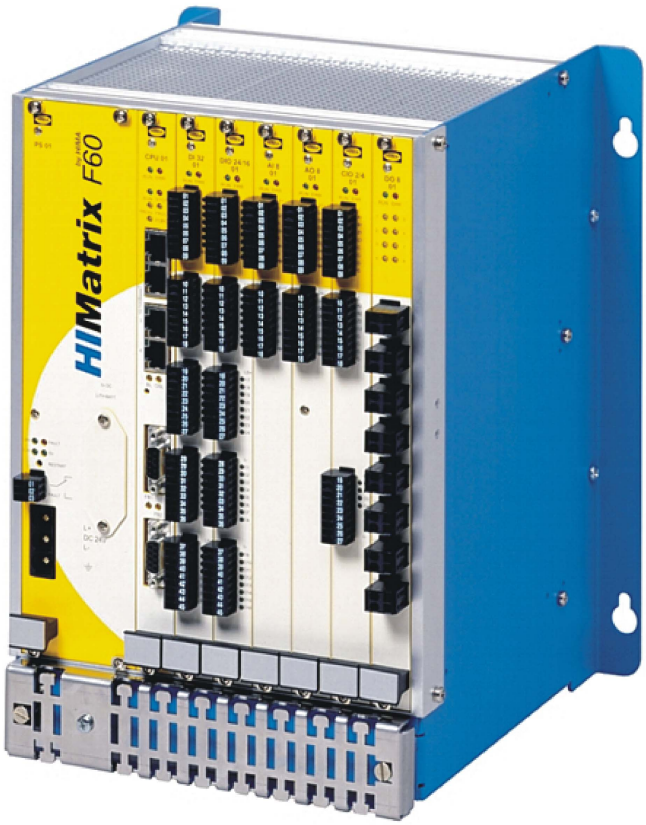
HIMatrix

Safety-Related Controller

AI 8 01 Manual



HIMA Paul Hildebrandt GmbH + Co KG

Industrial Automation

Rev. 2.00

HI 800 195 E

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For further information, refer to the HIMA DVD and our website at `http://www.hima.de` and `http://www.hima.com`.

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Revision index	Revisions	Type of change	
		technical	editorial
1.00	Added: Configuration with SILworX	X	X
2.00	Added: AI 08 014, SIL 4 certified according to EN 50126, EN 50128 and EN 50129, Chapter 4.1.3	X	X

Table of Contents

1 Introduction 5

1.1 Structure and Use of this Manual 5

1.2 Target Audience 6

1.3 Formatting Conventions 7

1.3.1 Safety Notes 7

1.3.2 Operating Tips 8

2 Safety 9

2.1 Intended Use 9

2.1.1 Environmental Requirements 9

2.1.2 ESD Protective Measures 9

2.2 Residual Risk 10

2.3 Safety Precautions 10

2.4 Emergency Information 10

3 Product Description 11

3.1 Safety Function 11

3.1.1 Safety-Related Analog Inputs 11

3.1.1.1 Reaction in the Event of a Fault 12

3.2 Equipment, Scope of Delivery 12

3.3 Type Label 12

3.4 Structure 13

3.4.1 Block Diagram 13

3.4.2 Front View 14

3.4.3 Status Indicators 15

3.5 Product Data 16

3.5.1 Product Data AI 8 014 16

4 Start-up 17

4.1 Installation and Mounting 17

4.1.1 Mounting and Removing the Modules 17

4.1.2 Connecting the Analog Inputs 18

4.1.3 Cable Plugs 19

4.1.4 Mounting the AI 8 01 in Zone 2 20

4.2 Configuration 21

4.2.1 Module Slots 21

4.3 Configuration with SILworX 22

4.3.1 Parameters and Error Codes for the Inputs 22

4.3.2 Analog Inputs 23

4.3.2.1 Tab **Module** 23

4.3.2.2 Tab **AI 8 01 FS1000_1: Channels** or **AI 8 01 FS2000_1: Channels** 24

4.4 Configuration with ELOP II Factory 24
4.4.1 Configuring the Inputs 24
4.4.2 Signals and Error Codes for the Inputs 24
4.4.3 Analog Inputs 25

5 Operation 27

5.1 Handling 27
5.2 Diagnosis 27

6 Maintenance 28

6.1 Faults 28
6.2 Maintenance Measures 28
6.2.1 Loading the Operating System 28
6.2.2 Proof Test 28

7 Decommissioning 29

8 Transport 30

9 Disposal 31

Appendix 33

Glossary 33
Index of Figures 34
Index of Tables 35
Index 36

1 Introduction

This manual describes the technical characteristics of the module and its use. It provides information on how to install, start up and configure the module.

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

The HIMatrix F60 is available for the programming tools SILworX and ELOP II Factory. Which programming tool can be used, depends on the processor operating system of the HIMatrix F60, refer to the following table:

Programming tool	Processor operating system	Communication operating system
SILworX	CPU OS V7 and higher	COM OS V12 and higher
ELOP II Factory	CPU OS up to V6.x	COM OS up to V11.x

Table 1: Programming Tools for HIMatrix F60

In the manual, the differences are specified by using:

- Separated chapters
- Tables differentiating among the versions

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

The manual usually refers to the plug-in cards of the modular controller F60 as *modules*. *Modules* is also the term used in SILworX.

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 Safety Manual for Railway Applications	Safety functions of the HIMatrix system using the HIMatrix in railway applications	HI 800 437 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	-
SILworX First Steps	Introduction to SILworX using the HIMax system as an example	HI 801 103 E
ELOP II Factory First Steps	Introduction to ELOP II Factory	HI 800 006 E

Table 2: Additional Relevant Documents

The latest manuals can be downloaded from the HIMA website at 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: warning, caution, notice
- Type and source of risk
- Consequences arising from non-observance
- Risk prevention

⚠ SIGNAL WORD

Type and source of risk!
Consequences arising from non-observance
Risk prevention

The signal words have the following meanings:

- Warning indicates hazardous situation which, if not avoided, could result in death or serious injury.
- Caution 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

All safety information, notes and instructions specified in this document 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 risk 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 [1]
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
Housing	Standard: IP20
Supply voltage	24 VDC

[1] The values specified in the technical data apply and are decisive for devices with extended environmental requirements.

Table 3: Environmental Requirements

Exposing the HIMatrix 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 risk results from a HIMatrix system itself.

Residual risk may result from:

- Faults related to engineering
- Faults related to the user program
- Faults related to 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 system enters 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 module with 8 analog inputs and is used for the modular F60 system. The inputs are galvanically separated to the I/O bus.

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

The module is TÜV-certified for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061), Cat. 4 and PL e (EN ISO 13849-1) and SIL 4 (EN 50126, EN 50128 and EN 50129).
Further safety standards, application standards and test standards are specified in the certificates 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	Range of values 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) 250 Ω with external shunt, HIMA no.: 00 0710251

3) 500 Ω with external shunt (accuracy 0.05%, P1W). No longer available from HIMA.

Table 4: Input Values for the Analog Inputs

The module's value range can be configured to 1000-digit resolution (FS1000) or 2000 digits (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 is 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 Each unused input channels must be short-circuited to ground (I-).

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

The analog inputs are designed to retain the metrological accuracy for 10 years. A proof test must be performed every 10 years.

3.1.1.1 Reaction in the Event of a Fault

If the device detects a fault on an analog input, the *AI.Error Code* parameter is set to a value greater than 0. If a module fault occurred, the SILworX system parameter *Module Error Code* is set to a value greater than 0, or if ELOP II Factory is used, the *Module.Error Code* signal is set to a value greater than 0.

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

In addition to the analog value the 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 table specifies the available module variants:

Designation	Description
AI 8 01	Module with 8 analog inputs
AI 8 014	Module with 8 analog inputs, Operating temperature: -25...+70 °C (temperature class T1), Vibration and shock tested according to EN 50125-3 and EN 50155, class 1B according to IEC 61373

Table 5: Available Variants

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

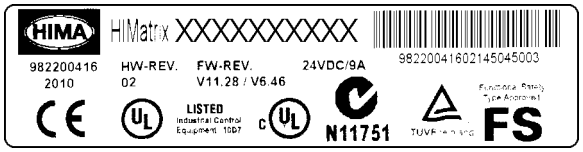


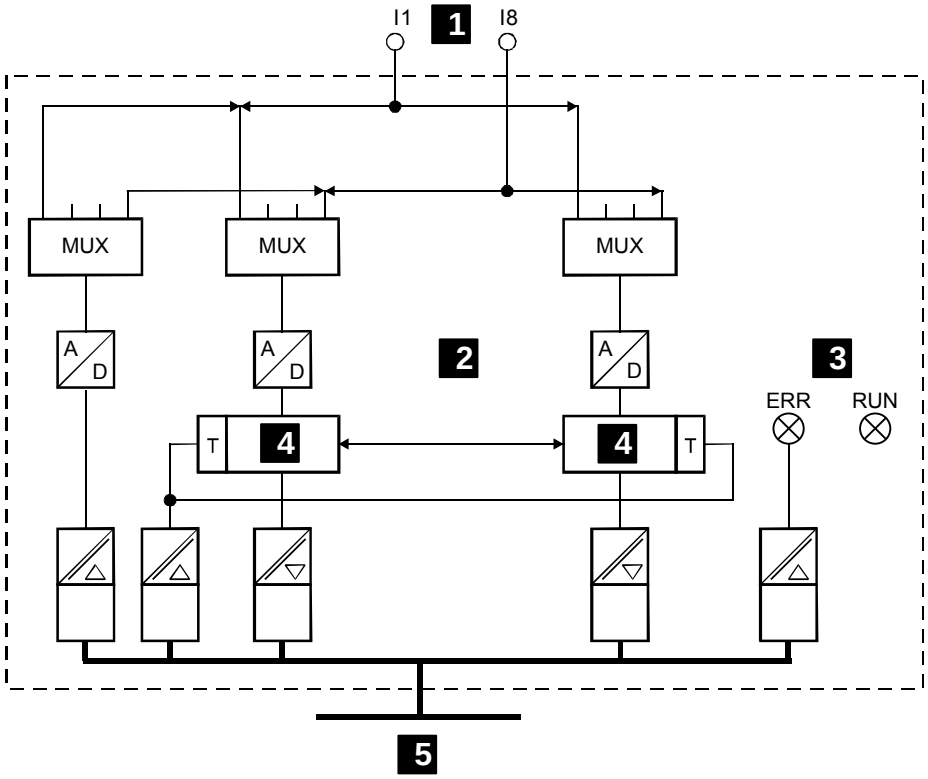
Figure 1: Sample Type Label

3.4 Structure

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

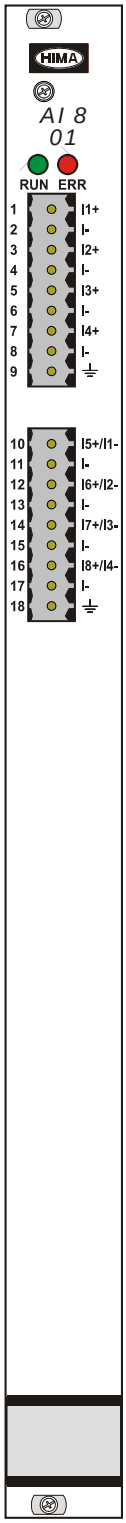


Figure 3: Front View

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 %, $r_{PP} \leq 15$ %, from a power supply unit with safe insulation in accordance with IEC 61131-2
Operating data	24 VDC / 380 mA 3.3 VDC / 150 mA
Ambient temperature	0...+60 °C
Storage temperature	-40...+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 separated)
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
Metrological accuracy on full temperature, 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

3.5.1 Product Data AI 8 014

The AI 8 014 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

AI 8 014	
Operating temperature	-25…+70 °C (temperature class T1)

Table 9: Product Data AI 8 014

The module AI 8 014 meets the vibration and shock requirements in accordance with EN 61373, Category 1, Class B.

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 subrack of the modular HIMatrix F60 system.

When laying cables (long cables, in particular), take appropriate measures to avoid interference, e.g., by separating the signal lines from the power lines.

When dimensioning the cables, ensure that their electrical properties have no negative impact on the measuring circuit.

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 subrack

1. Insert the module as far as it can go – without jamming it – into the two guiding rails which are located on the housing's upper and lower part.
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 subrack

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 Connecting the Analog Inputs

Only shielded cables may 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 on 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 invalid connections.

Use the following terminals to connect the analog 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	⏚	Ground / 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	⏚	Ground / shielding

Table 10: Terminal Assignment for the Analog Inputs

- Unipolar inputs:
  I1+ 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- terminals are interconnected.

4.1.3 Cable Plugs

Cable plugs attached to the pin headers of the module are used to connect to the field zone. The cable plugs are included within the scope of delivery of the HIMatrix modules.

Connection to the field zone	
Number of cable plugs	2 pieces, nine poles, screw terminals
Wire cross-section	0.2…1.5 mm^2 (single-wire) 0.2…1.5 mm^2 (finely stranded) 0.2…1.5 mm^2 (with wire end ferrule)
Stripping length	6 mm
Screwdriver	Slotted 0.4 x 2.5 mm
Tightening torque	0.2…0.25 Nm

Table 11: Cable Plug Properties

4.1.4 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.

Specific Conditions X

1. Mount the HIMatrix F60 controller in an enclosure that meets the EN 60079-15 requirements and achieves a type of protection of at least IP54, in accordance with 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 24 VDC power must come 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:

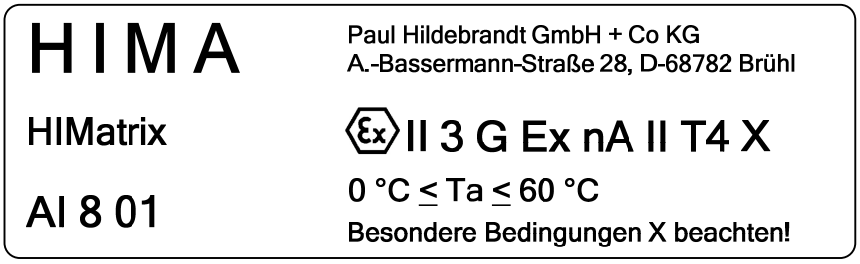


Figure 4: Label for Ex Conditions

4.2 Configuration

The 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):

- SILworX is required for CPU OS V7 and higher.
- ELOP II Factory is required for CPU OS up to V6.x.

i How to switch between operating systems is described in Chapter *Loading Operating Systems* of the system manual for the modular F60 systems (HI 800 191 E).

4.2.1 Module Slots

Slots 1 and 2 on the F60 subrack are reserved for the PS 01 power supply module and the central 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 12: Module Slots

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

4.3 Configuration with SILworX

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

- one processor module (CPU)
- one communication module (COM)
- 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…+10 V)
- AI 8 01 FS2000: Resolution of the analog value -2000…+2000 (-10…+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 Tab **Module**

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>FTT 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>Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>Faulty operating voltages</td></tr>
<tr><td>0x0800</td><td>Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x2000</td><td>Measuring system (characteristic) faulty (bipolar)</td></tr>
<tr><td>0x4000</td><td>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: invalid 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 [64 770$_{dec}$]</td></tr>
</table>

Table 13: 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, 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>
<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...+10 V
▪ Analog value of each channel [INT] from -2000...+2000 (device version: FS2000), voltage range: -10...+10 V
The validity depends on the AI[0x].Error code</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 14: SILworX - System Parameters for Analog Inputs, **AI 8 01 FS1000_1: Channels** or **AI 8 01 FS2000_1: Channels** Tab

4.4 Configuration with 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 [64 770$_{dec}$]</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: invalid 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 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>Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>Faulty operating voltages</td></tr>
<tr><td>0x0800</td><td>Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x2000</td><td>Measuring system (characteristic) faulty (bipolar)</td></tr>
<tr><td>0x4000</td><td>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 higher: not used</td></tr>
<tr><td>0x04</td><td>A/D converter faulty,
CPU operating system version 4 and higher: 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>
<tr><td>AI[0x].Value [INT]</td><td>R</td><td>▪ Analog value of each channel [INT] from -1000...+1000 (device version: FS1000), voltage range: -10...+10 V
▪ Analog value of each channel [INT] from -2000...+2000 (device version: FS2000), voltage range: -10...+10 V
The validity depends on the AI[0x].Error code</td></tr>
</table>

System signal	R/W	Description
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

Table 15: ELOP II Factory - System Signals for the Analog Inputs

5 Operation

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

5.1 Handling

Handling of the module during operation is not required.

5.2 Diagnosis

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

The module diagnostic history can also be read using the programming tool.

6 Maintenance

No maintenance measures are required during normal operation.

If a failure occurs, the defective module or device must be replaced with a module or device of the same type or with a replacement model approved by HIMA.

Only the manufacturer is authorized to repair the device or 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.

A module may only be replaced while 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 required for the modular F60 system:

- Load the operating system, if a new version is required
- Perform the proof test

6.2.1 Loading the Operating System

HIMA is continuously improving the operating system of the F60 central module. HIMA recommends to use system downtimes to load the current version of the operating system into the F60 controller.

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

The operating system is loaded using the programming tool.

Prior to loading the operating system, the F60 controller must be in STOP (displayed in the programming tool). Otherwise, stop the controller.

For more information, refer to the programming tool documentation and the system manual for the modular F60 system (HI 800 191 E).

6.2.2 Proof Test

HIMatrix devices and modules must be subjected to a proof test in intervals of 10 years. For more information, refer to the safety manual (HI 800 023 E).

7 Decommissioning

Remove the supply voltage of the PS 01 supply module 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 transport.

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
AO	Analog output
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
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
R	Read: The system variable or signal provides value, e.g., to the user program
Rack ID	Base plate identification (number)
Interference-free	Supposing that two input circuits are connected to the same source (e.g., a transmitter). An input circuit is termed *interference-free* if it does not distort the signals of the other input circuit.
R/W	Read/Write (column title for system variable/signal type)
SELV	Safety extra low voltage
SFF	Safe failure fraction, portion of faults that can be safely controlled
SIL	Safety integrity level (in accordance with IEC 61508)
SILworX	Programming tool for HIMatrix systems
SNTP	Simple network time protocol (RFC 1769)
SRS	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
r_{PP}	Peak-to-peak value of a total AC component
Watchdog (WD)	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

Figure 1: Sample Type Label 12

Figure 2: Block Diagram 13

Figure 3: Front View 14

Figure 4: Label for Ex Conditions 20

Index of Tables

Table 1:	Programming Tools for HIMatrix F60	5
Table 2:	Additional Relevant Documents	6
Table 3:	Environmental Requirements	9
Table 4:	Input Values for the Analog Inputs	11
Table 5:	Available Variants	12
Table 6:	Status Indicators	15
Table 7:	Product Data	16
Table 8:	Specifications for the Analog Inputs	16
Table 9:	Product Data AI 8 014	16
Table 10:	Terminal Assignment for the Analog Inputs	18
Table 11:	Cable Plug Properties	19
Table 12:	Module Slots	21
Table 13:	SILworX - System Parameters for Analog Inputs, Module Tab	23
Table 14:	SILworX - System Parameters for Analog Inputs, AI 8 01 FS1000_1: Channels or AI 8 01 FS2000_1: Channels Tab	24
Table 15:	ELOP II Factory - System Signals for the Analog Inputs	26

Index

block diagram 13
diagnosis 27
fault reaction
  analog inputs 12
front view 14
safety function 11
specifications 16

SAFETY
NONSTOP

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