SIMATIC

S7-1500/ET 200MP
Analog Input Module AI 8xU/I HF
(6ES7531-7NF00-0AB0)

Manual
Legal information

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

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Indicates that death or severe personal injury will result if proper precautions are not taken.</td>
<td></td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates that death or severe personal injury may result if proper precautions are not taken.</td>
<td></td>
</tr>
<tr>
<td>CAUTION</td>
<td>Indicates that minor personal injury can result if proper precautions are not taken.</td>
<td></td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates that property damage can result if proper precautions are not taken.</td>
<td></td>
</tr>
</tbody>
</table>

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

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Qualified personnel are those who, based on their training and experience, are capable of identifying risks and
avoiding potential hazards when working with these products/systems.

Proper use of Siemens products
Note the following:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
</table>
| WARNING| Siemens products may only be used for the applications described in the catalog and in the relevant technical
documentation. If products and components from other manufacturers are used, these must be recommended
or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and
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described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the
information in this publication is reviewed regularly and any necessary corrections are included in subsequent
editions.
Preface

Purpose of the documentation

This device manual supplements the S7-1500/ET 200MP 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.

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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Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens’ products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

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Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>4</td>
</tr>
<tr>
<td>1 Documentation guide</td>
<td>7</td>
</tr>
<tr>
<td>2 Product overview</td>
<td>11</td>
</tr>
<tr>
<td>2.1 Properties</td>
<td>11</td>
</tr>
<tr>
<td>3 Wiring</td>
<td>14</td>
</tr>
<tr>
<td>4 Parameters/address space</td>
<td>18</td>
</tr>
<tr>
<td>4.1 Measuring types and ranges</td>
<td>18</td>
</tr>
<tr>
<td>4.2 Parameters</td>
<td>19</td>
</tr>
<tr>
<td>4.3 Declaration of parameters</td>
<td>21</td>
</tr>
<tr>
<td>4.4 Address space</td>
<td>23</td>
</tr>
<tr>
<td>5 Interrupts/diagnostics alarms</td>
<td>29</td>
</tr>
<tr>
<td>5.1 Status and error displays</td>
<td>29</td>
</tr>
<tr>
<td>5.2 Interrupts</td>
<td>31</td>
</tr>
<tr>
<td>5.3 Diagnostics alarms</td>
<td>33</td>
</tr>
<tr>
<td>6 Technical specifications</td>
<td>34</td>
</tr>
<tr>
<td>A Dimensional drawing</td>
<td>38</td>
</tr>
<tr>
<td>B Parameter data records</td>
<td>40</td>
</tr>
<tr>
<td>B.1 Parameter assignment and structure of the parameter data records</td>
<td>40</td>
</tr>
<tr>
<td>C Representation of analog values</td>
<td>45</td>
</tr>
<tr>
<td>C.1 Representation of input ranges</td>
<td>46</td>
</tr>
<tr>
<td>C.2 Representation of analog values in voltage measuring ranges</td>
<td>47</td>
</tr>
<tr>
<td>C.3 Representation of analog values in the current measuring ranges</td>
<td>48</td>
</tr>
<tr>
<td>C.4 Measured values for wire break diagnostic</td>
<td>49</td>
</tr>
<tr>
<td>D Open Source Software</td>
<td>50</td>
</tr>
</tbody>
</table>
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.

**General information**

Function manuals on general topics
- Diagnostics
- Communication
- Motion control
- Web server
- Cycle and response times
- PROFINET
- PROFIBUS
- ...

**Device information**

Manuals with detailed information about modules
- CPUs
- Interface modules
- Digital modules
- Analog modules
- Communication modules
- Technology modules
- Power supply module

**Basic information**

Information about the system
- Getting Started S7-1500
- System Manual S7-1500/ET 200MP
- Operating Instructions ET 200pro and CPU 1516pro-2 PN
- Online Help TIA Portal

**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.


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

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

Manual Collection S7-1500/ET 200MP

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

You can find the Manual Collection on the Internet [https://support.industry.siemens.com/cs/ww/en/view/86140384].

SIMATIC S7-1500 comparison list for programming languages

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

You can find the comparison list on the Internet [https://support.industry.siemens.com/cs/ww/en/view/86630375].

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In 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

2.1 Properties

Article number

6ES7531-7NF00-0AB0

View of the module

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

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

<table>
<thead>
<tr>
<th>Function</th>
<th>Firmware version of the module</th>
<th>Configuration software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmware update</td>
<td>V1.0.0 or higher</td>
<td>STEP 7 (TIA Portal) as of V13, SP1 and HSP 0166</td>
</tr>
<tr>
<td>Identification data I&amp;M0 to I&amp;M3</td>
<td>V1.0.0 or higher</td>
<td>GSD file in STEP 7 (TIA Portal) V12 or higher, or STEP 7 V5.5 SP3 or higher</td>
</tr>
<tr>
<td>Parameter assignment in RUN</td>
<td>V1.0.0 or higher</td>
<td>X</td>
</tr>
<tr>
<td>Module internal Shared Input (MSI)</td>
<td>V1.0.0 or higher</td>
<td>X</td>
</tr>
<tr>
<td>Configurable submodules / submodules for Shared Device</td>
<td>V1.0.0 or higher</td>
<td>X</td>
</tr>
</tbody>
</table>
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 must be ordered separately:

Front connectors, including potential jumpers and cable ties

Wiring

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.

---

Note
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.

![Image 3-1 Power supply element wiring](Image 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)
2. Electrical isolation
3. Backplane bus interface
4. Supply voltage via power supply element
5. Equipotential bonding cable (optional)

Image 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)

Image 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
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)

Image 3-4  Block diagram and terminal assignment for 2-wire transducer for current measurement
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.

<table>
<thead>
<tr>
<th>Measuring type</th>
<th>Measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>1 V to 5 V</td>
</tr>
<tr>
<td></td>
<td>±2.5 V</td>
</tr>
<tr>
<td></td>
<td>±5 V</td>
</tr>
<tr>
<td></td>
<td>±10 V</td>
</tr>
<tr>
<td>Current 2WMT (2-wire transducer)</td>
<td>4 mA to 20 mA</td>
</tr>
<tr>
<td>Current 4WMT (4-wire transducer)</td>
<td>4 mA to 20 mA</td>
</tr>
<tr>
<td></td>
<td>0 mA to 20 mA</td>
</tr>
<tr>
<td></td>
<td>±20 mA</td>
</tr>
<tr>
<td>Deactivated</td>
<td></td>
</tr>
</tbody>
</table>

The tables of the input ranges, overflow, undershoot range, etc. are available in appendix Representation of analog values (Page 45).
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 the GSD file and the configuration software of any provider. The module does not check the validity of the parameterized 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 40).

The following parameter settings for the channels are possible:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Range of values</th>
<th>Default setting</th>
<th>Configuration in RUN</th>
<th>Scope with configuration software, e.g., STEP 7 (TIA Portal)</th>
<th>GSD file PROFINET IO</th>
<th>PROFIBUS DP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostics</strong></td>
<td></td>
<td></td>
<td></td>
<td>Integrate in the hardware catalog STEP 7 (TIA Portal) as of V13 or GSD file PROFINET IO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing supply voltage L+</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel 1)</td>
<td>Module 3)</td>
<td></td>
</tr>
<tr>
<td>Overflow</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
<td>Module 3)</td>
<td></td>
</tr>
<tr>
<td>Underflow</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
<td>Module 3)</td>
<td></td>
</tr>
<tr>
<td>Wire break</td>
<td>Yes/No</td>
<td>(Voltage: 1 V to 5 V Current: 4 mA to 20 mA) No</td>
<td>Yes</td>
<td>Channel</td>
<td>Module 3)</td>
<td></td>
</tr>
<tr>
<td>Current limit for wire break diagnostics</td>
<td>1.185 mA or 3.6 mA</td>
<td>1.185 mA</td>
<td>Yes</td>
<td>Channel</td>
<td>--- 4)</td>
<td></td>
</tr>
</tbody>
</table>
## 4.2 Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Range of values</th>
<th>Default setting</th>
<th>Configuration in RUN</th>
<th>Scope with configuration software, e.g., STEP 7 (TIA Portal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring</td>
<td></td>
<td></td>
<td></td>
<td>Integrated in the hardware catalog STEP 7 (TIA Portal) as of V13 or GSD file PROFINET IO</td>
</tr>
<tr>
<td>Measuring type</td>
<td>See section Measuring types and ranges (Page 18)</td>
<td>Voltage</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Measuring range</td>
<td>±10 V</td>
<td>Yes</td>
<td>Channel</td>
<td></td>
</tr>
<tr>
<td>Operating mode</td>
<td>Standard</td>
<td>Standard</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Interference frequency suppression</td>
<td>400 Hz 60 Hz 50 Hz 10 Hz</td>
<td>50 Hz</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Smoothing</td>
<td>None/low/medium/high</td>
<td>None</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Hardware interrupt</td>
<td></td>
<td></td>
<td></td>
<td>GSD file PROFIBUS DP</td>
</tr>
<tr>
<td>Hardware interrupt high limit 1</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Hardware interrupt low limit 1</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Hardware interrupt high limit 2</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
</tr>
<tr>
<td>Hardware interrupt low limit 2</td>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Channel</td>
</tr>
</tbody>
</table>

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 is applied 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

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 the low voltage range 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. It is valid for each signal change at the analog input.

![Image 4-1 Smoothing for AI 8xU/I HF](image)

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

**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)

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>
<thead>
<tr>
<th>Configuration</th>
<th>Short designation/module name in the GSD file</th>
<th>Configuration software, e.g., with STEP 7 (TIA Portal)</th>
<th>GSD file in STEP 7 (TIA Portal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 8-channel without value status</td>
<td>AI 8xU/I HF</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1 x 8-channel with value status</td>
<td>AI 8xU/I HF QI</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8 x 1-channel without value status</td>
<td>AI 8xU/I HF S</td>
<td>X (PROFINET IO only)</td>
<td>(PROFINET IO only)</td>
</tr>
<tr>
<td>8 x 1-channel with value status</td>
<td>AI 8xU/I HF S QI</td>
<td>X (PROFINET IO only)</td>
<td>(PROFINET IO only)</td>
</tr>
<tr>
<td>1 x 8-channel with value status for module-internal shared input with up to 4 submodules</td>
<td>AI 8xU/I HF MSI</td>
<td>X (PROFINET IO only)</td>
<td>(PROFINET IO only)</td>
</tr>
</tbody>
</table>
4.4 Address space

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

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 HF

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

IBx” represents the module start address input byte x.

![Image 4-2 Address space for configuration as 1 x 8-channel AI 8xU/I HF with value status](image-url)
### Address space for configuration as 8 x 1-channel 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.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Submodule</th>
<th>IB Address</th>
<th>Input Value</th>
<th>Value Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1st submodule</td>
<td>a, a+1</td>
<td>Channel 0</td>
<td>Value status QI0</td>
</tr>
<tr>
<td>1</td>
<td>2nd submodule</td>
<td>b, b+1</td>
<td>Channel 1</td>
<td>Value status QI1</td>
</tr>
<tr>
<td>2</td>
<td>3rd submodule</td>
<td>c, c+1</td>
<td>Channel 2</td>
<td>Value status QI2</td>
</tr>
<tr>
<td>7</td>
<td>8th submodule</td>
<td>h, h+1</td>
<td>Channel 7</td>
<td>Value status QI7</td>
</tr>
</tbody>
</table>

- **0**: read in value at channel is incorrect

Image 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.

Input value 1st submodule (Basic submodule):
- Channel 0
- Channel 1
- Channel 2
- Channel 3
- Channel 4
- Channel 5
- Channel 6
- Channel 7

Input value 2nd submodule (MSI submodule):
- Channel 0
- Channel 1
- Channel 2
- Channel 3
- Channel 4
- Channel 5
- Channel 6
- Channel 7

0 = read in value at channel is incorrect

Image 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.

![Address space diagram]

Reference

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.

![Image of LED displays of AI 8xU/I HF](Image 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:33).

**RUN and ERROR LED**

Table 5-1 Status and error displays RUN and ERROR

<table>
<thead>
<tr>
<th>LED</th>
<th>Meaning</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| 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| The module starts and flashes until the valid parameter assignment is set. | --- |
| On | Module is configured. | --- |
| On | 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 | Hardware defective. | Replace the module. |

**PWR LED**

Table 5-2 PWR status display

<table>
<thead>
<tr>
<th>LED PWR</th>
<th>Meaning</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Supply voltage L+ to module too low or missing</td>
<td>Check supply voltage L+.</td>
</tr>
<tr>
<td>On</td>
<td>Supply voltage L+ is present and OK.</td>
<td>---</td>
</tr>
</tbody>
</table>

**CHx LED**

Table 5-3 CHx status display

<table>
<thead>
<tr>
<th>LED CHx</th>
<th>Meaning</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Channel disabled</td>
<td>***</td>
</tr>
<tr>
<td>On</td>
<td>Channel configured and OK.</td>
<td>***</td>
</tr>
<tr>
<td>On</td>
<td>Channel is configured (channel error pending). Diagnostic alarm: e.g. wire break</td>
<td>Check the wiring. Disable diagnostics.</td>
</tr>
</tbody>
</table>
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

For detailed information on the error event, refer to the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt info) and to the STEP 7 online help.

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

![Image 5-2 OB start information](image-url)
5.2 Interrupts

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

<table>
<thead>
<tr>
<th>Data block name</th>
<th>Contents</th>
<th>Remark</th>
<th>Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USI (User Structure Identifier)</td>
<td>W#16#0001</td>
<td>Additional interrupt info for hardware interrupts of the I/O module</td>
<td>2</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Event</th>
<th>B#16#03</th>
<th>Low limit violated 1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B#16#04</td>
<td>High limit violated 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B#16#05</td>
<td>Low limit violated 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B#16#06</td>
<td>Violation of high limit 2</td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Diagnostics alarm</th>
<th>Error code</th>
<th>Meaning</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire break</td>
<td>6H</td>
<td>Impedance of sensor circuit too high</td>
<td>Use a different encoder type or modify the wiring, for example, using cables with larger cross-section</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wire break between the module and sensor</td>
<td>Connect the cable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channel not connected (open)</td>
<td>• Disable diagnostics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Connect the channel</td>
</tr>
<tr>
<td>Overflow</td>
<td>7H</td>
<td>Measuring range violated</td>
<td>Check the measuring range</td>
</tr>
<tr>
<td>Underflow</td>
<td>8H</td>
<td>Measuring range violated</td>
<td>Check the measuring range</td>
</tr>
<tr>
<td>Parameter assignment error</td>
<td>10H</td>
<td>• The module cannot evaluate parameters for the channel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Incorrect parameter assignment.</td>
<td>Correct the parameter assignment</td>
</tr>
<tr>
<td>Load voltage missing</td>
<td>11H</td>
<td>Supply voltage L+ of the module is missing</td>
<td>Connect supply voltage L+ to module/channel</td>
</tr>
</tbody>
</table>

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 of the AI 8xU/I HF

<table>
<thead>
<tr>
<th><strong>Technical specifications</strong></th>
<th>6ES7531-7NF00-0AB0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General information</strong></td>
<td></td>
</tr>
<tr>
<td>Product type designation</td>
<td>AI 8xU/I HF</td>
</tr>
<tr>
<td>Hardware functional status</td>
<td>FS01</td>
</tr>
<tr>
<td>Firmware version</td>
<td>V1.0.0</td>
</tr>
<tr>
<td>• FW update possible</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Product function</strong></td>
<td></td>
</tr>
<tr>
<td>I&amp;M data</td>
<td>Yes; I&amp;M0 to I&amp;M3</td>
</tr>
<tr>
<td>Scalable measuring range</td>
<td>No</td>
</tr>
<tr>
<td><strong>Engineering with</strong></td>
<td></td>
</tr>
<tr>
<td>STEP 7 TIA Portal can be configured/integrated as of version</td>
<td>V13 SP1 / V14</td>
</tr>
<tr>
<td>STEP 7 can be configured/integrated as of version</td>
<td>V5.5 SP3 / V5.5 SP4</td>
</tr>
<tr>
<td>PROFIBUS as of GSD version/GSD revision</td>
<td>V1.0 / V5.1</td>
</tr>
<tr>
<td>PROFINET as of GSD version/GSD revision</td>
<td>V2.3 / -</td>
</tr>
<tr>
<td><strong>Operating mode</strong></td>
<td></td>
</tr>
<tr>
<td>Oversampling</td>
<td>No</td>
</tr>
<tr>
<td>MSI</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>CIR Configuration in RUN</strong></td>
<td></td>
</tr>
<tr>
<td>Configuration in RUN possible</td>
<td>Yes</td>
</tr>
<tr>
<td>Calibration in RUN possible</td>
<td>No</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td></td>
</tr>
<tr>
<td>Rated value (DC)</td>
<td>24 V</td>
</tr>
<tr>
<td>Valid range, low limit (DC)</td>
<td>20.4 V</td>
</tr>
<tr>
<td>Valid range, high limit (DC)</td>
<td>28.8 V</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Input current</strong></td>
<td></td>
</tr>
<tr>
<td>Current consumption, max.</td>
<td>50 mA; with 24 V DC supply</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td></td>
</tr>
<tr>
<td>Power consumption from the backplane bus</td>
<td>0.85 W</td>
</tr>
<tr>
<td><strong>Power loss</strong></td>
<td></td>
</tr>
<tr>
<td>Power loss, typ.</td>
<td>1.9 W</td>
</tr>
</tbody>
</table>
### Analog Inputs

<table>
<thead>
<tr>
<th>Number of analog inputs</th>
<th>8ES7531-7NF00-0AB0</th>
</tr>
</thead>
<tbody>
<tr>
<td>- For current measurement</td>
<td>8</td>
</tr>
<tr>
<td>- For voltage measurement</td>
<td>8</td>
</tr>
</tbody>
</table>

#### 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

<table>
<thead>
<tr>
<th>Range</th>
<th>Input resistance</th>
<th>1 V to 5 V</th>
<th>-10 V to +10 V</th>
<th>-2.5 to +2.5 V</th>
<th>-5 V to +5 V</th>
<th>Input resistance</th>
<th>-20 mA to +20 mA</th>
<th>4 mA to 20 mA</th>
<th>Input resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 V to 5 V</td>
<td>100 kΩ</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100 kΩ</td>
<td>Yes</td>
<td>Yes</td>
<td>25 Ω; plus approx. 42 ohm for overvoltage protection by PTC</td>
</tr>
<tr>
<td>-10 V to +10 V</td>
<td>100 kΩ</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100 kΩ</td>
<td>Yes</td>
<td>Yes</td>
<td>25 Ω; plus approx. 42 ohm for overvoltage protection by PTC</td>
</tr>
</tbody>
</table>

#### Input ranges (rated values), currents

<table>
<thead>
<tr>
<th>Range</th>
<th>Input resistance</th>
<th>0 mA to 20 mA</th>
<th>-20 mA to +20 mA</th>
<th>4 mA to 20 mA</th>
<th>Input resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 mA to 20 mA</td>
<td>25 Ω; plus approx. 42 ohm for overvoltage protection by PTC</td>
<td>Yes</td>
<td>25 Ω; plus approx. 42 ohm for overvoltage protection by PTC</td>
<td>25 Ω; plus approx. 42 ohm for overvoltage protection by PTC</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Cable length

Shielded, max.
800 m

### Formation of analog values for the inputs

<table>
<thead>
<tr>
<th>6ES7531-7NF00-0AB0</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 bit</td>
</tr>
</tbody>
</table>

### Integration and conversion time/ resolution per channel

<table>
<thead>
<tr>
<th>Resolution with overrange (bit including sign), max.</th>
<th>16 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration time configurable</td>
<td>Yes</td>
</tr>
<tr>
<td>Integration time (ms)</td>
<td></td>
</tr>
<tr>
<td>Basic conversion time, including integration time (ms)</td>
<td></td>
</tr>
<tr>
<td>Disturbance voltage suppression for interference frequency f1 in Hz</td>
<td></td>
</tr>
<tr>
<td>Basic execution time of the module (all channels enabled)</td>
<td></td>
</tr>
</tbody>
</table>

Corresponds to the channel with the highest basic conversion time
### Technical specifications

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

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

<table>
<thead>
<tr>
<th>Function</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostics indicator LED</strong></td>
<td></td>
</tr>
<tr>
<td>RUN LED</td>
<td>Yes; green LED</td>
</tr>
<tr>
<td>ERROR LED</td>
<td>Yes; red LED</td>
</tr>
<tr>
<td>Monitoring of supply voltage (PWR LED)</td>
<td>Yes; green LED</td>
</tr>
<tr>
<td>Channel status display</td>
<td>Yes; green LED</td>
</tr>
<tr>
<td>For channel diagnostics</td>
<td>Yes; red LED</td>
</tr>
<tr>
<td>For module diagnostics</td>
<td>Yes; red LED</td>
</tr>
<tr>
<td><strong>Electrical isolation</strong></td>
<td></td>
</tr>
<tr>
<td>Electrical isolation of channels</td>
<td></td>
</tr>
<tr>
<td>Between the channels</td>
<td>Yes</td>
</tr>
<tr>
<td>Between the channels, in groups of</td>
<td>1</td>
</tr>
<tr>
<td>Between the channels and backplane bus</td>
<td>Yes</td>
</tr>
<tr>
<td>Between the channels and power supply of the</td>
<td>Yes</td>
</tr>
<tr>
<td>electronics</td>
<td></td>
</tr>
<tr>
<td><strong>Permitted potential difference</strong></td>
<td></td>
</tr>
<tr>
<td>Between different circuits</td>
<td>60 V DC / 30 V AC; Isolation measured for 120 V AC basic isolation: Between</td>
</tr>
<tr>
<td></td>
<td>the channels and supply voltage L+, between the channels and the backplane bus,</td>
</tr>
<tr>
<td></td>
<td>between the channels</td>
</tr>
<tr>
<td><strong>Isolation</strong></td>
<td></td>
</tr>
<tr>
<td>Isolation tested with</td>
<td>2000 V DC between the channels and the supply voltage L+, 2000 V DC between</td>
</tr>
<tr>
<td></td>
<td>the channels and the backplane bus, 2000 V DC between the channels, 707 V DC</td>
</tr>
<tr>
<td></td>
<td>(type test) between the supply voltage L+ and the backplane bus</td>
</tr>
<tr>
<td><strong>Ambient conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Ambient temperature in operation</td>
<td></td>
</tr>
<tr>
<td>Horizontal mounting position, min.</td>
<td>0 °C</td>
</tr>
<tr>
<td>Horizontal mounting position, max.</td>
<td>60 °C</td>
</tr>
<tr>
<td>Vertical mounting position, min.</td>
<td>0 °C</td>
</tr>
<tr>
<td>Vertical mounting position, max.</td>
<td>40 °C</td>
</tr>
<tr>
<td><strong>Distributed mode</strong></td>
<td></td>
</tr>
<tr>
<td>Prioritized startup</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>35 mm</td>
</tr>
<tr>
<td>Height</td>
<td>147 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>129 mm</td>
</tr>
<tr>
<td><strong>Weights</strong></td>
<td></td>
</tr>
<tr>
<td>Weight, approx.</td>
<td>280 g</td>
</tr>
</tbody>
</table>
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.

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

Image A-2  Dimension drawing of the AI 8xU/I HF module, side view with open front cover
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>
<thead>
<tr>
<th>Device-specific parameters (GSD file)</th>
<th>Dependent parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current limit for wire break</td>
<td>Only for <strong>measuring type</strong> current with <strong>measuring range</strong> 4 mA to 20 mA.</td>
</tr>
<tr>
<td>Wire break</td>
<td>Only for <strong>measuring type</strong> resistance with <strong>measuring range</strong> 1V to 5 V and current with <strong>measuring range</strong> 4 mA to 20 mA.</td>
</tr>
<tr>
<td>Hardware interrupt limits</td>
<td>Only if hardware interrupts are enabled.</td>
</tr>
</tbody>
</table>

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 device manual for the PROFIBUS DP interface module in 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".
**Parameter assignment and structure of the parameter data records**

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

Manual, 03/2016, A5E36649087-AA

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

**The high limit must be greater than the low limit**

Image B-2 Structure of data record 0: Bytes 7 to 27
Parameter data records

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

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

<table>
<thead>
<tr>
<th>Measuring type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deactivated</td>
<td>0000 0000</td>
</tr>
<tr>
<td>Voltage</td>
<td>0000 0001</td>
</tr>
<tr>
<td>Current 4-wire transducer</td>
<td>0000 0010</td>
</tr>
<tr>
<td>Current 2-wire transducer</td>
<td>0000 0011</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Measuring range</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td></td>
</tr>
<tr>
<td>±2.5 V</td>
<td>00000111</td>
</tr>
<tr>
<td>±5 V</td>
<td>00001000</td>
</tr>
<tr>
<td>±10 V</td>
<td>00001001</td>
</tr>
<tr>
<td>1 V to 5 V</td>
<td>00001010</td>
</tr>
<tr>
<td>Current 4-wire transducer</td>
<td></td>
</tr>
<tr>
<td>0 mA to 20 mA</td>
<td>0000 0010</td>
</tr>
<tr>
<td>4 mA to 20 mA</td>
<td>0000 0011</td>
</tr>
<tr>
<td>±20 mA</td>
<td>0000 0100</td>
</tr>
<tr>
<td>Current 2-wire transducer</td>
<td></td>
</tr>
<tr>
<td>4 mA to 20 mA</td>
<td>0000 0011</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>±2.5 V, ±5 V, ±10 V</td>
<td>1 V to 5 V</td>
</tr>
<tr>
<td>±20 mA</td>
<td>4 mA to 20 mA, 0 mA to 20 mA</td>
</tr>
<tr>
<td>32510</td>
<td>32510</td>
</tr>
<tr>
<td>-32511</td>
<td>-4863</td>
</tr>
<tr>
<td>32510</td>
<td>32510</td>
</tr>
<tr>
<td>-32511</td>
<td>-4863</td>
</tr>
</tbody>
</table>

High limit

Low limit
Representation of analog values

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

<table>
<thead>
<tr>
<th>Resolution in bits including sign</th>
<th>Values</th>
<th>Analog value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decimal</td>
<td>Hexadecimal</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1h</td>
</tr>
<tr>
<td></td>
<td>Sign</td>
<td>0 0 0 0 0 0 0 0 1</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Units</th>
<th>Measured value in %</th>
<th>Data word</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2^15</td>
<td>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</td>
</tr>
<tr>
<td>32767</td>
<td>&gt;117.589</td>
<td>0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
<td>Overflow</td>
</tr>
<tr>
<td>32511</td>
<td>117.589</td>
<td>0 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1</td>
<td>Overshoot range</td>
</tr>
<tr>
<td>27649</td>
<td>100.004</td>
<td>0 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>27648</td>
<td>100.000</td>
<td>0 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0</td>
<td>Rated range</td>
</tr>
<tr>
<td>1</td>
<td>0.003617</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>-0.003617</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
<td>Undershoot range</td>
</tr>
<tr>
<td>-27648</td>
<td>-100.000</td>
<td>1 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>-27649</td>
<td>-100.004</td>
<td>1 0 0 1 0 0 1 1 1 1 1 1 1 1 1 1</td>
<td></td>
</tr>
<tr>
<td>-32512</td>
<td>-117.593</td>
<td>1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>-32768</td>
<td>&lt;-117.593</td>
<td>1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>Underflow</td>
</tr>
</tbody>
</table>

### Table C-3 Unipolar input ranges

<table>
<thead>
<tr>
<th>Units</th>
<th>Measured value in %</th>
<th>Data word</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2^15</td>
<td>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</td>
</tr>
<tr>
<td>32767</td>
<td>&gt;117.589</td>
<td>0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
<td>Overflow</td>
</tr>
<tr>
<td>32511</td>
<td>117.589</td>
<td>0 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1</td>
<td>Overshoot range</td>
</tr>
<tr>
<td>27649</td>
<td>100.004</td>
<td>0 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0</td>
<td>Rated range</td>
</tr>
<tr>
<td>27648</td>
<td>100.000</td>
<td>0 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.003617</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>-0.003617</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
<td>Undershoot range</td>
</tr>
<tr>
<td>-4864</td>
<td>-17.593</td>
<td>1 1 1 0 1 1 0 1 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>-32768</td>
<td>&lt;-17.593</td>
<td>1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>Underflow</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Values</th>
<th>Voltage measuring range</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dec</td>
<td>hex</td>
</tr>
<tr>
<td>32767</td>
<td>7FF</td>
<td>FFF</td>
</tr>
<tr>
<td>32511</td>
<td>7FF</td>
<td>EFF</td>
</tr>
<tr>
<td>27649</td>
<td>6C01</td>
<td></td>
</tr>
<tr>
<td>27648</td>
<td>6C00</td>
<td></td>
</tr>
<tr>
<td>20736</td>
<td>5100</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>FFF</td>
<td></td>
</tr>
<tr>
<td>-20736</td>
<td>AF00</td>
<td></td>
</tr>
<tr>
<td>-27648</td>
<td>9400</td>
<td></td>
</tr>
<tr>
<td>-27649</td>
<td>93FF</td>
<td></td>
</tr>
<tr>
<td>-32512</td>
<td>8100</td>
<td></td>
</tr>
<tr>
<td>-32768</td>
<td>8000</td>
<td></td>
</tr>
</tbody>
</table>

Table C- 5 Voltage measuring range 1 to 5 V

<table>
<thead>
<tr>
<th>Values</th>
<th>Voltage measuring range</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dec</td>
<td>hex</td>
</tr>
<tr>
<td>32767</td>
<td>7FF</td>
<td>FFF</td>
</tr>
<tr>
<td>32511</td>
<td>7FF</td>
<td>EFF</td>
</tr>
<tr>
<td>27649</td>
<td>6C01</td>
<td></td>
</tr>
<tr>
<td>27648</td>
<td>6C00</td>
<td></td>
</tr>
<tr>
<td>20736</td>
<td>5100</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>FFF</td>
<td></td>
</tr>
<tr>
<td>-4864</td>
<td>ED00</td>
<td></td>
</tr>
<tr>
<td>-32768</td>
<td>8000</td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Values</th>
<th>Current measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>dec</td>
<td>hex</td>
</tr>
<tr>
<td>32767</td>
<td>7FFF</td>
</tr>
<tr>
<td>32511</td>
<td>7EFF</td>
</tr>
<tr>
<td>27649</td>
<td>6C01</td>
</tr>
<tr>
<td>27648</td>
<td>6C00</td>
</tr>
<tr>
<td>20736</td>
<td>5100</td>
</tr>
<tr>
<td>-1</td>
<td>FFFF</td>
</tr>
<tr>
<td>-20736</td>
<td>AF00</td>
</tr>
<tr>
<td>-27648</td>
<td>9400</td>
</tr>
<tr>
<td>-27649</td>
<td>93FF</td>
</tr>
<tr>
<td>-32512</td>
<td>8100</td>
</tr>
<tr>
<td>-32768</td>
<td>8000</td>
</tr>
</tbody>
</table>

Table C-7 Current measuring ranges 0 to 20 mA and 4 to 20 mA

<table>
<thead>
<tr>
<th>Values</th>
<th>Current measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>dec</td>
<td>hex</td>
</tr>
<tr>
<td>32767</td>
<td>7FFF</td>
</tr>
<tr>
<td>32511</td>
<td>7EFF</td>
</tr>
<tr>
<td>27649</td>
<td>6C01</td>
</tr>
<tr>
<td>27648</td>
<td>6C00</td>
</tr>
<tr>
<td>20736</td>
<td>5100</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-1</td>
<td>FFFF</td>
</tr>
<tr>
<td>-4864</td>
<td>ED00</td>
</tr>
</tbody>
</table>
| -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

<table>
<thead>
<tr>
<th>Format</th>
<th>Parameter assignment</th>
<th>Measured values</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7</td>
<td>• &quot;Wire break&quot; diagnostics enabled</td>
<td>32767</td>
<td>&quot;Wire break&quot; or &quot;Open circuit&quot; diagnostic alarm</td>
</tr>
<tr>
<td></td>
<td>• &quot;Overflow/Underflow&quot; diagnostics enabled or disabled (&quot;Wire break&quot; diagnostics takes priority over &quot;Overflow/Underflow&quot; diagnostics)</td>
<td>7FFFH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Wire break&quot; diagnostics disabled</td>
<td>-32767</td>
<td>• Measured value after leaving the undershoot range</td>
</tr>
<tr>
<td></td>
<td>• &quot;Overflow/Underflow&quot; diagnostics enabled</td>
<td>8000H</td>
<td>• Diagnostic alarm &quot;Low limit violated&quot;</td>
</tr>
<tr>
<td></td>
<td>• &quot;Wire break&quot; diagnostics disabled</td>
<td>-32767</td>
<td>Measured value after leaving the undershoot range</td>
</tr>
<tr>
<td></td>
<td>• &quot;Overflow/Underflow&quot; diagnostics disabled</td>
<td>8000H</td>
<td></td>
</tr>
</tbody>
</table>
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<tr>
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<th>Open Source Software [Yes/No]</th>
<th>Acknowledgements</th>
<th>Copyright Information / File</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altera Nios II Embedded Design Suite 13.1</td>
<td>NO</td>
<td></td>
<td>LICENSE AND COPYRIGHT INFORMATION FOR COMPONENT ALTERA NIOS II EMBEDDED DESIGN SUITE 13.1</td>
</tr>
<tr>
<td>Dinkumware C/C++ Library 5.01</td>
<td>NO</td>
<td></td>
<td>LICENSE AND COPYRIGHT INFORMATION FOR COMPONENT DINKUMWARE C/C++ LIBRARY 5.01</td>
</tr>
<tr>
<td>GNU GCC libgcc 4.3.2</td>
<td>YES</td>
<td></td>
<td>LICENSE AND COPYRIGHT INFORMATION FOR COMPONENT GNU GCC LIBGCC 4.3.2</td>
</tr>
<tr>
<td>GNU GCC libstdc++ / libsupc++ 4.3.2</td>
<td>YES</td>
<td></td>
<td>LICENSE AND COPYRIGHT INFORMATION FOR COMPONENT GNU GCC LIBSTDCC++ / LIBSUPC++ 4.3.2</td>
</tr>
</tbody>
</table>
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53
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60 Manual, 03/2016, A5E36649087-AA
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