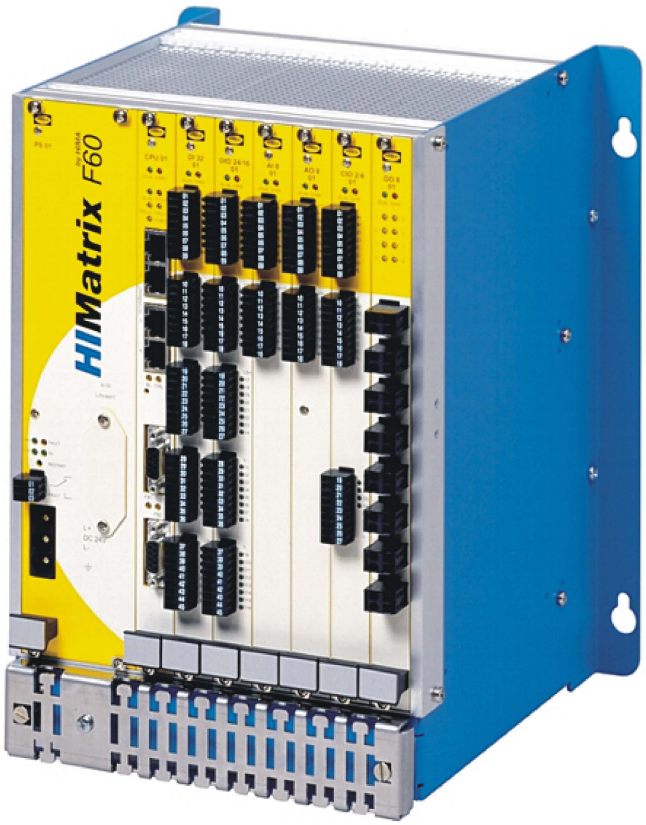
HIMatrix

Safety-Related Controller

AI 8 01 Manual



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Industrial Automation

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HI 800 195 E

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Revision index	Revision	Type of Change	
		technical	editorial
1.00	Added: Configuration with SILworX	X	X

Table of Contents

1 Introduction

This manual describes the technical characteristics of the module and its use. It also includes instructions on how to install, start up and replace it.

1.1 Structure and Use of this Manual

The content of this manual is part of the hardware description of the HIMatrix programmable electronic system.

This manual is organized in the following main chapters:

- Introduction
- Safety
- Product Description
- Start-Up
- Operation
- Maintenance
- Decommissioning
- Transport
- Disposal

This manual distinguishes between the following variants of the HIMatrix system:

Programming tool	Processor operating system	Communication operating system
SILworX	Version 7 and beyond	Version 12 and beyond
ELOP II Factory	Versions prior to 7	Versions prior to 12

Table 1: HIMatrix System Variants

The manual distinguishes among the different variants using:

- Separated chapters
- Tables differentiating among the versions, e.g., version 7 and beyond, or prior to version 7

Projects created with ELOP II Factory cannot be edited with SILworX, and vice versa!

This manual usually refers to compact controllers and remote I/Os as *devices*, and to the plug-in cards of a modular controller as *modules*.

Additionally, the following documents must be taken into account:

Name	Content	Document number
HIMatrix System Manual Compact Systems	Hardware description of the HIMatrix compact systems	HI 800 141 E
HIMatrix System Manual Modular System F60	Hardware description of the HIMatrix modular system	HI 800 191 E
Himatrix Safety Manual	Safety functions of the HIMatrix system	HI 800 023 E
HIMatrix Engineering Manual	Project planning description for HIMatrix systems	HI 800 101 E
SILworX Online Help	Instructions on how to use SILworX	-
ELOP II Factory Online Help	Instructions on how to use ELOP II Factory, Ethernet IP protocol, INTERBUS protocol	-
First Steps SILworX	Introduction to SILworX using the HIMax system as an example	HI 801 103 E
First Steps ELOP II Factory	Introduction to ELOP II Factory	HI 800 006 E

Table 2: Additional Relevant Documents

The latest manuals can be downloaded from the HIMA website www.hima.com. The revision index on the footer can be used to compare the current version of existing manuals with the Internet edition.

1.2 Target Audience

This document addresses system planners, configuration engineers, programmers of automation devices and personnel authorized to implement, operate and maintain the modules and systems. Specialized knowledge of safety-related automation systems is required.

1.3 Formatting Conventions

To ensure improved readability and comprehensibility, the following fonts are used in this document:

Bold:	To highlight important parts Names of buttons, menu functions and tabs that can be clicked and used in the programming tool.
Italics:	For parameters and system variables
`Courier`	Literal user inputs
RUN	Operating state are designated by capitals
Chapter 1.2.3	Cross references are hyperlinks even though they are not particularly marked. When the cursor hovers over a hyperlink, it changes its shape. Click the hyperlink to jump to the corresponding position.

Safety notes and operating tips are particularly marked.

1.3.1 Safety Notes

The safety notes are represented as described below.
These notes must absolutely be observed to reduce the risk to a minimum. The content is structured as follows:

- Signal word: danger, warning, caution, notice
- Type and source of danger
- Consequences arising from the danger
- Danger prevention

⚠ SIGNAL WORD

Type and source of danger!
Consequences arising from the danger
Danger prevention

The signal words have the following meanings:

- Danger indicates hazardous situation which, if not avoided, will result in death or serious injury.
- Warning indicates hazardous situation which, if not avoided, could result in death or serious injury.
- Warning indicates hazardous situation which, if not avoided, could result in minor or modest injury.
- Notice indicates a hazardous situation which, if not avoided, could result in property damage.

NOTE

Type and source of damage!
Damage prevention

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

i	The text corresponding to the additional information is located here.

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

2 Safety

The following safety information, notes and instructions must be strictly observed. The product may only be used if all guidelines and safety instructions are adhered to.

This product is operated with SELV or PELV. No imminent danger results from the product itself. The use in Ex-Zone is permitted if additional measures are taken.

2.1 Intended Use

HIMatrix components are designed for assembling safety-related controller systems.

When using the components in the HIMatrix system, comply with the following general requirements

2.1.1 Environmental Requirements

Requirement type	Range of values
Protection class	Protection class III in accordance with IEC/EN 61131-2
Ambient temperature	0...+60 °C
Storage temperature	-40...+85 °C
Pollution	Pollution degree II in accordance with IEC/EN 61131-2
Altitude	< 2000 m
Enclosure	Standard: IP20
Supply voltage	24 VDC

Table 3: Environmental Requirements

Exposing the HIMax system to environmental conditions other than those specified in this manual can cause the HIMatrix system to malfunction.

2.1.2 ESD Protective Measures

Only personnel with knowledge of ESD protective measures may modify or extend the system or replace devices.

NOTE

Device damage due to electrostatic discharge!

- **When performing the work, make sure that the workspace is free of static and wear an ESD wrist strap.**
- **If not used, ensure that the device is protected from electrostatic discharge, e.g., by storing it in its packaging.**

2.2 Residual Risk

No imminent danger results from a HIMatrix system itself.

Residual risk may result from:

- Faults in the engineering
- Faults in the user program
- Faults in the wiring

2.3 Safety Precautions

Observe all local safety requirements and use the protective equipment required on site.

2.4 Emergency Information

A HIMatrix system is a part of the safety equipment of a site. If a device or a module fails, the site adopts the safe state.

In case of emergency, no action that may prevent the HIMatrix systems from operating safely is permitted.

3 Product Description

The AI 8 01 is a plug-in module with 8 analog inputs and is used for the modular F60 system. The inputs are galvanically isolated to the I/O BUS.

The module can be inserted in the F60 subrack's slot 3...8 as many times as required. Slots 1 and 2 are reserved for the power supply module and CPU module, respectively.

The module has been certified by the TÜV for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061), Cat. 4 (EN 954-1) and PL e (EN ISO 13849-1). Further safety standards, application standards and test standards are specified in the certificate available on the HIMA website.

3.1 Safety Function

The module is equipped with safety-related analog inputs.

3.1.1 Safety-Related Analog Inputs

The analog inputs can be configured for 8 unipolar or 4 bipolar functions.

The module is intended to measure the voltage on the inputs.

To measure the current on the inputs, connect a resistor of up to 500 Ω in parallel to each input. With smaller shunts, the measurement range is spread (less resolution), and zero point errors increase by the spreading value.

The following input values are available:

Input channels	Polarity	Current Voltage	Value range in the application		Safety-related accuracy
			FS1000[1)]	FS2000[1)]	
8	unipolar	-10…+10 V	-1000…+1000	-2000…+2000	1 %
8	unipolar	0…20 mA	0…1000[3)]	0…2000[3)]	1 %
8	unipolar	0…20 mA	0…500[2)]	0…1000[2)]	4 %
4	bipolar	-10…+10 V	-1000…+1000	-2000…+2000	1 %

[1)] To specify when selecting the device type in the programming tool

[2)] with 250 Ω external shunt, HIMA no.: 00 0710251

[3)] with 500 Ω external shunt, HIMA no.: 00 0603501 (accuracy 0.05%, P1W)

Table 4: Input Values of the Analog Inputs

The module's value range can be configured to 1000-digit resolution (FS1000) or 2000-digit resolution (FS2000), when the device type of the F60 modules (AI 8 01 FS1000 or AI 8 01 FS2000) is selected in the programming tool.

If an open-circuit occurs (the line is not monitored), any input signals are processed on the high-resistance inputs. The value resulting from this fluctuating input voltage does not correspond to the process values. With voltage inputs, the channels must thus be terminated with a 10 kΩ resistor. The internal source resistance must be taken into account (≤ 500 Ω).

For a current measurement with the shunt connected in parallel, the 10 kΩ resistor is not required.

i Unused input channels must each be short-circuited to the ground (I-).

The max. permitted voltage between the analog terminals is ±13 V.

The analog inputs are designed such that the measurement accuracy is maintained for 10 years. A recalibration must be carried out every 10 years.

3.1.1.1 Reaction in the Event of a Fault

If the module detects a fault on an analog input, the *AI.Error Code* system parameter > 0 is set. In case of module faults, the *Mod. Error Code* system parameter > 0 is set.

In both cases, the device activates the *ERR* LED.

In addition to the analog value the error code must be evaluated. The analog value must be configured to ensure a safety-related reaction.

The error code allows the user to configure additional fault reactions in the user program.

3.2 Equipment, Scope of Delivery

The following list specifies the available components and the corresponding part numbers:

Designation	Description	Part no.
AI 8 01	Plug-in module with 8 analog inputs	98 2200214

Table 5: Part Numbers

3.3 Type Label

The type plate contains the following details:

- Product name
- Bar code (1D or 2D code)
- Part no.
- Production year
- Hardware revision index (HW Rev.)
- Firmware revision index (FW Rev.)
- Operating voltage
- Mark of conformity

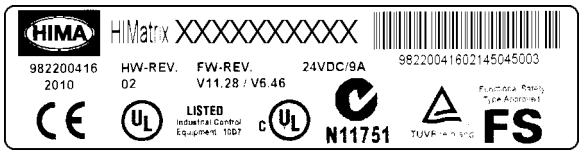


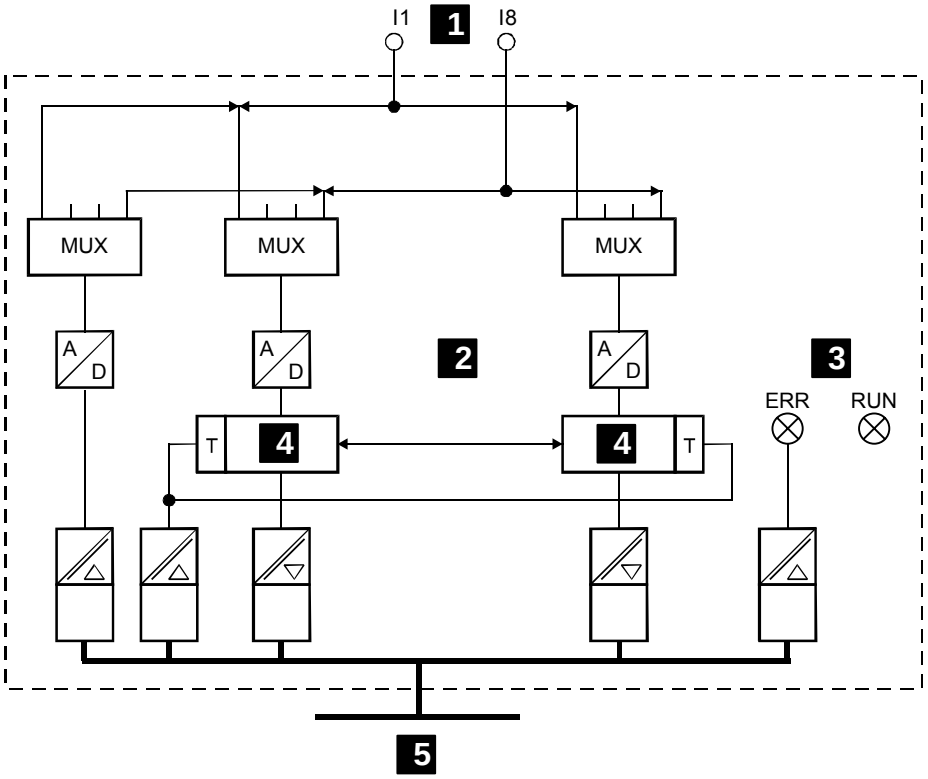
Figure 1: Sample Type Label

3.4 Assembly

The analog values are processed in parallel via two multiplexers and two analog/digital converters with 12-bit resolution and the results are compared. This value is then made available to the user program.

Additionally, test values are used by the existing digital/analog converters, converted back to digital values, and then compared with the default value.

3.4.1 Block Diagram



1 Analog Inputs
2 A/D Converter with 12-bit Resolution
3 Status Indicators
4 Logic
5 I/O Bus

Figure 2: Block Diagram

3.4.2 Front View

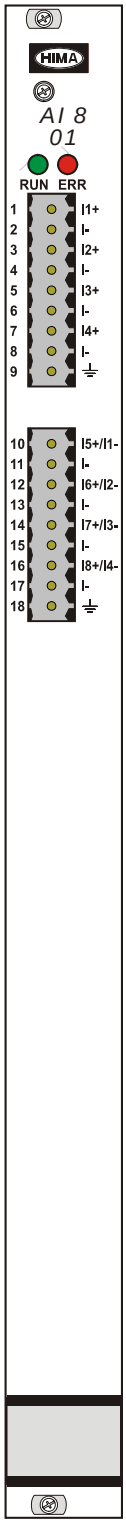


Figure 3: Front View

3.4.3 Status Indicators

LED	Color	Status	Description
RUN	Green	On	Operating voltage present
		Off	No operating voltage
ERR	Red	On	Module fault and / or channel fault Reaction as dictated by the diagnosis
		Off	No module faults and / or no channel faults

Table 6: Status Indicators

3.5 Product Data

General	
Operating voltage	24 VDC, -15 %...+20 %, w_{ss} ≤ 15 %, provided by a power supply unit with safe isolation in accordance with IEC 61131-2 requirements.
Operating data	24 VDC / 380 mA 3.3 VDC / 150 mA
Ambient temperature	0 °C...+60 °C
Storage temperature	-40 °C...+85 °C
Space requirement	6 RU, 4 HP
Weight	240 g

Table 7: Product Data

Analog inputs	
Number of inputs	8 unipolar or 4 bipolar (galvanically isolated)
Nominal range	0...±10 V or 0...+20 mA (with shunt)
Operating range	0...±10.25 V or 0...+20.5 mA (with shunt)
Input resistance	1 MΩ
Digital resolution	12-bit
Source resistance input of the input signal	≤ 500 Ω
Measurement accuracy at 25 °C, max.	±0.1 % of final value
Measurement accuracy on full temperature range, max.	±0.5 % of final value
Temperature coefficient, max.	±0.011 %/K of final value
Safety-related accuracy, max.	±1 % of final value
Measured value refresh	once per F60 cycle
Sampling time	approx. 45 µs per channel

Table 8: Specifications for the Analog Inputs

4 Start-Up

To start up the controller, it must be mounted, connected and configured in the programming tool.

4.1 Installation and Mounting

The module is mounted in the F60 subrack of the modular HIMatrix F60 system.

4.1.1 Mounting and Removing the Modules

To mount and remove the modules, the connection cable clamp terminals must be unplugged.

Additionally, personnel must be protected from electrostatic discharge. For details, refer to Chapter 2.1.2.

Mounting the Modules

To mount a module into the rack

1. Insert the module as far as it can go – without jamming it – into the two guiding rails which are located on the upper and lower part of the enclosure.
2. Apply pressure to the upper and lower extremity of the front plate until the module plugs snap into the backplane socket.
3. Secure the module with the screws located on upper and lower extremity of the front plate.

The module is mounted.

Removing the Modules

To remove a module from the rack

1. Remove the plugs from the module front plate.
2. Release the locking screws located on the upper and lower extremity of the front plate.
3 Loosen the module using the handle located on the lower part of the front plate and remove it from the guiding rails.

The module is removed.

4.1.2 Connection of the Analog Inputs

Only shielded cables with a length of a maximum of 300 m must be connected to the analog inputs. Each analog input must be connected to a twisted pair of wires. The shielding must be connected to the controller and the sensor housing and earthed of one end to the controller side to form a Faraday cage.

Necessary shunts must be connected directly to the inputs of the module.

The inputs are connected using 9-pole connectors with numbered terminals. The terminal pins on the front plate of the module have the same numbered sequence to avoid improper connections.

Use the following terminals to connect the digital inputs:

Terminal	Designation	Function
1	I1+	Analog input 1
2	I-	Ground input 1
3	I2+	Analog input 2
4	I-	Ground input 2
5	I3+	Analog input 3
6	I-	Ground input 3
7	I4+	Analog input 4
8	I-	Ground input 4
9	⏚	Earth / shielding
Terminal	Designation	Function
10	I5+/I1-	Analog input 5
11	I-	Ground input 5
12	I6+/I2-	Analog input 6
13	I-	Ground input 6
14	I7+/I3-	Analog input 7
15	I-	Ground input 7
16	I8+/I4-	Analog input 8
17	I-	Ground input 8
18	⏚	Earth / shielding

Table 9: Terminal Assignment for the Analog Inputs

- Unipolar inputs:
  1+ and I-, I2+ and I-, I3+ and I-, I4+ and I-, … I8+ and I-
- Bipolar inputs
  I1+ and I5+/I1-, I2+ and I6+/I2-, I3+ and I7+/I3-, I4+ and I8+/I4-

All I- connections are interconnected.

4.1.3 Mounting the AI 8 01 in Zone 2

(EC Directive 94/9/EC, ATEX)

The module is suitable for mounting in zone 2. Refer to the corresponding declaration of conformity available on the HIMA website.

When mounting the device, observe the special conditions specified in the following section.

Special Conditions X

1. The F60 AI 8 01 module must be mounted in an enclosure, which fulfills the requirements of the EN 60079-15 with the type of protection at least IP54, according to EN 60529. Provide the device with the following label:

   Work is only permitted in the de-energized state

   Exception:
   If a potentially explosive atmosphere has been precluded, work can be also performed when the device is under voltage.
2. The enclosure in use must be able to safely dissipate the generated heat. The power dissipation of the module is 12 W at maximum depending on the power supply voltage.
3. The HIMatrix AI 8 01 module must be supplied with 24 VDC from a power supply unit with safe isolation. Use power supply units of type PELV or SELV only.
4. Applicable standards:

VDE 0170/0171 Part 16,	DIN EN 60079-15: 2004-5
VDE 0165 Part 1,	DIN EN 60079-14: 1998-08

Pay particular attention to the following sections:

DIN EN 60079-15:	
Chapter 5	Design
Chapter 6	Terminals and cabling
Chapter 7	Air and creeping distances
Chapter 14	Connectors
DIN EN 60079-14:	
Chapter 5.2.3	Equipment for use in zone 2
Chapter 9.3	Cabling for zones 1 and 2
Chapter 12.2	Equipment for zones 1 and 2

The controller is additionally equipped with the label represented below:

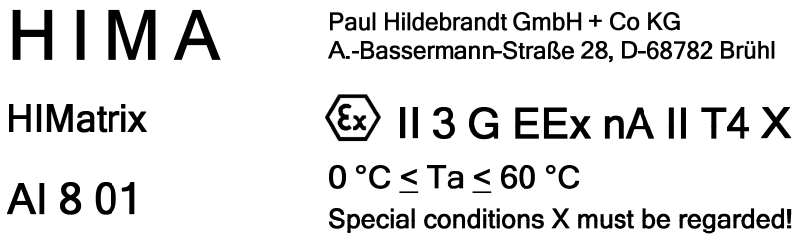


Figure 4: Label for Ex Conditions

4.2 Configuration

The AI 8 01 module can be configured using a programming tool, SILworX or ELOP II Factory. Which programming tool should be used depends on the revision status of the operating system (firmware):

- ELOP II Factory is required for operating system versions prior to 7.
- SILworX is required for operating system version 7 and beyond.

ELOP II Factory is required to load a new operating system (version 7 or beyond) into a controller with a CPU operating system version prior to 7. SILworX is then required once the loading procedure is completed.

4.2.1 Module Slots

Slots 1 and 2 on the F60 module rack are reserved for the PS 01 power supply module and CPU module, respectively. Any type of I/O modules can be plugged in to slots 3...8.

The module slots in SILworX and ELOP II Factory are numbered as follows:

Module	Slot on the rack	Slot in SILworX	Slot in ELOP II Factory
PS 01	1	-	-
CPU/COM	2	0/1	-
I/O	3	2	1
I/O	4	3	2
I/O	5	4	3
I/O	6	5	4
I/O	7	6	5
I/O	8	7	6

Table 10: Module Slots

- The PS 01 power supply module is not configured.
- CPU and COM are both on the F 60 CPU 01 module. In the programming tools, however, they are represented as separated items.

4.3 Configuring a Module with SILworX

In the Hardware Editor, the controller is represented with the following modules:

- one processor module (CPU)
- one communication module
- 6 slots available for I/O modules

To insert I/O modules, drag them from the module list onto an available slot.

Two variants are available for the AI 8 01 module:

- AI 8 01 FS1000: Resolution of the analog value -1000…+1000 (-10 V…+10 V)
- AI 8 01 FS2000: Resolution of the analog value -2000…+2000 (-10 V…+10 V)

Double-click the module to open the Detail View with the corresponding tabs. The tabs are used to assign the global variables configured in the user program to the system parameters of the corresponding module.

4.3.1 Parameters and Error Codes for the Inputs

The following tables specify the system parameters that can be read and set for the inputs, including the corresponding error codes.

In the user program, the error codes can be read using the variables assigned within the logic.

The error codes can also be displayed in SILworX.

4.3.2 Analog Inputs

The following tables present the statuses and parameters for the input module in the same order as given in the Hardware Editor.

4.3.2.1 **Module** Tab

The **Module** tab contains the following system parameters.

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>AI.Error Code</td><td>WORD</td><td>R</td><td>Error codes for all analog inputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0008</td><td>FTZ test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0010</td><td>FTT test: Error while checking coefficients</td></tr>
<tr><td>0x0020</td><td>FTT test: Operating voltages faulty</td></tr>
<tr><td>0x0040</td><td>A/D conversion faulty (DRDY_LOW)</td></tr>
<tr><td>0x0080</td><td>MOT test: Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>MOT test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>MOT test: Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>MOT test: Operating voltages faulty</td></tr>
<tr><td>0x0800</td><td>MOT test: Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>MOT test: Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x2000</td><td>MOT test: Measuring system (characteristic) faulty (bipolar)</td></tr>
<tr><td>0x4000</td><td>MOT test: Measuring system (final values, zero point) faulty (bipolar)</td></tr>
<tr><td>0x8000</td><td>A/D conversion faulty (DRDY_HIGH)</td></tr>
</table></td></tr>
<tr><td>AI.Mode</td><td>BOOL</td><td>W</td><td>All channels unipolar or bipolar:
0 = unipolar measurement
1 = bipolar measurement</td></tr>
<tr><td>Module Error Code</td><td>WORD</td><td>R</td><td>Module error code
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors, see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Module SRS</td><td>UDINT</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module Type</td><td>UINT</td><td>R</td><td>Type of module, target value: 0xFD02 [64770_{dez}]</td></tr>
</table>

Table 11: SILworX - System Parameters for Analog Inputs, **Module** Tab

4.3.2.2 Tab **AI 8 01 FS1000_1: Channels** or **AI 8 01 FS2000_1: Channels**

The **AI 8 01 FS1000_1: Channels** or **AI 8 01 FS2000_1: Channels** tab contains the following system variables:

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>-> Error Code [BYTE]</td><td>BYTE</td><td>R</td><td>Error codes for the analog input channels (1...8)
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the analog input module</td></tr>
<tr><td>0x02</td><td>Not used</td></tr>
<tr><td>0x04</td><td>A/D converter faulty, measuring values not valid</td></tr>
<tr><td>0x08</td><td>Measured value out of the safety-related accuracy</td></tr>
<tr><td>0x10</td><td>Measured value overflow</td></tr>
<tr><td>0x20</td><td>Channel not operating</td></tr>
<tr><td>0x40</td><td>Address error of both A/D converters</td></tr>
<tr><td>0x80</td><td>Configuration of the hysteresis faulty</td></tr>
</table></td></tr>
<tr><td>-> Value [INT]</td><td>INT</td><td>R</td><td>▪ Analog value of each channel [INT] from -1000...+1000 (device version: FS1000), voltage range: -10 V...+10 V
▪ Analog value of each channel [INT] from -2000 to +2000 (device version: FS2000), voltage range: -10 V to +10 V
The validity depends on the Error Code [BYTE]</td></tr>
<tr><td>Channel Used [BOOL] -></td><td>BOOL</td><td>W</td><td>Channel configuration:
1 = Channel operating
0 = Channel not operating</td></tr>
</table>

Table 12: SILworX - System Parameters for Analog Inputs, **AI 8 01 FS1000_1: Channels** or **AI 8 01 FS2000_1: Channels Tab**

4.4 Configuring a Module Using ELOP II Factory

4.4.1 Configuring the Inputs

The signals previously defined in the Signal Editor (Hardware Management) are assigned to the individual channels (inputs) using ELOP II Factory. Refer to the System Manual for the Modular F60 System or the online help for more details.

The following chapter describes the system signals used for assigning signals in the controller.

4.4.2 Signals and Error Codes for the Inputs

The following tables specify the system signals that can be read and set for the inputs, including the corresponding error codes.

In the user program, the error codes can be read using the signals assigned within the logic.

The error codes can also be displayed in ELOP II Factory.

4.4.3 Analog Inputs

<table>
<tr><th>System Signal</th><th>R/W</th><th>Description</th></tr>
<tr><td>Mod.SRS [UDINT]</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Mod. Type [UINT]</td><td>R</td><td>Type of module,target value: 0xFD02 [64770_{dec}]</td></tr>
<tr><td>Mod. Error Code [WORD]</td><td>R</td><td>Error codes for the module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors
see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>AI.Error Code [WORD]</td><td>R</td><td>Error codes for all analog inputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault.</td></tr>
<tr><td>0x0008</td><td>FTT test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0010</td><td>FTT test: Error checking coefficients</td></tr>
<tr><td>0x0020</td><td>FTT test: Operating voltages faulty</td></tr>
<tr><td>0x0040</td><td>A/D conversion faulty (DRDY_LOW)</td></tr>
<tr><td>0x0080</td><td>MOT test: Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>MOT test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>MOT test: Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>MOT test: Operating voltages faulty</td></tr>
<tr><td>0x0800</td><td>MOT test: Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>MOT test: Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x2000</td><td>MOT test: Measuring system (characteristic) faulty (bipolar)</td></tr>
<tr><td>0x4000</td><td>MOT test: Measuring system (final values, zero point) faulty (bipolar)</td></tr>
<tr><td>0x8000</td><td>A/D conversion faulty (DRDY_HIGH)</td></tr>
</table></td></tr>
<tr><td>AI[0x].Error Code [BYTE]</td><td>R</td><td>Error codes for the analog input channels
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the analog input module</td></tr>
<tr><td>0x02</td><td>CPU operating system versions prior to 4: measured values invalid,
CPU operating system version 4 and beyond: not used</td></tr>
<tr><td>0x04</td><td>A/D converter faulty
with CPU operating system version 4 and beyond: Measured values invalid</td></tr>
<tr><td>0x08</td><td>Measured value out of the safety-related accuracy</td></tr>
<tr><td>0x10</td><td>Measured value overflow</td></tr>
<tr><td>0x20</td><td>Channel not operating</td></tr>
<tr><td>0x40</td><td>Address error of both A/D converters</td></tr>
</table></td></tr>
</table>

System Signal	R/W	Description
AI[0x].Value [INT]	R	▪ Analog value of each channel [INT] from -1000...+1000 (device version: FS1000), voltage range: -10 V...+10 V ▪ Analog value of each channel [INT] from -2000...+2000 (device version: FS2000), voltage range: -10 V...+10 V The validity depends on the *AI[0x].Error Code*
AI[0x]. Used [BOOL]	W	Channel configuration: 1 = operating 0 = not operating
AI.Mode [BOOL]	W	All channels unipolar or bipolar: 0 = unipolar measurement 1 = bipolar measurement

Tabee 13: ELOP II Factory - Analog Input System Signals

5 Operation

The module runs within a HIMatrix base plate and does not require any specific monitoring.

5.1 Handling

Handling of the controller during operation is not required.

5.2 Diagnosis

A first diagnosis results from evaluating the LEDs, see Chapter 3.4.3.

The device's diagnostic history can also be read using the programming tool.

6 Maintenance

No maintenance measures are required during normal operation.

If a device or module fails, replace it with an identical type or an alternative type which is admitted by HIMA.

Only the manufacturer is authorized to repair the device/module.

6.1 Faults

Refer to Chapter 3.1.1.1, for more information on the fault reaction of analog inputs.

NOTE

If a failure occurs, the module must be replaced to ensure the plant's safety.

The module may only be replaced if the power is switched off.

i Modules may not be removed or inserted during operation.

The instructions specified in Chapter 4.1.1 must be observed when replacing an existing module or installing a new one.

6.2 Maintenance Measures

The following measures are rarely required for the processor module:

- Loading the operating system, if a new version is required
- Executing the proof test

6.2.1 Loading the Operating System

HIMA is continuously improving the operating system of the controller. HIMA recommends to use system downtimes to load a current version of the operating system into the controller.

Refer to the release list to check the consequences of the new operation system version on the system!

Load the operating system using the programming tool.

Prior to loading the operating system, the controller must be in STOP (displayed in the programming tool). Otherwise, stop the controller.

For more information, refer to the programming tool documentation.

6.2.2 Proof Test

Test the HIMatrix modules every 10 years. For more information, refer to the Safety Manual (HI 800 003 E).

7 Decommissioning

Remove the supply voltage to decommission the module. Afterwards pull out the pluggable screw terminal connector blocks for inputs and outputs and the Ethernet cables.

8 Transport

To avoid mechanical damage, HIMatrix components must be transported in packaging.

Always store HIMatrix components in their original product packaging. This packaging also provides protection against electrostatic discharge. Note that the product packaging alone is not suitable for transmission.

9 Disposal

Industrial customers are responsible for correctly disposing of decommissioned HIMatrix hardware. Upon request, a disposal agreement can be arranged with HIMA.

All materials must be disposed of in an ecologically sound manner.

Appendix

Glossary

Term	Description
ARP	Address Resolution Protocol: Network protocol for assigning the network addresses to hardware addresses
AI	Analog Input
COM	COMmunication module
CRC	Cyclic Redundancy Check
DI	Digital Input
DO	Digital Output
ELOP II Factory	Programming tool for HIMatrix systems
EMC	ElectroMagnetic Compatibility
EN	European Norm
ESD	ElectroStatic Discharge
FB	FieldBus
FBD	Function Block Diagrams
FTA	Field Termination Assembly
FTT	Fault Tolerance Time
ICMP	Internet Control Message Protocol: Network protocol for status or error messages
IEC	International Electrotechnical Commission
MAC address	Media Access Control address: Hardware address of one network connection
PADT	Programming And Debugging Tool (in accordance with IEC 61131-3), PC with SILworX or ELOP II Factory
PE	Protective Earth
PELV	Protective Extra Low Voltage
PES	Programmable Electronic System
PFD	Probability of Failure on Demand, probability of failure on demand of a safety function
PFH	Probability of Failure per Hour, probability of a dangerous failure per hour
R	Read: The system variable or signal provides value, e.g., to the user program
Rack ID	Base plate identification (number)
Non-reactive	Supposing that two input circuits are connected to the same source (e.g., a transmitter). An input circuit is termed *non-reactive* if it does not distort the signals of the other input circuit.
R/W	Read/Write (column title for system variable/signal type)
SB	System Bus (module)
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction, portion of safely manageable faults
SIL	Safety Integrity Level (in accordance with IEC 61508)
SILworX	Programming tool for HIMatrix systems
SNTP	Simple Network Time Protocol (RFC 1769)
S.R.S	System.Rack.Slot addressing of a module
SW	Software
TMO	TiMeOut
W	Write: System variable/signal is provided with value, e.g., from the user program
WD	WatchDog: Time monitoring for modules or programs. If the watchdog time is exceeded, the module or program enters the ERROR STOP state.
WDT	WatchDog Time

Index of Figures

Index of Tables

Index

SAFETY
NONSTOP

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