SIEMENS

SIMATIC

S7-1500 / ET 200MP

Analog Input Module AI 8xU/I HF (6ES7531-7NF00-0AB0)

Manual

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Analog Input Module AI 8xU/I HF
(6ES7531-7NF00-0AB0)

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⚠ 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

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Preface

Purpose of the documentation

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

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:

- As of firmware version V1.1.0, the module supports the following functions:
  - Measuring range adjustment
  - Scaling of measured values
- Original texts of the license conditions and copyright notes for open-source software are available on the Internet as of 09/2016.

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

For legal reasons, we are obliged to publish the original text of the license conditions and copyright notices. Please read the information relating to this on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109739516).

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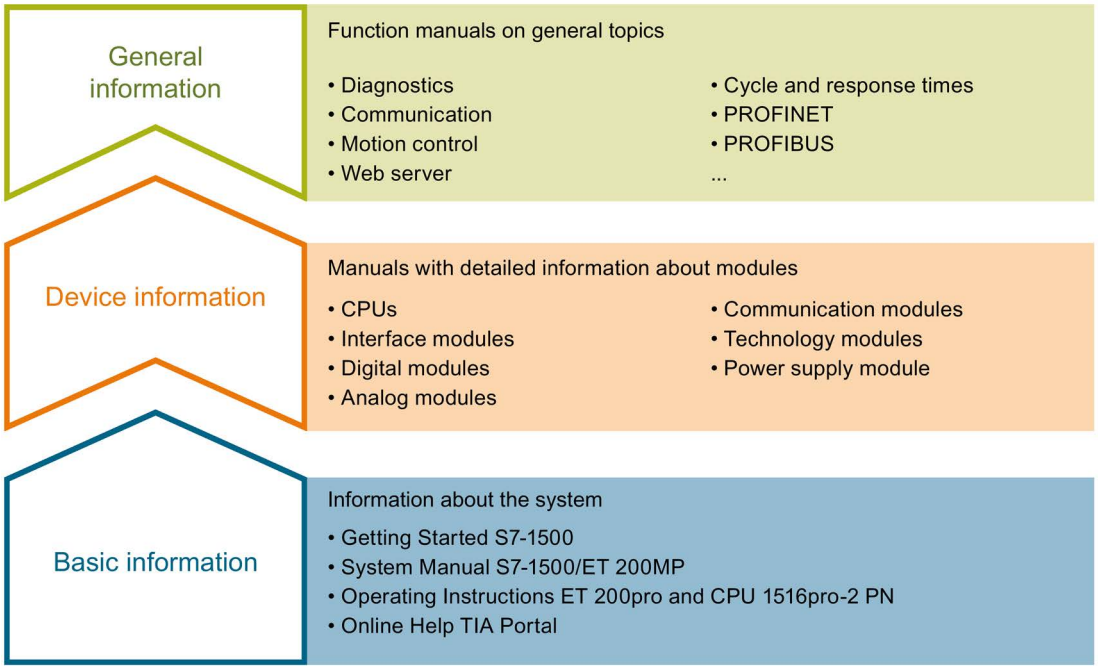
Documentation guide

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 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

6ES7531-7NF00-0AB0

View of the module

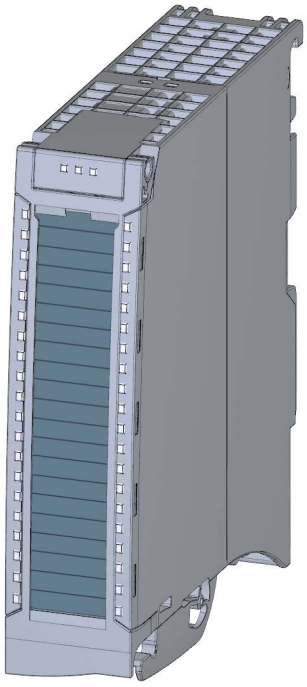


Figure 2-1 View of the AI 8xU/I HF module

Properties

The module has the following technical properties:

- 8 electrically isolated analog inputs
- Voltage measurement type can be set per channel
- Current measurement type can be set per channel
- Two operating modes
  - Fast: shortest integration time 2.5 ms
  - Standard: shortest integration time 7.5 ms
- Resolution 16 bits including sign
- Configurable diagnostics (per channel)
- Hardware interrupt on limit violation can be set per channel (two low and two high limits per channel)

The module supports the following functions:

Table 2- 1 Version dependencies of the module functions

Function	Firmware version of the module	Configuration software	
		STEP 7 (TIA Portal) as of V13, SP1 and HSP 0166	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	X	--- / X
Identification data I&M0 to I&M3	V1.0.0 or higher	X	X
Parameter assignment in RUN	V1.0.0 or higher	X	X
Module internal Shared Input (MSI)	V1.0.0 or higher	X (PROFINET IO only)	X (PROFINET IO only)
Configurable submodules / submodules for Shared Device	V1.0.0 or higher	X (PROFINET IO only)	X (PROFINET IO only)
Measuring range adjustment	V1.1.0 or higher	V14 or higher and HSP 0186 (only PROFINET IO)	X (PROFINET IO only)
Scaling of measured values			

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

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 cover

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 Measuring range adjustment

Introduction

The measuring range adjustment is available for current and voltage measuring ranges. Live zero measuring ranges are not supported.

Function

The measuring range adjustment is an adjustment of the measuring range at the sensor.

It allows you to increase the resolution for a configurable part of the measuring range in S7 format.

- You activate the function in STEP 7 (TIA Portal) via the "Measuring range adjustment" parameter.
- The "Measuring range adjustment high limit" parameter sets the high limit of the measuring range in mV or µA.
- The "Measuring range adjustment low limit" parameter sets the low limit of the measuring range in mV or µA.

Note

- The "Measuring range adjustment" function can be used in combination with the "Measured value scaling" function, see also Scaling of measured values (Page 17).
- When the "Measuring range adjustment high limit" and "Measuring range adjustment low limit" parameters are too close together, resolution may be lost, which means it may no longer be possible to show every value.

Rules

- The limits of the measuring range adjustment must be selected within the nominal range of the base measuring range. They are specified in integers.
- The measuring range adjustment is resolved depending on the base measuring range from 0_H to $6C00_H$ or 9400_H to $6C00_H$.
- Underranges/overranges apply in accordance with the S7 format and the base measuring range.

Example

The following values result, for example:

Table 2- 2 Example of measuring range adjustment

Measuring range adjustment	Measuring range resolution	
	Bipolar	Unipolar
Base measuring range	±10 V	0 mA to 20 mA
Adjusted measuring range	+2 V to +5 V	+2 mA to +15 mA
Measuring range adjustment high limit	5000 mV (S7: +27648)	15 mA (S7: +27648)
Measuring range adjustment low limit	2000 mV (S7: -27648)	2 mA (S7: 0)

The following example illustrates the effect of a measuring range adjustment:

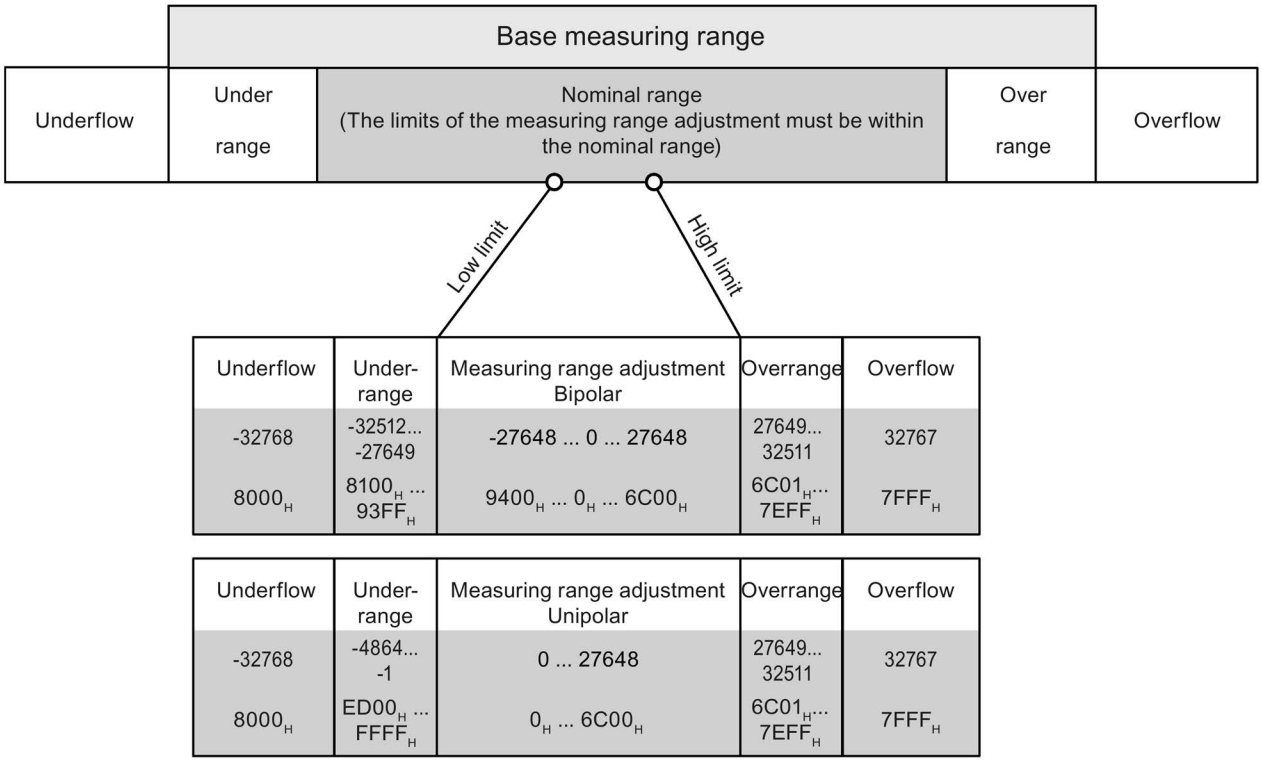


Figure 2-2 Example of a measuring range adjustment

Example of a configuration

The following figure shows an example of a configuration with a measuring range adjustment of 2000 mV to 5000 mV.

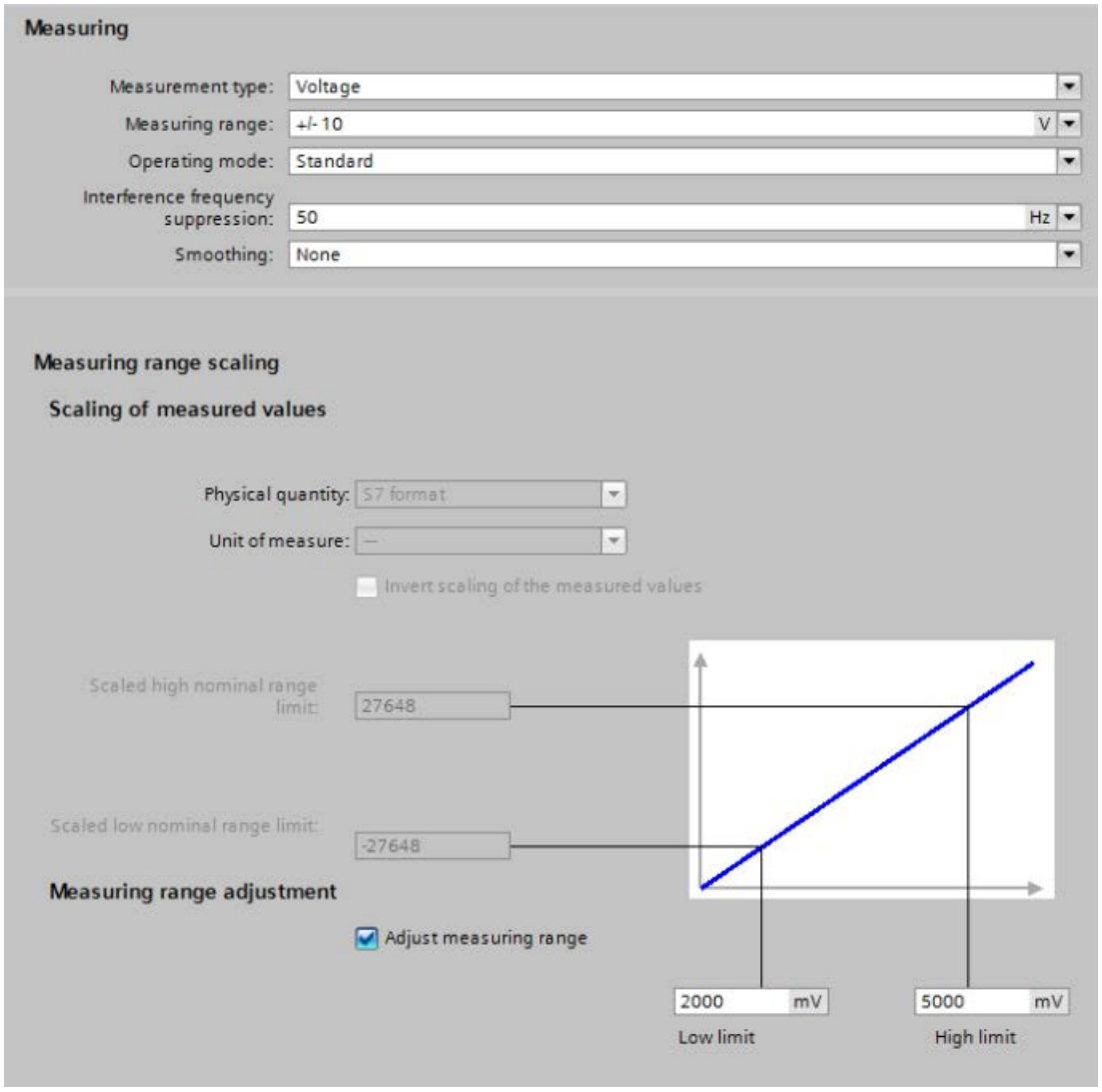


Figure 2-3 Example of a measuring range adjustment in STEP 7 (TIA Portal)

2.2.2 Scaling of measured values

Introduction

The measured value scaling can be combined with the measuring range adjustment. In this case, the measuring range is adjusted first and then the representation of the measuring range is scaled.

Function

With measured value scaling, the user data of the module is displayed in REAL format (32-bit floating point) instead of S7 format.

The representation of the measuring range is defined by the following parameters:

- The "Scaled high nominal range limit" parameter sets the desired display value (in REAL format) for the high nominal range limit of the measuring range.
- The "Scaled low nominal range limit" parameter sets the desired display value (in REAL format) for the low nominal range limit of the measuring range.

Note

Effects of inversion

- It is possible to set the "Scaled high nominal range limit" parameter lower than the "Scaled low nominal range limit" parameter, whereby the representation of the measuring range will be inverted compared to the terminal value (V, mA).
- Overflow/underflow and hardware interrupts are always based on representation in REAL format. A terminal value of > 11.76 V triggered an underflow for an inverted measured value scaling. Hardware interrupts react similarly.

Substitute value for underflow/overflow

With measured value scaling, the substitute value is minus infinity for underflow (FF80 0000H) and plus infinity for overflow (7F80 0000H).

Resolution at the parameter "Scaled high/low nominal range limit"

When the Parameter "Scaled high nominal range limit" and "Scaled low nominal range limit" parameters are too close together, resolution may be lost, which means it may no longer be possible to show every value.

Example

The following values result, for example:

Table 2- 3 Example of measured value scaling

	Low nominal range limit	High nominal range limit
Base measuring range	-10 V	+10 V
S7 format	-27648	+27648
Scaling of measured values	1.00	7.00

As shown in the table, -10 V corresponds to 1.00 and +10 V corresponds to 7.00.

Combination with measuring range adjustment

If the measuring range adjustment is enabled in addition to measured value scaling, first the measuring range is adjusted and then the representation of the measuring range scaled. The table below shows an example of the combination of measured value scaling and measuring range adjustment.

Table 2- 4 Example for a combination of measured value scaling and measuring range adjustment

	Low nominal range limit	High nominal range limit
Measuring range adjustment	-4000 mV	8000 mV
S7 format	-27648	+27648
Scaling of measured values	1.00	7.00

As shown in the table, -4 V corresponds to 1.00 and +8 V corresponds to 7.00.

Configuration

The following figures show examples of a configuration in STEP 7 (TIA Portal):

Configuration of measured value scaling

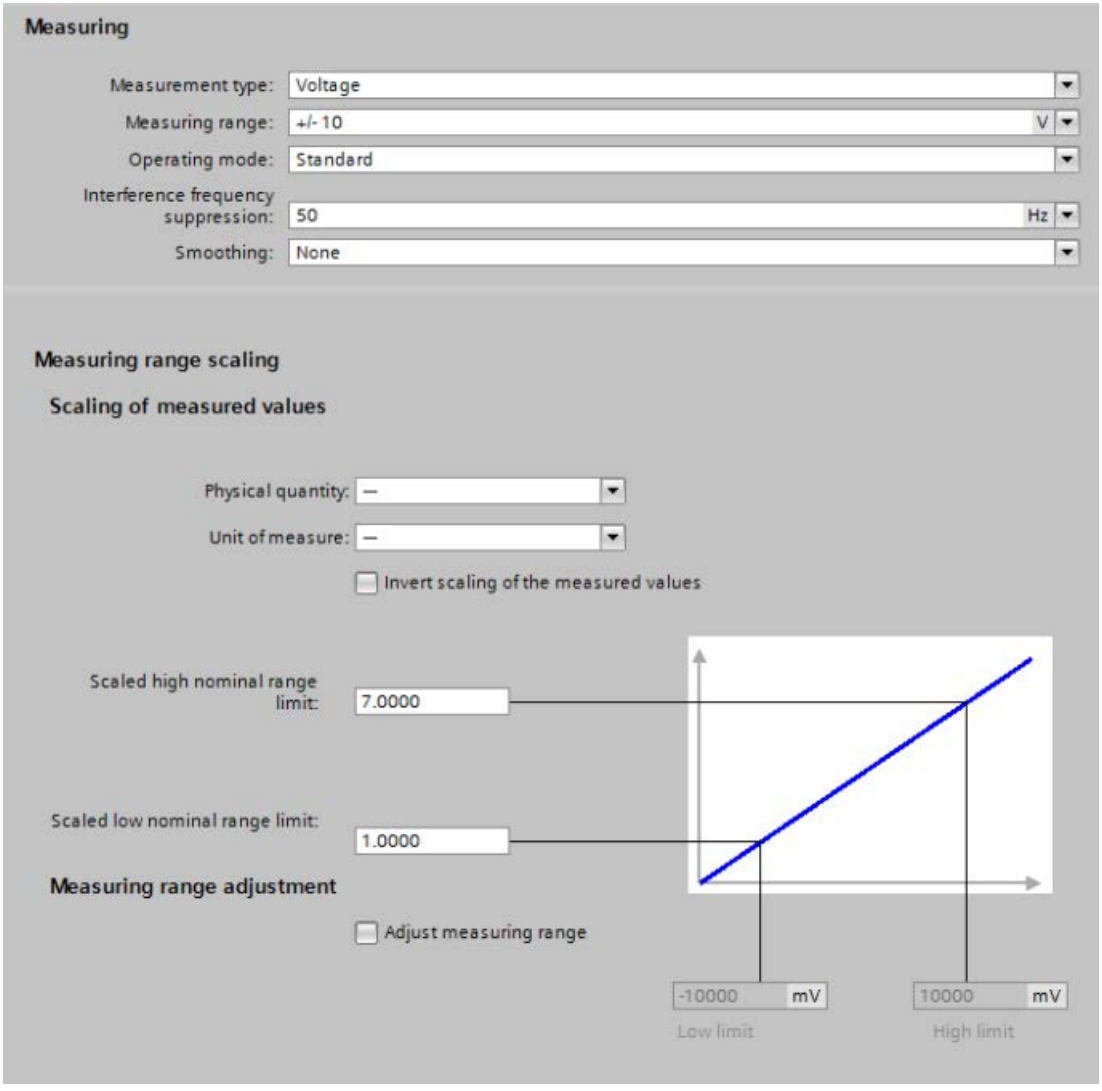


Figure 2-4 Configuration of measured value scaling

Configuration with measuring range adjustment and measured value scaling

In the configuration example, a measuring range adjustment of -4000 mV to 8000 mV is displayed and additionally converted to a scaled high and low nominal range limit of 1.00 to 7.00.

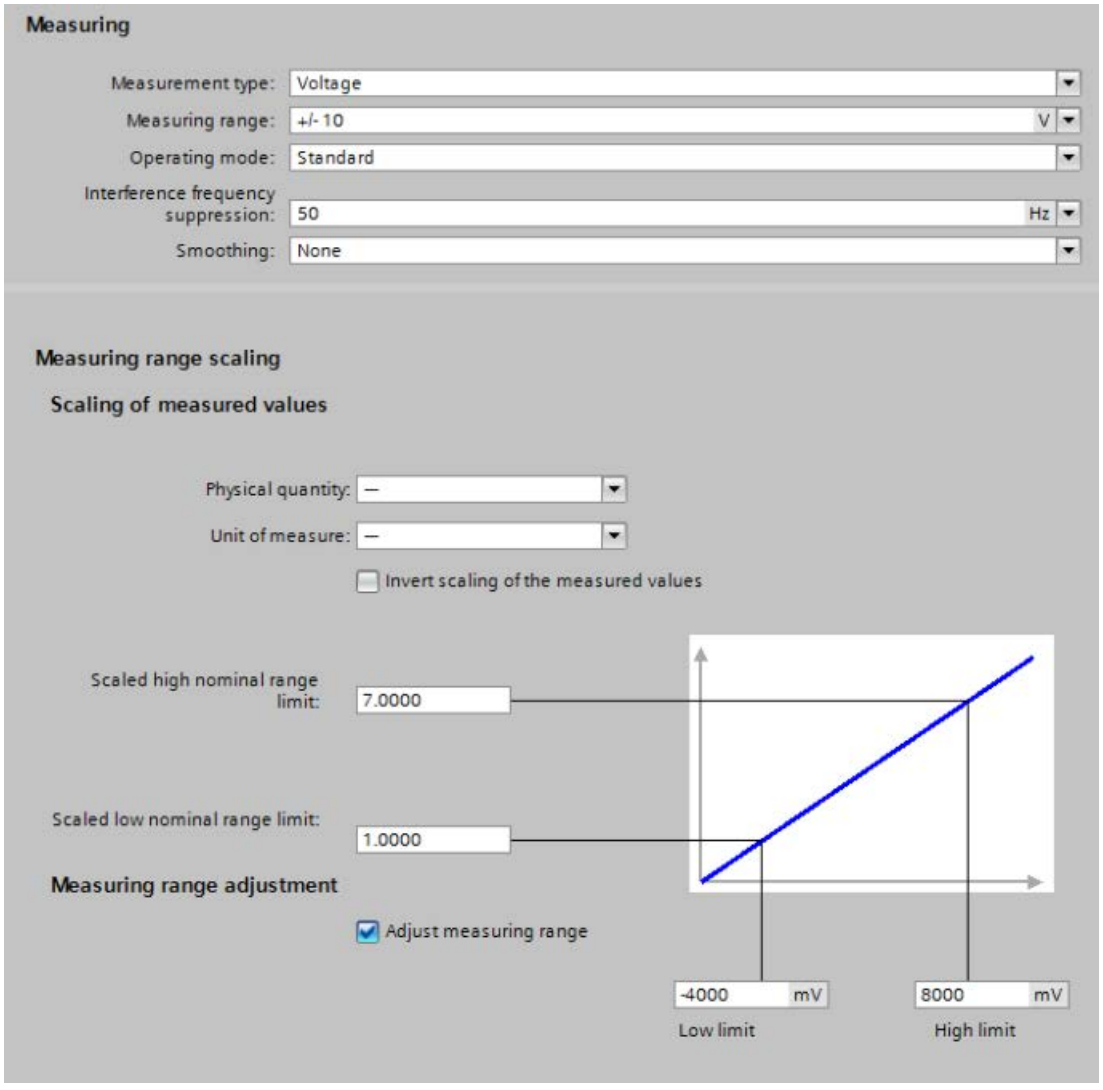


Figure 2-5 Configuration with measuring range adjustment and measured value scaling

Wiring

3

The section below includes 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) 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)
L+	Supply voltage connection
M	Ground connection

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.

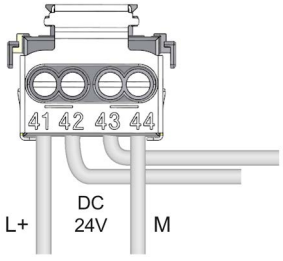
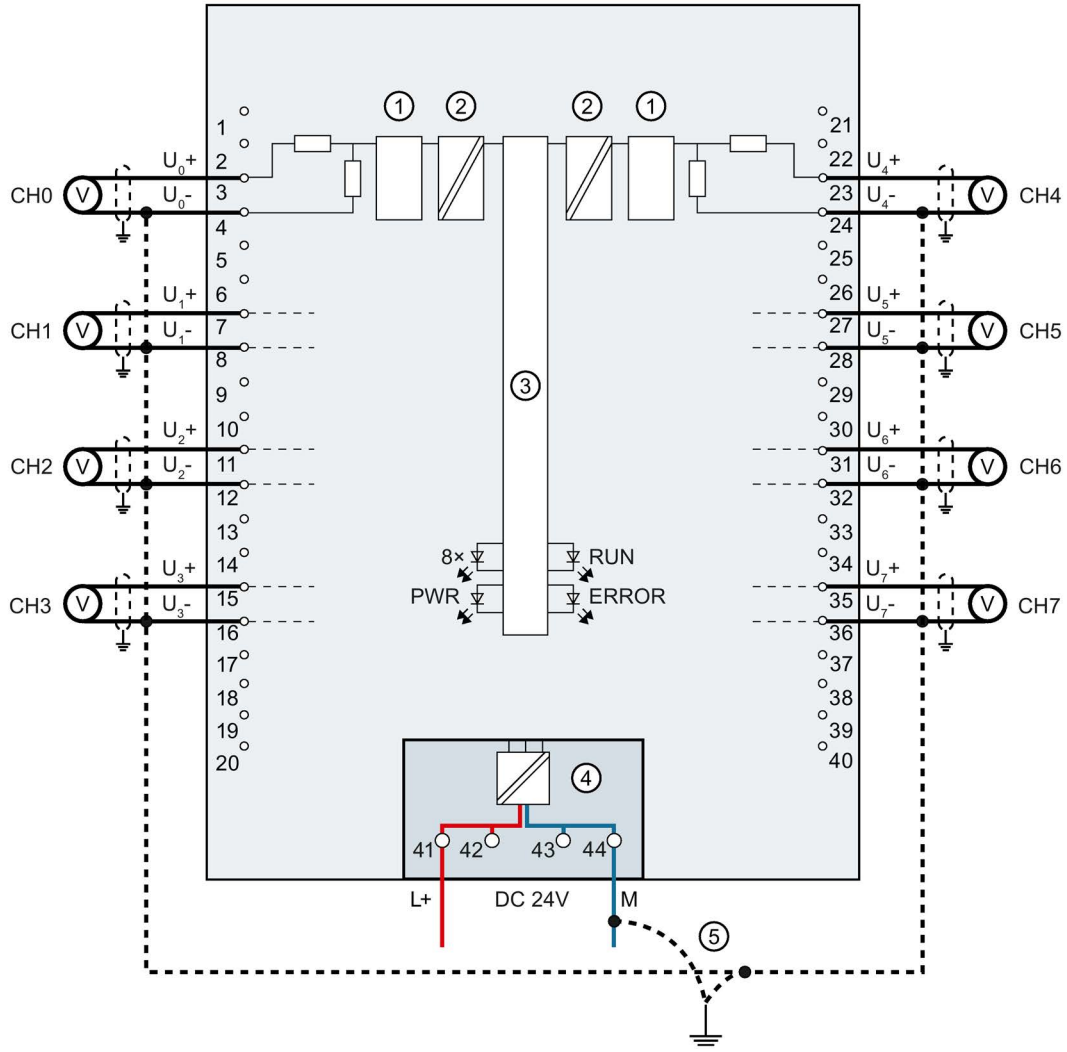


Figure 3-1 Power supply element wiring

Block diagram and pin assignment for voltage measurement

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

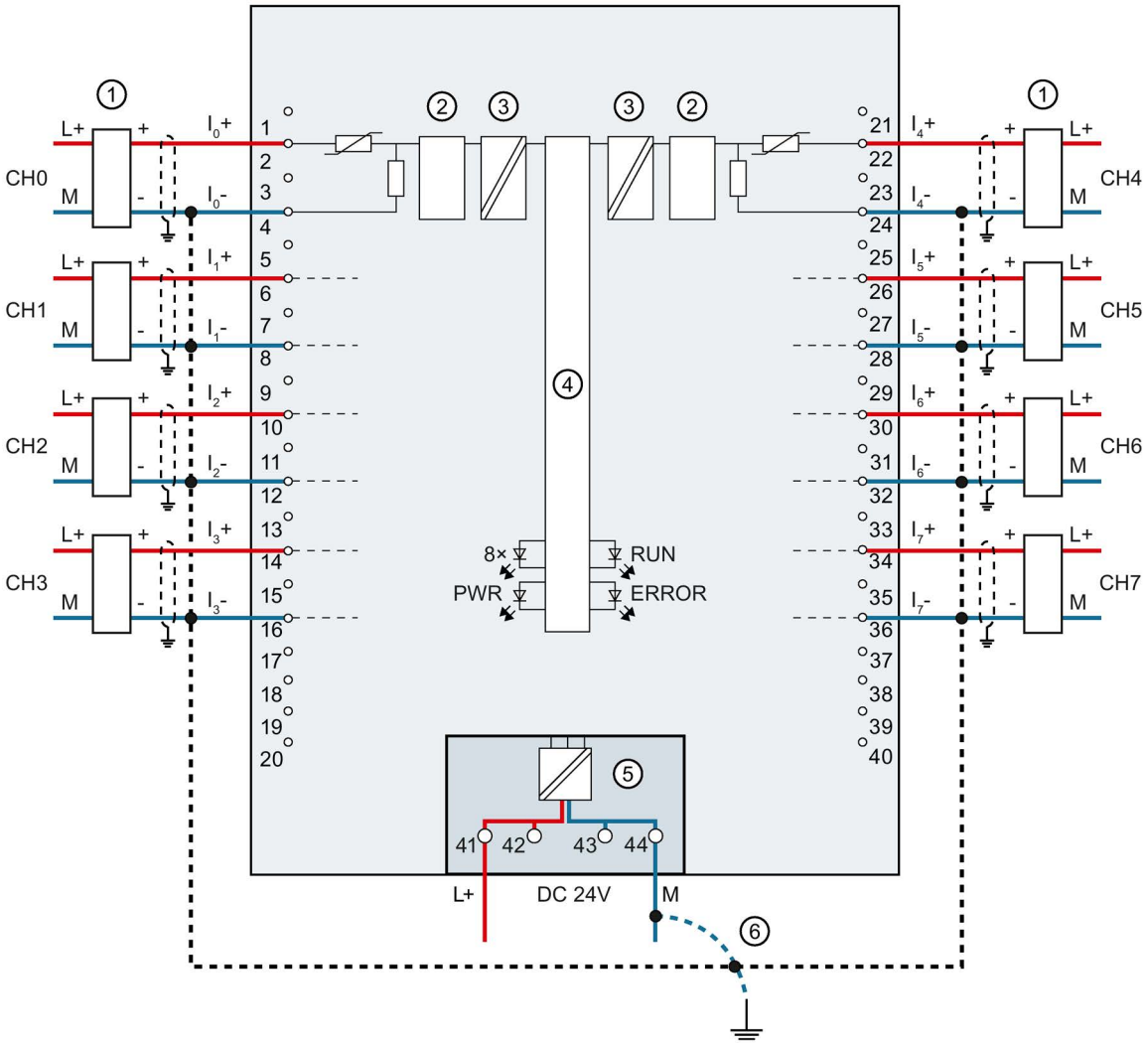


①	Analog-to-Digital Converter (ADC)	CHx	Channel or 8 x channel status (green/red)
②	Electrical isolation	RUN	Status display LED (green)
③	Backplane bus interface	ERROR	Error display LED (red)
④	Supply voltage via power supply element	PWR	LED for power supply (green)
⑤	Equipotential bonding cable (optional)		

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

Block diagram and terminal assignment for 4-wire transducer for current measurement

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



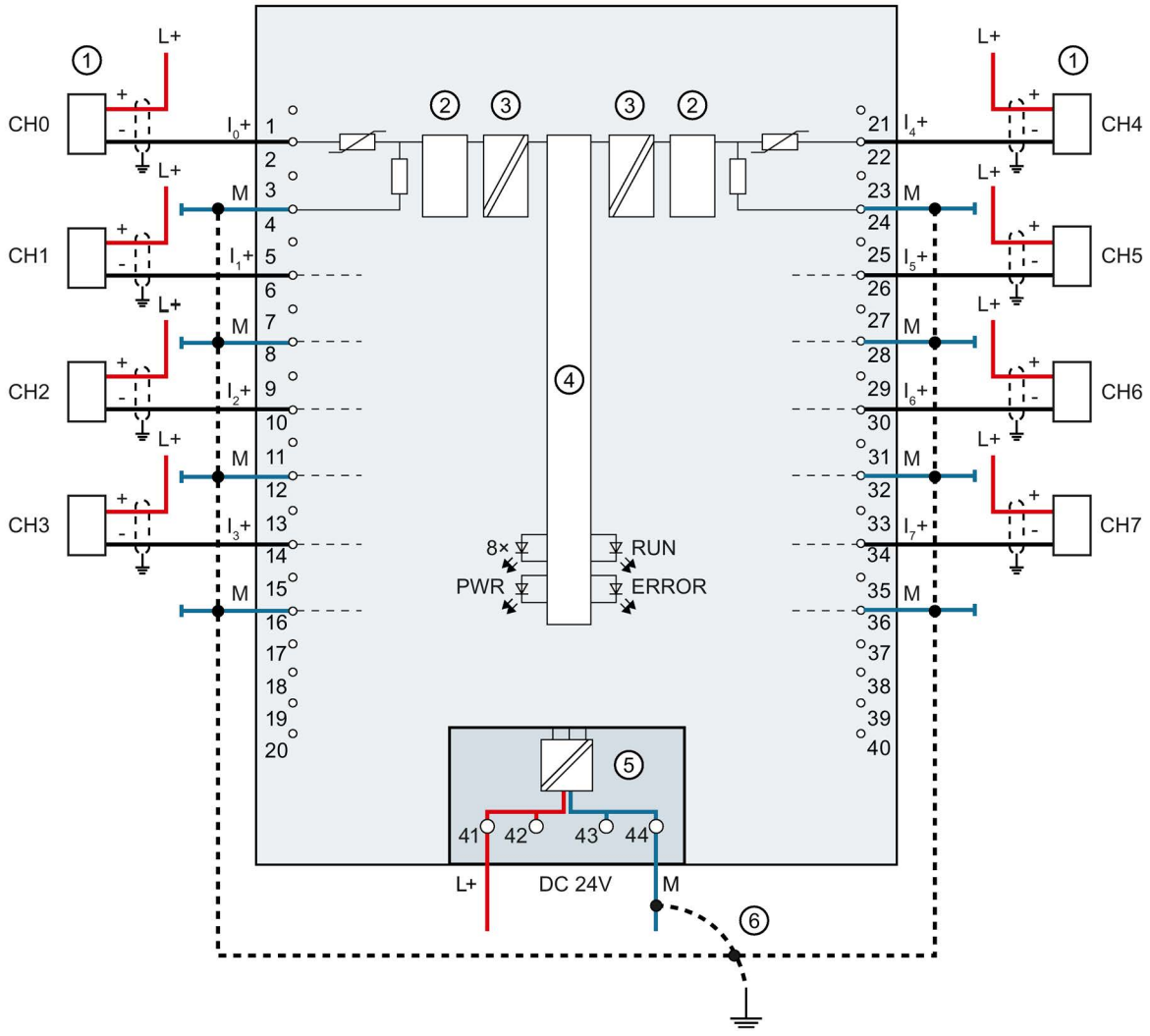
① Connector 4-wire transducer
② Analog-to-Digital Converter (ADC)
③ Electrical isolation
④ Backplane bus interface
⑤ Supply voltage via power supply element
⑥ Equipotential bonding cable (optional)

CHx	Channel or 8 x channel status (green/red)
RUN	Status display LED (green)
ERROR	Error display LED (red)
PWR	LED for power supply (green)

Figure 3-3 Block diagram and terminal assignment for 4-wire transducer for current measurement

Block diagram and terminal assignment for 2-wire transducer for current measurement

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



①	Connector 2-wire transducer	CHx	Channel or 8 x channel status (green/red)
②	Analog-to-Digital Converter (ADC)	RUN	Status display LED (green)
③	Electrical isolation	ERROR	Error display LED (red)
④	Backplane bus interface	PWR	LED for power supply (green)
⑤	Supply voltage via power supply element		
⑥	Equipotential bonding cable (optional)		

Figure 3-4 Block diagram and terminal assignment for 2-wire transducer 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.

Measurement type	Measuring range	Representation of analog values
Voltage	1 V to 5 V ±2.5 V ±5 V ±10 V	See Appendix Representation of analog values in voltage measuring ranges (Page 62).
Current 2WMT (2-wire transducer)	4 mA to 20 mA	See Appendix Representation of analog values in the current measuring ranges (Page 63).
Current 4WMT (4-wire transducer)	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 60).

4.2 Parameters

Parameters of AI 8xU/I HF

The AI 8xU/I HF 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 (Page 50).

The following parameter settings for the channels are possible:

Table 4- 1 Configurable parameters and their defaults

Parameters	Range of values	Default setting	Configuration in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				Integrated in the hardware catalog STEP 7 (TIA Portal) as of V13 or GSD file PROFINET IO	GSD file PROFIBUS DP
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]
• Current limit for wire break diagnostics [2]	1.185 mA or 3.6 mA	1.185 mA	Yes	Channel	--- [4]

Parameters	Range of values	Default setting	Configuration in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				Integrated in the hardware catalog STEP 7 (TIA Portal) as of V13 or GSD file PROFINET IO	GSD file PROFIBUS DP
Measuring					
• Measurement type	See section Measuring types and ranges (Page 25)	Voltage	Yes	Channel	Channel
• Measuring range		±10 V	Yes	Channel	Channel
• Operating mode	Standard Fast	Standard	Yes	Channel	--- [4]
• Interference frequency suppression	400 Hz 60 Hz 50 Hz 10 Hz	50 Hz	Yes	Channel	Module
• Smoothing	None/low/medium/high	None	Yes	Channel	Channel
• Measuring range adjustment	• Disable • Enable	Disable	Yes	Channel	Channel
• Measuring range adjustment high limit (mV or µA)	Value within the nominal range of the measuring range greater than lower limit	High limit	Yes	Channel	Channel [4]
• Measuring range adjustment low limit (mV or µA)	Value within the nominal range of the measuring range smaller than high limit	Low limit	Yes	Channel	Channel [4]
• Scaled high nominal range limit	Scale • High limit • Low limit	High limit	Yes	Channel	---
• Scaled low nominal range limit	Scale • High limit • Low limit	Low limit	Yes	Channel	---

Parameters	Range of values	Default setting	Configuration in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				Integrated in the hardware catalog STEP 7 (TIA Portal) as of V13 or GSD file PROFINET IO	GSD file PROFIBUS DP
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, the "Measuring range adjustment high and low limit" and the hardware interrupt limits in the user program with data records 0 to 7.

4.3 Declaration of parameters

Missing supply voltage L+

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

Overflow

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

Underflow

Enabling of the diagnostics 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.

Interference frequency suppression

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

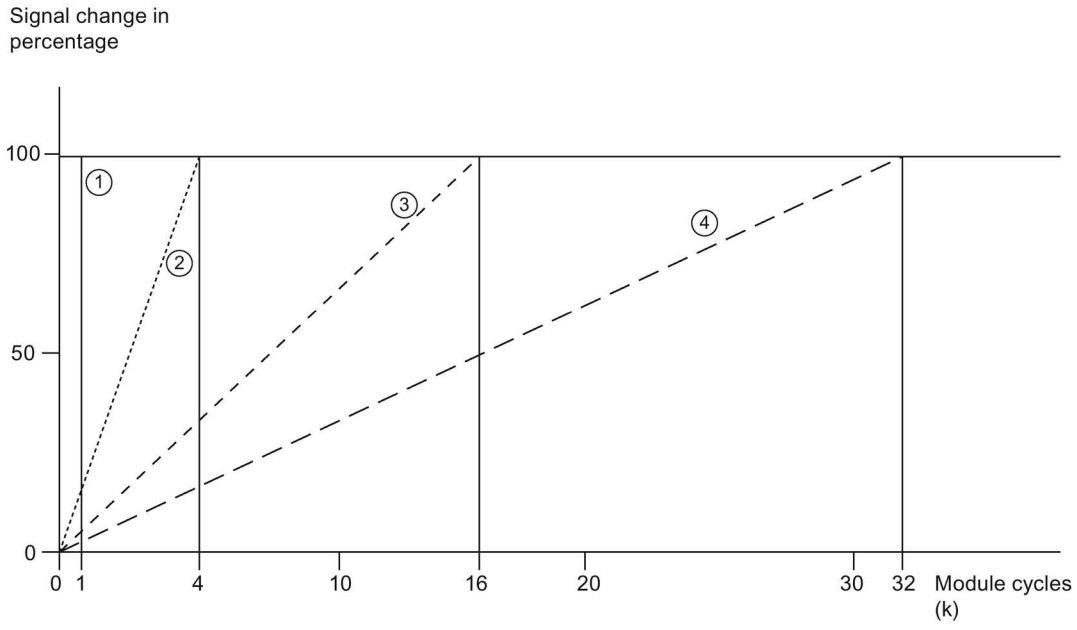
The frequency of the AC voltage network can negatively affect the measured value, in particular when measuring in low voltage ranges and with thermocouples. With this parameter, the user specifies the line frequency that is predominant in the plant.

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 HF

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.

Operating mode Fast / Standard

You can use this parameter to determine the operating mode for the module.

- Fast mode; easy integration time with less frequency suppression (minimal integration time 2.5 ms)
- Standard mode; triple integration time with higher frequency suppression (minimal integration time 7.5 ms)

Measuring range adjustment

With this parameter, you disable or enable the measuring range adjustment function.

Measuring range adjustment high limit

With this parameter, you specify the high limit of the measuring range.

Measuring range adjustment low limit

With this parameter, you specify the low limit of the measuring range.

Scaled high nominal range limit

With this parameter, you set the desired display value (in REAL) for the high nominal range limit of the measuring range.

Scaled low nominal range limit

With this parameter, you set the desired display value (in REAL) for the low nominal range limit of the measuring range.

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 HF

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 the hardware catalog STEP 7 (TIA Portal) as of V13, SP1 and HSP 0166	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 HF	X	X
1 x 8-channel with value status	AI 8xU/I HF QI	X	X
8 x 1-channel without value status	AI 8xU/I HF S	X (PROFINET IO only)	X (PROFINET IO only)
8 x 1-channel with value status	AI 8xU/I HF S QI	X (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 HF MSI	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status for scaling of measured values	AI 8xU/I HF Scale	V14 or higher with HSP 0186 (PROFINET IO only)	X (PROFINET IO only)

Value status (Quality Information, QI)

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

- AI 8xU/I HF QI
- AI 8xU/I HF S QI
- AI 8xU/I HF MSI
- AI 8xU/I HF Scale

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 for configuration as 1 x 8-channel AI 8xU/I HF and AI 8xU/I HF QI

The figure below shows the address space assignment with the configuration as 1 x 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.

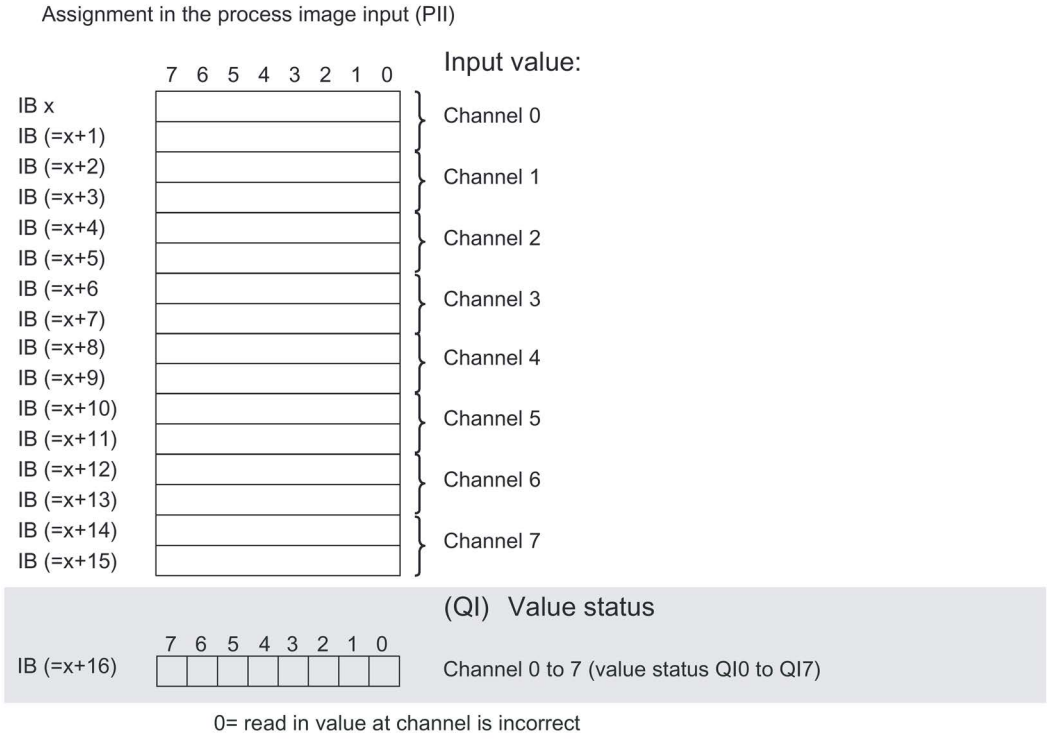


Figure 4-2 Address space for configuration as 1 x 8-channel AI 8xU/I HF with value status

Address space for configuration as 8 x 1-channel AI 8xU/I HF S and AI 8xU/I HF 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.

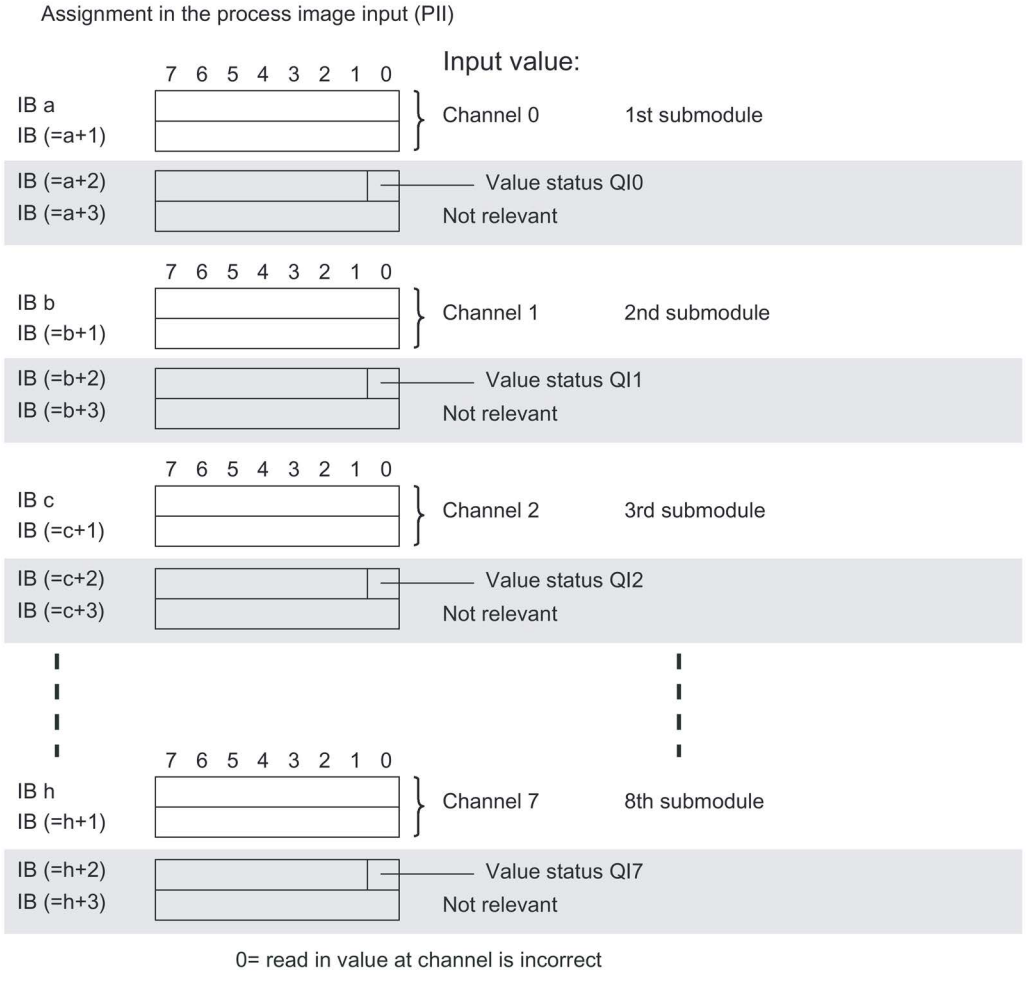


Figure 4-3 Address space for configuration as 8 x 1-channel AI 8xU/I HF S QI with value status

Address space for configuration as 1 x 8-channel AI 8xU/I HF 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 IO controllers depends on the interface module used. Please observe the information in the manual for the particular interface module.

Value status (Quality Information, QI)

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

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

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

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

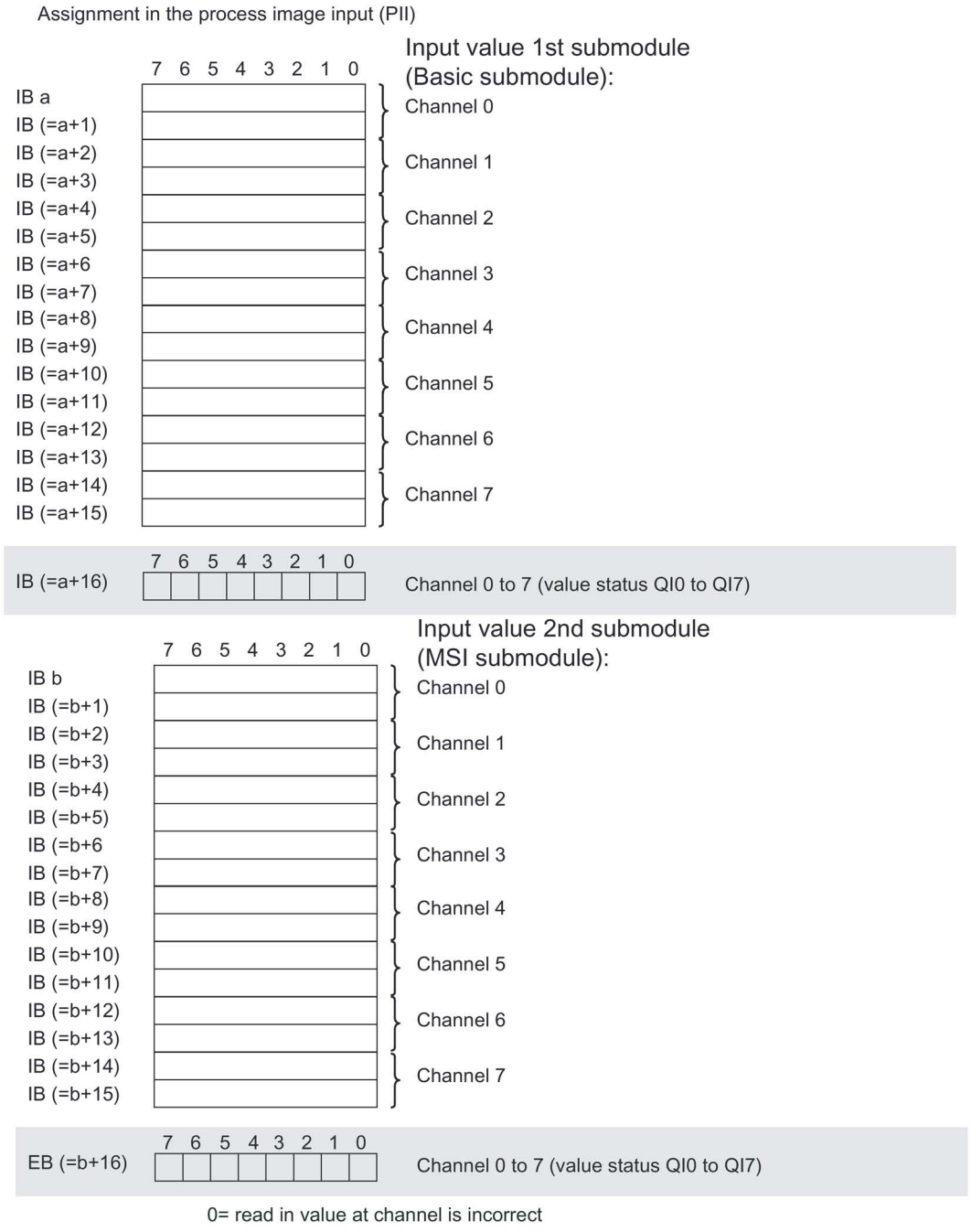


Figure 4-4 Address space for configuration as 1 x 8-channel AI 8xU/I HF MSI with value status

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

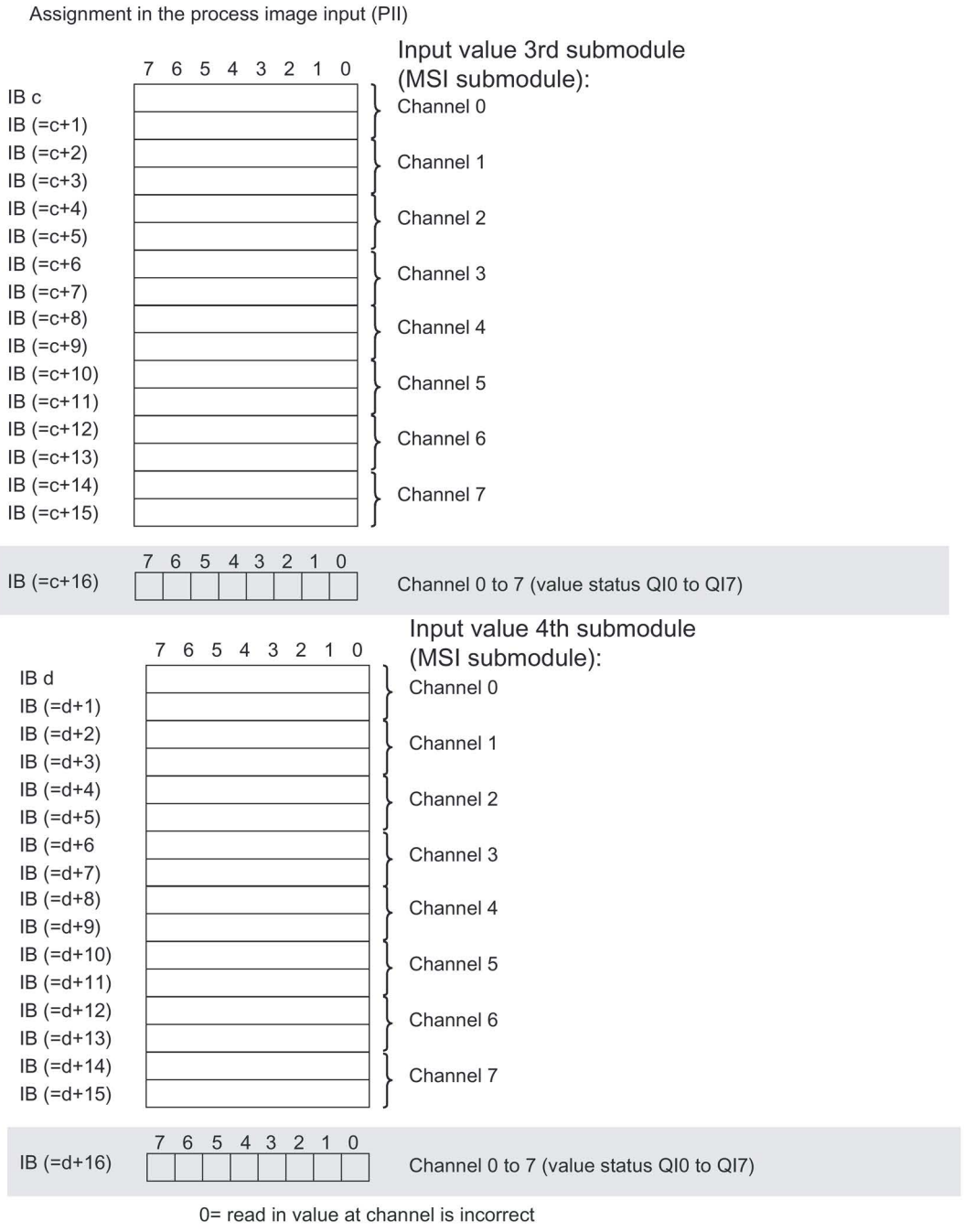


Figure 4-5 Address space for configuration as 1 x 8-channel AI 8xU/I HF MSI with value status

Address space for configuration as 1 x 8-channel AI 8xU/I HF and Scale

The figure below shows the address space assignment for configuration as a 1 x 8-channel module for scaling (Scale) of the measured values. 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.

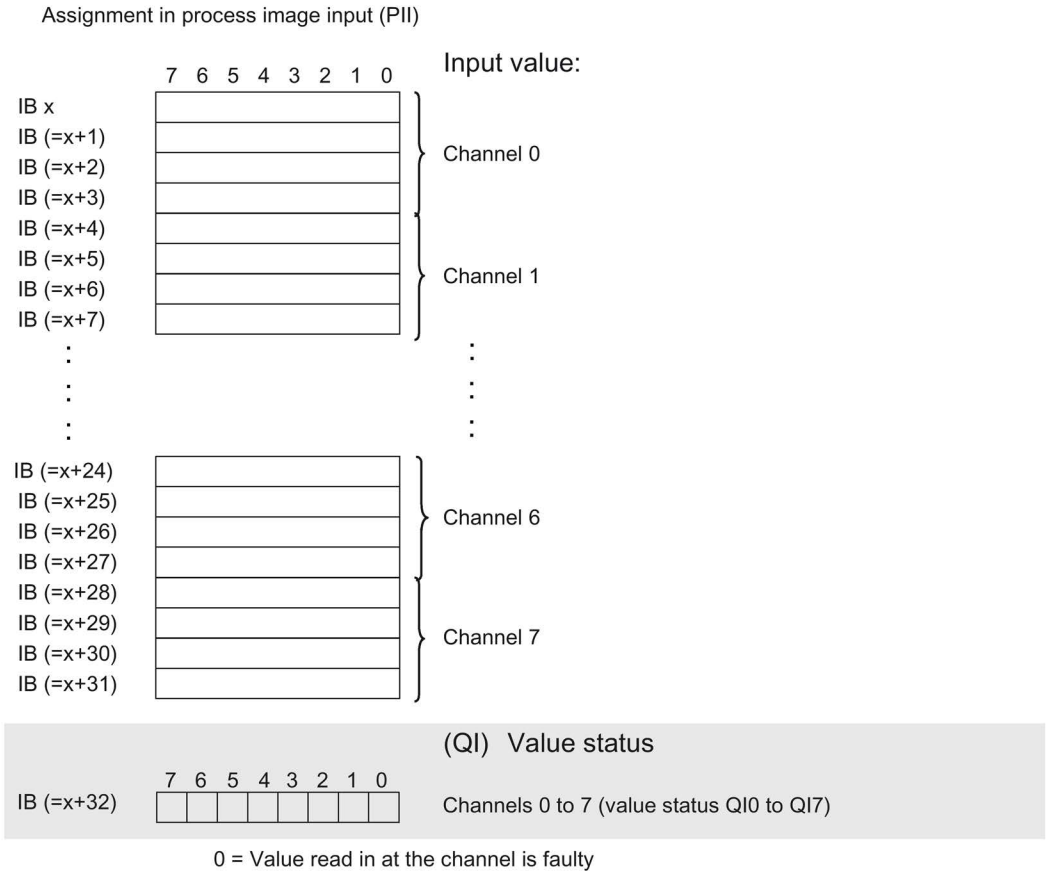


Figure 4-6 Address space for configuration as 1 x 8-channel AI 8xU/I HF MSI Scale with value status

Reference

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

Interrupts/diagnostics alarms

5

5.1 Status and error displays

LED displays

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

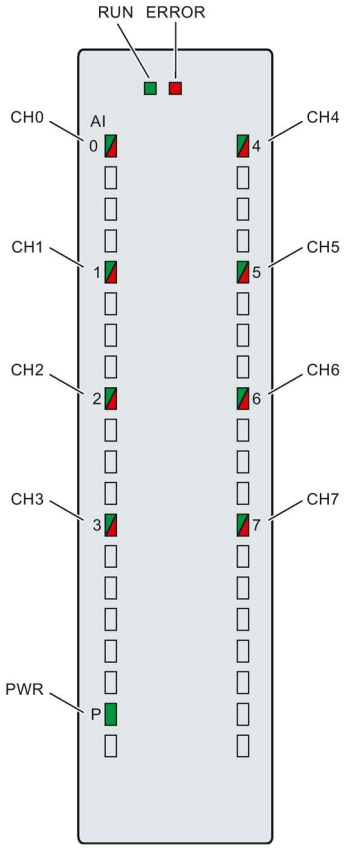


Figure 5-1 LED displays of the module AI 8xU/I HF

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 (Page 43).

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 whether 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.

5.2 Interrupts

Analog input module AI 8xU/I HF 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 following figure shows the assignment of the local data double word 8 by the start information of the hardware interrupt organization block.

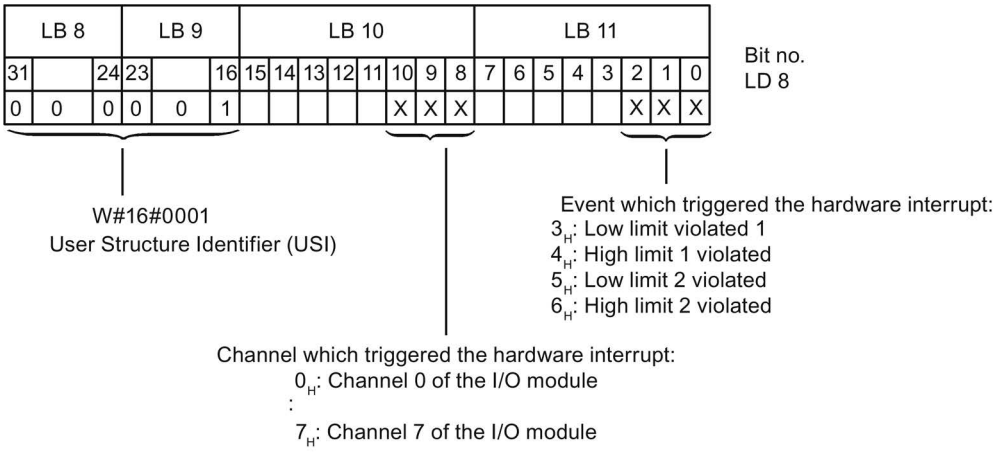


Figure 5-2 OB start information

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 for each diagnostics event on the module. 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 previous "Wire break" diagnostics and aborts after this error message. The "Underflow" diagnostics is not detected.

Recommendation: To ensure that all errors are subjected to the diagnostics, select all check boxes under "Diagnostics".

Technical specifications

6

Technical specifications of the AI 8xU/I HF

	6ES7531-7NF00-0AB0
General information	
Product type designation	AI 8xU/I HF
Hardware functional status	FS01
Firmware version	V1.1.0
• FW update possible	Yes
Product function	
I&M data	Yes; I&M0 to I&M3
Measuring range scalable	No
Measured values scalable	Yes
Measuring range adjustment	Yes
Engineering with	
STEP 7 TIA Portal can be configured/integrated as of version	V14 / -
STEP 7 can be configured/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	No
MSI	Yes
CiR Configuration in RUN	
Configuration in RUN possible	Yes
Calibration in RUN possible	Yes
Supply voltage	
Rated value (DC)	24 V
Valid range, low limit (DC)	20.4 V
Valid range, high limit (DC)	28.8 V
Reverse polarity protection	Yes
Input current	
Current consumption, max.	50 mA; with 24 V DC supply
Power	
Power consumption from the backplane bus	0.85 W
Power loss	
Power loss, typ.	1.9 W

	6ES7531-7NF00-0AB0
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	
1 V to 5 V	Yes
Input resistance (1 V to 5 V)	100 kΩ
-10 V to +10 V	Yes
Input resistance (-10 V to +10 V)	100 kΩ
-2.5 to +2.5 V	Yes
Input resistance (-2.5 to +2.5 V)	100 kΩ
-5 V to +5 V	Yes
Input resistance (-5 V to +5 V)	100 kΩ
Input ranges (rated values), currents	
0 mA to 20 mA	Yes
Input resistance (0 mA to 20 mA)	25 Ω; plus approx. 42 ohm for overvoltage protection by PTC
-20 mA to +20 mA	Yes
Input resistance (-20 mA to +20 mA)	25 Ω; plus approx. 42 ohm for overvoltage protection by PTC
4 mA to 20 mA	Yes
Input resistance (4 mA to 20 mA)	25 Ω; plus approx. 42 ohm for overvoltage protection by PTC
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
Configurable integration time	Yes
Integration time (ms)	Fast mode: 2.5 / 16.67 / 20 / 100 ms; standard mode: 7.5 / 50 / 60 / 300 ms
Basic conversion time, including integration time (ms)	Fast mode: 4 / 18 / 22 / 102 ms; standard mode: 9 / 52 / 62 / 302 ms
Interference voltage suppression for interference frequency f1 in Hz	400 / 60 / 50 / 10 Hz
Basic execution time of the module (all channels enabled)	Corresponds to the channel with the highest basic conversion time

	6ES7531-7NF00-0AB0
Smoothing of the measured values	
Configurable	Yes
Level: None	Yes
Level: Weak	Yes
Level: Medium	Yes
Level: Strong	Yes
Encoders	
Connection of the signal encoders	
For voltage measurement	Yes
for current measurement as 2-wire transducer	Yes; with external transmitter supply
for current measurement as 4-wire transducer	Yes
Errors/accuracies	
Linearity error (in relation to input range), (+/-)	0.02%
Temperature error (in relation to input range), (+/-)	0.005%/K
Crosstalk between the inputs, max.	-80 dB
Repeat accuracy in settled state at 25 °C (in relation to input range), (+/-)	0.02%
Operational limit in overall temperature range	
Voltage in relation to input range, (+/-)	0.1%
Current in relation to input range, (+/-)	0.1%
Basic error limit (operational limit at 25 °C)	
Voltage in relation to input range, (+/-)	0.05%
Current in relation to input range, (+/-)	0.05%
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
Series-mode interference (peak of the interference < rated value of the input range), min.	80 dB; in Standard mode, 40 dB in Fast mode
Common mode voltage, max.	60 V DC / 30 V AC
Common mode interference, min.	80 dB
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	No
Interrupts/diagnostics/status information	
Diagnostics function	Yes
Interrupts	
Diagnostic interrupt	Yes
Limit interrupt	Yes; two high limits and two low limits each
Diagnostics alarms	
Monitoring of supply voltage	Yes
Wire break	Yes; only for 1 to 5 V and 4 to 20 mA
Overflow/underflow	Yes

	6ES7531-7NF00-0AB0
Diagnostics indicator LED	
RUN LED	Yes; green LED
ERROR LED	Yes; red LED
Monitoring of 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
Electrical isolation	
Electrical isolation of channels	
Between the channels	Yes
Between the channels, in groups of	1
Between the channels and backplane bus	Yes
Between the channels and power supply of the electronics	Yes
Permitted potential difference	
Between different circuits	60 V DC / 30 V AC; Isolation measured for 120 V AC basic isolation: Between the channels and supply voltage L+, between the channels and the backplane bus, between the channels
Isolation	
Isolation tested with	2000 V DC between the channels and the supply voltage L+, 2000 V DC between the channels and the backplane bus, 2000 V DC between the channels, 707 V DC (type test) between the supply voltage L+ and the backplane bus
Ambient conditions	
Ambient temperature during operation	
Horizontal mounting position, min.	0 °C
Horizontal mounting position, max.	60 °C
Vertical mounting position, min.	0 °C
Vertical mounting position, max.	40 °C
Distributed mode	
Prioritized startup	Yes
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	280 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.

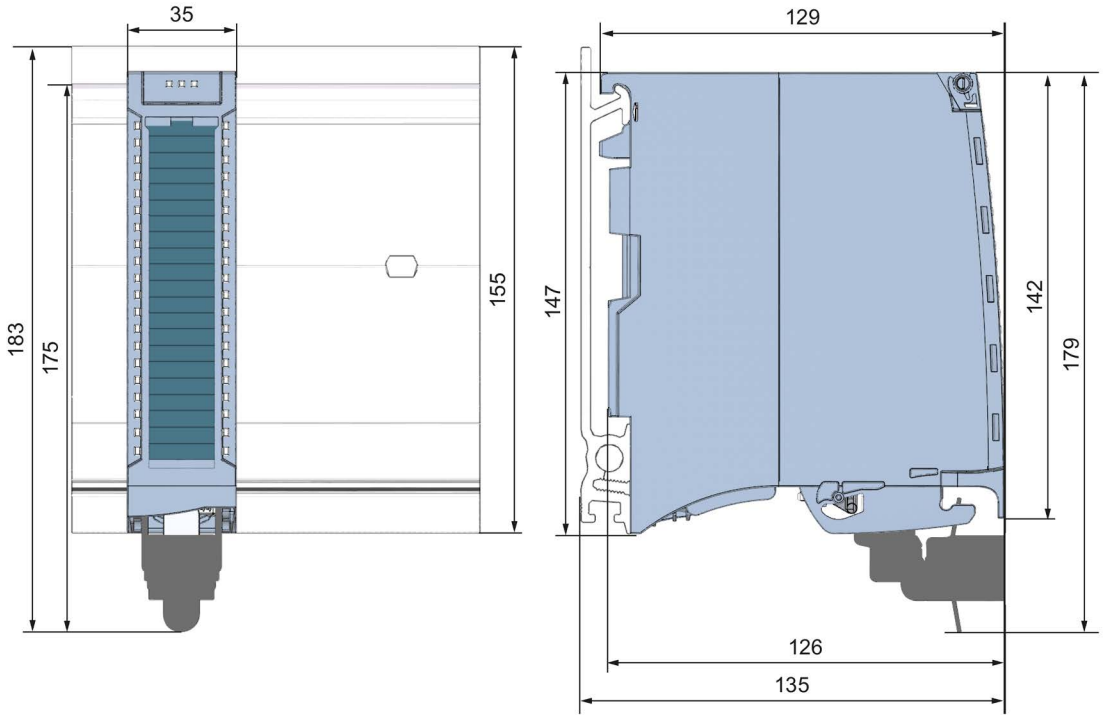


Figure A-1 Dimension drawing of the AI 8xU/I HF module

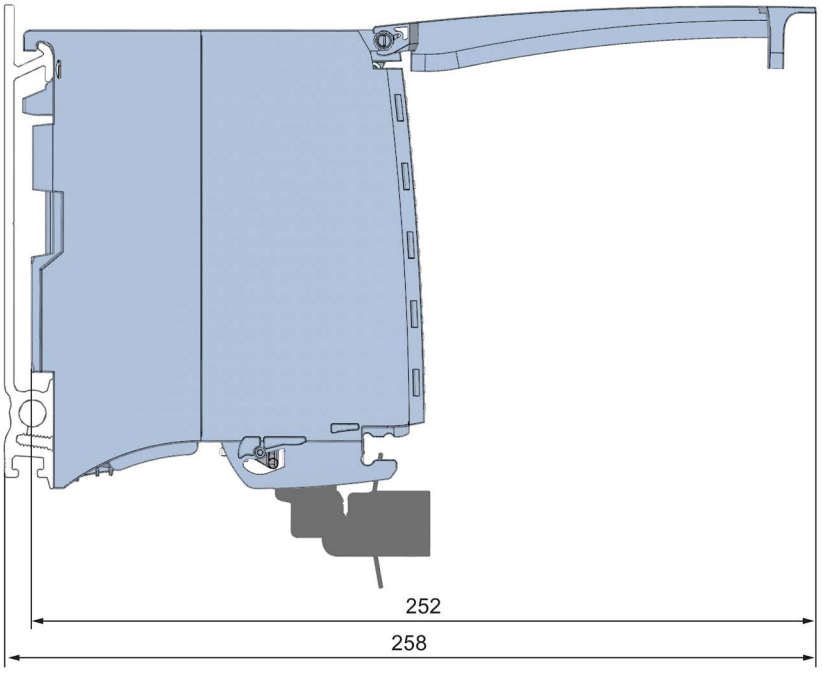


Figure A-2 Dimension drawing of the AI 8xU/I HF module, side view with open front cover

Parameter data records

B

B.1 Parameter assignment

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.

Dependency of the parameter data records

The structure of the parameter data record differs depending on the configuration:

- 28 bytes data length for configuration without scaling of the measured values, see section Structure of the parameter data records without scaling of measured values (Page 52).
- 40 bytes data length for configuration with scaling of the measured values, see section Structure of the parameter data records with scaling of measured values (Page 55).

B.2 Structure of the parameter data records without scaling of measured values

Structure of a data record without scaling of the measured values

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

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

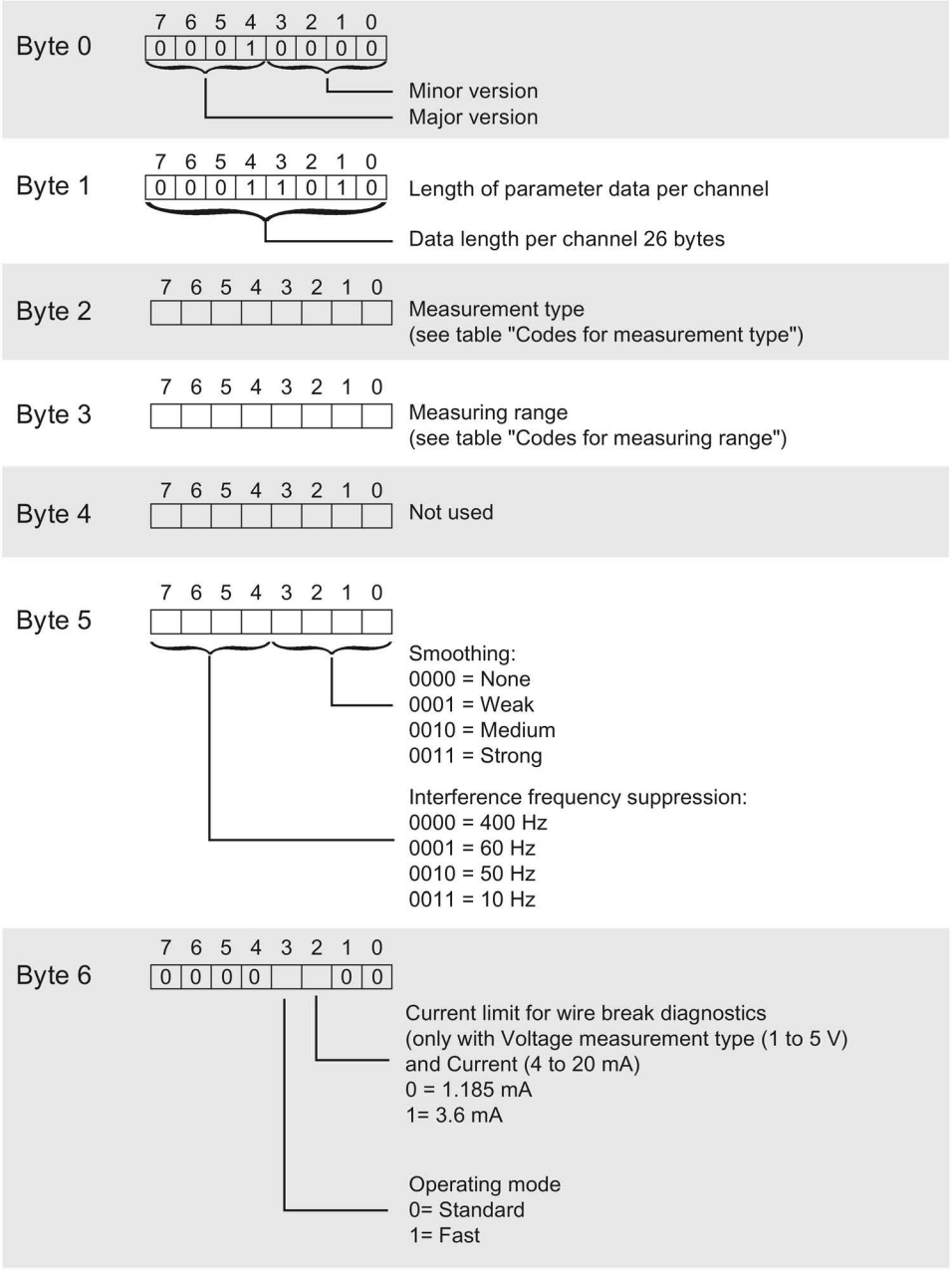
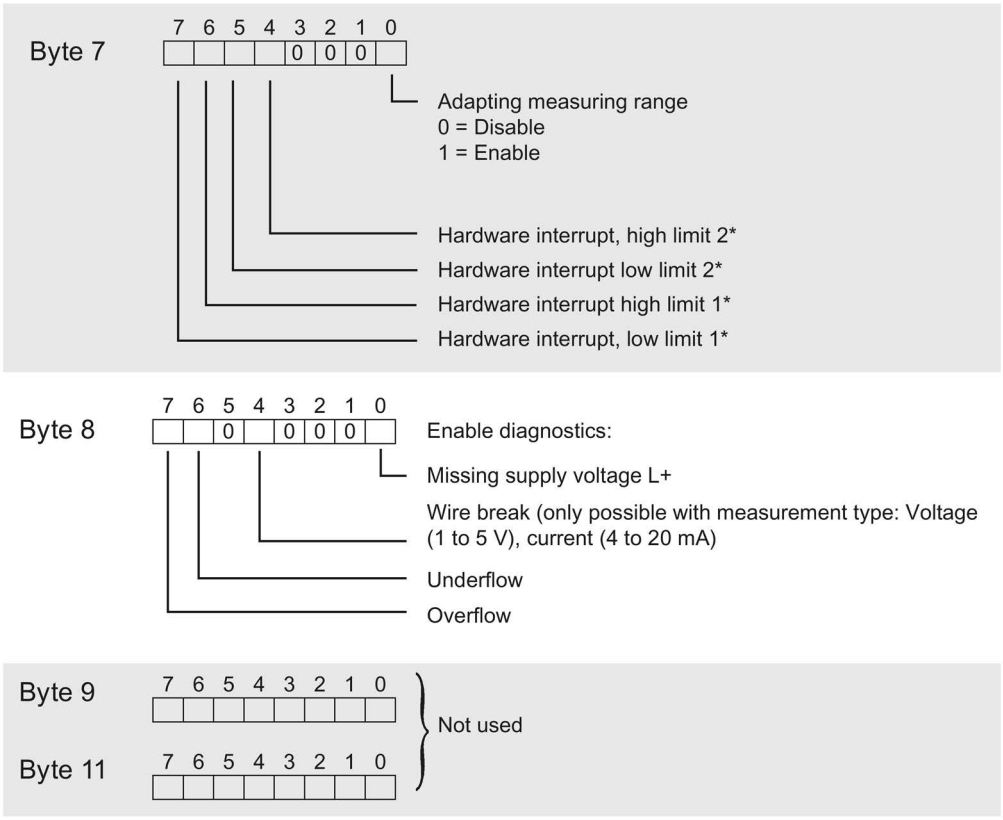
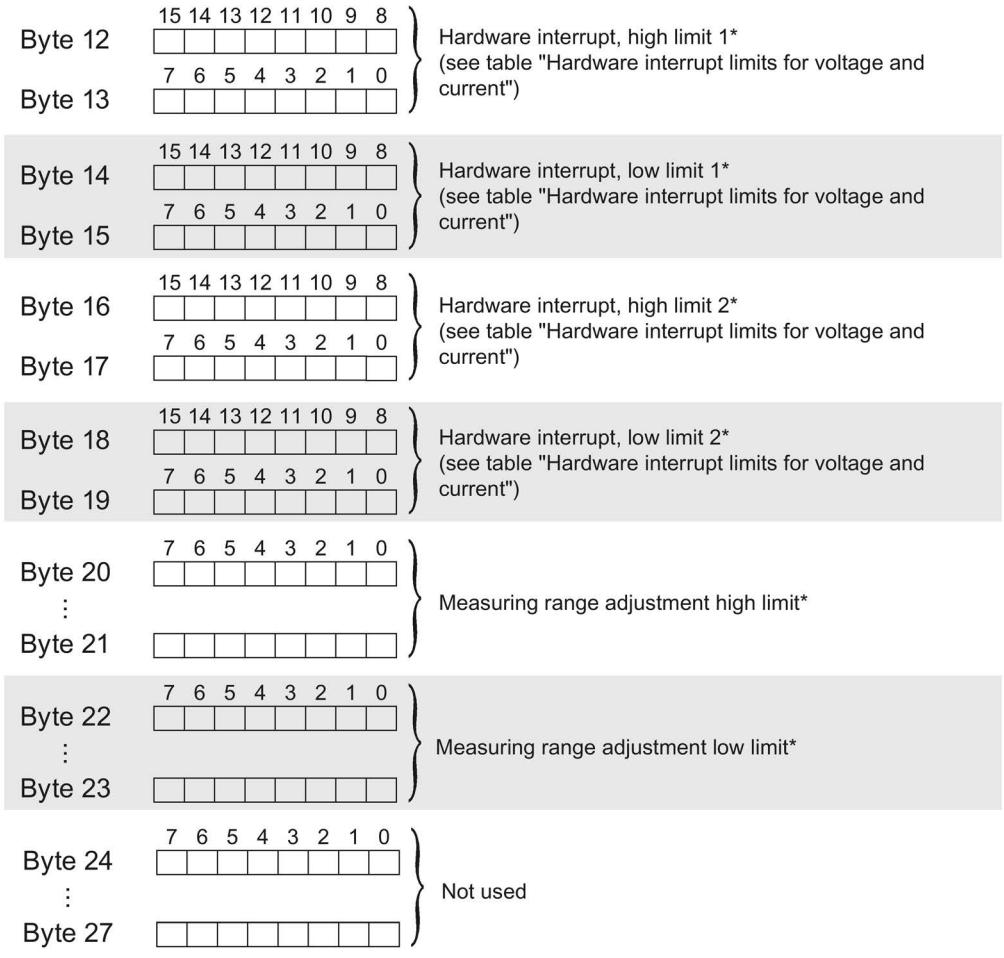


Figure B-1 Structure of data record 0: Byte 0 to 6 without scaling of measured values



* Hardware interrupts can only be activated via data record if the channel is assigned a hardware interrupt OB in STEP 7

Figure B-2 Structure of data record 0: Byte 7 to 11 without scaling of measured values



* High limit must be greater than low limit

Figure B-3 Structure of data record 0: Byte 12 to 27 without scaling of measured values

See also

Codes for measurement types/measuring ranges and limits for hardware interrupts (Page 58)

B.3 Structure of the parameter data records with scaling of measured values

Structure of a data record with scaling of the measured values

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

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

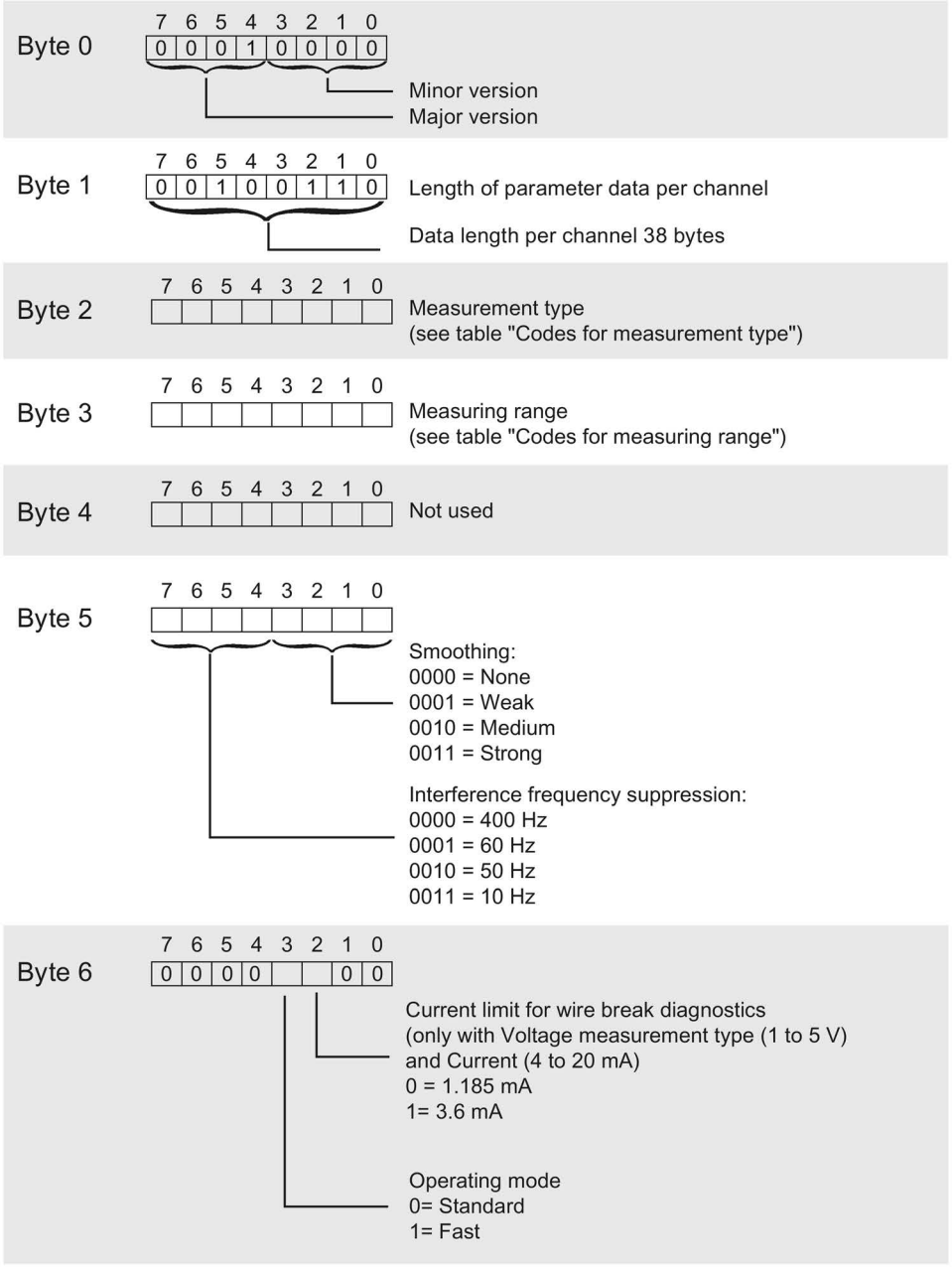
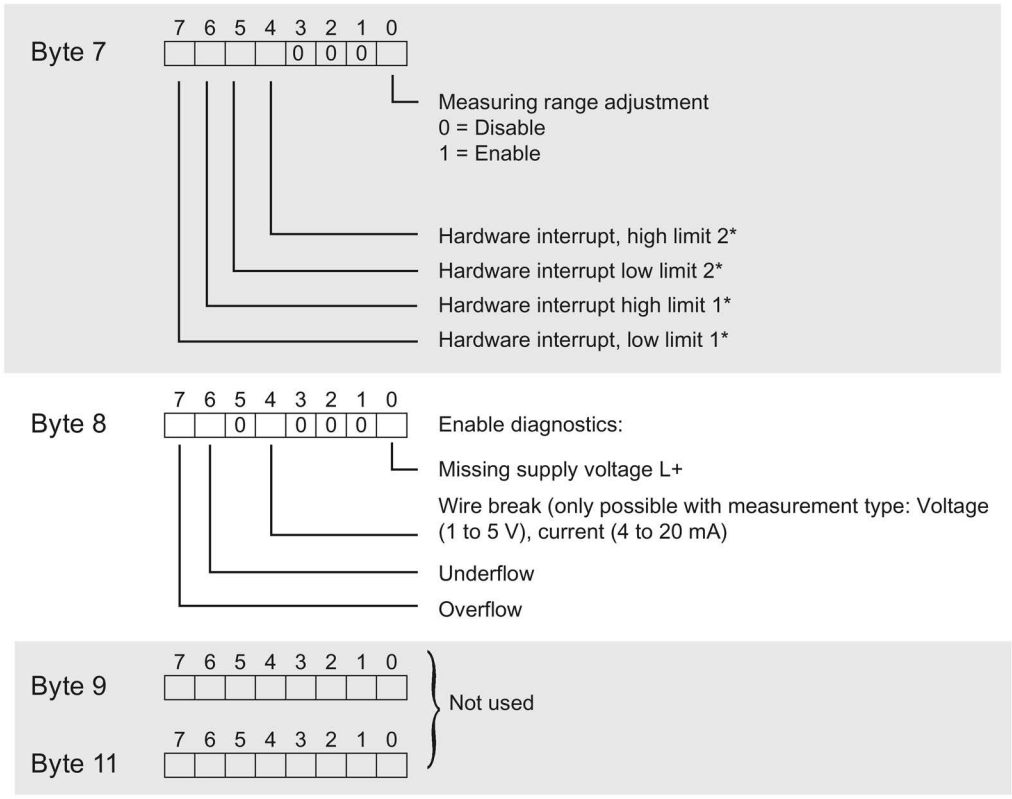


Figure B-4 Structure of data record 0: Byte 0 to 6 for scaling of measured values



* Hardware interrupts can only be activated via data record if the channel is assigned a hardware interrupt OB in STEP 7

Figure B-5 Structure of data record 0: Byte 7 to 11 for scaling of measured values

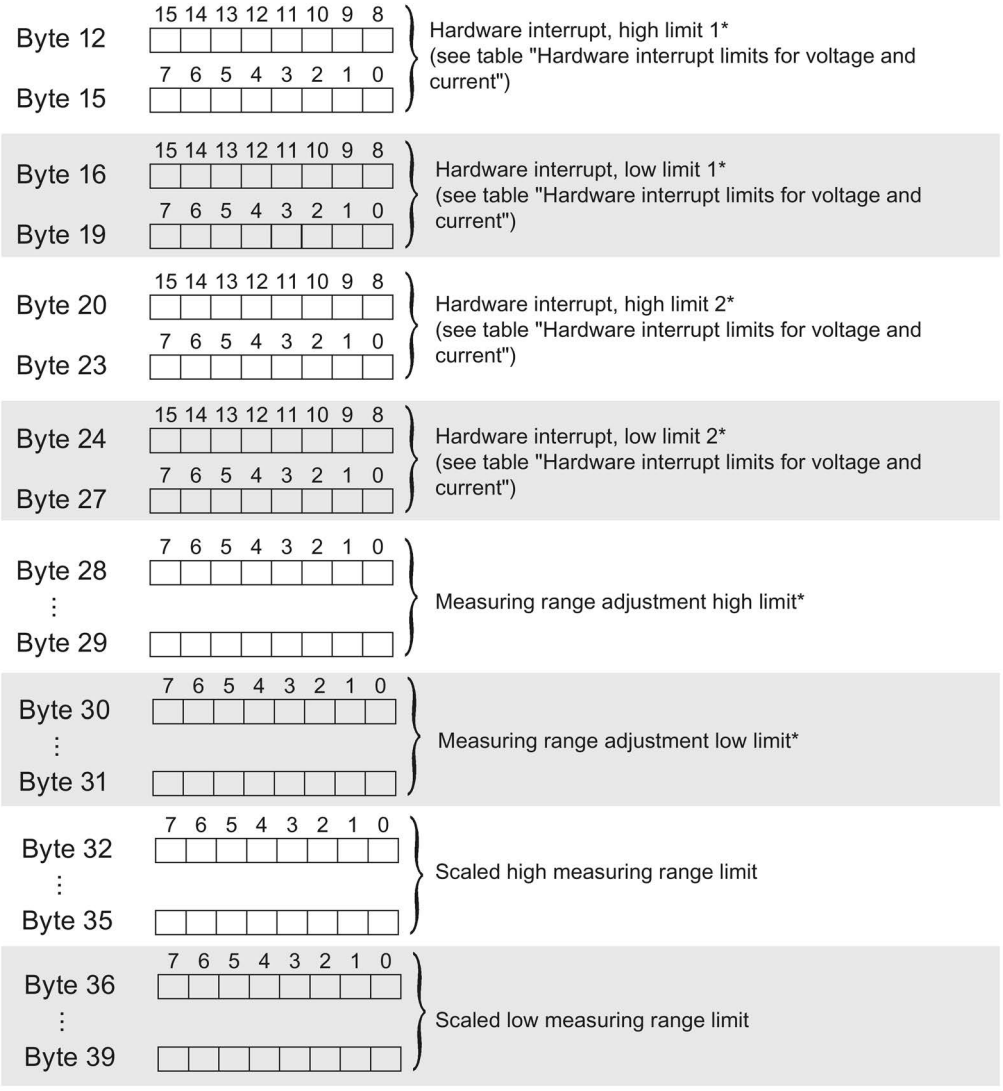


Figure B-6 Structure of data record 0: Byte 12 to 39 for scaling of measured values

See also

Codes for measurement types/measuring ranges and limits for hardware interrupts (Page 58)

B.4 Codes for measurement types/measuring ranges and limits for hardware interrupts

Codes for measuring types

The following table lists all measuring types of the analog input module along with their codes. Enter these codes in byte 2 of the respective data record.

Table B- 2 Code for the measuring type

Measurement type	Code
Deactivated	0000 0000
Voltage	0000 0001
Current 4-wire transducer	0000 0010
Current 2-wire transducer	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 in byte 3 of the respective data record.

Table B- 3 Code for the measuring range

Measuring range	Code
Voltage	
±2.5 V	0000 0111
±5 V	0000 1000
±10 V	0000 1001
1 V to 5 V	0000 1010
Current 4-wire transducer	
0 mA to 20 mA	0000 0010
4 mA to 20 mA	0000 0011
±20 mA	0000 0100
Current 2-wire transducer	
4 mA to 20 mA	0000 0011

Hardware interrupt limits

The following tables list the valid hardware interrupt limits. The limit values depend on the selected measuring type and range. The values that you can set for hardware interrupts (high/low limit) must not exceed the respective rated measuring range.

Enter the limits in bytes 12 to 19 or 12 to 27 of the corresponding data record.

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

Voltage		Current		
±2.5 V, ±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 appendix shows the analog values for all measuring ranges supported by the AI 8xU/I HF 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 tables below set out the digitized representation of the input ranges separately for bipolar and unipolar input ranges. 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 ranges ±10 V, ±5 V and ±2.5 V

Values		Voltage measuring range			Range
dec	hex	±10 V	±5 V	±2.5 V	
32767	7FFF	>11.759 V	>5.879 V	>2.939 V	Overflow
32511	7EFF	11.759 V	5.879 V	2.939 V	Overshoot range
27649	6C01				
27648	6C00	10 V	5 V	2.5 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V	
1	1	361.7 µV	180.8 µV	90.4 µV	
0	0	0 V	0 V	0 V	
-1	FFFF				
-20736	AF00	-7.5 V	-3.75 V	- 1.875 V	
-27648	9400	-10 V	-5 V	- 2.5 V	
-27649	93FF				Undershoot range
-32512	8100	-11.759 V	-5.879 V	- 2.939 V	
-32768	8000	< -11.759 V	< -5.879 V	<-2.939 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