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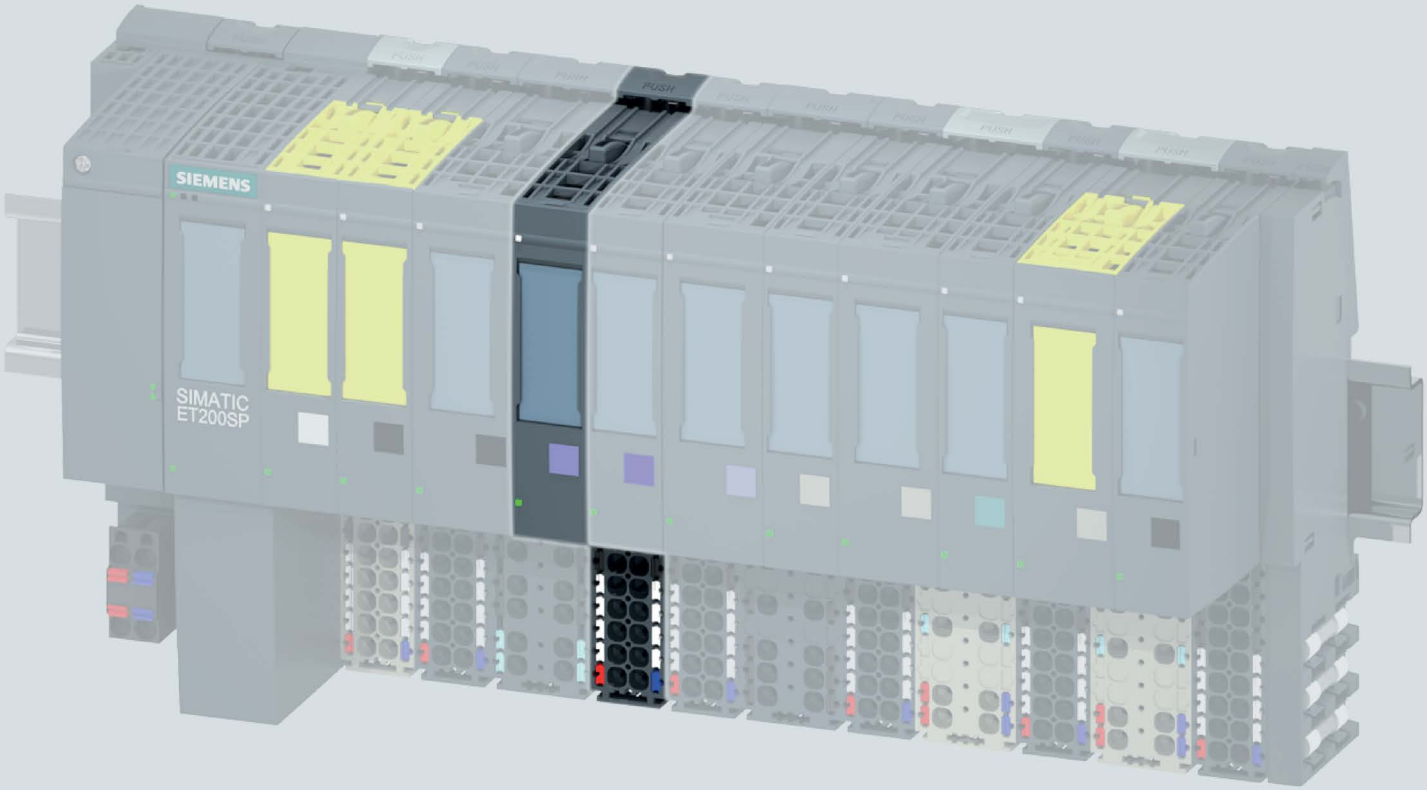

Manual

SIMATIC

ET 200SP

Analog input module
AI 4xTC HS (6ES7134-6JD00-0DA1)

Edition 03/2019

support.industry.siemens.com

SIEMENS

SIMATIC

ET 200SP
Analog input module AI 4xTC HS (6ES7134-6JD00-0DA1)

Manual

03/2019
A5E42405270-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.

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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.

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Preface

Purpose of the documentation

This equipment manual supplements the system manual ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293).

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

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

Changes compared to the previous version

Compared to the previous version, this equipment manual contains the following change:

- Thermocouple types B and C are not suitable for reference junction temperatures below 0 °C on account of their defined characteristic curve as of 0 °C.
- Technical specifications: Ambient temperature in horizontal and vertical mounting position, extended to min. -30 °C.

Conventions

CPU: When the term "CPU" is used in this manual, it applies to the CPUs of the S7-1500 automation system as well as to the CPUs/interface modules of the ET 200SP distributed I/O system.

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software "STEP 7 (TIA Portal)".

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.

Recycling and disposal

For environmentally friendly recycling and disposal of your old equipment, contact a certified electronic waste disposal company and dispose of the equipment according to the applicable regulations in your country.

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 can 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.

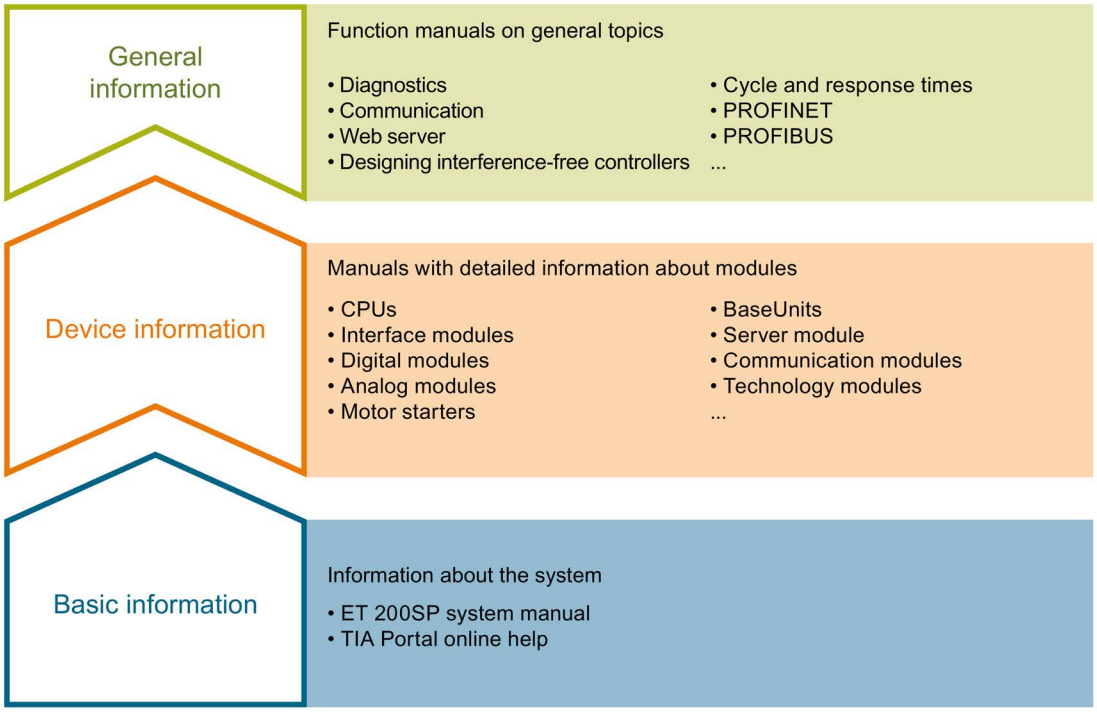
To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

Table of contents

Guide to documentation

1

The documentation for the SIMATIC ET 200SP 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 describes in detail the configuration, installation, wiring and commissioning of the SIMATIC ET 200SP. distributed I/O system. 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 ET 200SP distributed I/O system, e.g. diagnostics, communication, Web server, motion control and OPC UA.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742709).

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/73021864).

Manual Collection ET 200SP

The Manual Collection contains the complete documentation on the SIMATIC ET 200SP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (http://support.automation.siemens.com/WW/view/en/84133942).

"mySupport"

With "mySupport", your personal workspace, you make the most of your Industry Online Support.

In "mySupport" you can store filters, favorites and tags, request CAx data and put together your personal library in the Documentation area. Furthermore, your data is automatically filled into support requests and you always have an overview of your current requests.

You need to register once to use the full functionality of "mySupport".

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

"mySupport" - Documentation

In the Documentation area of "mySupport", you have the possibility to combine complete manuals or parts of them to make your own manual.
You can export the manual in PDF format or in an editable format.

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

"mySupport" - CAx Data

In the CAx Data area of "mySupport", you can have access the latest 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 in 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 in individual products.

You can 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 run commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independently of the TIA Portal.

The SIMATIC Automation Tool provides a multitude of functions:

- Scanning of a PROFINET/Ethernet network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the data and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- Operating mode switchover RUN/STOP
- Localization of the CPU by means of LED flashing
- Reading out CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Updating the firmware 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

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

- The topology overview independently scans PROFINET 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

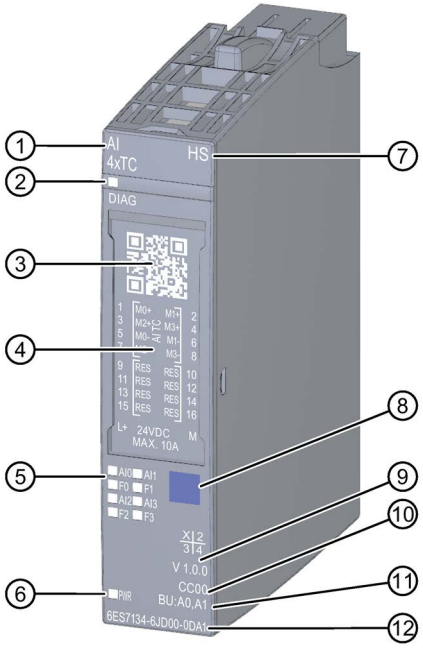
2

2.1 Properties

Article number

6ES7134-6JD00-0DA1

View of the module



① Module type and name
② LED for diagnostics
③ 2D matrix code
④ Wiring diagram
⑤ LEDs for channel status
⑥ LED for supply voltage
⑦ Function class
⑧ Color coding module type
⑨ Function and firmware version
⑩ Color code for selecting the color identification labels
⑪ BU type
⑫ Article number

Figure 2-1 View of the module AI 4×TC HS

Properties

The module has the following technical properties:

- Analog input module with 4 inputs
- Resolution: Up to 16 bits including sign
- Limited exchange compatibility with analog input module AI 4xRTD/TC 2-/3-/4-wire HF (6ES7134-6JD00-0CA1), see section Spare part compatibility (Page 12)
- Voltage measurement type can be set per channel
- Thermocouple (TC) measurement type can be set per channel
- Configurable diagnostics for each channel
- Configurable wire break check per channel
- Hardware interrupt on limit violation can be set per channel (two high and two low limits per channel)

The module supports the following functions:

Table 2- 1 Version dependencies of the functions

Function	STEP 7	GSD file	
	TIA Portal	PROFINET IO	PROFIBUS DP
Outlier suppression	as of V15 with HSP 0265	X	X[1]
Firmware update	as of V15 with HSP 0265	X	X
Identification data I&M0 to I&M3	as of V15 with HSP 0265	X	X
Calibration in runtime	as of V15 with HSP 0265	X	X
Module-internal shared input (MSI)	as of V15 with HSP 0265	X	-
REAL representation	as of V15 with HSP 0265	X	-
Scalable measuring range	as of V15 with HSP 0265	X	-
Configuration in RUN	as of V15 with HSP 0265	X	X
Value status (PROFINET IO only)	as of V15 with HSP 0265	X	-

[1] Outlier suppression is always enabled for configuration with the PROFIBUS GSD file. You can set this parameter via data record 128.

You can configure the module with STEP 7 and with a GSD file.

Accessories

The following accessories must be ordered separately:

- Labeling strips
- Color identification labels
- Reference identification label
- Shield connection

See also

You can find more information on accessories in the ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual.

2.2 Spare part compatibility

Replacement of an AI 4xRTD/TC 2-/3-/4-wire HF (6ES7134-6JD00-0CA1)

With an AI 4xTC HS (6ES7134-6JD00-0DA1), you can replace an AI 4xRTD/TC 2-/3-/4-wire HF (6ES7134-6JD00-0CA1), that is configured for the "Thermocouple" or "Voltage" measuring ranges.
You do not have to perform new configuration or new wiring. The "Outlier suppression" function is enabled. You can find additional information on outlier suppression in the section Explanation of parameters (Page 19), "Outlier suppression" section.

Note

Restricted measuring range functionality

The AI 4xTC HS module (6ES7134-6JD00-0DA1) does not support RTD and resistance measuring ranges. If you have configured these measuring ranges, the parameter assignment is rejected with the diagnostic message "Parameter assignment error".

Wiring

3

3.1 Wiring and block diagram

This section includes the block diagram of the AI 4×TC HS module with the terminal assignments.

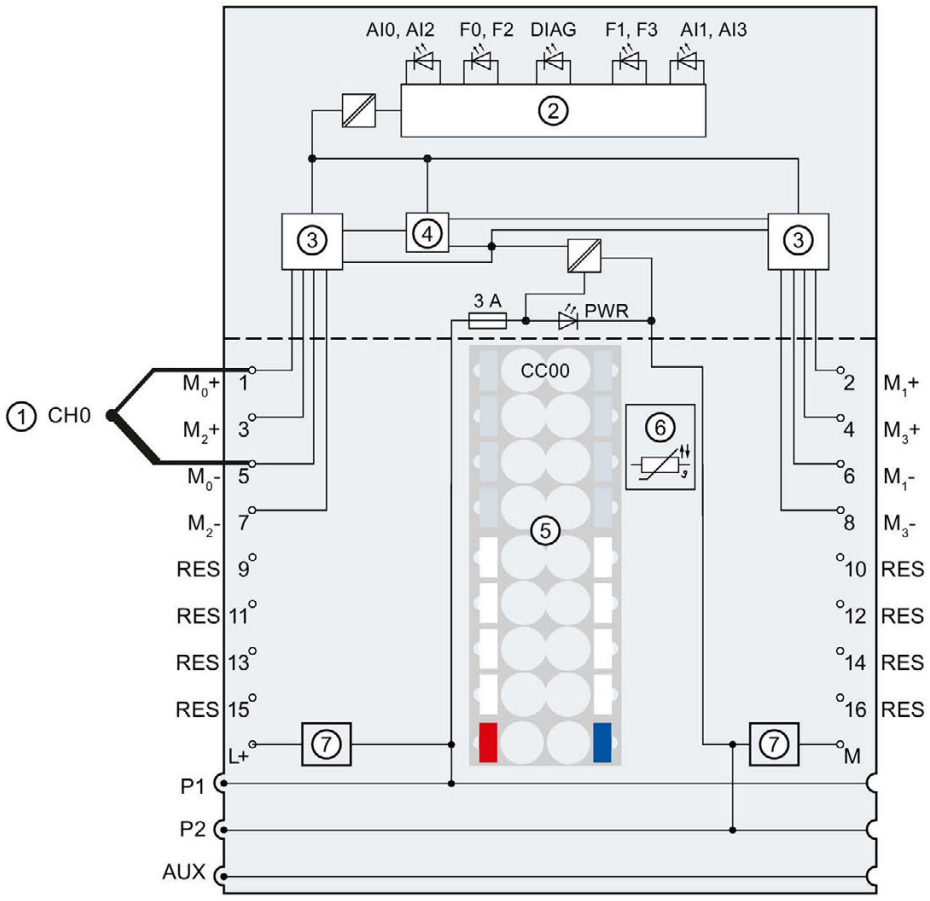
You can find information on wiring the BaseUnit in the ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual.

Note

The load group of the module must begin with a light-colored BaseUnit. Keep this in mind also during the configuration.

Wiring: 2-wire connection for thermocouples

The following figure shows the block diagram and an example of the terminal assignment of the analog input module AI 4×TC HS on the BaseUnit BU type A0/A1.



①	2-wire connection of thermocouples	M_n+	Measuring line positive, channel n
		M_n-	Measuring line negative, channel n
②	Backplane bus interface	L+	24 V DC (feed for light-colored BaseUnit only)
③	Multiplexer	P1, P2, AUX	Internal self-assembling voltage buses Connection to left (dark-colored BaseUnit) Connection to left interrupted (light-colored BaseUnit)
④	Analog-to-digital converter (ADC)	DIAG	Diagnostics LED (green, red)
⑤	Color-coded label with color code CC00 (optional)	AI0 to AI3	Channel status LED (green)
⑥	Temperature recording for BU type A1 only	F0 to F3	Channel fault LED (red)
⑦	Filter connection supply voltage (only when light-colored BaseUnit is present)	PWR	Power LED (green)

Figure 3-1 Wiring and block diagram for connection of thermocouples

Parameters/address space

4

4.1 Measurement types and measuring ranges

The following table lists the measuring range you can set for each measuring type:

Table 4- 1 Measurement types and measuring ranges

Measurement type	Measuring range
Deactivated	–
Thermocouple (TC)	Type E, N, J, K, L, S, R, B, T, C, U, TXK (acc. to GOST)
Voltage	±50 mV / ±80 mV / ±250 mV / ±1 V

See also

Technical specifications (Page 42)

4.2 Parameters

Parameters of the AI 4xTC HS

Specify the module properties with the various parameters in the course of your STEP 7 configuration. 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 an ET 200SP CPU
- Distributed operation on PROFINET IO in an ET 200SP system
- Distributed operation with PROFIBUS DP in an ET 200SP system

When assigning parameters in the user program, use the WRREC instruction to transfer the parameters to the module by means of data records, see section Parameter assignment and structure of parameter data record (Page 51). The following parameter settings are possible:

Table 4- 2 Configurable parameters and their defaults (GSD file)

Parameter	Value range	Default	Reconfiguration 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+	• Disable • Enable	Disable	Yes	Channel	Channel
Diagnostics: Reference junction	• Disable • Enable	Disable	Yes	Channel	Module
Diagnostics: Overflow	• Disable • Enable	Disable	Yes	Channel	Module
Diagnostics: Underflow	• Disable • Enable	Disable	Yes	Channel	
Wire break check	• Disable • Enable	Enable	Yes	Channel	Module
Diagnostics: Wire break	• Disable • Enable	Disable	Yes	Channel	Channel
Type/range of measurement	• Deactivated • Voltage – ±50 mV – ±80 mV – ±250 mV – ± 1 V • Thermocouple – Type B (PtRh-PtRh) – Type N (NiCrSi-NiSi) – Type E (NiCr-CuNi) – Type R (PtRh-Pt) – Type S (PtRh-Pt) – Type J (Fe-CuNi) – Type L (Fe-CuNi) – Type T (Cu-CuNi) – Type K (NiCr-NiAl) – Type U (Cu-CuNi) – Type C (WRe-WRe) – Type TXK	Type K (NiCr-NiAl)	Yes	Channel	Channel

Parameter	Value range	Default	Reconfiguration in RUN	Scope with configuration software e.g. STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
Outlier suppression [1]	• Disable • Enable	Enable	Yes	Channel	Cannot be changed
Temperature unit	• Degrees Celsius • Degrees Fahrenheit • Kelvin	Degrees Celsius	Yes	Channel	Module
Reference junction [2]	• Internal reference junction [4] • Reference channel of group 0 • Reference channel of group 1 • Reference channel of group 2 • Reference channel of group 3 • Fixed reference temperature	Fixed reference temperature	Yes	Channel	Channel
Fixed reference temperature	Temperature	0 °C	Yes	Channel	-
Smoothing	• None • Weak • Medium • Strong	None	Yes	Channel	Channel
Interference frequency suppression [1]	• 60 Hz • 50 Hz [3] • 16.6 Hz • None	50 Hz	Yes	Channel	Module
Scalable measuring range [1]	• Disable • Enable	Disable	Yes	Channel	-
Measuring range resolution [1]	• 2 decimal places • 3 decimal places	2 decimal places	Yes	Channel	-
Measuring range center [1]	• Value within the nominal range of the measuring range	0	Yes	Channel	-
Hardware interrupt high limit 1 [1]	• Disable • Enable	Disable	Yes	Channel	-

Parameter	Value range	Default	Reconfiguration in RUN	Scope with configuration software e.g. STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP
High limit 1 [1]	• Value (INT) • Value (REAL) [5]	• 13720 • 1372.0 [4]	Yes	Channel	-
Hardware interrupt low limit 1 [1]	• Disable • Enable	Disable	Yes	Channel	-
Low limit 1 [1]	• Value (INT) • Value (REAL) [5]	• -2699 • -269.9 [4]	Yes	Channel	-
Hardware interrupt high limit 2 [1]	• Disable • Enable	Disable	Yes	Channel	-
High limit 2 [1]	• Value (INT) • Value (REAL) [5]	• 13720 • 1372.0 [4]	Yes	Channel	-
Hardware interrupt low limit 2 [1]	• Disable • Enable	Disable	Yes	Channel	-
Low limit 2 [1]	• Value (INT) • Value (REAL) [5]	• -2699 • -269.9 [4]	Yes	Channel	-
Potential group	• Use potential group of the left module • Enable new potential group	Use potential group of the left module	No	Module	Module

[1] Due to the limited number of parameters at a maximum of 244 bytes per ET 200SP station with a PROFIBUS GSD configuration, the parameter assignment options are restricted. If required, you can still assign these parameters using data record 128 as described in the "GSD file PROFINET IO" column (see table above). The parameter length of the I/O module is 13 bytes.

[2] Only for configuration with PROFIBUS GSD file: The set reference junction is used with the additional parameter "Kx Reference junction activated" in the case of "Enable". In the case of "Disable", no "fixed reference temperature" is used for TC.

[3] Interference frequency suppression: Noise at 400 Hz is automatically included in the filtering at 50 Hz.

[4] Thermocouple types B and C are not suitable for reference junction temperatures below 0 °C on account of their defined characteristic curve as of 0 °C.

[5] Only for REAL representation.

Note

Unused channels

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

A disabled channel always returns the value $7FFF_H$ (REAL representation: $7F800000_H$).

4.3 Explanation of parameters

Diagnostics: Missing supply voltage L+

Enabling of the diagnostics for missing or insufficient supply voltage L+.

Diagnostics: Reference junction

Enabling of the reference junction diagnostics if the reference temperature of the reference junction needs to be determined for the TC channel being operated.

Reference junction using the PROFINET GSD file

As reference junction for the TC measurement, a BaseUnit with internal temperature sensor (BU..T) or the reference channel of the group 0, 1, 2, 3 can be used.

A possible parameter assignment is represented below:

Table 4- 3 TC channel

Setting	Description
Internal reference junction	The reference junction temperature is read by an internal temperature sensor on the BaseUnit. Diagnostics: Reference junction is triggered if there is an incorrect BaseUnit type.
Reference channel of group 0, 1, 2, 3	The channel acts as a **receiver** for the reference junction temperature of a group.
Fixed reference temperature	The reference temperature of the thermocouple is set to 0 °C. As a result, no temperature compensation is performed.

Note

Shared Device and "Reference channel of group 0, 1, 2, 3"

If the transmitter and receiver for the reference junction temperature of a group are assigned to different IO controllers, then both IO controllers must be performing data exchange with the IO device to ensure error-free operation of the temperature compensation.

Reference junction using the PROFIBUS GSD file

As reference junction for the TC measurement, a BaseUnit with internal temperature sensor (BU..T) or the reference channel of the group 0, 1, 2, 3 can be used.

Table 4- 4 **TC channel**

Setting	Description
Internal reference junction	The reference junction temperature is read by an internal temperature sensor on the BaseUnit. Diagnostics: Reference junction is triggered if there is an incorrect BaseUnit type.
Reference channel of group 0, 1, 2, 3	The channel acts as a **receiver** for the reference junction temperature of a group.
Fixed reference temperature	The reference temperature of the thermocouple is set to 0 °C. As a result, no temperature compensation is performed.

Setting	Description
Channel x Reference junction activated	• Disable: Channel x is configured with the setting "Fixed reference temperature". • Enable: Channel x is configured with the setting selected above.

Diagnostics: Overflow

Enabling of the diagnostics when the measured value exceeds the overrange.

Diagnostics: Underflow

Enabling of the diagnostics if the measured value falls below the underrange.

Wire break check

Enable for wire break check. The module only detects an interruption at the input when the wire break check is activated.

Diagnostics: Wire break

Enabling of the diagnostics, if the module detects interruption at the corresponding configured input.

Type/range of measurement

See section Measurement types and measuring ranges (Page 15).

Outlier suppression

Suppresses interference pulses in analog input modules that can be 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. These limits are dynamically adjusted when the distribution of the measured values changes. New measured values that lie outside the determined limits are suppressed, i.e. the last value is kept.
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.

Temperature unit

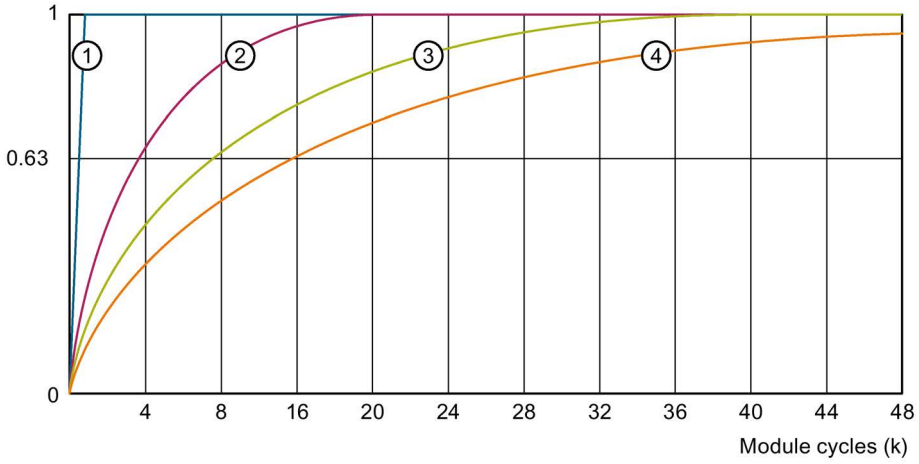
Selection between Degrees Celsius, Fahrenheit and Kelvin as the temperature unit for the selected measuring range.

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



① No smoothing (k = 1)
② Weak (k = 4)
③ Medium (k = 8)
④ Strong (k = 16)

Figure 4-1 Smoothing with AI 4×TC HS

Interference frequency suppression

Suppresses the interferences affecting analog input modules that are caused by the frequency of the AC voltage network used.

The frequency of the AC voltage network is likely to have a negative effect on measured values particularly with measurement in the low voltage range and on thermocouples. With this parameter, the user specifies the line frequency that is predominant in the plant.

Measuring range resolution

Parameters for the thermocouple measurement type.

Allows you to increase the resolution to 2 or 3 decimal places for a configurable section of the measuring range. See section Scalable measuring range (Page 23).

Measuring range center

Determines the temperature over which the scalable measuring range is symmetrically spanned. The value must be within the nominal range of the underlying measuring range. It is specified in integers.

Maximum / Minimum

Corresponds to overflow / underflow for the scalable measuring range.

Hardware interrupt enable

Enabling of a hardware interrupt if the high limit 1/2 or the low limit 1/2 is violated.

Low limit 1/2

Specify a threshold which triggers a hardware interrupt when violated.

High limit 1/2

Specify a threshold which triggers a hardware interrupt when violated.

Potential group

Specifies that a BaseUnit with incoming voltage supply is located on this slot (see system manual ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293)).

4.4 Scalable measuring range

Introduction

The scalable measuring range is available for the temperature measuring ranges of thermocouples. The measuring ranges for voltage are not supported.

The scalable measuring range is valid for the following ranges:

- Nominal range
- Underrange
- Overrange

Function

The scalable measuring range is a limited section of a measuring range supported by the module.

It allows you to increase the resolution for a configurable section.

- The "Measuring range resolution" parameter determines the resolution to 2 or 3 decimal places.
- The "Measuring range center" parameter determines the temperature over which the scalable measuring range is symmetrically spanned.

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 an absolute temperature, the measuring range center in the application program (as offset) must be calculated with the value of the user data of the scalable measuring range.

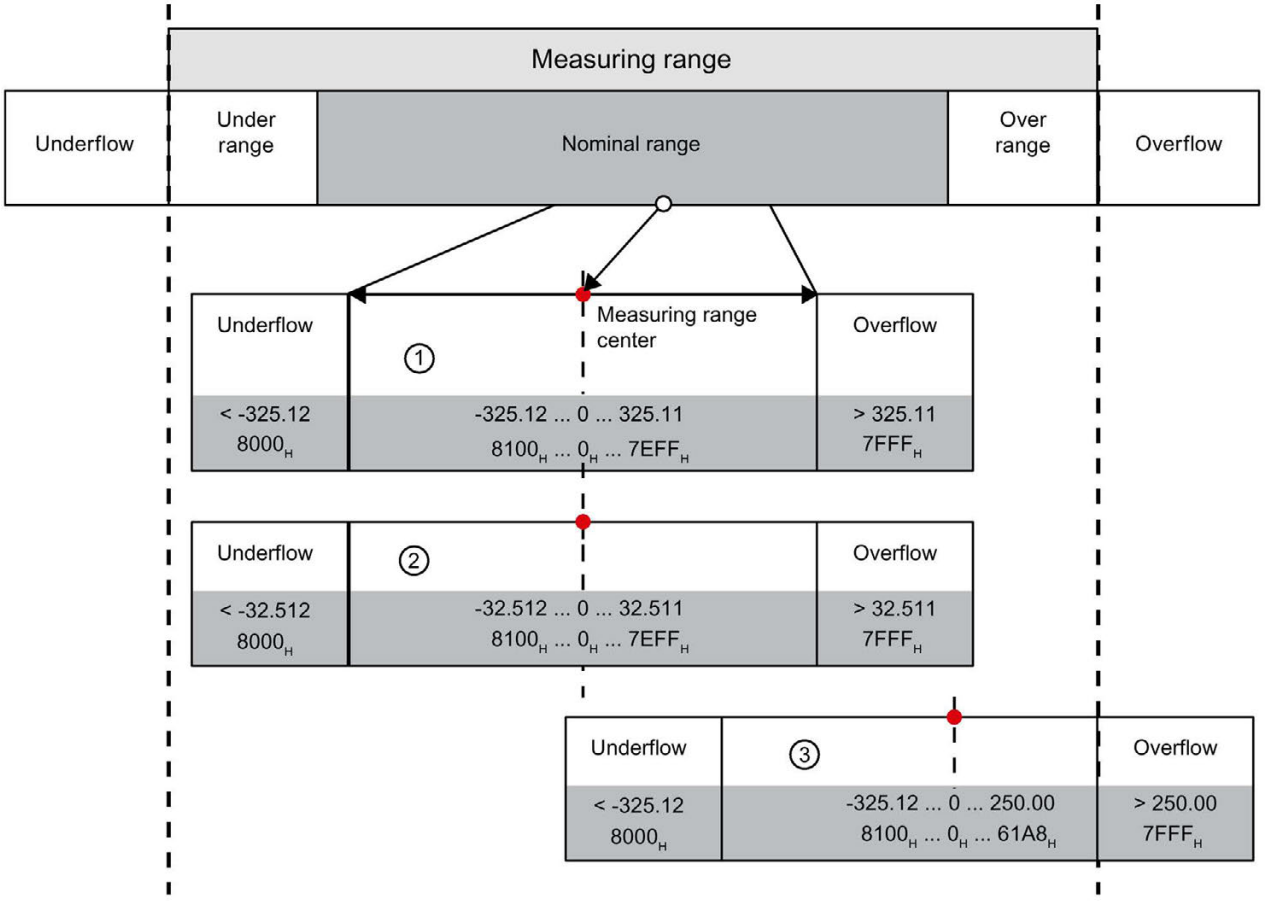
The measuring range center is always output in the user data as the value "0". The user data are correspondingly mapped to the bipolar input ranges in S7 format. Underflow / overflow is also formed in accordance with the limits of S7.

Rules

- The measuring range center must be within the nominal range of the underlying measuring range. It 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:
  - It is clipped at the underflow when it falls below the limit.
  - It is clipped at the overflow when it exceeds the limit (③).

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

4.4.1 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:

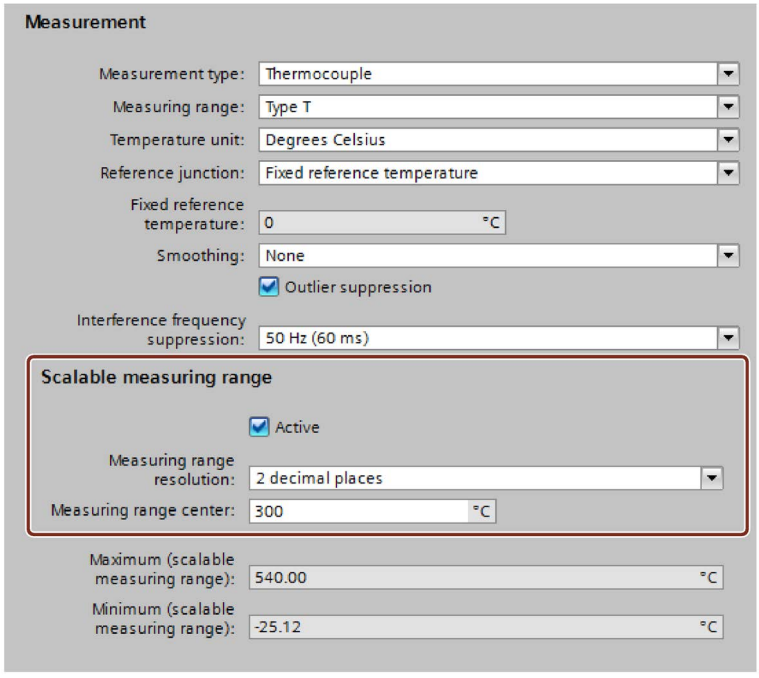


Figure 4-3 Configuration for the scalable measuring range

Reference

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

4.4.2 Evaluate status and limits of scalable measuring range

Evaluation in the user program

In the user program, you can evaluate the status and the limits of the scalable measuring range with data record 235, which may result by reaching underflow/overflow.

Structure of data record 235

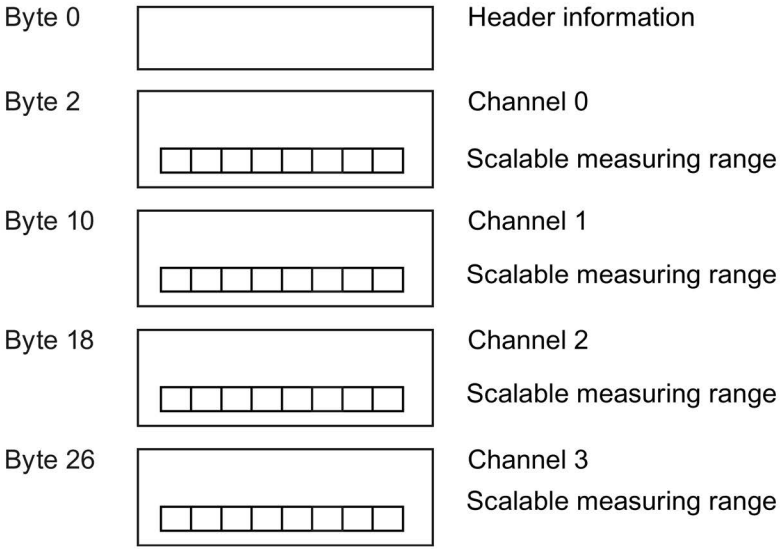


Figure 4-4 Structure of data record 235

Header information

The figure below shows the structure of the header information.

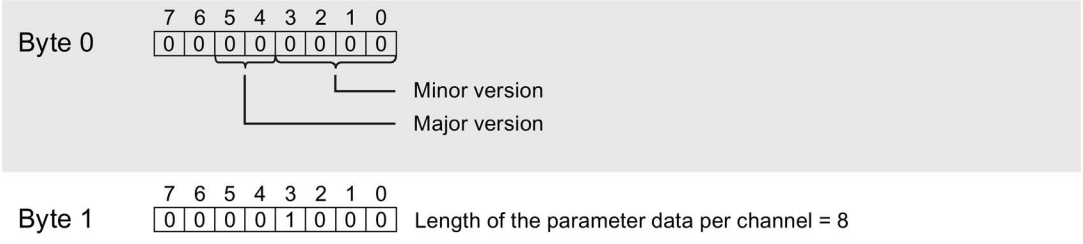


Figure 4-5 Header information of data record 235

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)

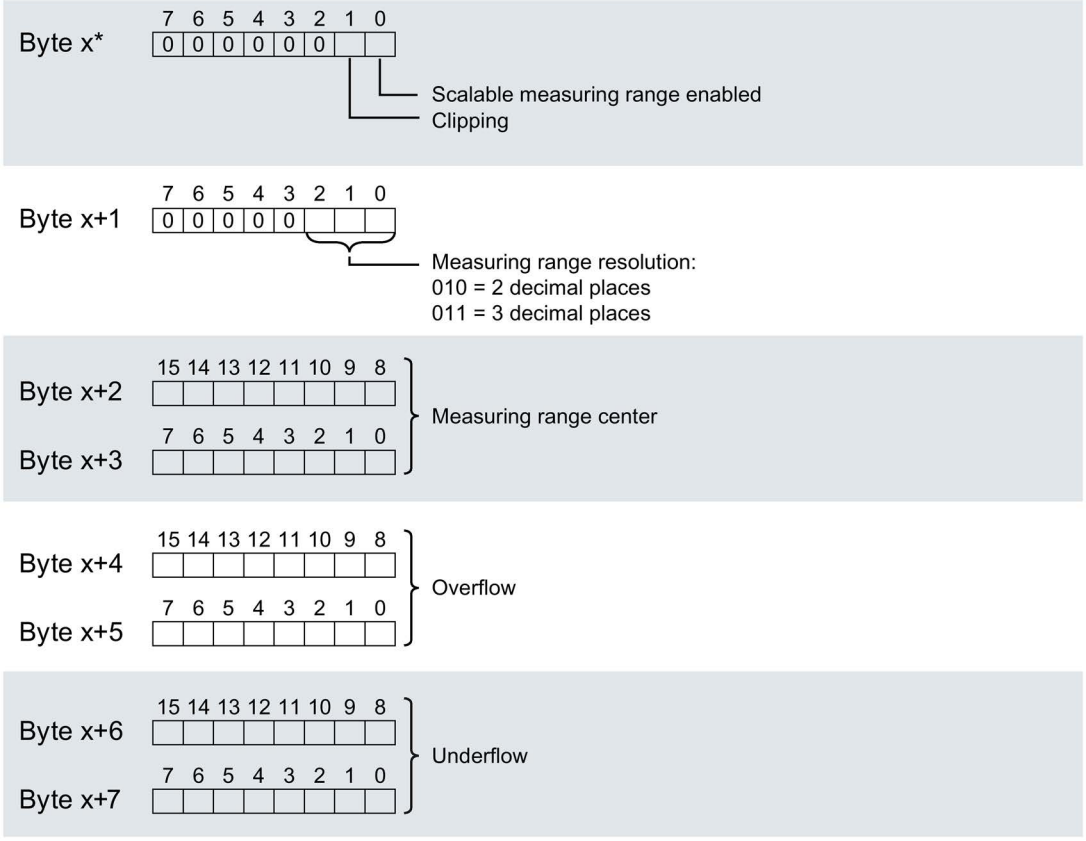


Figure 4-6 Structure of data record 235 - channel parameter byte x to x+7

Description of the parameters

Table 4- 6 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 24)).
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 thermocouple type T:

Table 4- 7 Example of thermocouple type T

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
$012C_H$	300	Measuring range center: 300 °C
$5DC0_H$	24000	Overflow (Maximum): 240.**00** + 300 = 540.00 °C Scalable measuring range is clipped at the overflow.
8100_H	-32512	Underflow (Minimum): -325.**12** + 300 = -25.12 °C

4.5 REAL representation

Special features of REAL representation

If you have configured the module with REAL representation, the user data and hardware interrupt limits are displayed in REAL data format (32-bit floating point number) instead of S7 format.

The representation of the measured values in the REAL representation is always related to a physical unit, unlike in S7 representation.
This physical unit results from the measuring range you have set. For temperature ranges, the physical unit is determined by the "Temperature unit" parameter.

REAL representation has no influence on the overranges or underranges, the overflow or underflow diagnostics, or the QI characteristics.

Note

Substitute value for REAL representation

With REAL representation, the overflow of the substitute value $7F800000_H$ is output, for underflow it is substitute value $FF800000_H$.

Examples

The following examples show value ranges of different measuring ranges in REAL representation:

Table 4- 8 Value range in REAL representation

Measuring range	Value range	Unit
Voltage ±1 V	- 1.0 V to + 1.0 V	V
Voltage ± 50 mV	- 50.0 mV to + 50.0 mV	mV
Thermocouple type K	- 270.00 °C to +1372.00 °C	Configured temperature unit (°C, °F, K)

4.6 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 input.

Configuration options of AI 4xTC HS

You can configure the module with STEP 7 (TIA Portal) or with a GSD file. If you configure the module by means of a GSD file, the configurations are available under various short designations/module names; see the table below. The following configurations are possible:

Table 4- 9 Configuration options with GSD file

Configuration	Short designation/module name in the GSD file	Configuration software, e.g. with STEP 7 (TIA Portal)		
		Integrated in the hardware catalog STEP 7, as of V15 with HSP0265	GSD file PROFINET IO	GSD file PROFIBUS DP
1 x 4-channel without value status	AI 4xTC HS V1.0	X	X	X
1 x 4-channel with value status	AI 4xTC HS V1.0, QI	X	X	---
1 x 4-channel with value status for module-internal Shared Input with up to 4 submodules	AI 4xTC HS V1.0, MSI [1]	X	X	---
1 x 4-channel with REAL representation	AI 4xTC HS V1.0, REAL	X	X	---
1 x 4-channel with REAL representation and value status	AI 4xTC HS V1.0, REAL, QI	X	X	---
1 x 4-channel with REAL representation, value status for module-internal Shared Input up to 4 submodules	AI 4xTC HS V1.0, REAL, MSI [1]	X	X	---

[1] When using the module in a shared device, ensure that you only configure associated MSI submodules for a basic submodule.

Value status (Quality Information, QI)

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

- AI 4xTC HS V1.0, QI
- AI 4xTC HS V1.0, MSI
- AI 4xTC HS V1.0, REAL, QI
- AI 4xTC HS V1.0, REAL, MSI

Evaluating the value status

An additional byte is occupied in the input address space if you enable the value status for the analog module. Bits 0 to 3 in this byte are assigned to a channel. They provide information about the validity of the analog value.

Bit =1: No fault is present on the channel.

Bit = 0: The channel is disabled or the wiring, the value created on the channel, etc. is incorrect.

Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, QI

The following figure shows the assignment of the address space with value status (Quality Information (QI)). The addresses for the value status are only available if the value status is enabled.

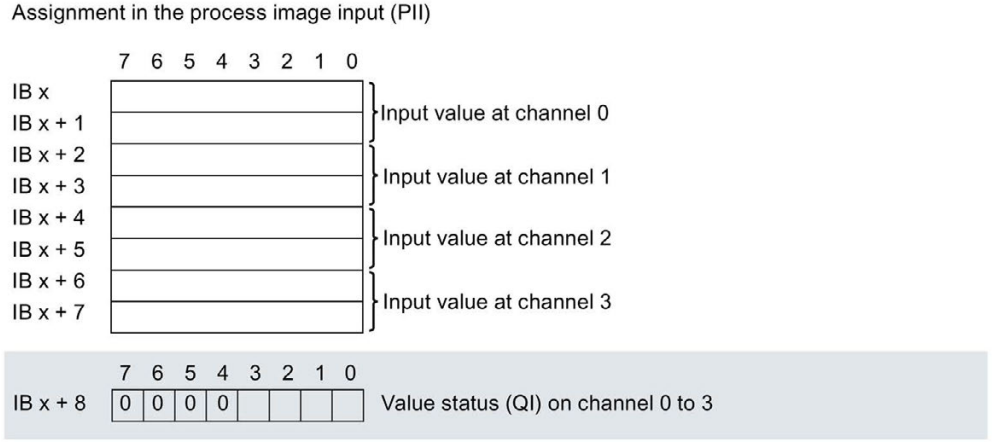


Figure 4-7 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, QI with value status

Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, MSI

The channels 0 to 3 of the module are copied in up to 4 submodules with configuration 1 x 4-channel module (Module-internal shared input, MSI). Channels 0 to 3 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 available submodules depends on the used interface module. 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 first 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).

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

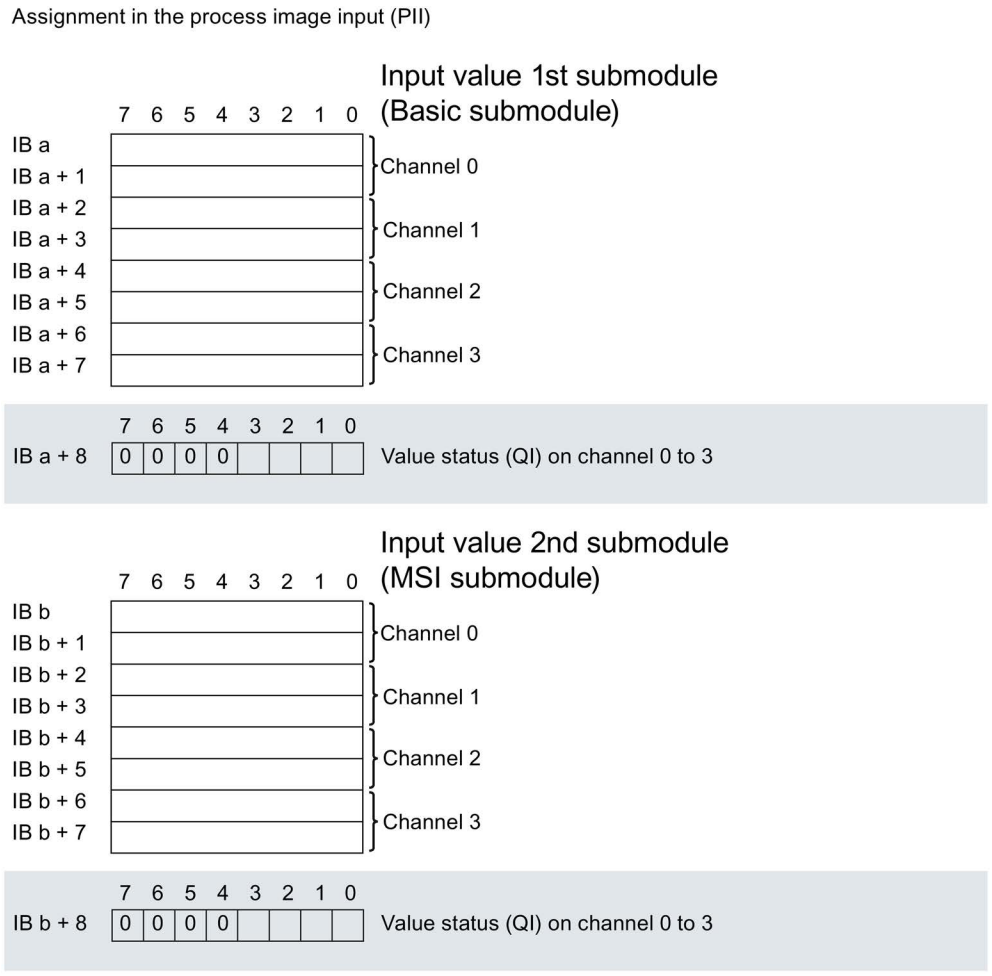


Figure 4-8 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, MSI with value status, submodule 1 and 2

The figure below shows the assignment of the address space with submodules 3 and 4.

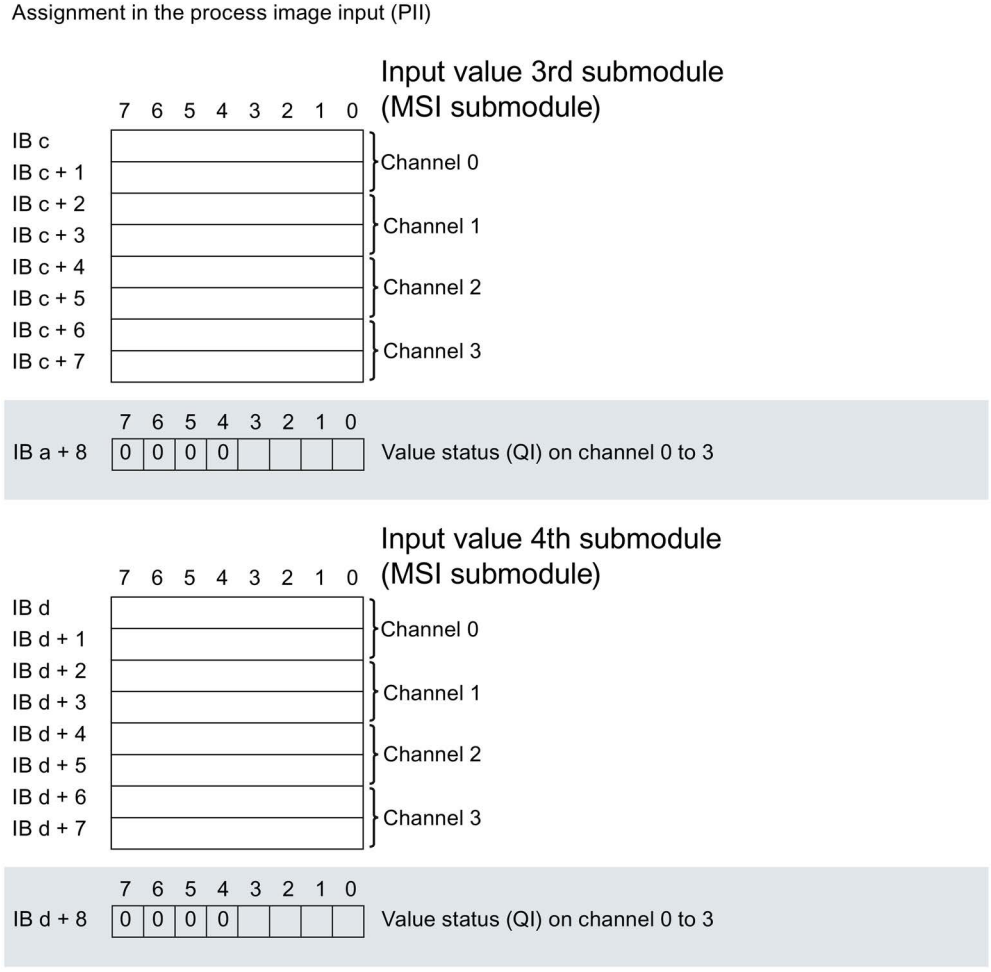


Figure 4-9 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, MSI with value status, submodule 3 and 4

Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, REAL, QI

The following figure shows the assignment of the address space in REAL representation with value status (Quality Information (QI)). In REAL representation, each channel occupies 4 bytes in the process image of the inputs.
The addresses for the value status are only available if the value status is enabled.

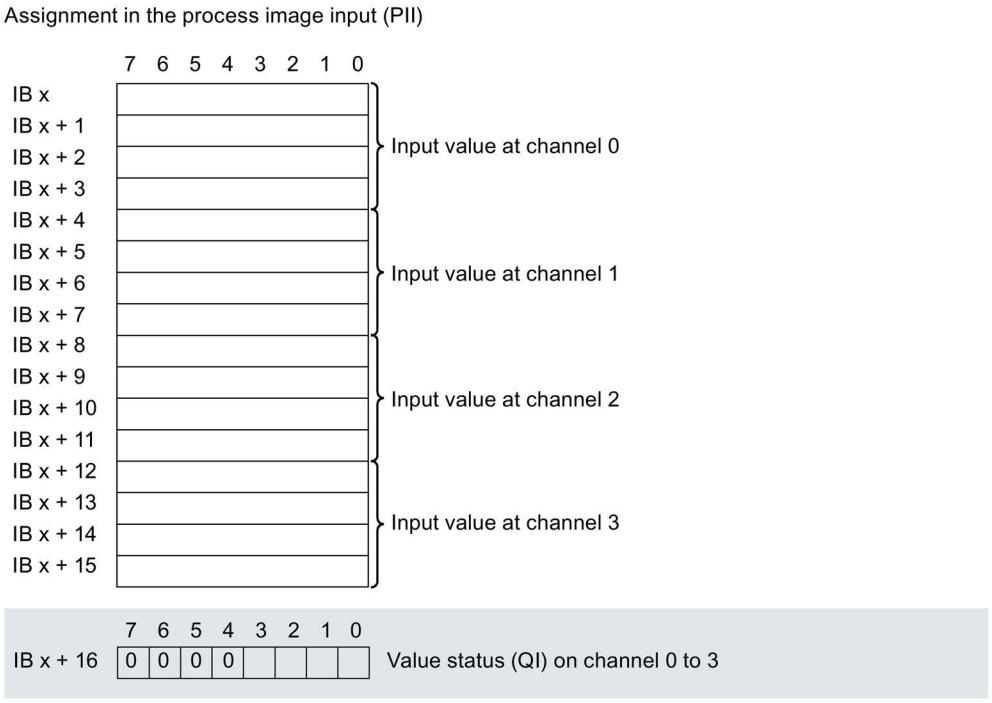


Figure 4-10 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, REAL, QI with value status

Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, REAL, MSI

For the configuration as a 1 x 4-channel module REAL MSI, the channels react as in the 1 x 4-channel AI 4xTC HS V1.0, MSI configuration.
In REAL representation, each channel occupies 4 bytes in the process image of the inputs.

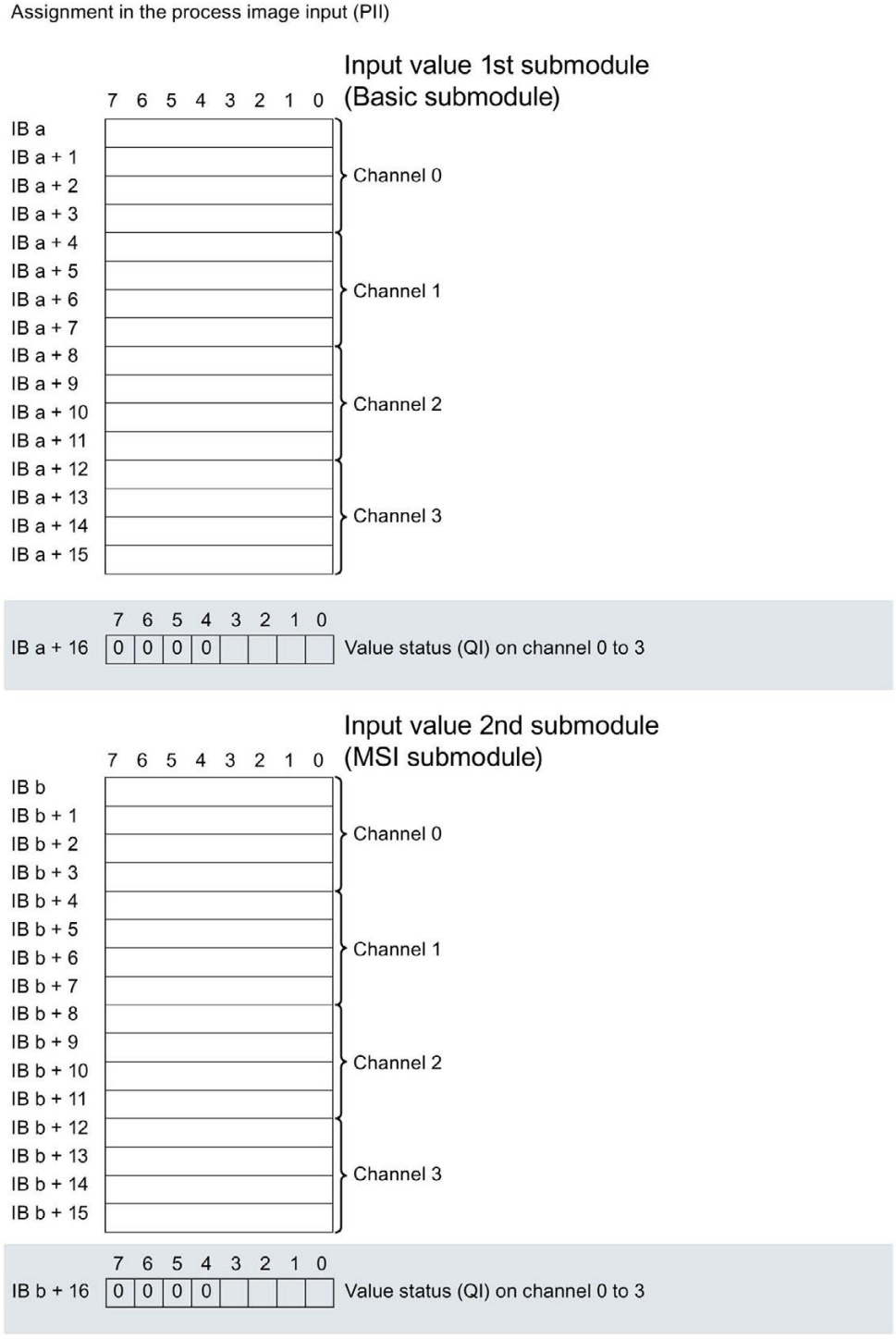


Figure 4-11 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, REAL, MSI with value status, submodule 1 and 2

The figure below shows the assignment of the address space with submodules 3 and 4.

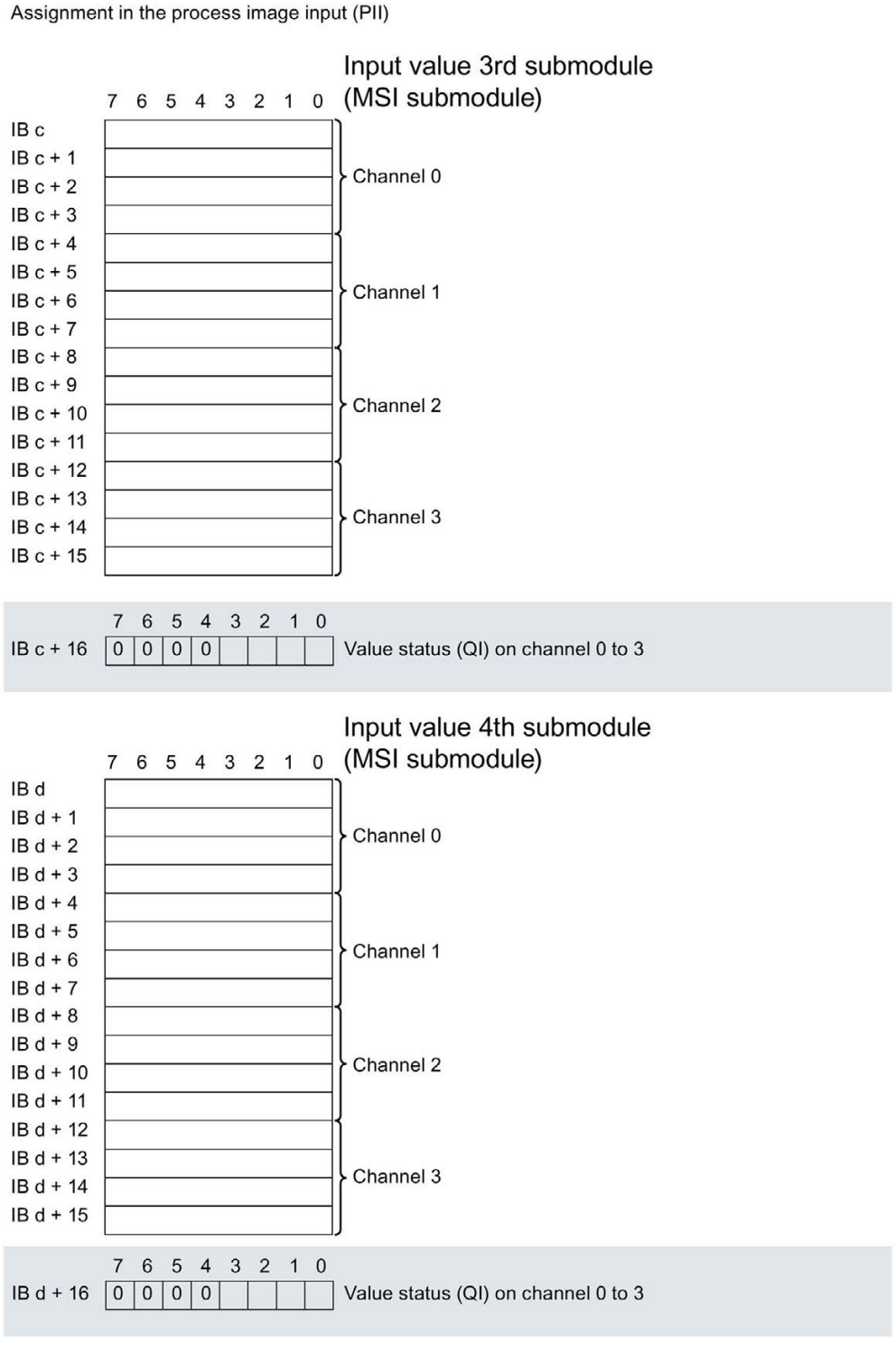


Figure 4-12 Address space for configuration as 1 x 4-channel AI 4xTC HS V1.0, REAL, MSI with value status, submodule 3 and 4

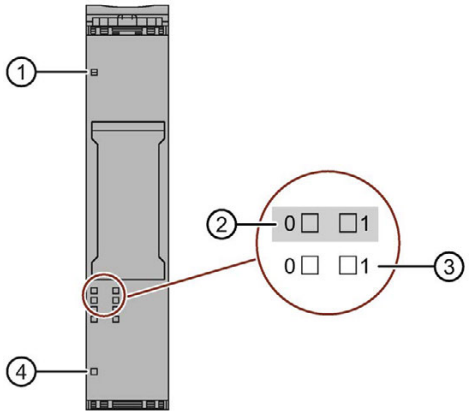
Interrupts/diagnostics alarms

5

5.1 Status and error display

LED display

The following figure shows you the LED display of the AI 4xTC HS:



① DIAG (green/red)
② Channel status (green)
③ Channel error (red)
④ PWR (green)

Figure 5-1 LED display

Meaning of the LED displays

The following tables contain the meaning of the status and error displays. Remedies for diagnostics alarms can be found in section Diagnostics alarms (Page 40).

LED DIAG

Table 5- 1 LED DIAG fault display

LED DIAG	Meaning
Off	Backplane bus supply of the ET 200SP not OK
Flashes	Module parameters not assigned
On	Module parameters assigned and no module diagnostics
Flashes	Module parameters assigned and module diagnostics

Channel status/channel error LED

Table 5- 2 Status and error display of the LED channel status / channel error

LEDs		Meaning
Channel status	Channel error	
Off	Off	Channel deactivated
On	Off	Channel activated and no channel diagnostics
Off	On	Channel activated and channel diagnostics
On	On	Not permitted (error)

PWR LED

Table 5- 3 Status display of the PWR LED

PWR LED	Meaning
Off	Supply voltage L+ missing
On	Supply voltage L+ present

5.2 Interrupts

Evaluating hardware interrupts with IO controller

The module generates a hardware interrupt at the following events:

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

You can obtain detailed information on the event in the hardware interrupt organization block with the "RALARM" (read additional interrupt information) instruction and in the STEP 7 online help.

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

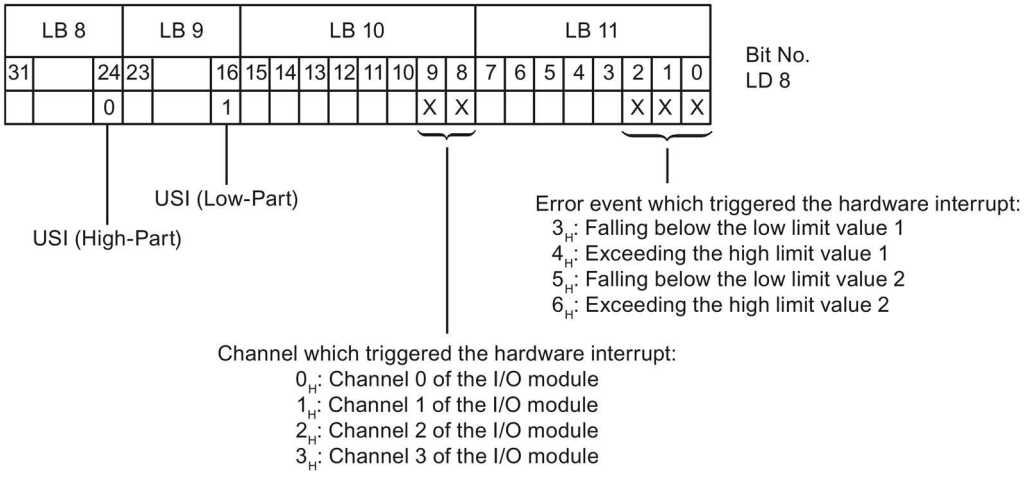


Figure 5-2 OB start information

Structure of the additional interrupt information

Table 5- 4 Structure of the additional interrupt information

Data block name		Content	Comment	Bytes
USI (User Structure Identifier)		W#16#0001	additional interrupt information for hardware interrupts of the I/O module	2
Channel that triggered the hardware interrupt.				
	Channel	B#16#00 to B#16#03	Channel 0 to 3 of the I/O module	1
Event that triggered the hardware interrupt.				
	Event	B#16#03	Violation of low limit 1	1
		B#16#04	Violation of high limit 1	
		B#16#05	Violation of low limit 2	
		B#16#06	Violation of high limit 2	

Diagnostic error interrupt

The module generates a diagnostic error interrupt at the following events:

- Channel temporarily unavailable
- Hardware interrupt lost
- Reference channel error
- Error
- Violation of low limit
- Violation of high limit
- Wire break
- Supply voltage missing
- Parameter assignment error

5.3 Diagnostics alarms

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

Table 5- 5 Diagnostics alarms, their meaning and remedies

Diagnostics alarms	Error code	Meaning	Solution
Wire break	6_H	Resistance of sensor circuit too high	Use a different sensor 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)	• Deactivate diagnostics • Connect or deactivate the channel
Violation of high limit[1]	7_H	Value lies above the overrange.	Correct module/sensor interplay
Violation of low limit[1]	8_H	Value lies below the underrange.	Correct module/sensor interplay
Error	9_H	Internal module error has occurred (diagnostics alarm on channel 0 applies to the entire module).	Replace module
Parameter assignment error	10_H	The module cannot evaluate parameters for the channel. Incorrect parameter assignment.	Correct the parameter assignment (wire break diagnostics only allowed with the permitted measuring ranges).
Supply voltage missing	11_H	Missing or insufficient supply voltage L+	• Check supply voltage L+ on the BaseUnit • Check BaseUnit type

Diagnostics alarms	Error code	Meaning	Solution
Reference channel error (reference junction)	15_H	Reference temperature of the reference junction for the TC channel being operated with compensation is invalid.	• Check BaseUnit type • Select correct reference junction through parameter assignment[2] • Check whether the reference junction (reference channel of the group 0, 1, 2, 3) is only assigned once as the sender in the entire setup.
Hardware interrupt lost	16_H	At least one hardware interrupt could not be signaled because too many hardware interrupts are pending.	Correct the program or the process
Channel temporarily unavailable	$1F_H$	• Firmware update is currently in progress or has been canceled. The module does not read in process values in this state. • The channel is currently being calibrated.	• Wait for firmware update. • Restart the firmware update. • Complete calibration.

1 The alarm refers to the diagnostics and depends on the configured measuring range.

2 Shared device and "Reference temperature" diagnostics: If the sender and receiver of the reference junction temperature of a group are assigned to different IO controllers, you may need to download both configurations again in the case of diagnostics. First download the configuration containing the receiver.

Technical specifications

6

Technical specifications of the AI 4xTC HS

The following table shows the technical specifications as of 03/2019. You will find a data sheet including daily updated technical specifications on the Internet (https://support.industry.siemens.com/cs/ww/en/pv/6ES7134-6JD00-0DA1/td?dl=en).

Article number	6ES7134-6JD00-0DA1
General information	
Product type designation	AI 4xTC HS
HW functional status	From FS02
Firmware version	
• FW update possible	Yes
usable BaseUnits	BU type A0, A1
Color code for module-specific color identification plate	CC00
Product function	
• I&M data	Yes; I&M0 to I&M3
• Measuring range scalable	Yes
Engineering with	
• STEP 7 TIA Portal configurable/integrated as of version	V15 with HSP 265/integrated as of V15.1
• STEP 7 configurable/integrated as of version	V5.5 SP3 or higher
• PROFIBUS as of GSD version/GSD revision	One GSD file each, Revision 3 and 5 and higher
• PROFINET as of GSD version/GSD revision	GSDML V2.3
Operating mode	
• Oversampling	No
• 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)	19.2 V
permissible range, upper limit (DC)	28.8 V
Reverse polarity protection	Yes

Article number	6ES7134-6JD00-0DA1
Input current	
Current consumption (rated value)	37 mA
Current consumption, max.	50 mA
Power loss	
Power loss, typ.	0.9 W
Address area	
Address space per module	
• Address space per module, max.	16 byte; + 1 byte for QI information
Hardware configuration	
Automatic encoding	
• Mechanical coding element	Yes
Selection of BaseUnit for connection variants	
• 2-wire connection	BU type A0, A1
Analog inputs	
Number of analog inputs	4
permissible input voltage for voltage input (destruction limit), max.	30 V
Cycle time (all channels), min.	5 ms; Sum of the basic conversion times and additional processing times (depending on the parameterization of the active channels)
Technical unit for temperature measurement adjustable	Yes; °C/°F/K
Input ranges (rated values), voltages	
• -1 V to +1 V	Yes; 16 bit incl. sign
• Input resistance (-1 V to +1 V)	1 MΩ
• -250 mV to +250 mV	Yes; 16 bit incl. sign
• Input resistance (-250 mV to +250 mV)	1 MΩ
• -50 mV to +50 mV	Yes; 16 bit incl. sign
• Input resistance (-50 mV to +50 mV)	1 MΩ
• -80 mV to +80 mV	Yes; 16 bit incl. sign
• Input resistance (-80 mV to +80 mV)	1 MΩ

Article number	6ES7134-6JD00-0DA1
Input ranges (rated values), thermocouples	
• Type B	Yes; 16 bit incl. sign
• Input resistance (Type B)	1 MΩ
• Type C	Yes; 16 bit incl. sign
• Input resistance (Type C)	1 MΩ
• Type E	Yes; 16 bit incl. sign
• Input resistance (Type E)	1 MΩ
• Type J	Yes; 16 bit incl. sign
• Input resistance (type J)	1 MΩ
• Type K	Yes; 16 bit incl. sign
• Input resistance (Type K)	1 MΩ
• Type L	Yes; 16 bit incl. sign
• Input resistance (Type L)	1 MΩ
• Type N	Yes; 16 bit incl. sign
• Input resistance (Type N)	1 MΩ
• Type R	Yes; 16 bit incl. sign
• Input resistance (Type R)	1 MΩ
• Type S	Yes; 16 bit incl. sign
• Input resistance (Type S)	1 MΩ
• Type T	Yes; 16 bit incl. sign
• Input resistance (Type T)	1 MΩ
• Type U	Yes; 16 bit incl. sign
• Input resistance (Type U)	1 MΩ
• Type TXK/TXK(L) to GOST	Yes; 16 bit incl. sign
• Input resistance (Type TXK/TXK(L) to GOST)	1 MΩ
Thermocouple (TC)	
Temperature compensation	
– parameterizable	Yes
– Reference channel of the module	No
– internal comparison point	Yes; with BaseUnit type A1
– Reference channel of the group	Yes
– Number of reference channel groups	4; Group 0 to 3
– fixed reference temperature	Yes

Article number	6ES7134-6JD00-0DA1
Cable length	
• shielded, max.	200 m; 100 m for thermocouples
Analog value generation for the inputs	
Measurement principle	integrating (Sigma-Delta)
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Integration time, parameterizable	Yes
• Basic conversion time, including integration time (ms)	
– additional processing time for wire-break check	1 ms
• Interference voltage suppression for interference frequency f1 in Hz	16.6 / 50 / 60 Hz / off
• Conversion time (per channel)	180/60/50/1.25 ms
Smoothing of measured values	
• Number of smoothing levels	4; None; 4/8/16 times
• parameterizable	Yes
• Step: None	Yes
• Step: low	Yes
• Step: Medium	Yes
• Step: High	Yes
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.01 %
Temperature error (relative to input range), (+/-)	0.005 %/K
Crosstalk between the inputs, min.	-70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.03 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.1 %; 0.3 % when SFU OFF
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.05 %; 0.2 % when SFU OFF

Article number	6ES7134-6JD00-0DA1
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	70 dB
• Common mode voltage, max.	60 V; DC
• Common mode interference, min.	90 dB
Isochronous mode	
Isochronous operation (application synchronized up to terminal)	No
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; channel by channel
• Group error	Yes
• Overflow/underflow	Yes; channel by channel
Diagnostics indication LED	
• Monitoring of the supply voltage (PWR-LED)	Yes; green PWR LED
• Channel status display	Yes; Green LED
• for channel diagnostics	Yes; Red LED
• for module diagnostics	Yes; Green/red LED
Potential separation	
Potential separation channels	
• between the channels	No
• 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)	60 V DC
Isolation	
Isolation tested with	707 V DC (type test)

Article number	6ES7134-6JD00-0DA1
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
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-30 °C
• horizontal installation, max.	60 °C
• vertical installation, min.	-30 °C
• vertical installation, max.	50 °C
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	2 000 m; On request: Installation altitudes greater than 2 000 m
Dimensions	
Width	15 mm
Height	73 mm
Depth	58 mm
Weights	
Weight, approx.	33 g

Operational and basic error limits for thermocouples

Error limits for thermocouples[1] (Interference frequency suppression: 16.6 Hz / 50 Hz / 60 Hz)	
Operational limit for thermocouples (in the entire temperature range)	±1.5 K
Basic error limit for thermocouples (operational limit at 25 °C)	±1 K
Overall error limits when using internal compensation	
• Operational limit (in the entire temperature range at static thermal state, ambient temperature change < 0.3 K/min)	± 2.5 K
• Basic error limit (operational limit at 25 °C at static thermal state, ambient temperature change < 0.3 K/min)	±1.5 K

[1] The indicated error limits apply as of the following temperatures:
Thermocouple type T: -200 °C
Thermocouple type K: -100 °C
Thermocouple type B: +700 °C
Thermocouple type N: -150 °C
Thermocouple type E: -150 °C
Thermocouple type R: +200 °C
Thermocouple type S: +100 °C

Error limits for thermocouples[1] (Interference frequency suppression: None)	
Operational limit for thermocouples (in the entire temperature range)	±3.75 K
Operational limit for thermocouples type B, C, E, R, S (in the entire temperature range)[1]	±7.5 K
Basic error limit for thermocouples (operational limit at 25 °C)	± 2.5 K
Basic error limit for thermocouples type B, C, E, R, S (operational limit at 25 °C)	±5 K
Overall error limits when using internal compensation	
• Operational limit (in the entire temperature range at static thermal state, ambient temperature change < 0.3 K/min)[2]	±5.25 K
• Basic error limit (operational limit at 25 °C at static thermal state, ambient temperature change < 0.3 K/min)[3]	±3 K

1 The indicated error limits apply as of the following temperatures:
Thermocouple type T: -200 °C
Thermocouple type K: -100 °C
Thermocouple type B: +700 °C
Thermocouple type N: -150 °C
Thermocouple type E: -150 °C
Thermocouple type R: +200 °C
Thermocouple type S: +100 °C

2 For thermocouple type B, C, E, R, S: ±9 K

3 For thermocouple type B, C, E, R, S: ±5.5 K

Dimension drawing

See equipment manual ET 200SP BaseUnits
(http://support.automation.siemens.com/WW/view/en/58532597/133300)

Parameter data records

A

A.1 Dependencies when configuring with GSD file

When configuring the module with a GSD file, remember that the settings of some parameters are dependent on each other.

Configuring with a PROFINET GSD file

The table lists the properties and their dependencies on the measurement type and measuring range for PROFINET.

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

Measurement type	Measuring range	Reference junction	Temperature unit
Deactivated	*	*	*
Voltage	±50 mV, ±80 mV, ±250 mV, ±1 V	*	*
Thermocouple	Type B, N, E, R, S, J, L, T, K, U, C, TXK	Internal reference junction Reference channel of group 0, 1, 2, 3[1]	Degrees Celsius Degrees Fahrenheit Kelvin
		Fixed reference temperature	

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

[1] Use of "Reference channel of group 0, 1, 2, 3":
For each TC channel in the IO device that is intended to use this reference, "Reference junction" must be set to "Reference channel of group 0, 1, 2, 3".

Configuring with a PROFINET GSD file

The table lists the properties and their dependencies on the measurement type for PROFINET.

Table A- 2 Dependencies on the measurement type

Measurement type	Scalable measuring range	Measuring range resolution	Wire break check	Diagnostics				
				Underflow	Overflow	Wire break	Missing supply voltage L+	Reference junction
Deactivated	*	*	*	*	*	*	*	*
Voltage	–	*	-	x	x	–	x	–
Thermocouple	x	2 and 3 decimal places	x	x	x	x[1]	x	x[2]

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

1 Property is only permitted if the "Wire break check" parameter is enabled.

2 Property is not relevant when "Fixed reference temperature" is used.

Configuring with a PROFIBUS GSD file

The table lists the properties and their dependencies on the measurement type and measuring range for PROFIBUS.

Table A- 3 Dependencies of the measurement type / measuring range

Measurement type	Measuring range	Slot reference junction	Temperature unit	Wire break check	Diagnostics			
					Underflow / overflow	Wire break	Missing supply voltage L+	Reference junction
Deactivated	*	*	*	*	*	*	*	*
Voltage	±50 mV, ±80 mV, ±250 mV, ±1 V	*	*	-	x	–	x	–
Thermocouple	Type B, N, E, R, S, J, L, T, K, U, C, TXK	Internal reference junction Reference channel of group 0, 1, 2, 3[1]	Degrees Celsius Degrees Fahrenheit Kelvin	x	x	x[2]	x	x
		Fixed reference temperature	Degrees Celsius Degrees Fahrenheit Kelvin	x	x	x[2]	x	*

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

1 Use of "Reference channel of group 0, 1, 2, 3":
For each TC channel in the IO device that is intended to use this reference, "Reference junction" must be set to "Reference channel of group 0, 1, 2, 3".

2 Property is only allowed if the "Wire break check" is enabled.

A.2 Parameter assignment and structure of the parameter data record (S7 representation)

The data record of the module has an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO. With data record 128, you can reconfigure the module in your user program regardless of your programming. This means that you can use all the functions of the module even if you configured it via PROFIBUS-GSD.

Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, the measuring range of selected channels can be changed in RUN without having an effect on the other channels.

Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set with STEP 7 will not be changed on the CPU, which means that the parameters set in STEP 7 will be valid again after a restart.

Output parameter STATUS

If errors occur when transferring parameters with the "WRREC" instruction, the module continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

You will find a description of the "WRREC" instruction and the error codes in the STEP 7 online help.

Structure of data record 128

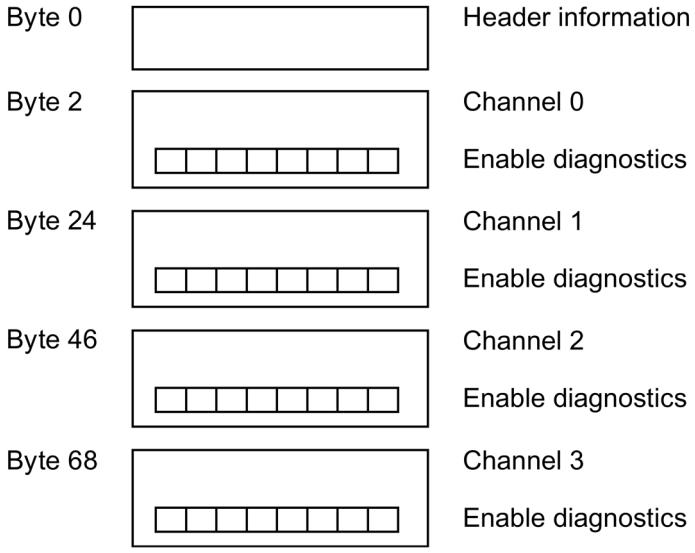


Figure A-1 Structure of data record 128

Header information

The figure below shows the structure of the header information in S7 representation.

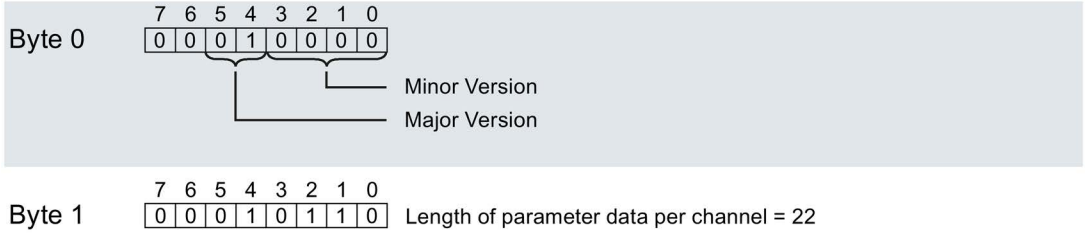


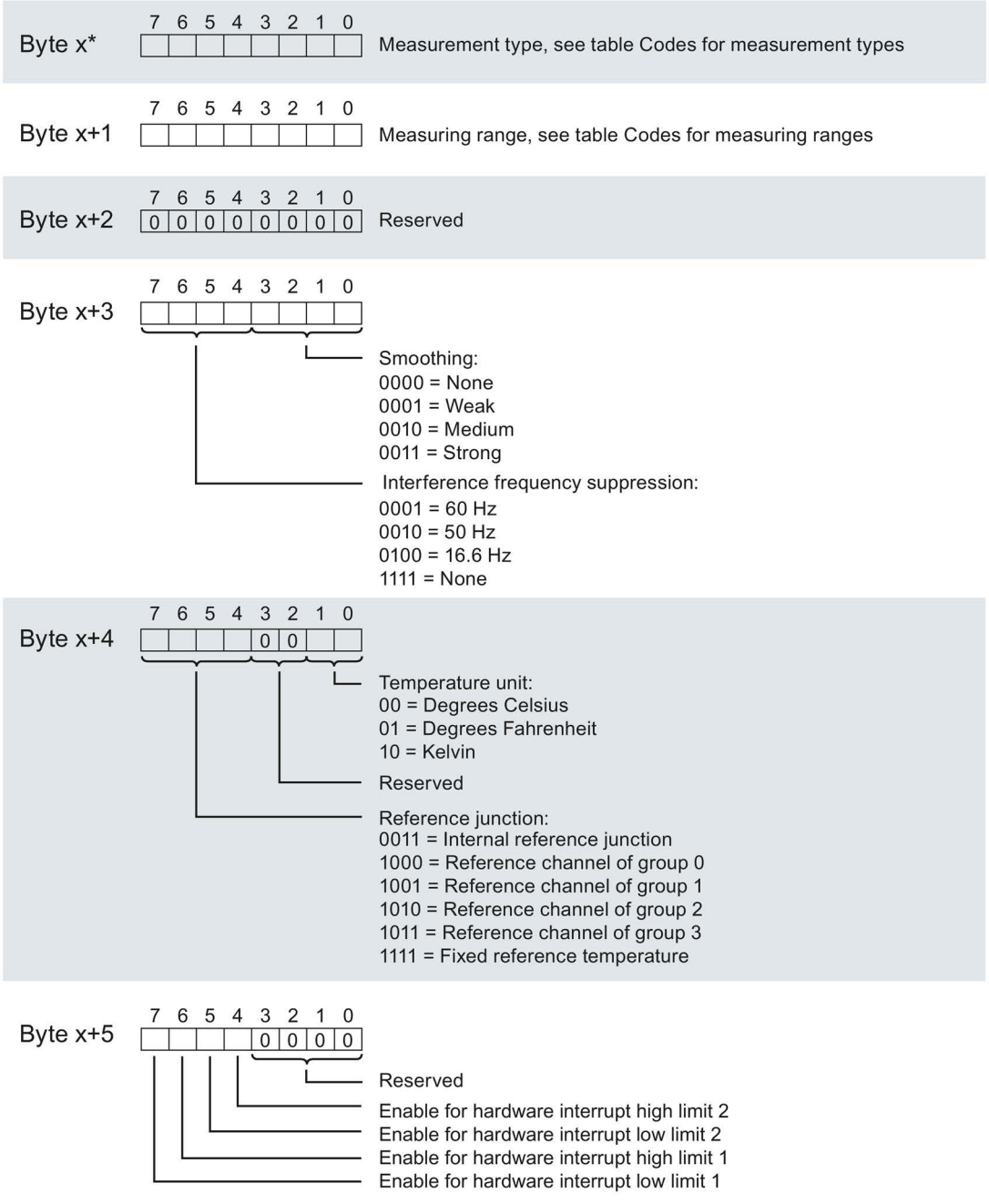
Figure A-2 Header information - S7 representation

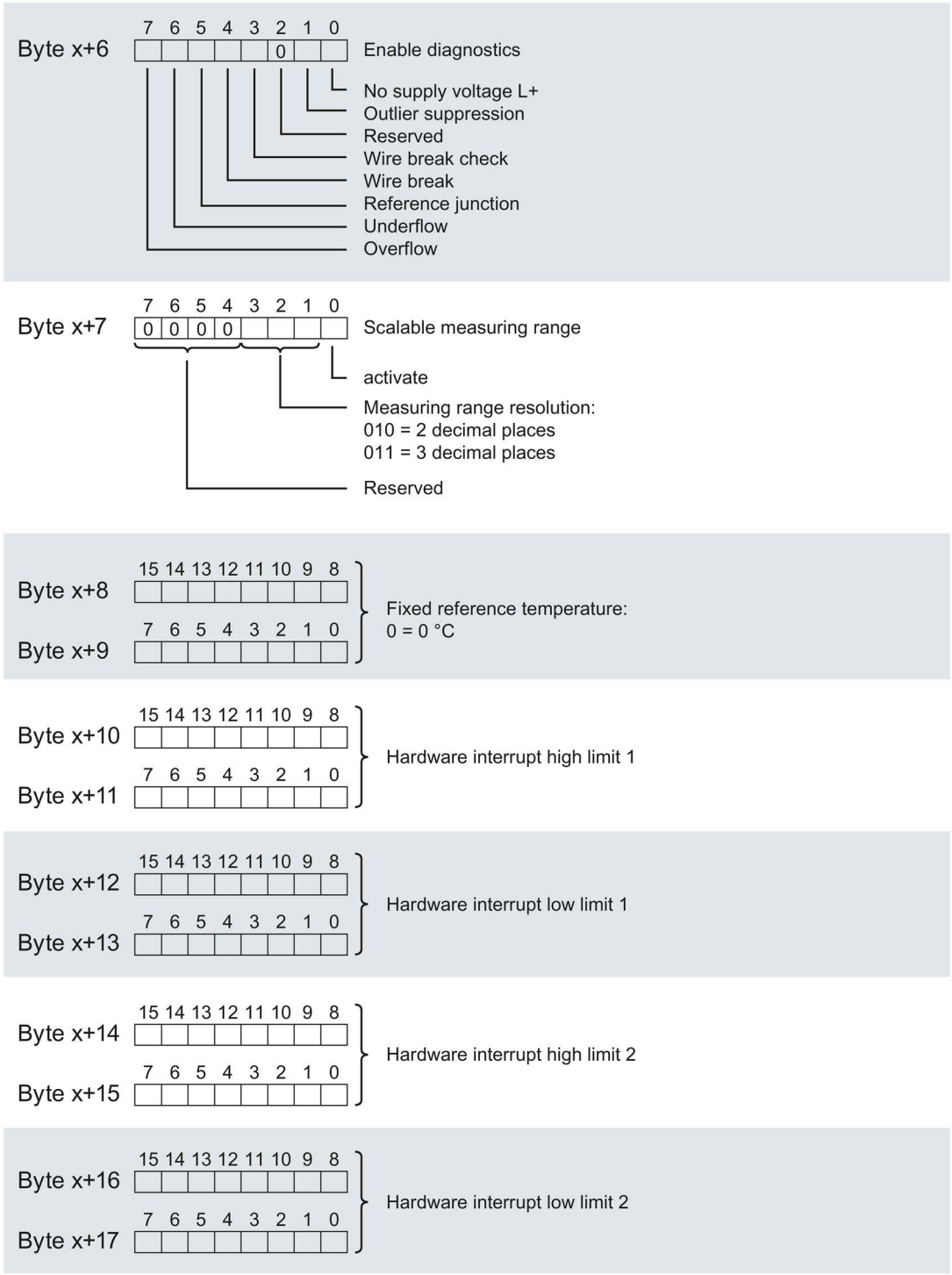
Channel parameter block

The figure below shows the structure of the parameters for channels 0 to 3.

You can activate a parameter by setting the corresponding bit to "1".

* x = 2 + (channel number * 22); channel number = 0 to 3




Byte x+6
7 6 5 4 3 2 1 0
0
Enable diagnostics
No supply voltage L+
Outlier suppression
Reserved
Wire break check
Wire break
Reference junction
Underflow
Overflow
Byte x+7
7 6 5 4 3 2 1 0
0 0 0 0
Scalable measuring range
activate
Measuring range resolution:
010 = 2 decimal places
011 = 3 decimal places
Reserved
Byte x+8
Byte x+9
15 14 13 12 11 10 9 8
7 6 5 4 3 2 1 0
Fixed reference temperature:
0 = 0 °C
Byte x+10
Byte x+11
Hardware interrupt high limit 1
Byte x+12
Byte x+13
Hardware interrupt low limit 1
Byte x+14
Byte x+15
Hardware interrupt high limit 2
Byte x+16
Byte x+17
Hardware interrupt low limit 2

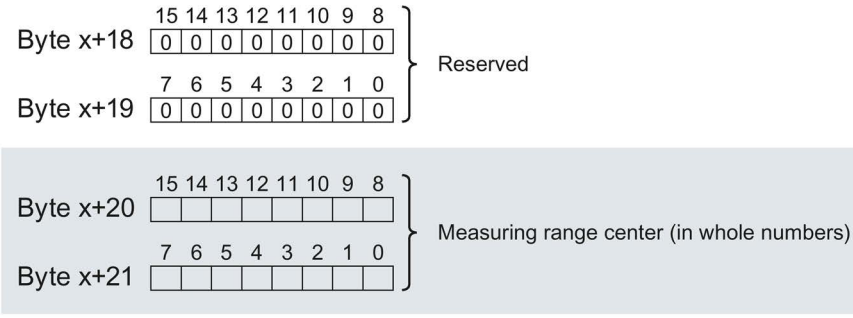


Figure A-3 Structure of byte x to x+21 for channel 0 to 3 - S7 representation

Codes for measurement type

The following table contains the codes for the measurement types of the analog input module. You need to enter these codes in the relevant byte x.

Table A- 4 Codes for measurement type

Measurement type	Code
Deactivated	0000 0000
Voltage	0000 0001
Thermocouple	0000 1010

Codes for measuring range

The following table contains the codes for the measuring ranges of the analog input module. You need to enter these codes in the relevant x+1.

Table A- 5 Codes for measuring range

Measuring range	Code
Voltage	
50 mV	0000 0001
80 mV	0000 0010
250 mV	0000 0011
1 V	0000 0101
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
Type TXK	0000 1011

Limits for hardware interrupts

The following tables contain the permitted limits for hardware interrupts (in each case, the usable value is given). The limits depend on the selected measurement type and the selected measuring range. The value for the high limit must be greater than the value for the low limit.

Table A- 6 Voltage limits

Voltage	
32510	High limit
-32511	Low limit

Table A- 7 Limits for thermocouple types B, C, and E

Thermocouple									
Type B			Type C			Type E			
°C	°F	K	°C	°F	K	°C	°F	K	
20699	32765	23431	24999	32765	27731	11999	21919	14731	High limit
-1199	-1839	1533	-1199	-1839	1533	-2699	-4539	33	Low limit

Table A- 8 Limits for thermocouple types R, S, J, and L

Thermocouple									
Types R, S			Type J			Type L			
°C	°F	K	°C	°F	K	°C	°F	K	
20189	32765	22921	14499	26419	17231	11499	21019	14231	High limit
-1699	-2739	1033	-2099	-3459	633	-1999	-3279	733	Low limit

Table A- 9 Limits for thermocouple types T, K, and U

Thermocouple									
Type T			Type K			Type U			
°C	°F	K	°C	°F	K	°C	°F	K	
5399	10039	8131	16219	29515	18951	8499	15619	11231	High limit
-2699	-4539	33	-2699	-4539	33	-1999	-3279	733	Low limit

Table A- 10 Limits for thermocouple types N and TXK

Thermocouple						
Type N			Type TXK			
°C	°F	K	°C	°F	K	
15499	28219	18231	10499	19219	13231	High limit
-2699	-4539	33	-1999	-3279	733	Low limit

Error transmitting the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns the appropriate error code if there are errors in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the parameter data record 128.

Table A- 11 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF_H	80_H	$B0_H$	00_H	Number of the data record unknown	Enter a valid number for the data record.
DF_H	80_H	$B1_H$	01_H	Length of the data record incorrect	Enter a valid value for the data record length.
DF_H	80_H	$B2_H$	00_H	Module not accessible	• Check station. • Module not correctly plugged in. • Check parameters of the WRREC block.
DF_H	80_H	$E0_H$	01_H	Incorrect version in header	Correct version number of the parameter block, see Figure A-2 Header information - S7 representation (Page 52).
DF_H	80_H	$E0_H$	02_H	Error in the header, length or number of parameter blocks	Correct the length and number of the parameter blocks, see Figure A-2 Header information - S7 representation (Page 52).
DF_H	80_H	$E1_H$	01_H	Reserved bit set	Write 0 to all reserved bits.
DF_H	80_H	$E1_H$	02_H	Invalid diagnostics enable bit set	Correct diagnostics enables. (Dependence on measurement type, measuring range, wire break check)
DF_H	80_H	$E1_H$	04_H	Value for hardware interrupt limit invalid	Use valid hardware interrupt limits, see Parameter assignment and structure of the parameter data record (S7 representation) (Page 51), "Limits for hardware interrupts" section.
DF_H	80_H	$E1_H$	08_H	Code for interference frequency suppression invalid	Use valid code for interference frequency suppression, see Figure A-3 Structure of byte x to x+21 for channel 0 to 3 - S7 representation (Page 55), byte x+3.
DF_H	80_H	$E1_H$	09_H	Code for smoothing invalid	Use valid code for smoothing.
DF_H	80_H	$E1_H$	$0F_H$	Code for reference junction invalid or not permissible	Use valid code for reference junction.
DF_H	80_H	$E1_H$	10_H	Code for the measurement type invalid	Use valid code for measurement type, see Table A-4 Codes for measurement type (Page 55).

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF_H	80_H	$E1_H$	11_H	Code for the measuring range invalid	Use valid code for measuring range, see Table A-5 Codes for measuring range (Page 56).
DF_H	80_H	$E1_H$	12_H	Value for fixed reference temperature invalid	Use valid reference temperature, see Figure A-3 Structure of byte x to x+21 for channel 0 to 3 - S7 representation (Page 55), byte x+8.
DF_H	80_H	$E1_H$	21_H	Code for temperature unit invalid	Use valid code for temperature unit Figure A-3 Structure of byte x to x+21 for channel 0 to 3 - S7 representation (Page 55), byte x+4.
DF_H	80_H	$E1_H$	22_H	Code for measuring range resolution invalid or scalable measuring range not permissible	• Use valid code for measuring range resolution. • Disable scalable measuring range.

A.3 Parameter assignment and structure of channel parameter (REAL representation)

The data record of the module has an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO. With data record 128, you can reconfigure the module in your user program regardless of your programming. This means that you can use all the functions of the module even if you configured it via PROFIBUS-GSD.

Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, the measuring range of selected channels can be changed in RUN without having an effect on the other channels.

Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set with STEP 7 will not be changed on the CPU, which means that the parameters set in STEP 7 will be valid again after a restart.

Output parameter STATUS

If errors occur when transferring parameters with the "WRREC" instruction, the module continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

You will find a description of the "WRREC" instruction and the error codes in the STEP 7 online help.

Structure of data record 128

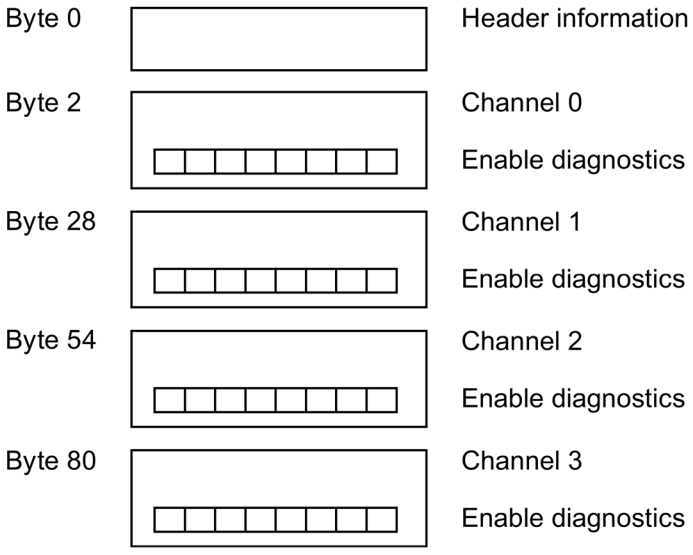


Figure A-4 Structure of data record 128

Header information

The figure below shows the structure of the header information in REAL representation.

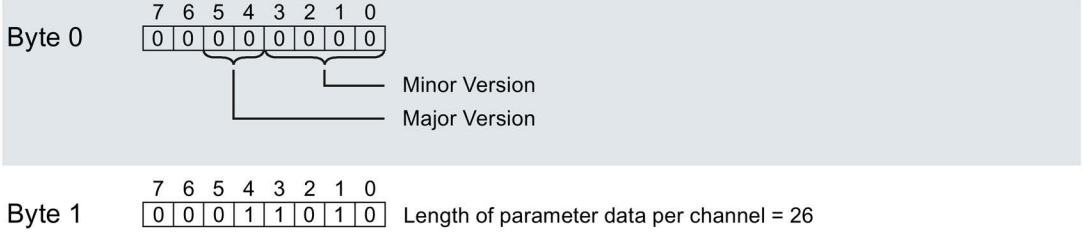


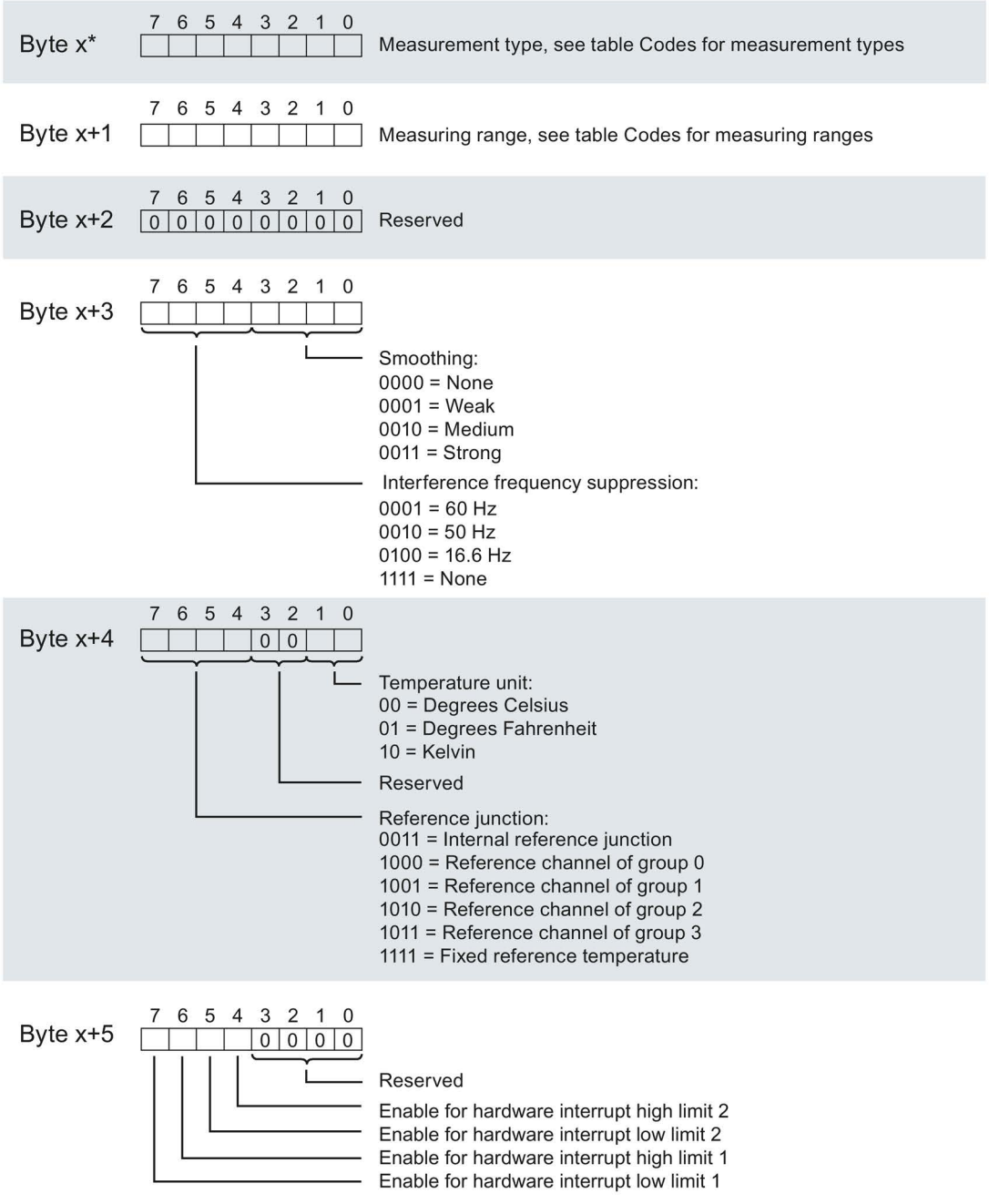
Figure A-5 Header information - REAL representation

Channel parameter block

The figure below shows the structure of the parameters for channels 0 to 3.

You can activate a parameter by setting the corresponding bit to "1".

* x = 2 + (channel number * 26); channel number = 0 to 3



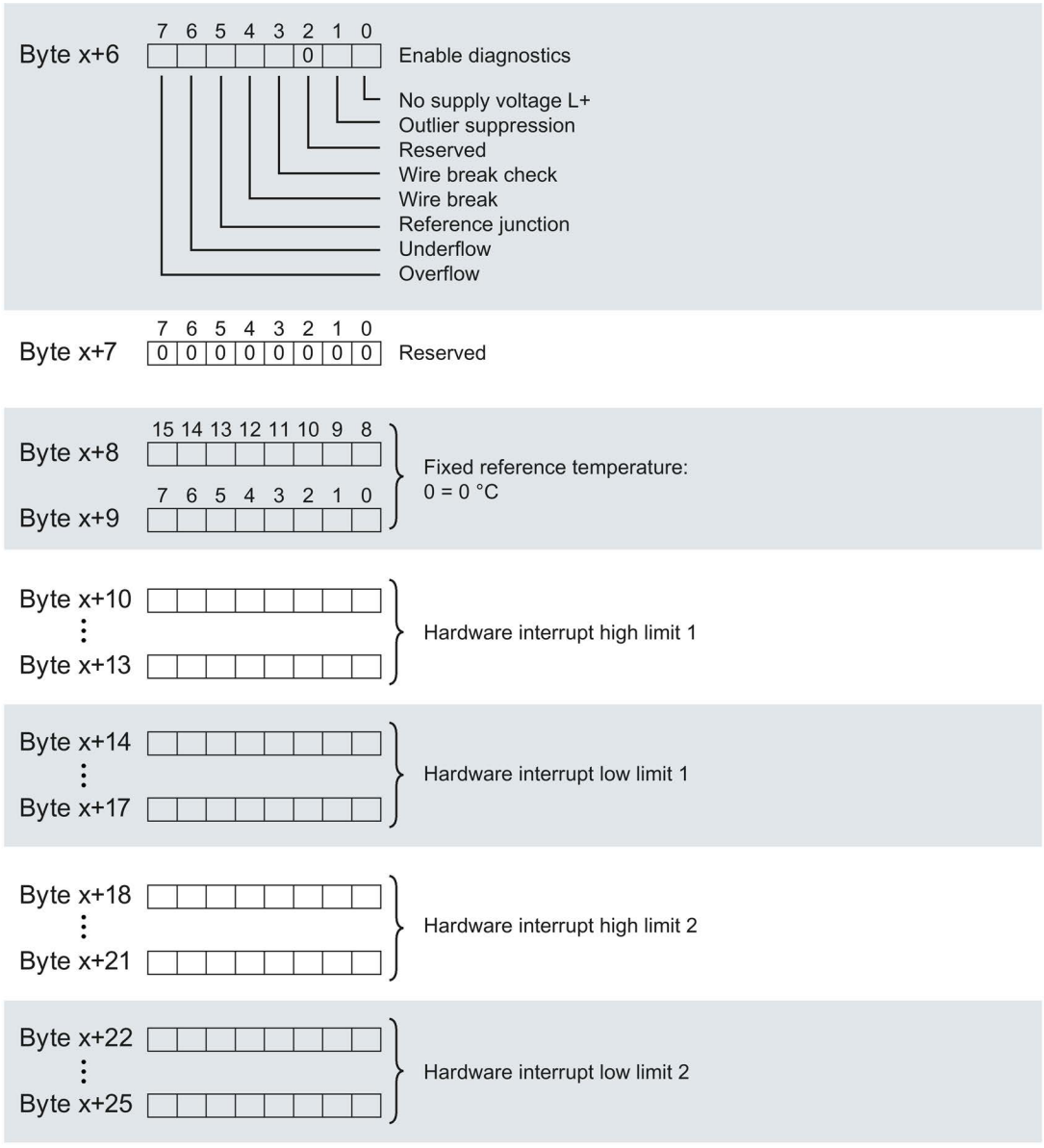


Figure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation

Codes for measurement type

The following table contains the codes for the measurement types of the analog input module. You need to enter these codes in the relevant byte x.

Table A- 12 Codes for measurement type

Measurement type	Code
Deactivated	0000 0000
Voltage	0000 0001
Thermocouple	0000 1010

Codes for measuring range

The following table contains the codes for the measuring ranges of the analog input module. You need to enter these codes in the relevant x+1.

Table A- 13 Codes for measuring range

Measuring range	Code
Voltage	
50 mV	0000 0001
80 mV	0000 0010
250 mV	0000 0011
1 V	0000 0101
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
Type TXK	0000 1011

Limits for hardware interrupts

The following tables contain the permitted limits for hardware interrupts (in each case, the usable value is given). The limits depend on the selected measurement type and the selected measuring range. The value for the high limit must be greater than the value for the low limit.

Table A- 14 Voltage limits

Voltage				
±50 mV	±80 mV	±250 mV	± 1 V	
58.7927 mV	94.0683 mV	293.963 mV	1.17585 V	High limit
-58.7945 mV	-94.0712 mV	-293.972 mV	-1.17589 V	Low limit

Table A- 15 Limits for thermocouple types B, C, and E

Thermocouple									
Type B			Type C			Type E			
°C	°F	K	°C	°F	K	°C	°F	K	
2069.9	3276.5	2343.1	2499.9	3276.5	2773.1	1199.9	2191.9	1473.1	High limit
-119.9	-183.9	153.3	-119.9	-183.9	153.3	-269.9	-453.9	3.3	Low limit

Table A- 16 Limits for thermocouple types R, S, J, and L

Thermocouple									
Types R, S			Type J			Type L			
°C	°F	K	°C	°F	K	°C	°F	K	
2018.9	3276.5	2292.1	1449.9	2641.9	1723.1	1149.9	2101.9	1423.1	High limit
-169.9	-273.9	103.3	-209.9	-345.9	63.3	-199.9	-327.9	73.3	Low limit

Table A- 17 Limits for thermocouple types T, K, and U

Thermocouple									
Type T			Type K			Type U			
°C	°F	K	°C	°F	K	°C	°F	K	
539.9	1003.9	813.1	1621.9	2951.5	1895.1	849.9	1561.9	1123.1	High limit
-269.9	-453.9	3.3	-269.9	-453.9	3.3	-199.9	-327.9	73.3	Low limit

Table A- 18 Limits for thermocouple types N and TXK

Thermocouple						
Type N			Type TXK			
°C	°F	K	°C	°F	K	
1549.9	2821.9	1823.1	1049.9	1921.9	1323.1	High limit
-269.9	-453.9	3.3	-199.9	-327.9	73.3	Low limit

Error transmitting the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns the appropriate error code if there are errors in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the parameter data record 128.

Table A- 19 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF_H	80_H	$B0_H$	00_H	Number of the data record unknown	Enter a valid number for the data record.
DF_H	80_H	$B1_H$	01_H	Length of the data record incorrect	Enter a valid value for the data record length.
DF_H	80_H	$B2_H$	00_H	Module not accessible	• Check station. • Module not correctly plugged in. • Check parameters of the WRREC block.
DF_H	80_H	$E0_H$	01_H	Incorrect version in header	Correct version number of the parameter block, see Figure A-5 Header information - REAL representation (Page 60).
DF_H	80_H	$E0_H$	02_H	Error in the header, length or number of parameter blocks	Correct the length and number of the parameter blocks, see Figure A-5 Header information - REAL representation (Page 60).
DF_H	80_H	$E1_H$	01_H	Reserved bit set	Write 0 to all reserved bits.
DF_H	80_H	$E1_H$	02_H	Invalid diagnostics enable bit set	Correct diagnostics enables. (Dependence on measurement type, measuring range, wire break check)
DF_H	80_H	$E1_H$	04_H	Value for hardware interrupt limit invalid	Use valid hardware interrupt limits, see Parameter assignment and structure of channel parameter (REAL representation) (Page 59), "Limits for hardware interrupts" section.
DF_H	80_H	$E1_H$	08_H	Code for interference frequency suppression invalid	Use valid code for interference frequency suppression, see Figure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation (Page 62), byte x+3.
DF_H	80_H	$E1_H$	09_H	Code for smoothing invalid	Use valid code for smoothingFigure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation (Page 62).
DF_H	80_H	$E1_H$	$0F_H$	Code for reference junction invalid or not permissible	Use valid code for reference junctionFigure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation (Page 62).
DF_H	80_H	$E1_H$	10_H	Code for the measurement type invalid	Use valid code for measurement type, see Table A-12 Codes for measurement type (Page 62).
DF_H	80_H	$E1_H$	11_H	Code for the measuring range invalid	Use valid code for measuring range, see Table A-13 Codes for measuring range (Page 63).

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF_H	80_H	$E1_H$	12_H	Value for fixed reference temperature invalid	Use valid reference temperature, see Figure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation (Page 62), byte x+8.
DF_H	80_H	$E1_H$	21_H	Code for temperature unit invalid	Use valid code for temperature unit Figure A-6 Structure of byte x to x+25 for channel 0 to 3 - REAL representation (Page 62), byte x+4.

Representation of analog values

B

This appendix shows the analog values for all measuring ranges that you can use with the analog module AI 4xTC HS.

Measured value resolution

The resolution of the analog values differs depending on the analog module 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 module. 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.1 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	
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

B.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 B- 3 Voltage measuring range ±1 V

Values		Voltage measuring range	Range
Dec.	Hex.	±1 V	
32767	7FFF	> 1.176 V	Overflow
32511	7EFF	1.176 V	Overrange
27649	6C01		
27648	6C00	1 V	Nominal range
20736	5100	0.75 V	
1	1	36.17 µV	
0	0	0 V	
-1	FFFF		
-20736	AF00	-0.75 V	
-27648	9400	-1 V	
-27649	93FF		Underrange
-32512	8100	-1.176 V	
-32768	8000	<-1.176 V	Underflow

Table B- 4 Voltage measuring range ±500 mV to ±50 mV

Values		Voltage measuring range			Range
Dec.	Hex.	±250 mV	±80 mV	±50 mV	
32767	7FFF	> 294.0 mV	> 94.1 mV	> 58.8 mV	Overflow
32511	7EFF	294.0 mV	94.1 mV	58.8 mV	Overrange
27649	6C01				
27648	6C00	250 mV	80 mV	50 mV	Nominal range
20736	5100	187.5 mV	60 mV	37.5 mA	
1	1	9.04 µV	2.89 µV	1.81 µV	
0	0	0 mV	0 mV	0 mV	
-1	FFFF				
-20736	AF00	-187.5 mV	-60 mV	-37.5 mV	
-27648	9400	-250 mV	-80 mV	-50 mV	
-27649	93FF				Underrange
-32512	8100	-294.0 mV	-94.1 mV	-58.8 mV	
-32768	8000	<-294.0 mV	<-94.1 mV	<-58.8 mV	Underflow

B.3 Representation of analog values for thermocouples

Note

A higher resolution can be configured for thermocouples, see section Scalable measuring range (Page 23).

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

Table B- 5 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
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- 6 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- 7 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- 8 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- 9 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- 10 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- 11 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- 12 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
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- 13 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- 14 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

Table B- 15 Thermocouple type TXK (GOST)

Type TXK in °C	Values		Type TXK in °F	Values		Type TXK in K	Values		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1050.0	32767	7FFF	> 1922.0	32767	7FFF	>1323.2	32767	7FFF	Overflow
1050.0 : 800.1	10500 : 8001	2904 : 1F41	1922.0 : 1472.1	19220 : 14721	4B14 : 3981	1323.2 : 1073.3	13232 : 10733	33B0 : 29ED	Overrange
800.0 : 0.0 : -200.0	8000 : 0 : -2000	1F40 : 0000 : F830	1472.0 : 32.0 : -328.0	14720 : 320 : -3280	3980 : 0140 : F330	1073.2 : 273 : 73.2	10732 : 2730 : 732	29EC : 0AAA : 02DC	Nominal range
< -200.0	-32768	8000	< -328.0	-32768	8000	<73.2	-32768	8000	Underflow