; Standard/climate
• Input resistance (Pt 100)	10 MΩ
• Pt 100 according to GOST	No
• Pt 1000	Yes; Standard/climate
• Input resistance (Pt 1000)	10 MΩ
• Pt 1000 according to GOST	No
• Pt 200	Yes; Standard/climate

Article number	6ES7531-7KF00-0AB0
<ul style="list-style-type: none"> • Input resistance (Pt 200) 	10 MΩ
<ul style="list-style-type: none"> • Pt 200 according to GOST 	No
<ul style="list-style-type: none"> • Pt 500 	Yes; Standard/climate
<ul style="list-style-type: none"> • Input resistance (Pt 500) 	10 MΩ
<ul style="list-style-type: none"> • Pt 500 according to GOST 	No
Input ranges (rated values), resistors	
<ul style="list-style-type: none"> • 0 to 150 ohms 	Yes
<ul style="list-style-type: none"> • Input resistance (0 to 150 ohms) 	10 MΩ
<ul style="list-style-type: none"> • 0 to 300 ohms 	Yes
<ul style="list-style-type: none"> • Input resistance (0 to 300 ohms) 	10 MΩ
<ul style="list-style-type: none"> • 0 to 600 ohms 	Yes
<ul style="list-style-type: none"> • Input resistance (0 to 600 ohms) 	10 MΩ
<ul style="list-style-type: none"> • 0 to 3000 ohms 	No
<ul style="list-style-type: none"> • 0 to 6000 ohms 	Yes
<ul style="list-style-type: none"> • Input resistance (0 to 6000 ohms) 	10 MΩ
<ul style="list-style-type: none"> • PTC 	Yes
<ul style="list-style-type: none"> • Input resistance (PTC) 	10 MΩ
Thermocouple (TC)	
Temperature compensation	
<ul style="list-style-type: none"> – parameterizable 	Yes
<ul style="list-style-type: none"> – internal temperature compensation 	Yes
<ul style="list-style-type: none"> – external temperature compensation via RTD 	Yes
<ul style="list-style-type: none"> – Compensation for 0 °C reference point temperature 	Yes; fixed value can be set
<ul style="list-style-type: none"> – Reference channel of the module 	Yes
Cable length	
<ul style="list-style-type: none"> • shielded, max. 	800 m; for U/I, 200 m for R/RTD, 50 m for TC

Article number	6ES7531-7KF00-0AB0
Analog value generation for the inputs	
Integration and conversion time/resolution per channel	
<ul style="list-style-type: none"> Resolution with overrange (bit including sign), max. 	16 bit
<ul style="list-style-type: none"> Integration time, parameterizable 	Yes
<ul style="list-style-type: none"> Integration time (ms) 	2,5 / 16,67 / 20 / 100 ms
<ul style="list-style-type: none"> Basic conversion time, including integration time (ms) 	9 / 23 / 27 / 107 ms
<ul style="list-style-type: none"> <ul style="list-style-type: none"> additional conversion time for wire-break monitoring 	9 ms (to be considered in R/RTD/TC measurement)
<ul style="list-style-type: none"> <ul style="list-style-type: none"> additional conversion time for resistance measurement 	150 ohm, 300 ohm, 600 ohm, Pt100, Pt200, Ni100: 2 ms, 6000 ohm, Pt500, Pt1000, Ni1000, LG-Ni1000, PTC: 4 ms
<ul style="list-style-type: none"> Interference voltage suppression for interference frequency f1 in Hz 	400 / 60 / 50 / 10 Hz
<ul style="list-style-type: none"> Time for offset calibration (per module) 	Basic conversion time of the slowest channel
Smoothing of measured values	
<ul style="list-style-type: none"> parameterizable 	Yes
<ul style="list-style-type: none"> Step: None 	Yes
<ul style="list-style-type: none"> Step: low 	Yes
<ul style="list-style-type: none"> Step: Medium 	Yes
<ul style="list-style-type: none"> Step: High 	Yes
Encoder	
Connection of signal encoders	
<ul style="list-style-type: none"> for voltage measurement 	Yes
<ul style="list-style-type: none"> for current measurement as 2-wire transducer 	Yes
<ul style="list-style-type: none"> <ul style="list-style-type: none"> Burden of 2-wire transmitter, max. 	820 Ω
<ul style="list-style-type: none"> for current measurement as 4-wire transducer 	Yes
<ul style="list-style-type: none"> for resistance measurement with two-wire connection 	Yes; Only for PTC
<ul style="list-style-type: none"> for resistance measurement with three-wire connection 	Yes; All measuring ranges except PTC; internal compensation of the cable resistances
<ul style="list-style-type: none"> for resistance measurement with four-wire connection 	Yes; All measuring ranges except PTC

Article number	6ES7531-7KF00-0AB0
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.02 %
Temperature error (relative to input range), (+/-)	0.005 %/K; With TC type T 0.02 ± % / K
Crosstalk between the inputs, max.	-80 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.02 %
Temperature error of internal compensation	±6 °C
Operational error limit in overall temperature range	
<ul style="list-style-type: none"> • Voltage, relative to input range, (+/-) • Current, relative to input range, (+/-) • Resistance, relative to input range, (+/-) • Resistance thermometer, relative to input range, (+/-) • Thermocouple, relative to input range, (+/-) 	0.3 % 0.3 % 0.3 % Ptxxx standard: ±1.5 K, Ptxxx climate: ±0.5 K, Nixxx standard: ±0.5 K, Nixxx climate: ±0.3 K Type B: > 600 °C ±4.6 K, type E: > -200 °C ±1.5 K, type J: > -210 °C ±1.9 K, type K: > -200 °C ±2.4 K, type N: > -200 °C ±2.9 K, type R: > 0 °C ±4.7 K, type S: > 0 °C ±4.6 K, type T: > -200 °C ±2.4 K
Basic error limit (operational limit at 25 °C)	
<ul style="list-style-type: none"> • Voltage, relative to input range, (+/-) • Current, relative to input range, (+/-) • Resistance, relative to input range, (+/-) • Resistance thermometer, relative to input range, (+/-) • Thermocouple, relative to input range, (+/-) 	0.1 % 0.1 % 0.1 % Ptxxx standard: ±0.7 K, Ptxxx climate: ±0.2 K, Nixxx standard: ±0.3 K, Nixxx climate: ±0.15 K Type B: > 600 °C ±1.7 K, type E: > -200 °C ±0.7 K, type J: > -210 °C ±0.8 K, type K: > -200 °C ±1.2 K, type N: > -200 °C ±1.2 K, type R: > 0 °C ±1.9 K, type S: > 0 °C ±1.9 K, type T: > -200 °C ±0.8 K
Interference voltage suppression for $f = n \times (f_1 \pm 1 \%)$, $f_1 =$ interference frequency	
<ul style="list-style-type: none"> • Series mode interference (peak value of interference < rated value of input range), min. • Common mode voltage, max. • Common mode interference, min. 	40 dB 10 V 60 dB
Isochronous mode	
Isochronous operation (application synchronized up to terminal)	No

Article number	6ES7531-7KF00-0AB0
Interrupts/diagnostics/status information	
Diagnostics function	Yes
Alarms	
• Diagnostic alarm	Yes
• Limit value alarm	Yes; two upper and two lower limit values in each case
Diagnostic messages	
• Monitoring the supply voltage	Yes
• Wire-break	Yes; Only for 1 to 5 V, 4 to 20 mA, TC, R, and RTD
• Overflow/underflow	Yes
Diagnostics indication LED	
• RUN LED	Yes; Green LED
• ERROR LED	Yes; Red LED
• Monitoring of the supply voltage (PWR-LED)	Yes; Green LED
• Channel status display	Yes; Green LED
• for channel diagnostics	Yes; Red LED
• for module diagnostics	Yes; Red LED
Potential separation	
Potential separation channels	
• between the channels	No
• between the channels, in groups of	8
• between the channels and backplane bus	Yes
• between the channels and the power supply of the electronics	Yes
Permissible potential difference	
between the inputs (UCM)	20 V DC
Between the inputs and MANA (UCM)	10 V DC
Isolation	
Isolation tested with	707 V DC (type test)
Standards, approvals, certificates	
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 E

Article number	6ES7531-7KF00-0AB0
Ambient conditions	
Ambient temperature during operation	
<ul style="list-style-type: none"> • horizontal installation, min. 0 °C • horizontal installation, max. 60 °C • vertical installation, min. 0 °C • vertical installation, max. 40 °C 	
Decentralized operation	
Prioritized startup	No
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	310 g
Other	
Note:	Additional basic error and noise for integration time = 2.5 ms: Voltage: ± 250 mV ($\pm 0.02\%$), ± 80 mV ($\pm 0.05\%$), ± 50 mV ($\pm 0.05\%$); resistance: 150 ohms $\pm 0.02\%$; resistance thermometer: Pt100 climate: ± 0.08 K, Ni100 climate: ± 0.08 K; thermocouple: Type B, R, S: ± 3 K, type E, J, K, N, T: ± 1 K

Dimensional drawing

A

The dimensional drawing of the module on the mounting rail, as well as a dimensional drawing with open front panel are provided in the appendix. Always adhere to the specified dimensions for installations in cabinets, control rooms, etc.

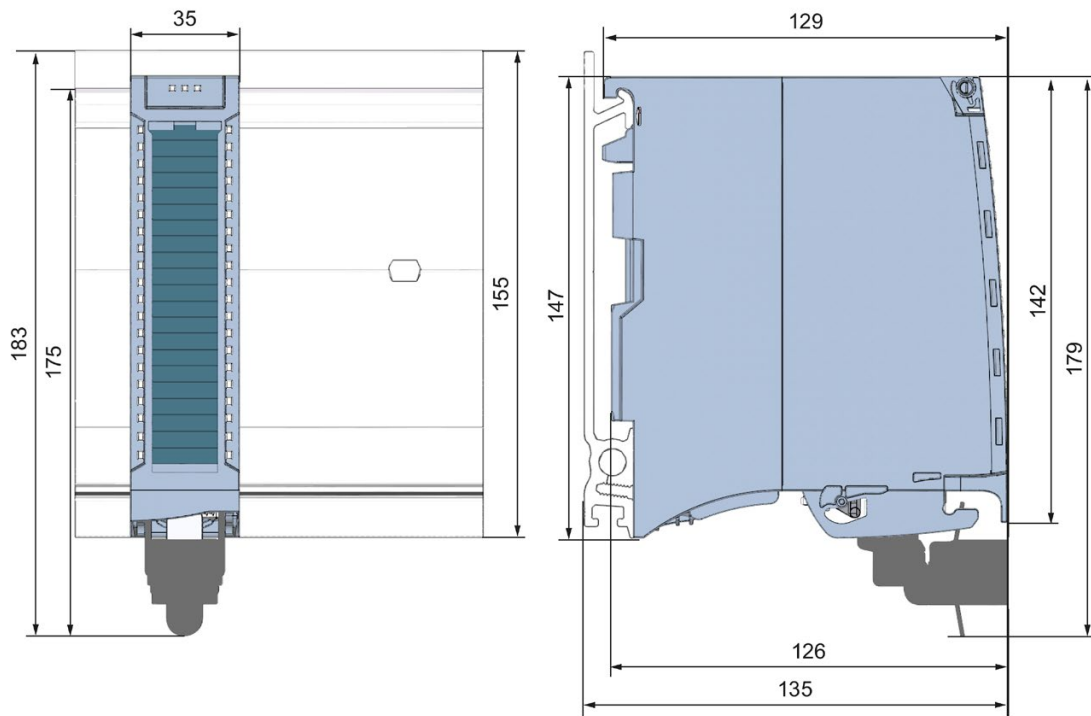


Figure A-1 Dimensional drawing of the AI 8xU//RTD/TC ST module



Figure A-2 Dimensional drawing of the AI 8xU/I/RTD/TC ST module, side view with open front panel

Parameter data records

B.1 Parameter assignment and structure of the parameter data records

The data records of the module have an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO.

Dependencies for configuration with GSD file

When configuring the module with a GSD file, remember that the settings of some parameters are dependent on each other. The parameters are only checked for plausibility by the module after the transfer to the module.

The following table lists the parameters that depend on one another.

Table B- 1 Dependencies of parameters for configuration with GSD file

Device-specific parameters (GSD file)	Dependent parameters
Current limit for wire break	Only for measuring type current with measuring range 4 mA to 20 mA.
Wire break	Only for measuring type resistance, thermal resistor RTD, thermocouple TC, voltage with measuring range 1V to 5 V and current with measuring range 4 mA to 20 mA.
Common mode error	Only for measuring type voltage, current and thermocouple TC.
Reference channel error	Only for measuring type thermocouple TC.
Measuring type resistance (4-wire connection, 3-wire connection)	Only for measuring range 150 Ω, 300 Ω, 600 Ω and 6000 Ω.
Measuring type resistance (4-wire connection, 3-wire connection, 2-wire connection)	Configurable for even channels (0, 2, 4 and 6) only.
Measuring type thermal resistor RTD (4-wire connection, 3-wire connection)	The following odd channel (1, 3, 5, 7) must be deactivated.
Hardware interrupt limits	Only if hardware interrupts are enabled.
Fixed reference temperature	Only if the value Fixed reference temperature is configured at parameter Reference junction for TC .
Temperature unit Kelvin (K)	Only for measuring type thermal resistor RTD and for thermocouple TC.

Parameter assignment in the user program

The module parameters can be assigned in RUN (for example, measuring ranges of selected channels can be edited in RUN without having an effect on the other channels).

Parameter assignment in RUN

Instruction WRREC is used to transfer the parameters by means of data records 0 to 7 and 8. The parameters set in STEP 7 do not change in the CPU, which means the parameters set in STEP 7 are still valid after a restart.

The parameters are only checked for plausibility by the module after the transfer to the module.

Output parameter STATUS

The module ignores errors that occurred during the transfer of parameters with the WRREC instruction and continues operation with the previous parameter assignment. However, a corresponding error code is written to the STATUS output parameter.

The description of the WRREC instruction and the error codes is available in the STEP 7 online help.

Operation of the module behind a PROFIBUS DP interface module

If the module is operated behind a PROFIBUS DP interface module, the parameter data records 0 and 1 are not read back. You obtain the diagnostics data records 0 and 1 with the read back parameter data records 0 and 1. You can find additional information in the Interrupts section of the manual for the PROFIBUS DP interface module on the Internet (<http://support.automation.siemens.com/WW/view/en/78324181>).

Assignment of data record and channel

The parameters in data records 0 to 7 and in data record 8 are available for 1x 8-channel configuration and are assigned as follows:

- Data record 0 for channel 0
- Data record 1 for channel 1
- ...
- Data record 6 for channel 6
- Data record 7 for channel 7
- Data record 8 for the reference channel (COMP)

For configuration 8 x 1-channel, the module has 8 submodules with one channel each and one submodule for the reference channel. The parameters for the channel are available in data record 0 and are assigned as follows:

- Data record 0 for channel 0 (submodule 1)
- Data record 0 for channel 1 (submodule 2)
- ...
- Data record 0 for channel 6 (submodule 7)
- Data record 0 for channel 7 (submodule 8)
- Data record 0 for the reference channel (COMP) (submodule 9)

Address the respective submodule for data record transfer.

Data record structure

The figure below shows the structure of data record 0 for channel 0 as an example. The structure is identical for channels 1 to 7. The values in byte 0 and byte 1 are fixed and may not be changed.

Enable a parameter by setting the corresponding bit to "1".

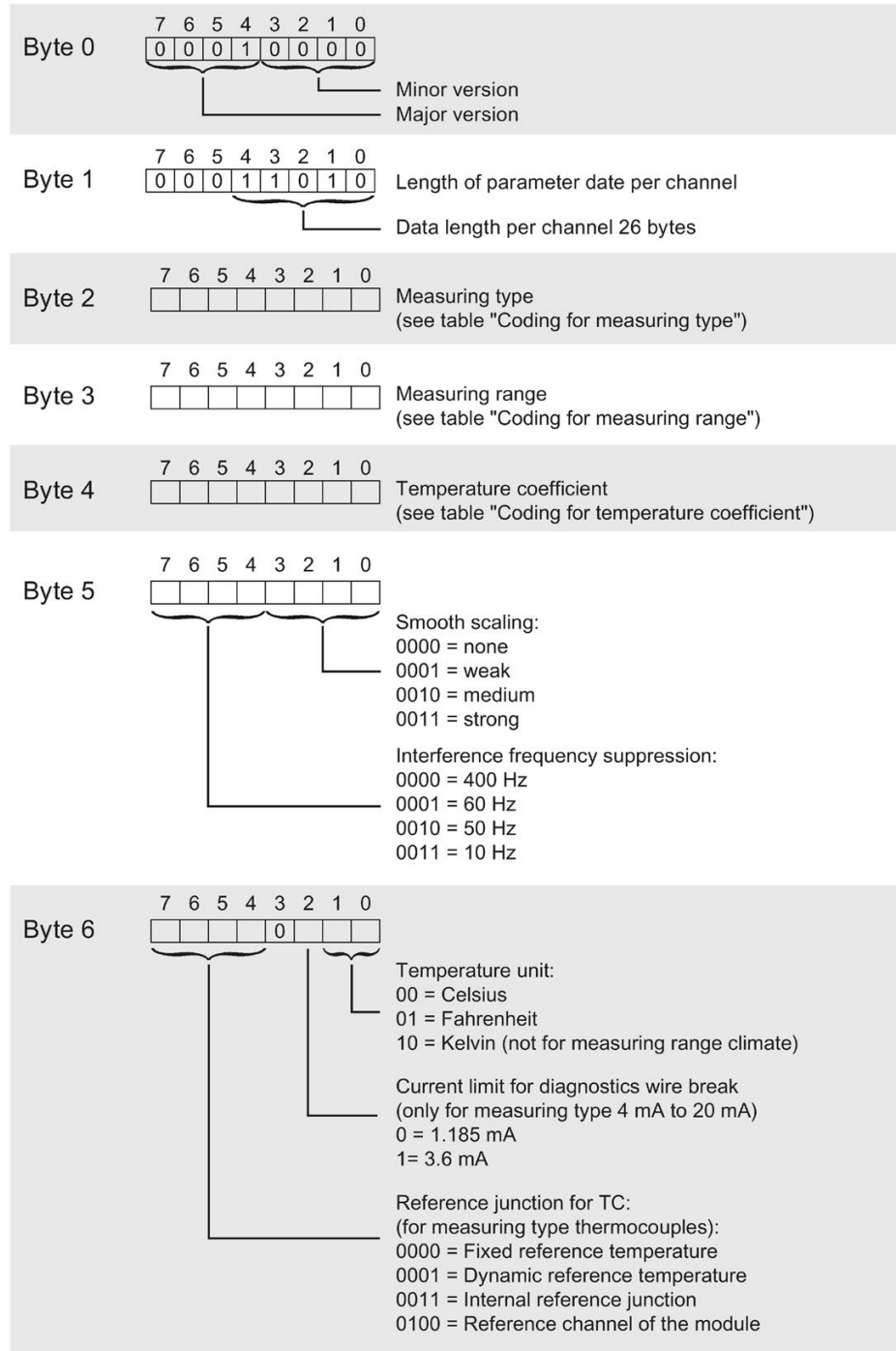
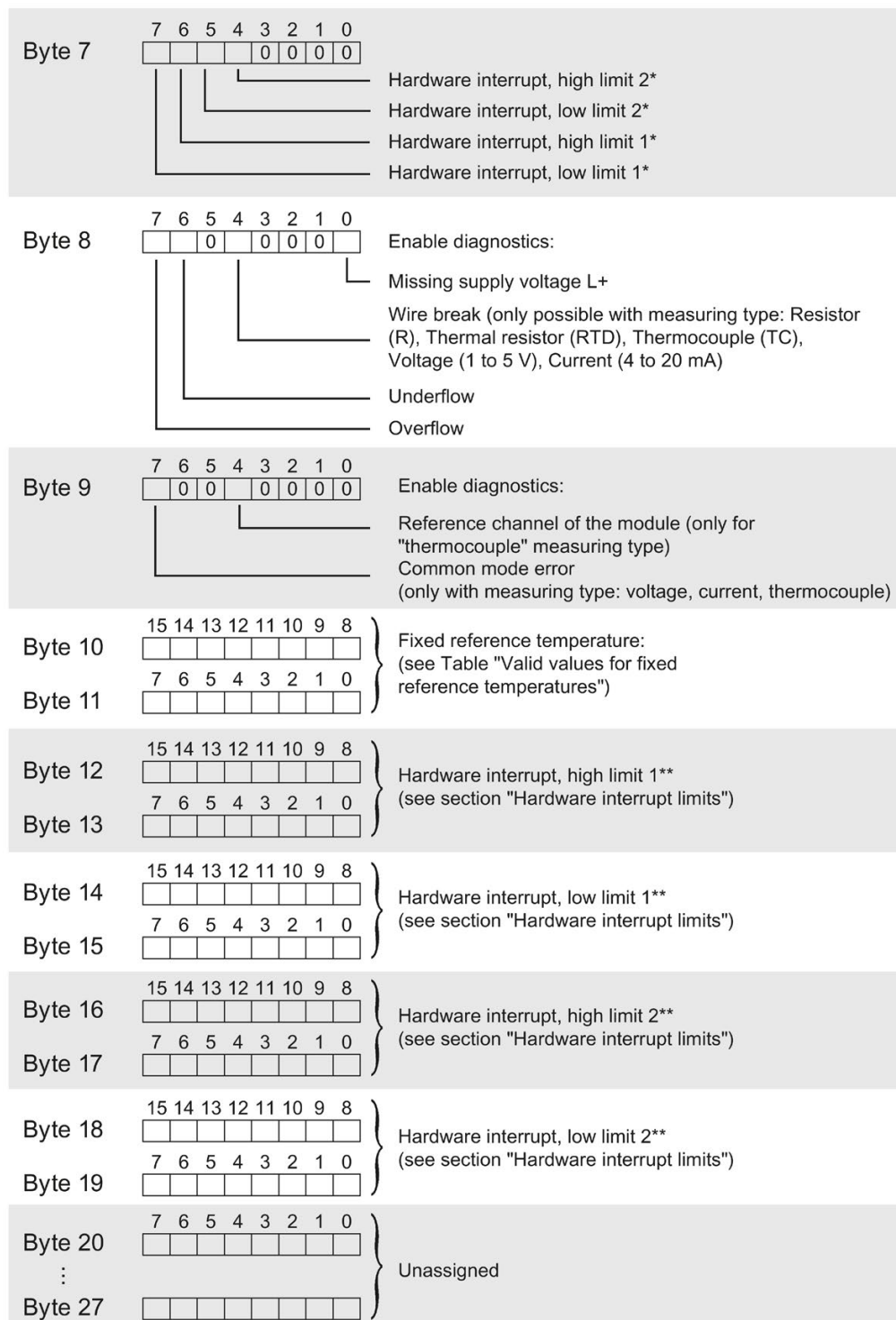


Figure B-1 Structure of data record 0: Bytes 0 to 6

B.1 Parameter assignment and structure of the parameter data records



* Enabling the hardware interrupts via data record is only possible when the channel is assigned a hardware interrupt OB in STEP 7

** High limit must be greater than the low limit

Figure B-2 Structure of data record 0: Bytes 7 to 27

Structure of data record 8, reference channel (COMP) of the module

The reference channel compensates the measured value for channels 0 to 7. The figure below shows the structure of data record 8. Enable a parameter by setting the corresponding bit to "1".

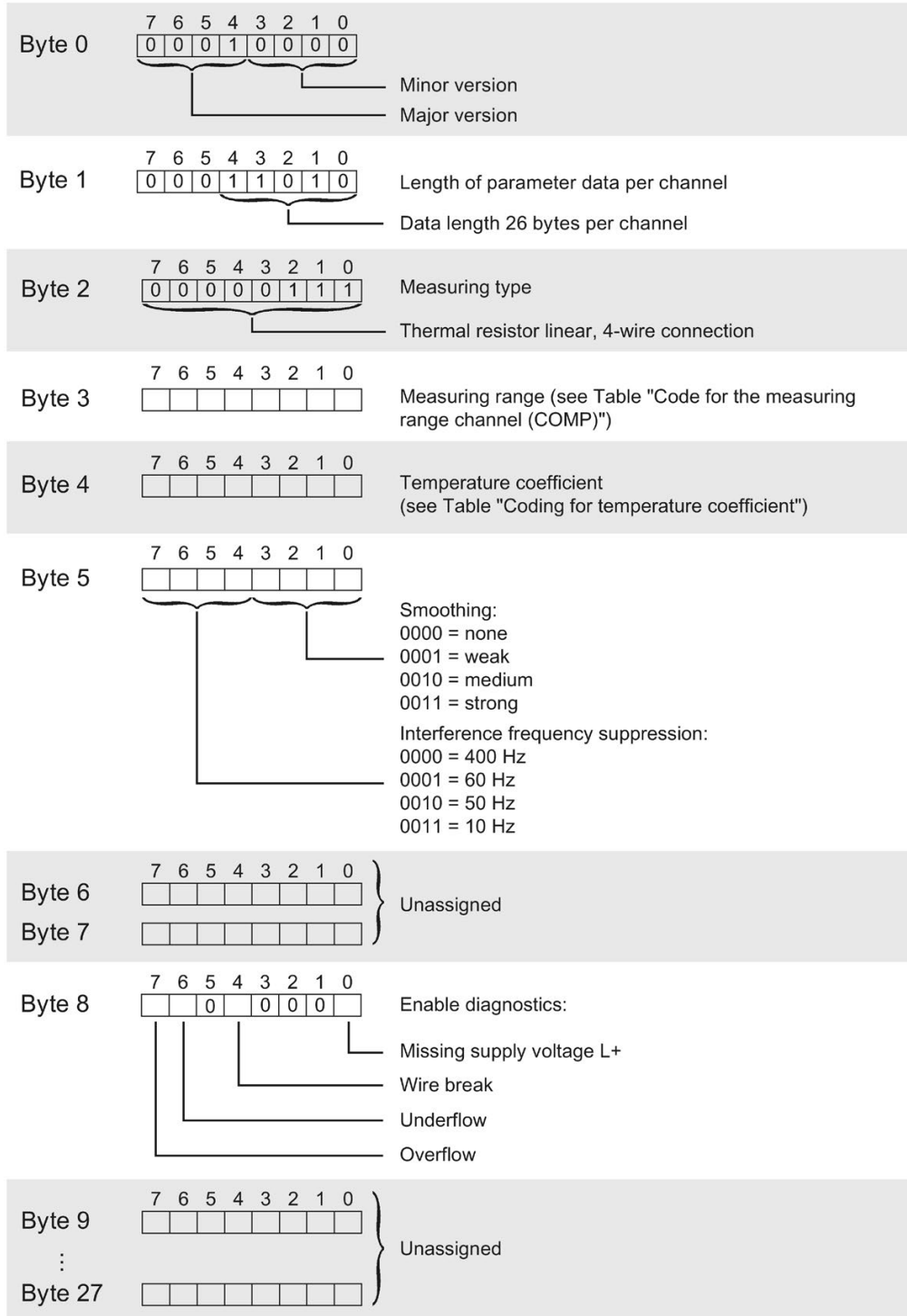


Figure B-3 Structure of data record 8, reference channel of the module: Bytes 0 to 27

Codes for measurement types

The following table lists all measurement types of the analog input module along with their codes. Enter these codes at byte 2 of the data record for the corresponding channel (see the figure Structure of data record 0: Bytes 7 to 27).

Table B- 2 Code for the measurement type

Measurement type	Code
Deactivated	0000 0000
Voltage	0000 0001
Current, 2-wire transmitter	0000 0011
Current, 4-wire transmitter	0000 0010
Resistance, 4-wire connection *) **)	0000 0100
Resistance, 3-wire connection *) **)	0000 0101
Resistance, 2-wire connection *) ***)	0000 0110
Thermal resistor linear, 4-wire connection *)	0000 0111
Thermal resistor linear, 3-wire connection *)	0000 1000
Thermocouple	0000 1010

*) only possible for channels 0, 2, 4 and 6

**) only for the following measuring ranges: 150 Ω , 300 Ω , 600 Ω , 6 k Ω

***) only for measuring range PTC

Special feature for configuration

If you configure one of the following measuring types at one of the channels 0, 2, 4 and 6:

- Resistance, 4-wire connection
- Resistance, 3-wire connection
- Resistance, 2-wire connection
- Thermal resistor linear, 4-wire connection
- Thermal resistor linear, 3-wire connection

then one of the following channels must be disabled.

Example:

You have configured "Resistance, 4-wire connection" at channel 0; channel 1 must be disabled. You have configured "Resistance, 2-wire connection" at channel 2; channel 3 must be disabled.

Codes for measuring ranges

The following table lists all measuring ranges of the analog input module along with their codes. Enter these codes accordingly at byte 3 of the data record for the corresponding channel (see the figure Structure of data record 0: Bytes 7 to 27).

Table B- 3 Code for the measuring range

Measuring range	Code
Voltage	
±50 mV	0000 0001
±80 mV	0000 0010
±250 mV	0000 0011
±500 mV	0000 0100
±1 V	0000 0101
±2.5 V	0000 0111
±5 V	0000 1000
±10 V	0000 1001
1 V to 5 V	0000 1010
Current, 4-wire transmitter	
0 mA to 20 mA	0000 0010
4 mA to 20 mA	0000 0011
±20 mA	0000 0100
Current, 2-wire transmitter	
4 mA to 20 mA	0000 0011
Resistor	
150 Ω	0000 0001
300 Ω	0000 0010
600 Ω	0000 0011
6 kΩ	0000 0101
PTC	0000 1111

B.1 Parameter assignment and structure of the parameter data records

Thermal resistor	
Pt100 Climate	0000 0000
Ni100 Climate	0000 0001
Pt100 standard	0000 0010
Ni100 standard	0000 0011
Pt500 standard	0000 0100
Pt1000 standard	0000 0101
Ni1000 standard	0000 0110
Pt200 Climate	0000 0111
Pt500 Climate	0000 1000
Pt1000 Climate	0000 1001
Ni1000 Climate	0000 1010
Pt200 standard	0000 1011
LG-Ni1000 standard	0001 1100
LG-Ni1000 Climate	0001 1101
Thermocouple	
B	0000 0000
N	0000 0001
E	0000 0010
R	0000 0011
S	0000 0100
J	0000 0101
T	0000 0111
K	0000 1000

B.1 Parameter assignment and structure of the parameter data records

Codes for measuring ranges, reference channel (COMP) of the module

The following table lists all measuring ranges along with their codes for the reference channel (COMP). Enter these codes in byte 3 of data record 8 (see figure Structure of data record 8, reference channel of the module: Bytes 0 to 27).

Table B- 4 Code for the measuring range, reference channel (COMP)

Measuring range	Code
Thermal resistor	
Pt100 Climate	0000 0000
Ni100 Climate	0000 0001
Pt100 standard	0000 0010
Ni100 standard	0000 0011
Pt500 standard	0000 0100
Pt1000 standard	0000 0101
Ni1000 standard	0000 0110
Pt200 Climate	0000 0111
Pt500 Climate	0000 1000
Pt1000 Climate	0000 1001
Ni1000 Climate	0000 1010
Pt200 standard	0000 1011
LG-Ni1000 standard	0001 1100
LG-Ni1000 Climate	0001 1101

Codes for temperature coefficients

The following table lists all temperature coefficients along with their codes for temperature measurements with the thermal resistors. You need to enter these codes in

- byte 4 of data record 8 (see figure, Structure of data record 8, reference channel of the module: bytes 0 to 27) and
- byte 4 of data records 0, 2, 4, 6 and 8 (see figure, Structure of data record 0: Bytes 0 to 6)

Table B- 5 Codes for temperature coefficient

Temperature coefficient	Code
Pt xxx	
0.003851	0000 0000
0.003916	0000 0001
0.003902	0000 0010
0.003920	0000 0011
Ni xxx	
0.006180	0000 1000
0.006720	0000 1001
LG-Ni	
0.005000	0000 1010

Valid values for fixed reference temperatures

The values that you can set for fixed reference temperatures must be in the valid range of values. The resolution is a tenth of a degree.

Table B- 6 Valid values for fixed reference temperatures

Temperature unit	Decimal	Hexadecimal
Celsius (default)	-1450 to 1550	FA56 _H to 60E _H
Fahrenheit (default)	-2290 to 3110	F70E _H to CCC _H
Kelvin (default)	1282 to 3276	502 _H to 10BA _H

Hardware interrupt limits

The values that you can set for hardware interrupts (high/low limit) must not violate the over/underrange of the respective rated measuring range.

The following tables list the valid hardware interrupt limits. The limits depend on the selected measurement type and measuring range.

Table B- 7 Voltage limits

Voltage		
±50 mV, ±80 mV, ±250 mV, ±500 mV, ±1 V, ±2.5 V, ±5 V, ±10 V	1 V to 5 V	
32510	32510	High limit
-32511	-4863	Low limit

Table B- 8 Current and resistance limits

Current		Resistor	
±20 mA	4 mA to 20 mA / 0 mA to 20 mA	(all configurable measuring ranges)	
32510	32510	32510	High limit
-32511	-4863	1	Low limit

Table B- 9 Limits for thermocouple types B, C, E, and J

Thermocouple									
Type B			Type E			Type J			
°C	°F	K	°C	°F	K	°C	°F	K	
20699	32765	23431	11999	21919	14731	14499	26419	17231	High limit
1	321	2733	-2699	-4539	33	-2099	-3459	633	Low limit

B.1 Parameter assignment and structure of the parameter data records

Table B- 10 Limits for thermocouples type K, N, R, and S

Thermocouple									
Type K			Type N			Types R, S			
°C	°F	K	°C	°F	K	°C	°F	K	
16219	29515	18951	15499	28219	18231	20189	32765	22921	High limit
-2699	-4539	33	-2699	-4539	33	-1699	-2739	1033	Low limit

Table B- 11 Limits for thermocouple type T

Thermocouple			
Type T			
°C	°F	K	
5399	10039	8131	High limit
-2699	-4539	33	Low limit

Table B- 12 Limits for thermal resistor Pt xxx Standard and Pt xxx Climatic

Thermal resistor						
Pt xxx Standard			Pt xxx Climate			
°C	°F	K	°C	°F	K	
9999	18319	12731	15499	31099	---	High limit
-2429	-4053	303	-14499	-22899	---	Low limit

Table B- 13 Limits for thermal resistor Ni xxx Standard and Ni xxx Climatic

Thermal resistor						
Ni xxx Standard			Ni xxx Climate			
°C	°F	K	°C	°F	K	
2949	5629	5681	15499	31099	---	High limit
-1049	-1569	1683	-10499	-15699	---	Low limit

B.2 Structure of a data record for dynamic reference temperature

The **WRREC** instruction is used to transfer the reference junction temperature via data record 192 to data record 199 to the module.

The description of the WRREC instruction can be found in the online help from STEP 7.

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

Assignment of data record and channel

The following assignment applies if no submodules (1 x 8-channel) are configured for the module:

- Data record 192 for channel 0
- Data record 193 for channel 1
- Data record 194 for channel 2
- Data record 195 for channel 3
- Data record 196 for channel 4
- Data record 197 for channel 5
- Data record 198 for channel 6
- Data record 199 for channel 7

If eight submodules (8 x 1-channel) are configured for the module, each submodule has only one channel. The parameters of the channel are in data record 192.

Background: Each submodule you address for the data record transfer has only one channel.

Structure of data record 192 for dynamic reference temperature

The following figure shows an example of the structure of data record 192 for channel 0. The structure for data records 193 to 199 is identical.

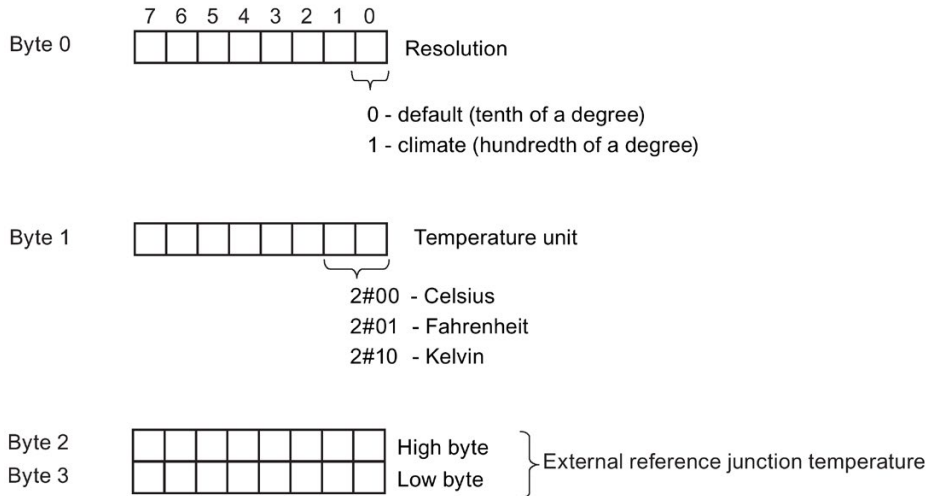


Figure B-4 Structure of data record 192

Valid values for fixed temperature compensation

You can enter the selectable values at byte 1 of the data record for the corresponding channel. The selectable values must lie within the permitted value range, see following table. The resolution is a tenth of a degree.

Table B- 14 Valid values for temperature compensation via data record

Temperature unit	Decimal	Hexadecimal
Celsius (default)	-1450 to 1550	FA56 _H to 60E _H
Fahrenheit (default)	-2290 to 3110	F70E _H to C26 _H
Kelvin (default)	1282 to 3276	502 _H to CCC _H
Celsius (climatic)	-14500 to 15500	C75C _H to 3C8C _H
Fahrenheit (climatic)	-22900 to 31100	A68C _H to 797C _H
Kelvin (climatic)	12820 to 32760	3214 _H to 7FF8 _H

Additional information

For more information on compensation of the reference junction temperature via data record refer to the Analog value processing (<http://support.automation.siemens.com/WW/view/en/67989094>) function manual in the internet.

Representation of analog values

Introduction

This chapter shows the analog values for all measuring ranges supported by the AI 8xU/I/RTD/TC ST analog module.

Measured value resolution

Each analog value is written left aligned to the tags. The bits marked with "x" are set to "0".

Note

This resolution does not apply to temperature values. The digitalized temperature values are the result of a conversion in the analog module.

Table C- 1 Resolution of the analog values

Resolution in bits including sign	Values		Analog value	
	Decimal	Hexadecimal	High byte	Low byte
16	1	1 _H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

C.1 Representation of input ranges

The following tables set out the digitalized representation of the input ranges by bipolar and unipolar range. The resolution is 16 bits.

Table C- 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	1	0	1	1	1	1	1	1	1	Overshoot range
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	Rated 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	Undershoot range
-27649	-100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Underflow
-32768	<-117.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table C- 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	Overshoot range
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	Rated 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	
-4864	-17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	Undershoot range
-32768	<-17.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

C.2 Representation of analog values in voltage measuring ranges

The following tables list the decimal and hexadecimal values (codes) of the possible voltage measuring ranges.

Table C- 4 Voltage measuring ranges ± 10 V, ± 5 V, ± 2.5 V, ± 1 V,

Values		Voltage measuring range				Range
dec	hex	± 10 V	± 5 V	± 2.5 V	± 1 V	
32767	7FFF	>11.759 V	>5.879 V	>2.940 V	> 1.176 V	Overflow
32511	7EFF	11.759 V	5.879 V	2.940 V	1.176 V	Overshoot range
27649	6C01					
27648	6C00	10 V	5 V	2.5 V	1 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V	0.75 V	
1	1	361.7 μ V	180.8 μ V	90.4 μ V	36.17 μ V	
0	0	0 V	0 V	0 V	0 V	
-1	FFFF					
-20736	AF00	-7.5 V	-3.75 V	-1.875 V	-0.75 V	
-27648	9400	-10 V	-5 V	-2.5 V	-1 V	
-27649	93FF					Undershoot range
-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.176 V	
-32768	8000	< -11.759 V	< -5.879 V	< -2.940 V	< -1.176 V	Underflow

Table C- 5 Voltage measuring ranges ± 500 mV, ± 250 mV, ± 80 mV, and ± 50 mV,

Values		Voltage measuring range				Range
dec	hex	± 500 mV	± 250 mV	± 80 mV	± 50 mV	
32767	7FFF	>587.9 mV	> 294.0 mV	> 94.1 mV	> 58.8 mV	Overflow
32511	7EFF	587.9 mV	294.0 mV	94.1 mV	58.8 mV	Overshoot range
27649	6C01					
27648	6C00	500 mV	250 mV	80 mV	50 mV	Rated range
20736	5100	375 mV	187.5 mV	60 mV	37.5 mA	
1	1	18.08 μ V	9.04 μ V	2.89 μ V	1.81 μ V	
0	0	0 mV	0 mV	0 mV	0 mV	
-1	FFFF					
-20736	AF00	-375 mV	-187.5 mV	-60 mV	-37.5 mV	
-27648	9400	-500 mV	-250 mV	-80 mV	-50 mV	
-27649	93FF					Undershoot range
-32512	8100	-587.9 mV	-294.0 mV	-94.1 mV	-58.8 mV	
-32768	8000	<-587.9 mV	< -294.0 mV	< -94.1 mV	< -58.8 mV	Underflow

Table C- 6 Voltage measuring range 1 to 5 V

Values		Voltage measuring range	Range
dec	hex	1 to 5 V	
32767	7FFF	>5.704 V	Overflow
32511	7EFF	5.704 V	Overshoot range
27649	6C01		
27648	6C00	5 V	Rated range
20736	5100	4 V	
1	1	1 V + 144.7 μ V	
0	0	1 V	
-1	FFFF		Undershoot range
-4864	ED00	0.296 V	
-32768	8000	< 0.296 V	Underflow

C.3 Representation of analog values in the current measuring ranges

The following tables list the decimal and hexadecimal values (codes) of the possible current measuring ranges.

Table C- 7 Current measuring range ± 20 mA

Values		Current measuring range	
dec	hex	± 20 mA	
32767	7FFF	>23.52 mA	Overflow
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Rated range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		
-20736	AF00	-15 mA	
-27648	9400	-20 mA	Undershoot range
-27649	93FF		
-32512	8100	-23.52 mA	
-32768	8000	< -23.52 mA	Underflow

Table C- 8 Current measuring ranges 0 to 20 mA and 4 to 20 mA

Values		Current measuring range		
dec	hex	0 to 20 mA	4 to 20 mA	
32767	7FFF	>23.52 mA	>22.81 mA	Overflow
32511	7EFF	23.52 mA	22.81 mA	Overshoot range
27649	6C01			
27648	6C00	20 mA	20 mA	Rated range
20736	5100	15 mA	16 mA	
1	1	723.4 nA	4 mA + 578.7 nA	
0	0	0 mA	4 mA	
-1	FFFF			
-4864	ED00	-3.52 mA	1.185 mA	Undershoot range
-32768	8000	<- 3.52 mA	< 1.185 mA	Underflow

C.4 Representation of the analog values of resistance-based sensors/resistance thermometers

The following tables list the decimal and hexadecimal values (codes) of the possible resistance-based sensor ranges.

Table C- 9 Resistance-based sensors of 150 Ω, 300 Ω, 600 Ω, and 6000 Ω

Values		Resistive transmitter range				
dec	hex	150 Ω	300 Ω	600 Ω	6000 Ω	
32767	7FFF	>176.38 Ω	>352.77 Ω	>705.53 Ω	>7055.3 Ω	Overflow
32511	7EFF	176.38 Ω	352.77 Ω	705.53 Ω	7055.3 Ω	Overshoot range
27649	6C01					
27648	6C00	150 Ω	300 Ω	600 Ω	6000 Ω	Rated range
20736	5100	112.5 Ω	225 Ω	450 Ω	4500 Ω	
1	1	5.43 mΩ	10.85 mΩ	21.70 mΩ	217 mΩ	
0	0	0 Ω	0 Ω	0 Ω	0 Ω	

The following tables list the decimal and hexadecimal values (codes) of the supported resistance thermometers.

Table C- 10 Thermal resistors Pt 100, Pt 200, Pt 500 and 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	10000	2710	1832.0	18320	4790	1273.2	12732	31BC	Overshoot range
:	:	:	:	:	:	:	:	:	
850.1	8501	2135	1562.1	15621	3D05	1123.3	11233	2BE1	
850.0	8500	2134	1562.0	15620	3D04	1123.2	11232	2BE0	Rated range
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	2DC	
-200.1	-2001	F82F	-328.1	-3281	F32F	73.1	731	2DB	Undershoot range
:	:	:	:	:	:	:	:	:	
-243.0	-2430	F682	-405.4	-4054	F02A	30.2	302	12E	
< -243.0	-32768	8000	< -405.4	-32768	8000	< 30.2	32768	8000	Underflow

C.4 Representation of the analog values of resistance-based sensors/resistance thermometers

Table C- 11 Thermal resistors Pt 100, Pt 200, Pt 500 and Pt 1000 Climate

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

Table C- 12 Thermal resistors Ni 100, Ni 1000, LG-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	2950	B86	563.0	5630	15FE	568.2	5682	1632	Overshoot range
:	:	:	:	:	:	:	:	:	
250.1	2501	9C5	482.1	4821	12D5	523.3	5233	1471	Rated range
250.0	2500	9C4	482.0	4820	12D4	523.2	5232	1470	
:	:	:	:	:	:	:	:	:	Undershoot range
-60.0	-600	FDA8	-76.0	-760	FD08	213.2	2132	854	
-60.1	-601	FDA7	-76.1	-761	FD07	213.1	2131	853	Undershoot range
:	:	:	:	:	:	:	:	:	
-105.0	-1050	FBE6	-157.0	-1570	F9DE	168.2	1682	692	Underflow
< -105.0	-32768	8000	< -157.0	-32768	8000	< 168.2	32768	8000	

Table C- 13 Thermal resistors Ni 100, Ni 1000, LG-Ni 1000 Climate

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

C.5 Representation of analog values for thermocouples

The following tables list the decimal and hexadecimal values (codes) of the supported thermocouples.

Table C- 14 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	20700	50DC	3276.6	32766	7FFE	2343.2	23432	5B88	Overshoot range
:	:	:	:	:	:	:	:	:	
1820.1	18201	4719	2786.6	27866	6CDA	2093.3	20933	51C5	Rated range
1820.0	18200	4718	2786.5	27865	6CD9	2093.2	20932	51C4	
:	:	:	:	:	:	:	:	:	Undershoot range
250.0	2500	09C4	482.0	4820	12D4	523.2	5232	1470	
249.9	2499	09C3	481.9	4819	12D3	523.1	5231	1469	Underflow
:	:	:	:	:	:	:	:	:	
0.0	0	0	32.0	320	0140	273.2	2732	0AAC	
< 0.0	-32768	8000	< 32.0	-32768	8000	< 273.2	32768	8000	

Table C- 15 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	12000	2EE0	2192.0	21920	55A0	1473.2	14732	398C	Overshoot range
:	:	:	:	:	:	:	:	:	
1000.1	10001	2711	1832.2	18322	4792	1273.3	12733	31BD	Rated range
1000.0	10000	2710	1832.0	18320	4790	1273.2	12732	31BC	
:	:	:	:	:	:	:	:	:	Underflow
-270.0	-2700	F574	-454.0	-4540	EE44	0	0	0000	
< -270.0	-32768	8000	< -454.0	-32768	8000	<0	-32768	8000	

Representation of analog values

C.5 Representation of analog values for thermocouples

Table C- 16 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	14500	38A4	2642.0	26420	6734	1723.2	17232	4350	Overshoot range
:	:	:	:	:	:	:	:	:	
1200.1	12001	2EE1	2192.2	21922	55A2	1473.3	14733	398D	
1200.0	12000	2EE0	2192.0	21920	55A0	1473.2	14732	398C	Rated range
:	:	:	:	:	:	:	:	:	
-210.0	-2100	F7CC	-346.0	-3460	F27C	63.2	632	0278	
< -210.0	-32768	8000	< -346.0	-32768	8000	< 63.2	-32768	8000	Underflow

Table C- 17 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	16220	3F5C	2951.6	29516	734C	1895.2	18952	4A08	Overshoot range
:	:	:	:	:	:	:	:	:	
1372.1	13721	3599	2501.7	25017	61B9	1645.3	16453	4045	
1372.0	13720	3598	2501.6	25016	61B8	1645.2	16452	4044	Rated range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	0	0	0000	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 0	-32768	8000	Underflow

Table C- 18 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	15500	3C8C	2822.0	28220	6E3C	1823.2	18232	4738	Overshoot range
:	:	:	:	:	:	:	:	:	
1300.1	13001	32C9	2372.2	23722	5CAA	1573.3	15733	3D75	
1300.0	13000	32C8	2372.0	23720	5CA8	1573.2	15732	3D74	Rated range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	0	0	0000	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 0	-32768	8000	Underflow

Table C- 19 Thermocouple type R and S

Type R, S in °C	Values		Type 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	20190	4EDE	3276.6	32766	7FFE	2292.2	22922	598A	Overshoot range
:	:	:	:	:	:	:	:	:	
1769.1	17691	451B	3216.4	32164	7DA4	2042.3	20423	4FC7	
1769.0	17690	451A	3216.2	32162	7DA2	2042.2	20422	4FC6	Rated range
:	:	:	:	:	:	:	:	:	
-50.0	-500	FE0C	-58.0	-580	FDBC	223.2	2232	08B8	
-50.1	-501	FE0B	-58.1	-581	FDBB	223.1	2231	08B7	Undershoot range
:	:	:	:	:	:	:	:	:	
-170.0	-1700	F95C	-274.0	-2740	F54C	103.2	1032	0408	
< -170.0	-32768	8000	< -274.0	-32768	8000	< 103.2	< 1032	8000	Underflow

Table C- 20 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	5400	1518	1004.0	10040	2738	813.2	8132	1FC4	Overshoot range
:	:	:	:	:	:	:	:	:	
400.1	4001	0FA1	752.2	7522	1D62	673.3	6733	1AAD	
400.0	4000	0FA0	752.0	7520	1D60	673.2	6732	1AAC	Rated range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	3.2	32	0020	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow