SIEMENS

SIMATIC

S7-1500 / ET 200MP

Analog Input Module AI 8xU/I HS (6ES7531-7NF10-0AB0)

Manual

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Analog Input Module AI 8xU/I HS
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12/2016

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

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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) automation system.

Functions that relate in general to the systems are described in these system manuals.

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:

- Updated technical specifications "common mode interference"

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 regarding the product described in the documentation or its handling, or draws special attention to a section of the documentation.

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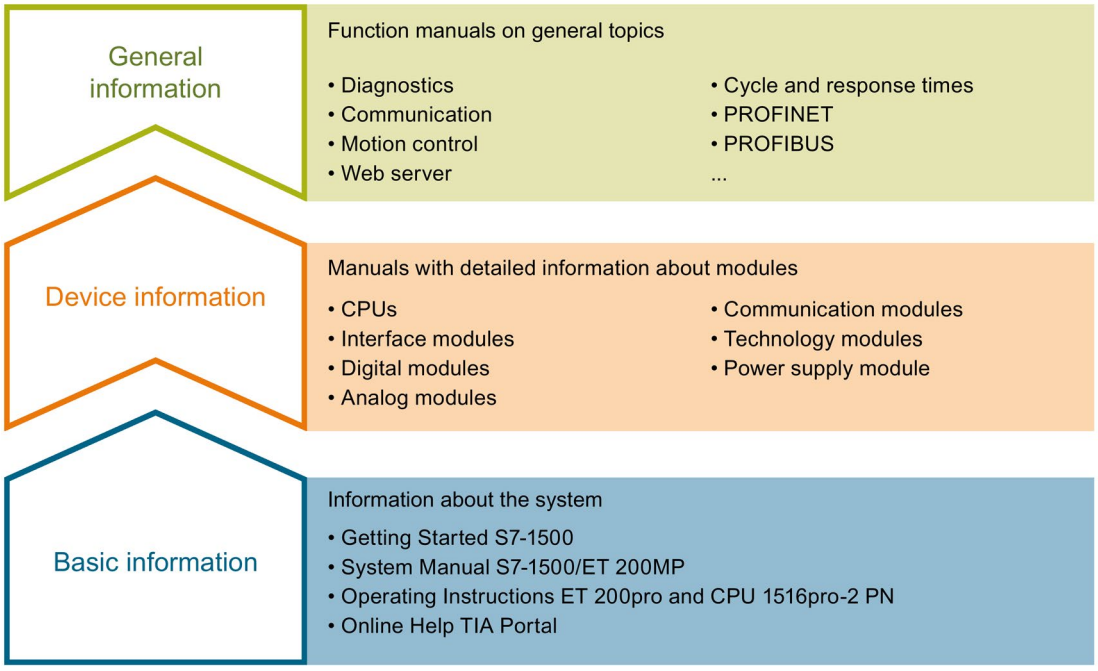
Documentation guide

1

The documentation for the SIMATIC S7-1500 automation system, the CPU 1516pro-2 PN based on SIMATIC S7-1500 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. For CPU 1516pro-2 PN you use the corresponding operating instructions. 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 (http://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx).

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

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

"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 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 date 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 PROFINET 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).

Product overview

2

2.1 Properties

Article number

6ES7531-7NF10-0AB0

View of the module

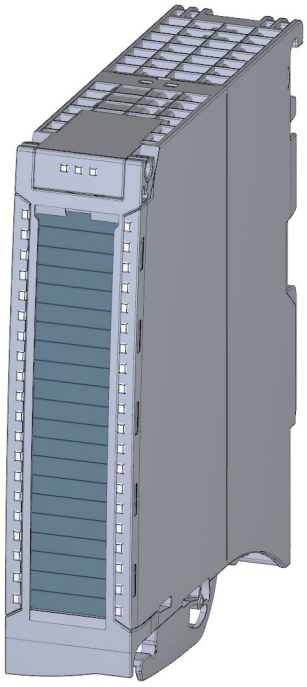


Figure 2-1 View of the AI 8xU/I HS module

Properties

The module has the following technical properties:

- 8 analog inputs
- Voltage or current measuring 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)
- High-speed update of measured values

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)
Oversampling	V2.1.0 or higher	V14 or higher and HSP 0186 (PROFINET IO only)	---

You can configure the module with STEP 7 (TIA Portal) and with a GSD file. The oversampling function requires isochronous mode and can therefore only be configured with STEP 7 (TIA Portal).

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 S7-1500/ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

2.2 Functions

2.2.1 Oversampling for inputs

Function

Oversampling is defined as the transfer of data in constant bus cycle segments (sub-cycles), whereby n sub-cycles correspond to one PROFINET bus cycle. The configured number n of sub-cycles corresponds to one data cycle. Each sub-cycle reads in a measured value.

Oversampling is useful whenever you require acquisition of data with high time resolution but without using an extremely short PROFINET bus cycle and thus fast CPU cycles.

With oversampling, a PROFINET bus cycle is divided into constant bus sub-cycles:

- One 16-bit value is read in per channel in each sub-cycle.
- The shortest possible sub-cycle is 62.5 µs.
- Sub-cycles are possible in increments of 2 to 16. The following applies here: Isochronous data cycle / number of sub-cycles ≥ permitted sub-cycle duration (62.5 µs).

Typical areas of applications

Quality-monitoring measurements, for example when recording pressure trends during the blowing process of PET bottle production.

Requirements

- Firmware version V2.1.0 or higher of the module.
- Isochronous mode has to be set.

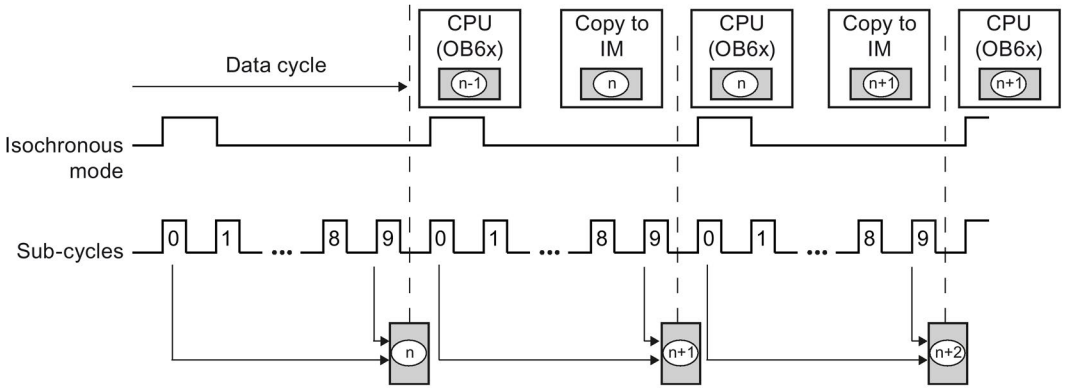
Configuration

You configure the oversampling function by means of the sampling rate parameter.

Chronological sequence

The recorded input data of a data cycle (send clock) is copied into the interface module in the next data cycle and is available for the module in the data cycle after that.

The figure below shows the chronological sequence for oversampling with 10 sub-cycles.



n Recorded value from Cycle n

Figure 2-2 Chronological sequence with oversampling

Sampling interval

The duration of a sub-cycle corresponds to the sampling time. The bus cycle time T_{DP} (send clock for isochronous mode) is specified in the configuration software. The actual sampling interval of the module results from this time divided by the set sampling rate (2-16).

$$\text{Sampling interval} = \frac{T_{DP}}{n_{Sample}} = \frac{1\ \text{ms}}{16} = 62.5\ \mu\text{s}$$

Figure 2-3 Example for the calculation of the sampling interval

Wiring

3

This section contains the block diagram of the module and various wiring options.
You can find information on wiring the front connector, establishing a cable shield, etc in the Wiring section of the S7-1500/ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792)hotspot text system manual.

Note

- You may use and combine the different wiring options for all channels.
- Do not insert the potential jumpers included 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)
I_n+/I_n-	Current input channel n (current only)
U_{Vn}	Supply voltage at channel n for 2-wire transmitters (2WT)
L+	Supply voltage connection
M	Ground connection
M_{ANA}	Reference potential of the analog circuit
CHx	Channel or display of the channel status
PWR	Display for the supply voltage

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). Use terminals 42 (L+) and 43 (M) to loop the potential to the next module.

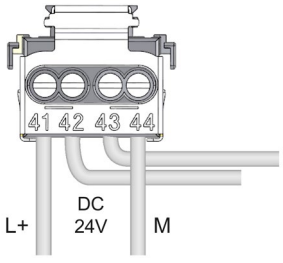
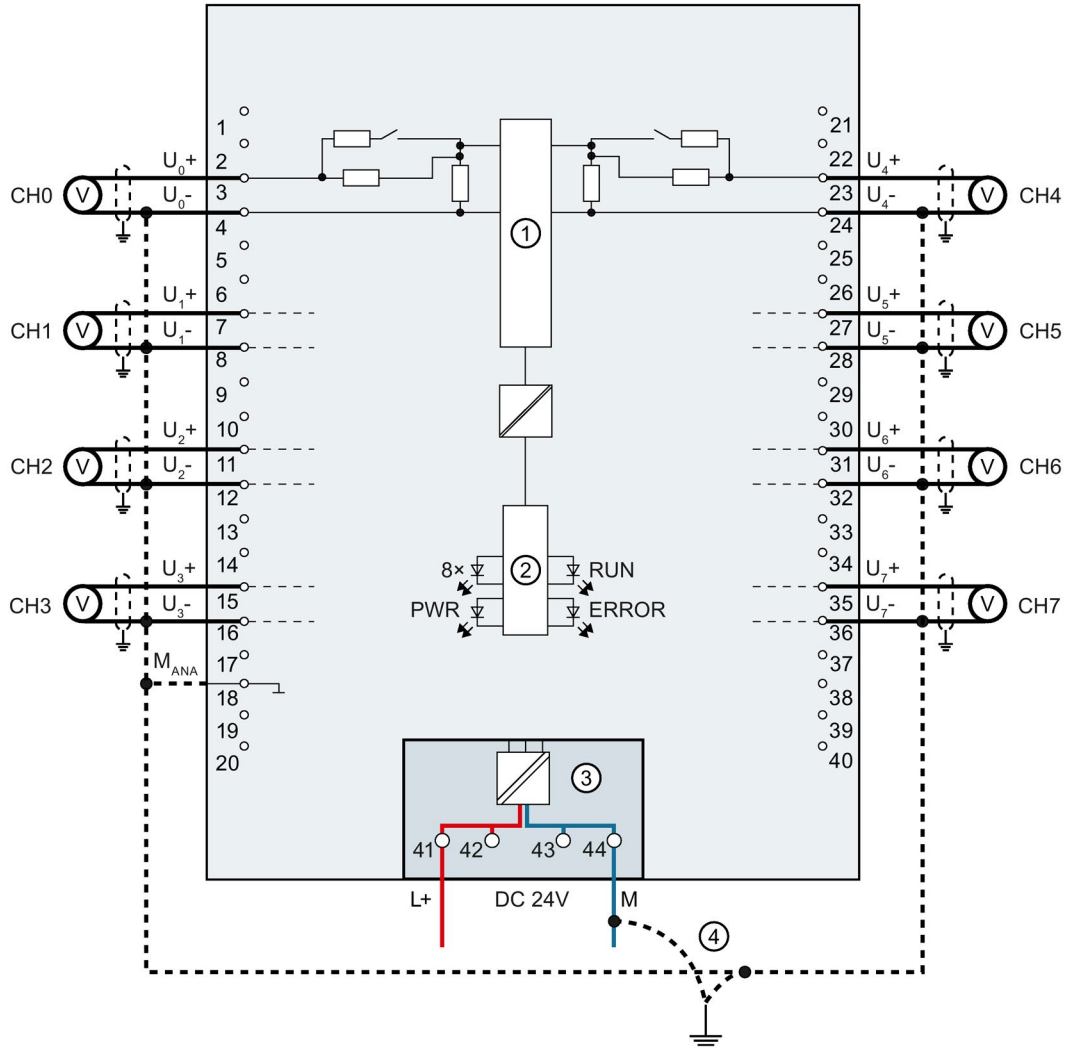


Figure 3-1 Power supply element wiring

Block diagram and pin assignment for voltage measurement

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

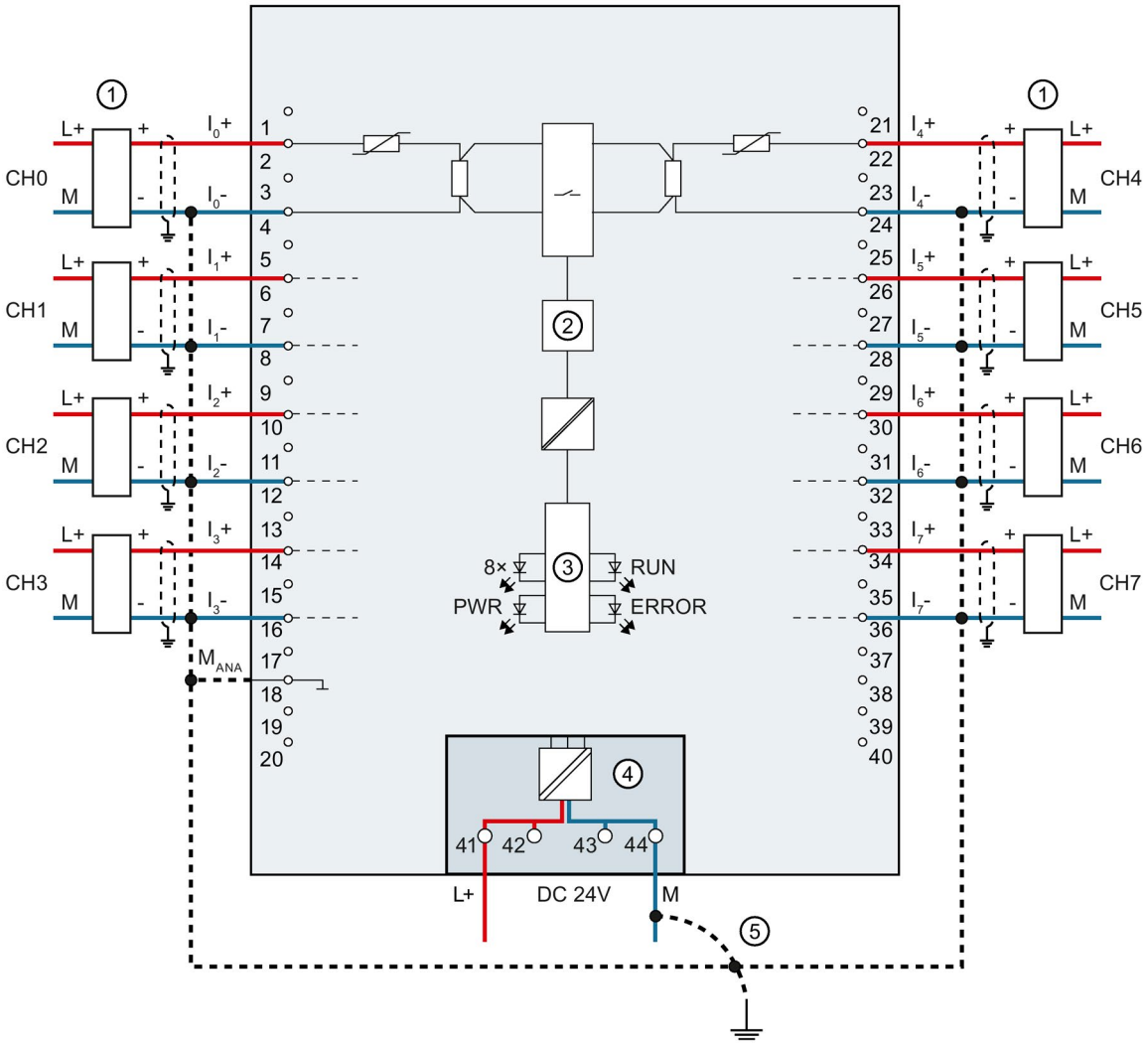


①	Analog-to-Digital Converter (ADC)	CHx	Channel or 8 x channel status (green/red)
②	Backplane bus interface	RUN	Status display LED (green)
③	Supply voltage via power supply element	ERROR	Error display LED (red)
④	Equipotential bonding cable (optional)	PWR	LED for power supply (green)

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

Block diagram and pin assignment for 4-wire transmitter for current measurement

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

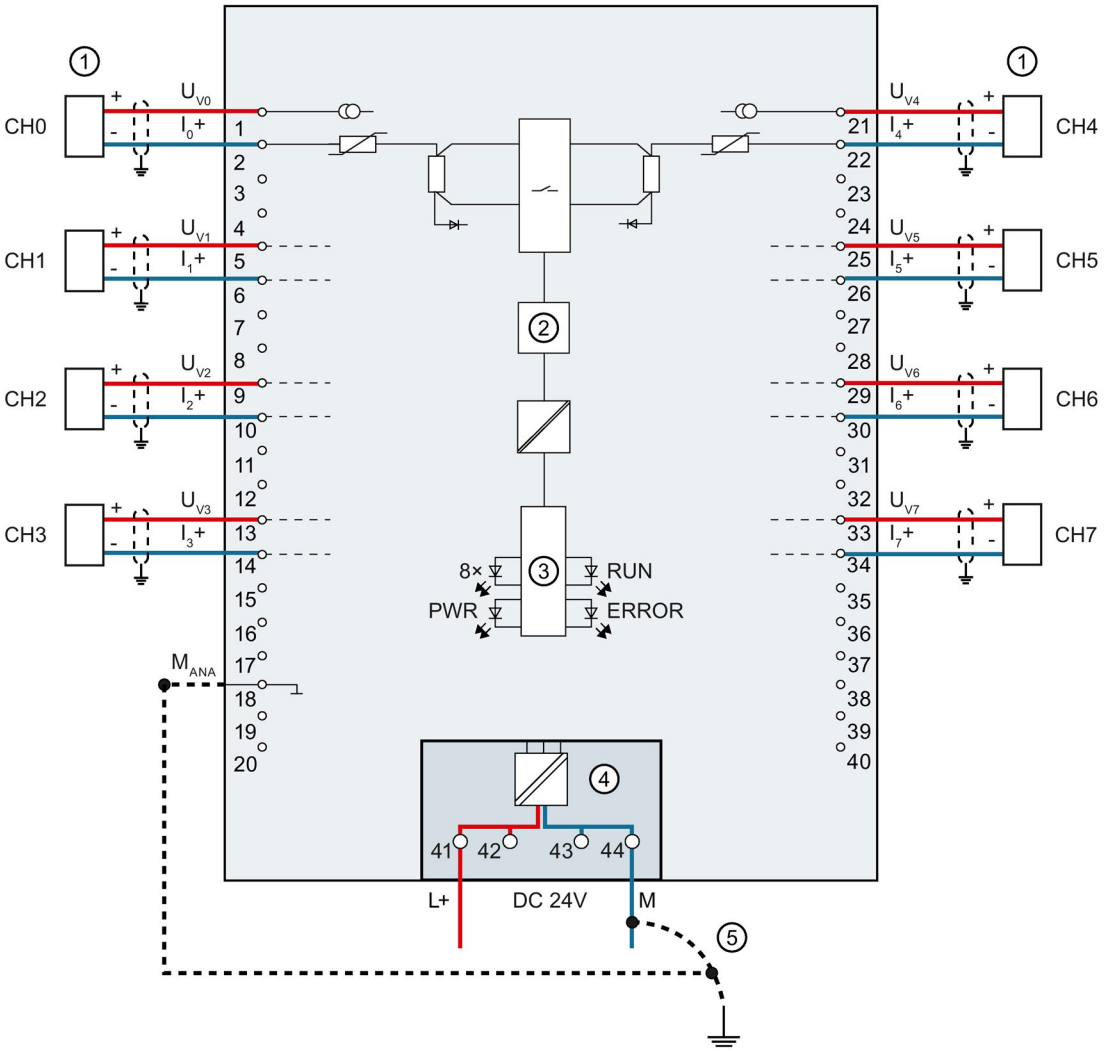


①	Wiring 4-wire transmitter	CHx	Channel or 8 x channel status (green/red)
②	Analog-to-Digital Converter (ADC)	RUN	Status display LED (green)
③	Backplane bus interface	ERROR	Error display LED (red)
④	Supply voltage via power supply element	PWR	LED for power supply (green)
⑤	Equipotential bonding cable (optional)		

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

Block diagram and pin assignment for 2-wire transmitter 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 8 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 2-wire transmitter for current measurement

Parameters/address space

4

4.1 Measuring types and ranges

Introduction

The module is set to voltage measuring 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 measuring type or range.

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

Measuring type	Measuring range
Voltage	1 V to 5 V ±5 V ±10 V
Current 2WMT (2-wire transmitter)	4 mA to 20 mA
Current 4WMT (4-wire transmitter)	4 mA to 20 mA 0 mA to 20 mA ±20 mA
Deactivated	-

The tables of the input ranges, overflow, undershoot range, etc. are available in appendix Representation of analog values (Page 49).

4.2 Parameters

Parameters of the AI 8xU/I HS

The AI 8xU/I HS is usually already integrated in the hardware catalog of STEP 7 (TIA Portal). In this case, STEP 7 (TIA Portal) checks the configured properties for plausibility during configuration.

However, you can also assign parameters to the module by means of a GSD file and the configuration software of any provider. The module does not check the validity of the configured properties until after the configuration has been loaded.

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 44).

The following parameter settings are possible:

Table 4- 1 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)	
				Integrated in the hardware catalog STEP 7 (TIA Portal) as of V12 or GSD file PROFINET IO	GSD file PROFIBUS DP
AI configuration					
Sampling rate (for the oversampling function)	1...16 values/cycle	1	No	Module (not GSD file)	---
Diagnostics					
• Missing supply voltage L+	Yes/No	No	Yes	Channel [1]	Module [3]
• Overflow	Yes/No	No	Yes	Channel	Module [3]
• Underflow	Yes/No	No	Yes	Channel	Module [3]
• Wire break	Yes/No (Voltage: 1 V to 5 V Current: 4 mA to 20 mA)	No	Yes	Channel	Module [3]

Parameters	Range of values	Default setting	Parameter assignment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				Integrated in the hardware catalog STEP 7 (TIA Portal) as of V12 or GSD file PROFINET IO	GSD file PROFIBUS DP
• Current limit for wire break diagnostics [2]	1.185 mA or 3.6 mA	1.185 mA	Yes	Channel	--- [4]
Measuring					
• Measurement type	See section Measuring types and ranges (Page 19)	Voltage	Yes	Channel	Channel
• Measuring range		±10 V	Yes	Channel	Channel
• Smoothing:	None/low/medium /high	None	Yes	Channel	Channel
Hardware interrupt					
• Hardware interrupt high limit 1	Yes/No	No	Yes	Channel	--- [4]
• Hardware interrupt low limit 1	Yes/No	No	Yes	Channel	--- [4]
• Hardware interrupt high limit 2	Yes/No	No	Yes	Channel	--- [4]
• Hardware interrupt low limit 2	Yes/No	No	Yes	Channel	--- [4]

[1] 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.

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

[4] You can set the current limit for wire break diagnostics, the "Hardware interrupt" parameter and the hardware interrupt limits in the user program with data records 0 to 7.

4.3 Declaration of parameters

Sampling rate

Specifies the number of sub-cycles per isochronous data cycle for the for the oversampling function.

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 if the measured value violates the low limit.

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

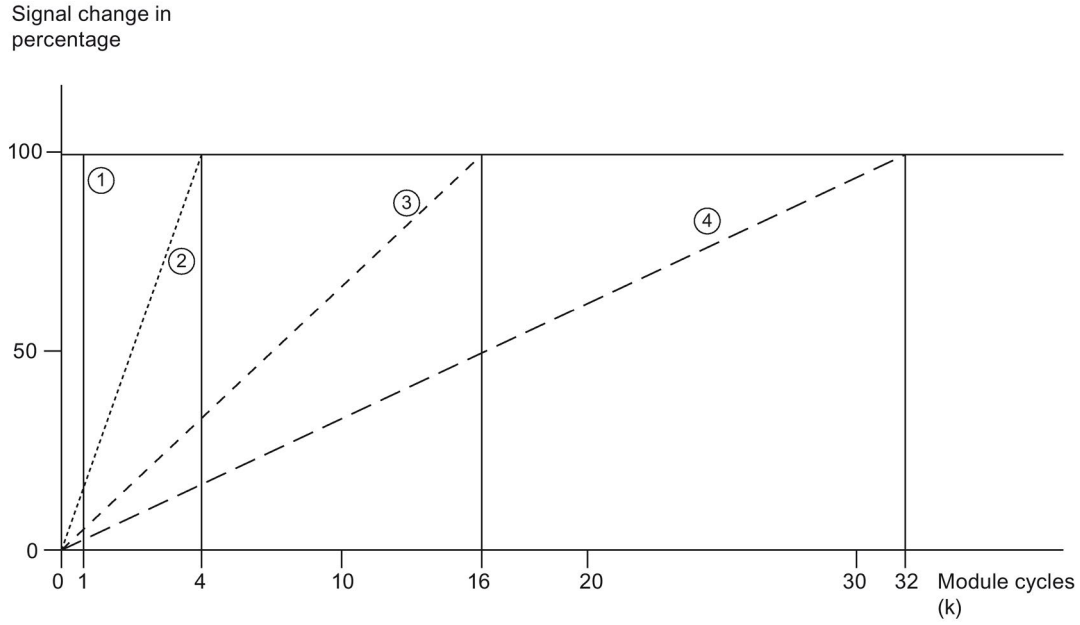
Threshold for reporting wire breaks. The value can be set to 1.185 mA or 3.6 mA, depending on the sensor used.

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 after how many module cycles the smoothed analog value is almost 100%, depending on the set smoothing. Is valid for each signal change at the analog input.



① None (k = 1)
② Weak (k = 4)
③ Medium (k = 16)
④ Strong (k = 32)

Figure 4-1 Smoothing with AI 8xU/I HS

Hardware interrupt 1 or 2

Enable 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 HS

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- 2 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 HS	V12 or higher	X
1 x 8-channel with value status	AI 8xU/I HS QI	V12 or higher	X
8 x 1-channel without value status	AI 8xU/I HS S	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
8 x 1-channel with value status	AI 8xU/I HS 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 HS MSI	V13 Update 3 or higher (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel without value status for oversampling	---	V14 or higher with HSP 0186 (PROFINET IO only)	---

Value status (Quality Information, QI)

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

- AI 8xU/I HS QI
- AI 8xU/I HS S QI
- AI 8xU/I HS 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 the AI 8xU/I HS and AQ 8xU/I HS QI

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.

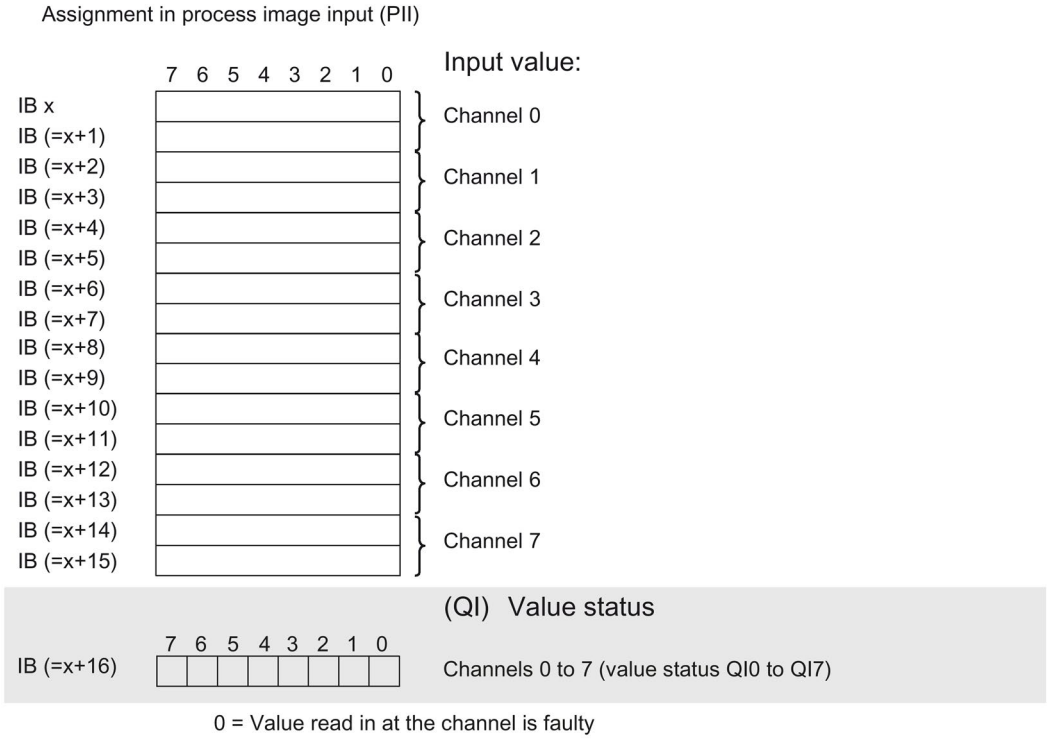


Figure 4-2 Address space for configuration as 1 x 8-channel AI 8xU/I HS with value status

Address space for configuration as 8 x 1-channel AI 8xU/I HS QI and AI 8xU/I HS S 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 submodules is dependent 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.

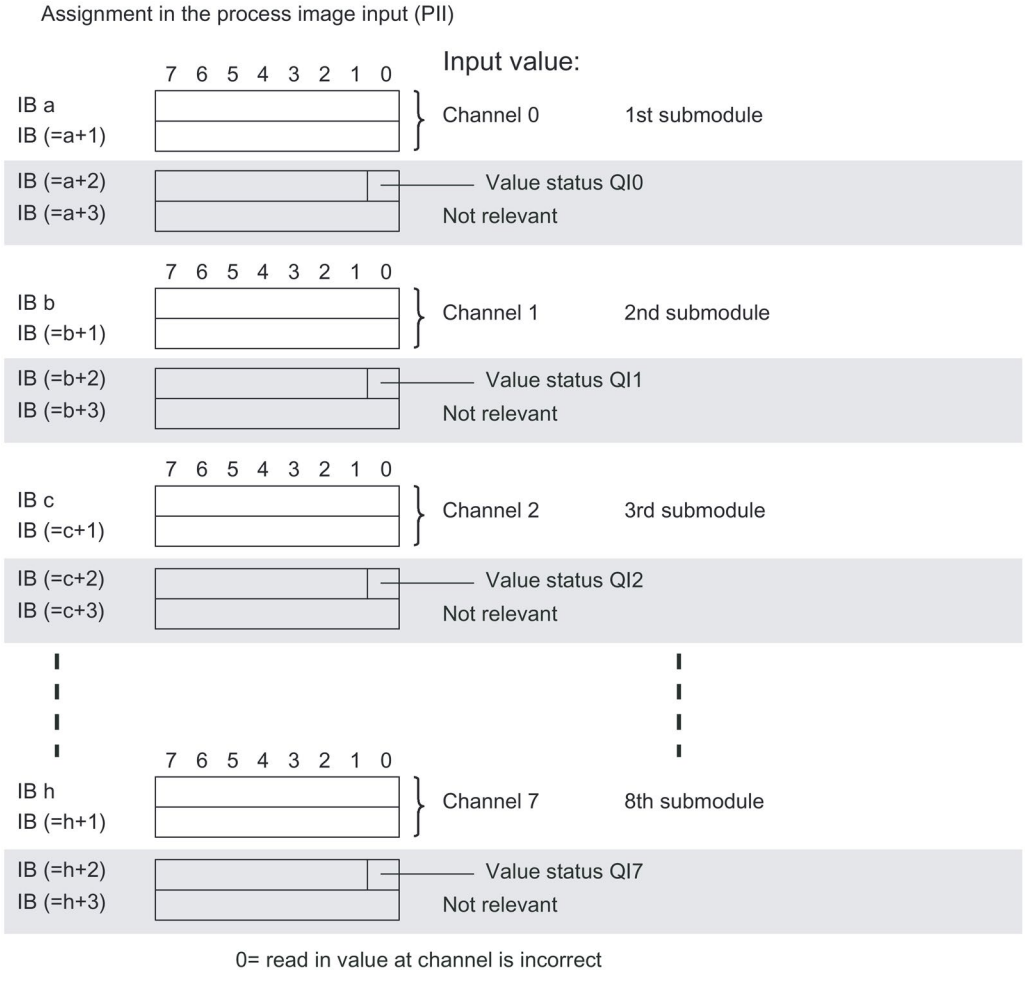


Figure 4-3 Address space for configuration as 8 x 1-channel AI 8xU/I HS S QI with value status

Address space for configuration as 1 x 8-channel AI 8xU/I HS 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 submodules is dependent 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).

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

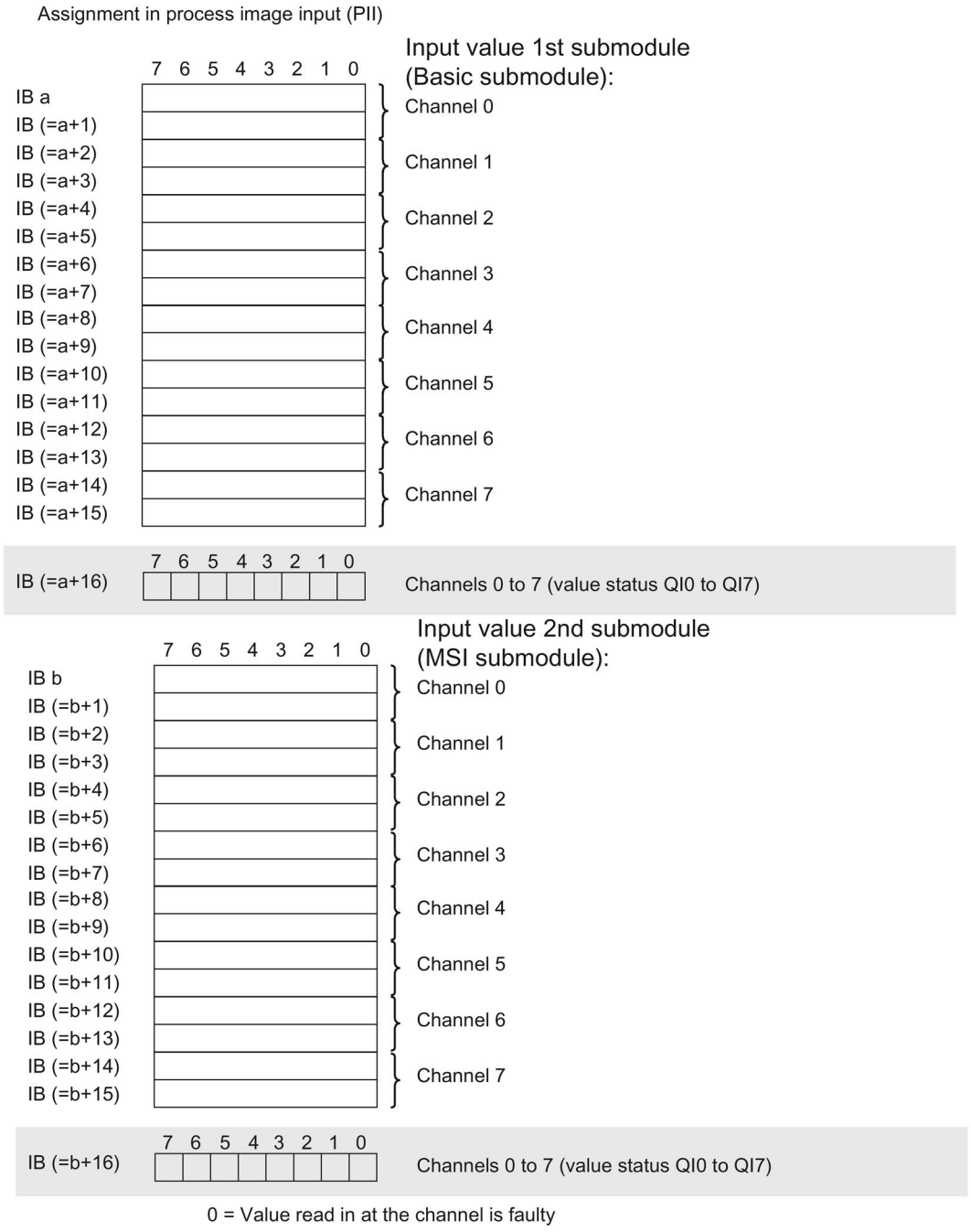


Figure 4-4 Address space for configuration as 1 x 8-channel AI 8xU/I HS MSI with value status

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

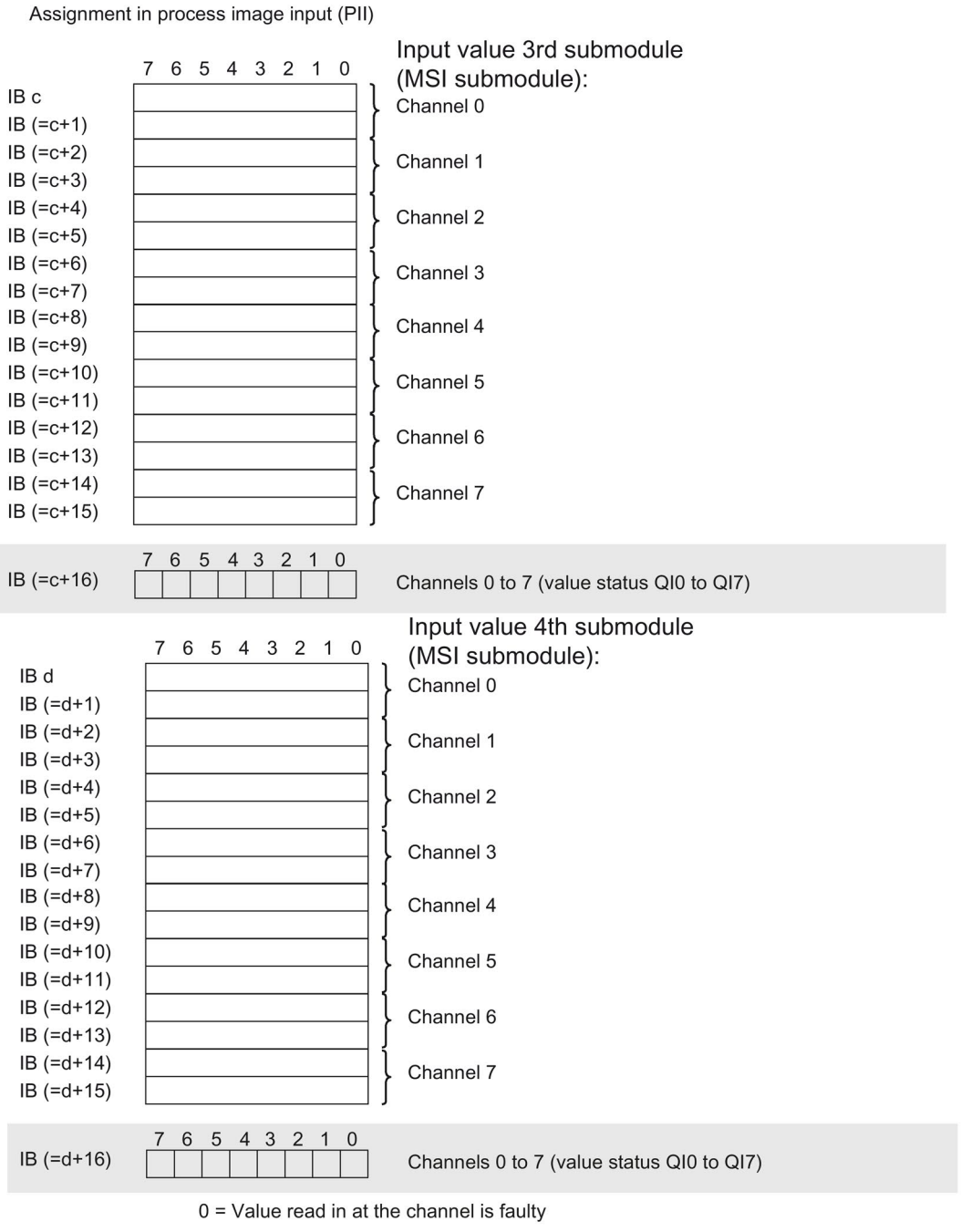


Figure 4-5 Address space for configuration as 1 x 8-channel AI 8xU/I HS MSI with value status

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.

Address space for configuration as 1 x 8-channel AI 8xU/I HS for oversampling

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

Writing always starts from IB x. If fewer than 16 sub-cycles are set, the addresses that are then unused are filled with $7FFF_H$.

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

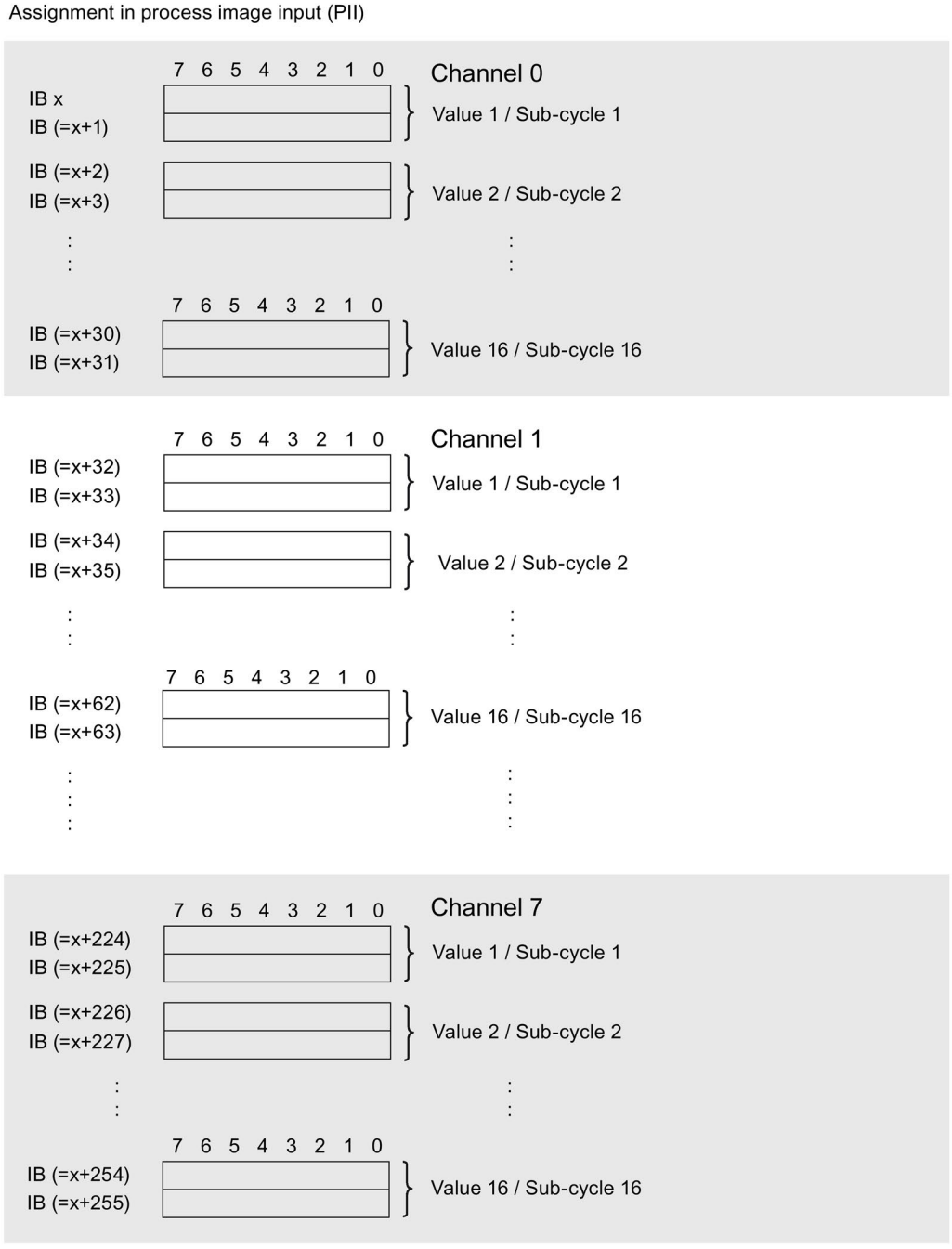


Figure 4-6 Address space for configuration as 1 x 8-channel AI 8xU/I HS for oversampling

Interrupts/diagnostics alarms

5

5.1 Status and error displays

LED displays

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

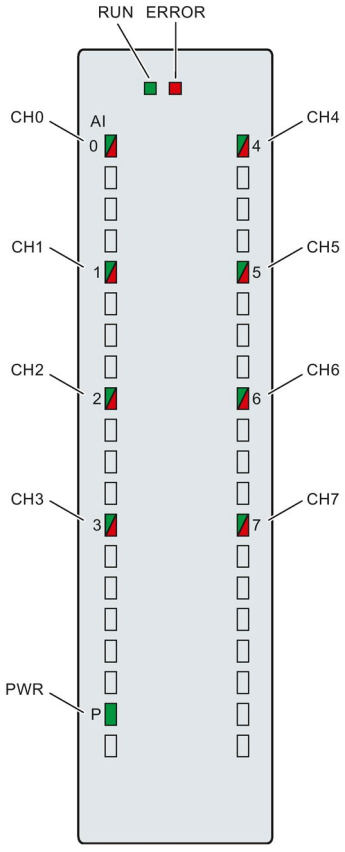


Figure 5-1 LED displays of the module AI 8xU/I HS

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

LED		Meaning	Remedy
RUN	ERROR		
Off	Off	Voltage missing or too low at backplane bus.	• 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 LED

Table 5- 3 CHx status display

LED CHx	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 35)

5.2 Interrupts

Analog input module AI 8xU/I HS 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
- 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
- Violation of 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.

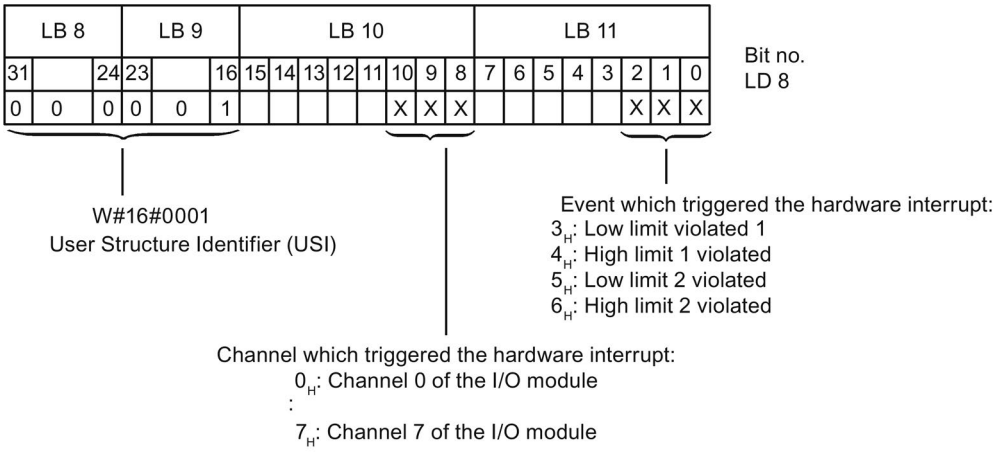


Figure 5-2 OB start information

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
It follows the error event that triggered the hardware interrupt.				
	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	Remedy
Wire break	6_H	Impedance of sensor 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)	• 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	• 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

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

6

Technical specifications of the AI 8xU/I HS

Order number	6ES7531-7NF10-0AB0
General information	
Product type designation	AI 8xU/I HS
HW functional status	FS01
Firmware version	V2.1.0
• FW update possible	Yes
Product function	
• I&M data	Yes; I&M0 to I&M3
• Measuring range scalable	No
• Scalable measured values	No
• Adjustment of measuring range	No
Engineering with	
• STEP 7 TIA Portal configurable/integrated as of version	V14 / -
• STEP 7 configurable/integrated as of version	V5.5 SP3 / -
• PROFIBUS as of GSD version/GSD revision	V1.0 / V5.1
• PROFINET as of GSD version/GSD revision	V2.3 / -
Operating mode	
• Oversampling	Yes
• 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
Input current	
Current consumption, max.	240 mA; with 24 V DC supply
Encoder supply	
24 V encoder supply	
• Short-circuit protection	Yes
• Output current, max.	53 mA

Order number	6ES7531-7NF10-0AB0
Power	
Power available from the backplane bus	1.15 W
Power loss	
Power loss, typ.	3.4 W
Analog inputs	
Number of analog inputs	8
• For current measurement	8
• For voltage measurement	8
permissible input voltage for voltage input (destruction limit), max.	28.8 V
permissible input current for current input (destruction limit), max.	40 mA
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)	50 kΩ
• -10 V to +10 V	Yes
• Input resistance (-10 V to +10 V)	100 kΩ
• -2.5 V to +2.5 V	No
• -25 mV to +25 mV	No
• -250 mV to +250 mV	No
• -5 V to +5 V	Yes
• Input resistance (-5 V to +5 V)	50 kΩ
• -50 mV to +50 mV	No
• -500 mV to +500 mV	No
• -80 mV to +80 mV	No
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
• Input resistance (0 to 20 mA)	41 Ω; Plus approx. 42 ohms for overvoltage protection by PTC
• -20 mA to +20 mA	Yes
• Input resistance (-20 mA to +20 mA)	41 Ω; Plus approx. 42 ohms for overvoltage protection by PTC
• 4 mA to 20 mA	Yes
• Input resistance (4 mA to 20 mA)	41 Ω; Plus approx. 42 ohms for overvoltage protection by PTC

Order number	6ES7531-7NF10-0AB0
Input ranges (rated values), thermocouples	
• Type B	No
• Type C	No
• Type E	No
• Type J	No
• Type K	No
• Type L	No
• Type N	No
• Type R	No
• Type S	No
• Type T	No
• Type TXK/TXK(L) to GOST	No
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	No
• Ni 100 according to GOST	No
• Ni 1000	No
• Ni 1000 according to GOST	No
• LG-Ni 1000	No
• Ni 120	No
• Ni 120 according to GOST	No
• Ni 200	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

Order number	6ES7531-7NF10-0AB0
• Pt 50	No
• Pt 50 according to GOST	No
• Pt 100	No
• Pt 100 according to GOST	No
• Pt 1000	No
• Pt 1000 according to GOST	No
• Pt 200	No
• Pt 200 according to GOST	No
• Pt 500	No
• Pt 500 according to GOST	No
Input ranges (rated values), resistors	
• 0 to 150 ohms	No
• 0 to 300 ohms	No
• 0 to 600 ohms	No
• 0 to 3000 ohms	No
• 0 to 6000 ohms	No
• PTC	No
Cable length	
• shielded, max.	800 m
Analog value generation for the inputs	
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Basic execution time of the module (all channels released)	62.5 µs; independent of number of activated channels
Smoothing of measured values	
• parameterizable	Yes
• Step: None	Yes
• Step: low	Yes
• Step: Medium	Yes
• Step: High	Yes

Order number	6ES7531-7NF10-0AB0
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes
• for current measurement as 2-wire transducer	Yes
– Burden of 2-wire transmitter, max.	820 Ω
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	No
• for resistance measurement with three-wire connection	No
• for resistance measurement with four-wire connection	No
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.02 %
Temperature error (relative to input range), (+/-)	0.005 %/K
Crosstalk between the inputs, max.	-60 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.02 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.3 %
• Current, relative to input range, (+/-)	0.3 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.2 %
• Current, relative to input range, (+/-)	0.2 %
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Common mode voltage, max.	10 V
Isochronous mode	
Isochronous operation (application synchronized up to terminal)	Yes
Filtering and processing time (TCI), min.	80 µs
Bus cycle time (TDP), min.	250 µs
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 ... 5 V and 4 ... 20 mA
• Overflow/underflow	Yes

Order number	6ES7531-7NF10-0AB0
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)
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	0 °C
• horizontal installation, max.	60 °C
• vertical installation, min.	0 °C
• vertical installation, max.	40 °C
Decentralized operation	
Prioritized startup	Yes
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	300 g

Dimensional drawing

A

This appendix contains the dimensional drawing of the module installed on a mounting rail and with a shield bracket. Always adhere to the specified dimensions for installations in cabinets, control rooms, etc.

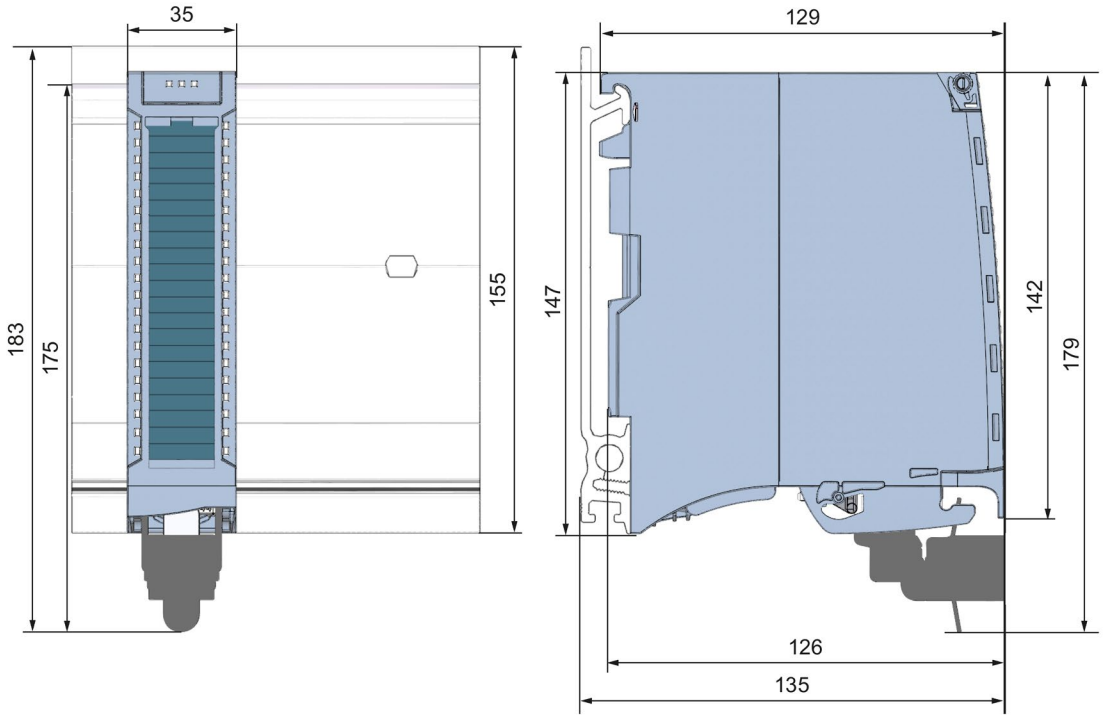


Figure A-1 Dimensional drawing of the AI 8xU/I HS module

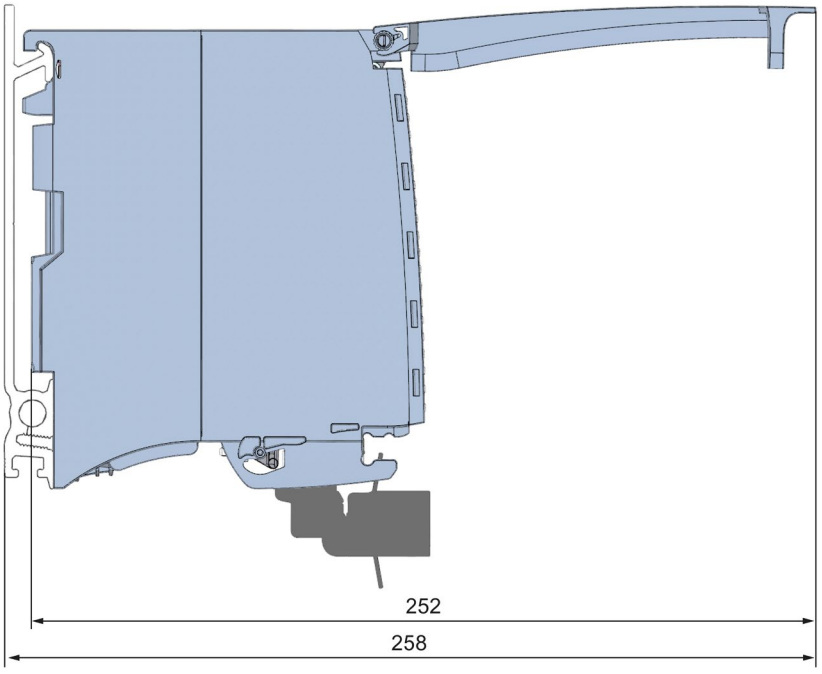


Figure A-2 Dimensional drawing of the AI 8xU/I HS module, side view with open front panel

Parameter data records

B

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 with **measuring range** 1V to 5 V and current with **measuring range** 4 mA to 20 mA.
Hardware interrupt limits	Only if hardware interrupts are enabled.

Parameter assignment in the user program

You have the option to assign module parameters in RUN (e.g., the voltage or current values of selected channels can be edited in RUN without having an effect on the other channels).

Parameter assignment in RUN

The WRREC instruction is used to transfer the parameters to the module using data records 0 to 7. 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

For the configuration as a 1 x 8-channel module, the parameters are located in data records 0 to 7 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

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

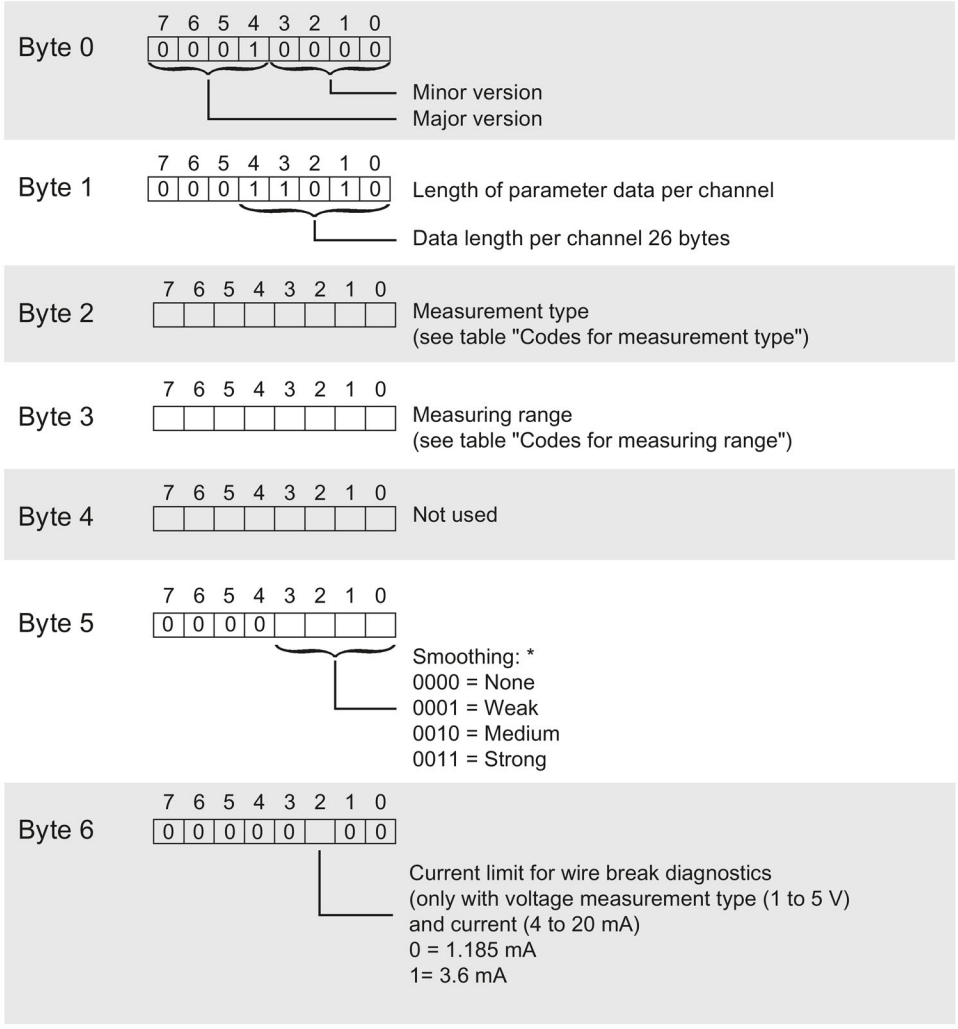
- Data record 0 for channel 0 (submodule 1)
- Data record 0 for channel 1 (submodule 2)
- …
- Data record 0 for channel 6 (submodule 7)
- Data record 0 for channel 7 (submodule 8)

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".



* not for the oversampling function

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

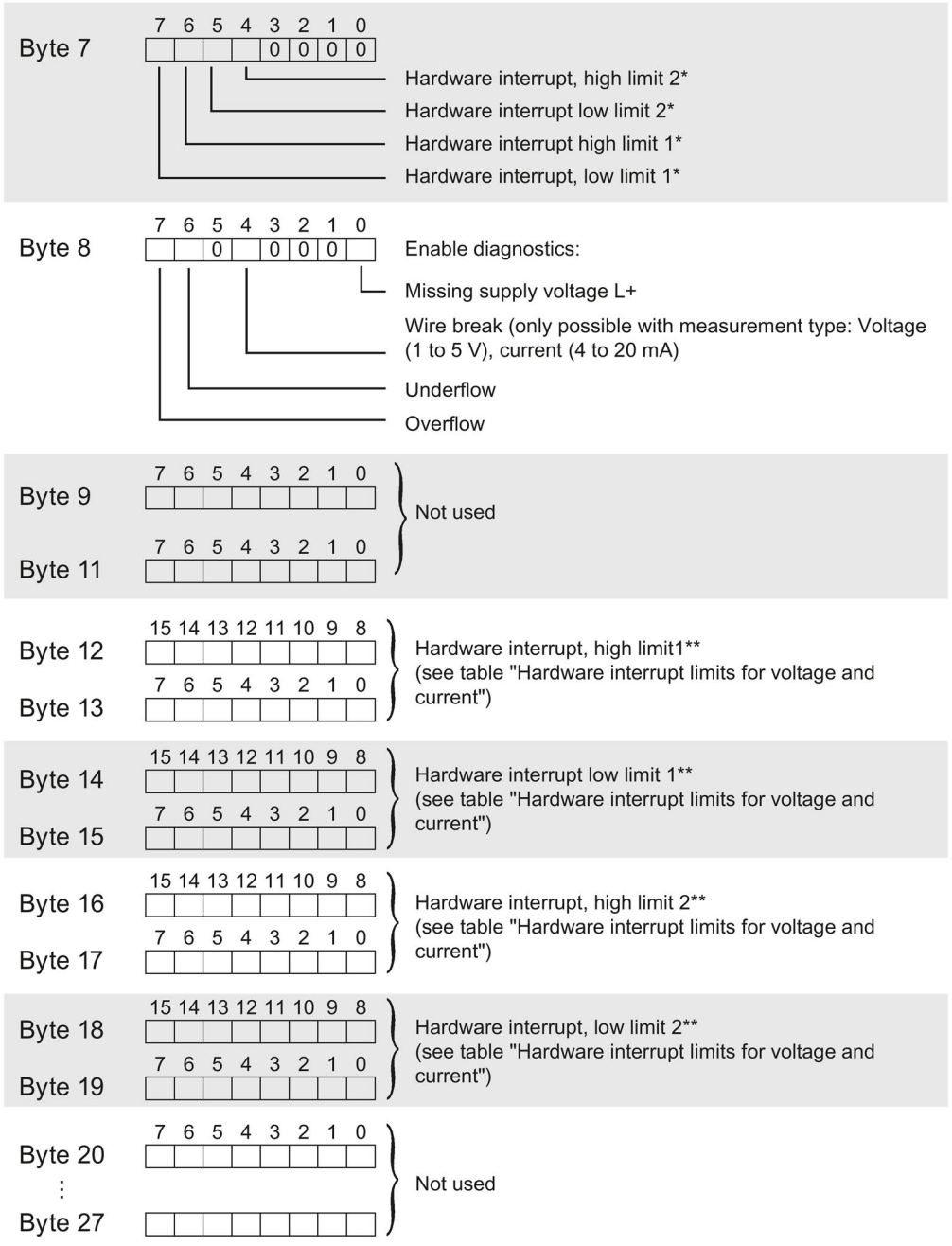


Figure B-2 Structure of data record 0: Bytes 7 to 27

Note

- You can only configure the oversampling function with STEP 7 (TIA Portal) via the sampling rate parameter.

Codes for measuring types

The following table lists all measuring types of the analog input module along with their codes. Enter these codes at byte 2 of the respective data record (see previous figure).

Table B- 2 Code for the measuring type

Measurement type	Code
Deactivated	0000 0000
Voltage	0000 0001
Current 4-wire transmitter	0000 0010
Current 2-wire transmitter	0000 0011

Codes for measuring ranges

The following table lists all measuring ranges of the analog input module along with their codes. Enter these codes at byte 3 of the respective data record (see previous figure).

Table B- 3 Code for the measuring range

Measuring range	Code
Voltage	
±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

Hardware interrupt limits

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

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

Table B- 4 Limits of hardware interrupts for voltage and current

Voltage		Current		
± 5 V, ± 10 V	1 V to 5 V	±20 mA	4 mA to 20 mA, 0 mA to 20 mA	
32510	32510	32510	32510	High limit
-32511	-4863	-32511	-4863	Low limit

Representation of analog values

C

Introduction

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

Measured value resolution

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

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

Units	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	
-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	Undershoot range
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32768	<-117.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Table C- 3 Unipolar input ranges

Units	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	
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Rated range
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	Undershoot range
-4864	-17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
-32768	<-17.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

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 range ±10 V and ±5 V

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

Table C- 5 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 µV	
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- 6 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	
-27649	93FF		Undershoot range
-32512	8100	-23.52 mA	
-32768	8000	< -23.52 mA	Underflow

Table C- 7 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			Undershoot range
-4864	ED00	-3.52 mA	1.185 mA	
-32768	8000	<- 3.52 mA	< 1.185 mA	Underflow

C.4 Measured values for wire break diagnostic

Measured values on diagnostic event "wire break", dependent on diagnostics enables

Error events initiate a diagnostics entry and trigger a diagnostics interrupt if configured accordingly.

Table C- 8 Measured values for wire break diagnostic

Format	Parameter assignment	Measured values		Explanation
S7	• "Wire break" diagnostics enabled • "Overflow/Underflow" diagnostics enabled or disabled ("Wire break" diagnostics takes priority over "Overflow/Underflow" diagnostics)	32767	$7FFF_H$	"Wire break" or "Open circuit" diagnostic alarm
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics enabled	-32767	8000_H	• Measured value after leaving the undershoot range • Diagnostic alarm "Low limit violated"
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics disabled	-32767	8000_H	Measured value after leaving the undershoot range