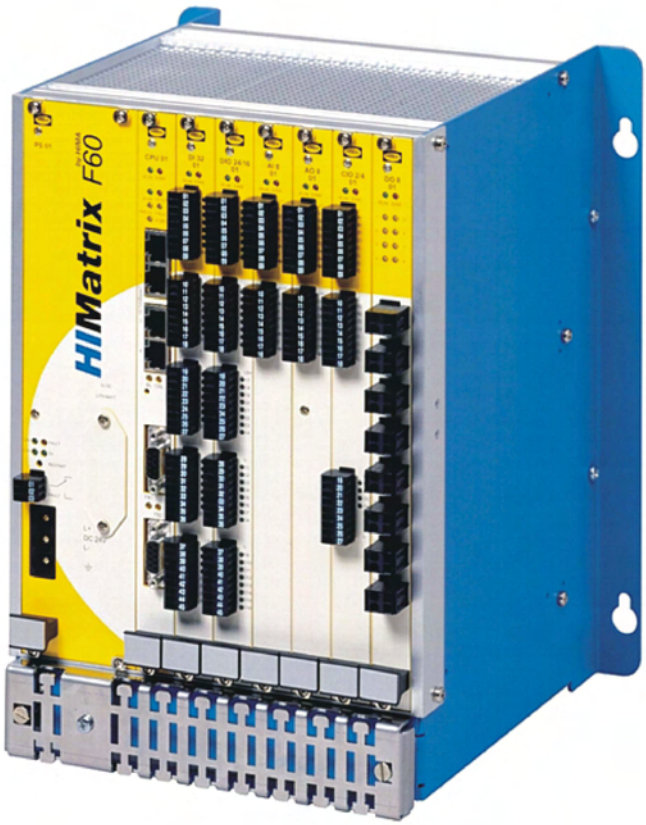
HIMatrix

Safety-Related Controller

DIO 24/16 01 Manual



HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

Rev. 2.00

HI 800 205 E

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		technical	editorial
1.00	Added: Configuration with SILworX	X	X
1.01	Table 11, digital outputs	X	X
1.02	Table 13, Table 16	X	X
2.00	Added: DIO 24/16 014, SIL 4 certified according to EN 50126, EN 50128 and EN 50129, Chapter 4.1.4	X	X

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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 DIO 24/16 01 is a module for the modular F60 HIMatrix system.

The DIO 24/16 01 module has 24 digital input channels and 16 digital output channels that are galvanically separated from the I/O bus. The status of the input and output signals is displayed by LEDs located on the front plate next to the terminal plugs.

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.

However, the load on the outputs must not exceed the total current input of the power supply module.

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 and PL e (EN ISO 13849-1) and SIL 4 (EN 50126, EN 50128 and EN 129).
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 inputs and outputs.

3.1.1 Safety-Related Inputs

Each group of eight inputs is provided with a common, short-circuit-proof supply LS + on the clamps.

The safety-related application (SIL 3 in accordance with IEC 61508) of the inputs and the sensors connected must comply with the safety requirements. For more information, refer to the HIMatrix safety manual (HI 800 023 E).

3.1.1.1 Reaction in the Event of a Fault

If the module detects a fault on a digital input, the user program processes a low level in accordance with the de-energized to trip principle.

The module activates the *ERR* LED.

In addition to the channel signal value, the user program must also consider the corresponding error code.

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

3.1.2 Safety-Related Outputs

Each group of eight outputs is provided with a connector on the clamps for the common ground.

If an output channel is overloaded, it is switched off for 10 s until the overload is no longer present. If the module output range has a total load of more than 8 A, the outputs are all switched off for 10 s and a new test is performed.

3.1.2.1 Reaction in the Event of a Fault

If the module detects a faulty signal on a digital output, the affected module output is set to the safe (de-energized) state using the safety switches.

If a module fault occurs, all digital outputs are switched off.

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

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

3.1.3 Line Control

The digital outputs DO 1 through DO 8 of the DIO 24/16 01 module can be used to detect the own digital inputs or the digital inputs of other modules (e.g., DI 32 01) for short-circuits and open-circuits, e.g., for an EMERGENCY STOP button complying with Cat. 4 and PL e in accordance with EN ISO 13849-1. To this end, the outputs are pulsed and connected to the safety-related digital inputs. In this case, the outputs assume the function of pulsed outputs.

i Pulsed outputs must not be used as safety-related outputs!

3.2 Equipment, Scope of Delivery

The following table specifies the available module variants:

Designation	Description
DIO 24/16 01	Module with 24 digital inputs and 16 digital outputs
DIO 24/16 014	Module with 24 digital inputs and 16 digital outputs, 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 4: 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

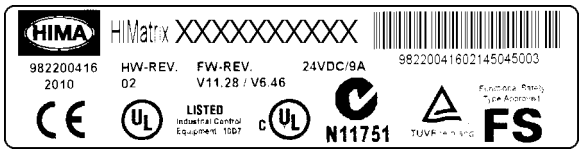
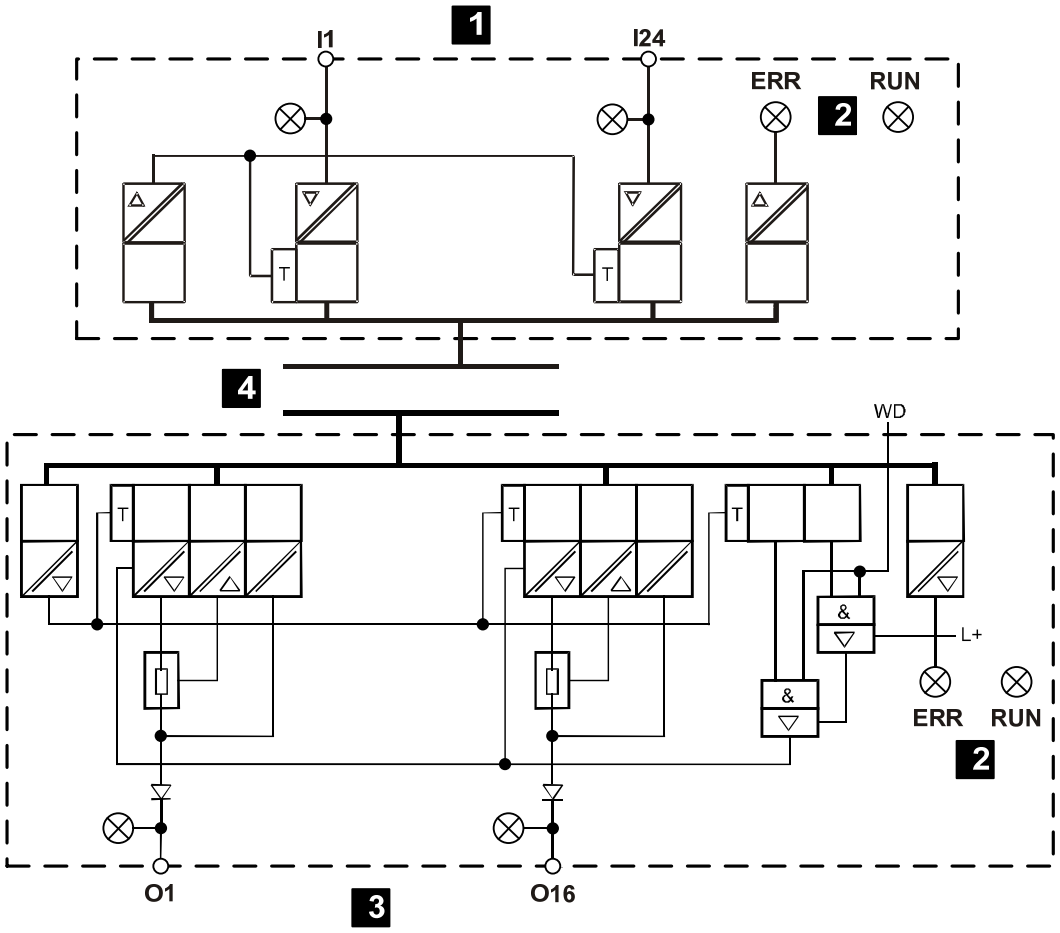


Figure 1: Sample Type Label

3.4 Structure

This chapter describes the layout and function of the module.

3.4.1 Block Diagram



1 24 Digital Inputs
2 Module Indicators
3 16 Digital Outputs
4 I/O Bus

Figure 2: Block Diagram

3.4.2 Front View

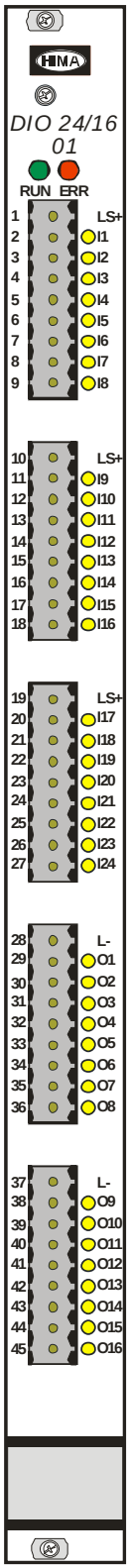


Figure 3: Front View

3.4.3 Module Indicators

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

Table 5: Module Indicators

3.4.4 I/O LEDs

LED	Color	Status	Description
I 1...24	Yellow	On	The related input is active (energized).
		Off	The related input is inactive (de-energized).
O 1...16	Yellow	On	The related output is active (energized).
		Off	The related output is inactive (de-energized).

Table 6: I/O LEDs

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	260 g

Table 7: Product Data

Digital inputs	
Number of inputs	24, galvanically separated
Input voltage High level Low level	nom. 24 VDC 10...30 V max. 5 V
Input current High level Low level	 2 mA at 10 V, 5 mA at 24 V 1 mA at 5 V
Switching point	typ. 7.5 V
Supply	3 x 20 V / 100 mA (at 24 V), short-circuit-proof

Table 8: Specifications for Digital Inputs

Digital outputs	
Number of outputs	16, galvanically separated
Output voltage	18.4...26.8 VDC
Internal voltage drop	max. 2 V at 2 A
Output current (at 30 °C)	2 A each channel, max. 8 A each module, permanently short-circuit-proof
Minimum load	2 mA for each channel
Leakage current (low level)	max. 1 mA at 2 V

Table 9: Specifications for the Digital Outputs

3.5.1 Product Data DIO 24/16 014

The DIO 24/16 014 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

DIO 24/16 014	
Operating temperature	-25…+70 °C (temperature class T1)

Table 10: Product Data of DIO 24/16 014

The DIO 24/16 014 module 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.

The use of shielded cables is not required, but improves the EMC conditions significantly. To allow the connection of the clamps to the earth grid of the F60, the diameter of the cable shielding should not exceed 12 mm.

The inputs and outputs 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.

4.1.2 Connecting the Digital Inputs

Use the following terminals to connect the digital inputs:

Terminal	Designation	Function
01	LS+	Supply of inputs 1...8
02	I1	Digital input 1
03	I2	Digital input 2
04	I3	Digital input 3
05	I4	Digital input 4
06	I5	Digital input 5
07	I6	Digital input 6
08	I7	Digital input 7
09	I8	Digital input 8
Terminal	Designation	Function
10	LS+	Supply of inputs 9...16
11	I9	Digital input 9
12	I10	Digital input 10
13	I11	Digital input 11
14	I12	Digital input 12
15	I13	Digital input 13
16	I14	Digital input 14
17	I15	Digital input 15
18	I16	Digital input 16
Terminal	Designation	Function
19	LS+	Supply of inputs 17...24
20	I17	Digital input 17
21	I18	Digital input 18
22	I19	Digital input 19
23	I20	Digital input 20
24	I21	Digital input 21
25	I22	Digital input 22
26	I23	Digital input 23
27	I24	Digital input 24

Table 11: Terminal Assignment for the Digital Inputs

4.1.2.1 Surges on Digital Inputs

Due to the short cycle time of the HIMatrix systems, a surge pulse as described in EN 61000-4-5 can be read in to the digital inputs as a short-term high level.

The following measures ensure proper operation in environments where surges may occur:

1. Install shielded input wires
2. Program noise blanking in the user program. A signal must be present for at least two cycles before it is evaluated. The fault reaction is triggered with a corresponding delay.

i The measures specified above are not necessary if the plant design precludes surges from occurring within the system.

In particular, the design must include protective measures with respect to overvoltage, lightning, earth grounding and plant wiring in accordance with the relevant standards and the instructions specified in the System Manual (HI 800 141 E or HI 800 191 E).

4.1.3 Connecting the Digital Outputs

Use the following terminals to connect the digital outputs:

Terminal	Designation	Function
28	L-	Supply of outputs 1...8
29	O1	Digital output 1
30	O2	Digital output 2
31	O3	Digital output 3
32	O4	Digital output 4
33	O5	Digital output 5
34	O6	Digital output 6
35	O7	Digital output 7
36	O8	Digital output 8
Terminal	Designation	Function
37	L-	Supply of outputs 9...16
38	O9	Digital output 9
39	O10	Digital output 10
40	O11	Digital output 11
41	O12	Digital output 12
42	O13	Digital output 13
43	O14	Digital output 14
44	O15	Digital output 15
45	O16	Digital output 16

Table 12: Terminal Assignment for the Digital Outputs

4.1.4 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	5 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 13: Cable Plug Properties

4.1.5 Mounting the DIO 24/16 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 enclosure with the following label:

   Work is only permitted in the de-energized state

   Exception:
   If a potentially explosive atmosphere has been precluded, work can also performed when the controller is under voltage.
2. The enclosure in use must be able to safely dissipate the generated heat. The power dissipation (PV) of each HIMatrix F60 DIO 24/16 01 module is 25 W at maximum output load.
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:

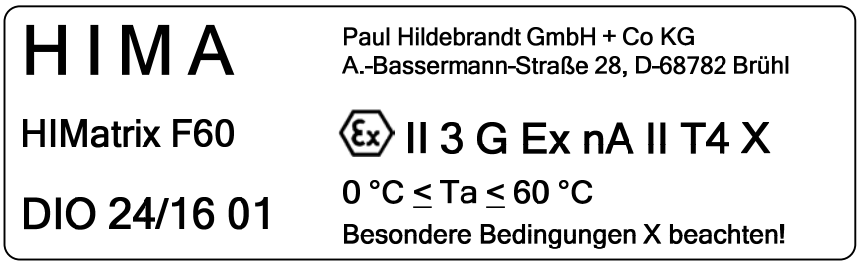


Figure 4: Label for Ex Conditions

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 system (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 14: 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.

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 and Outputs

The following tables specify the system parameters that can be read and set for the inputs and outputs, 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 Digital Inputs and Outputs

The following tables present the statuses and parameters for the input and output 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>DI Number of Pulsed Outputs</td><td>USINT</td><td>W</td><td>Number of pulsed outputs (supply outputs)
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0</td><td>No output planned for SC/OC[1)] detection</td></tr><tr><td>1</td><td>Output channel 1 planned for SC/OC[1)] detection</td></tr><tr><td>2</td><td>Output channels 1...2 planned for SC/OC[1)] detection</td></tr><tr><td>…</td><td>…</td></tr><tr><td>8</td><td>Output channels 1...8 planned for SC/OC[1)] detection</td></tr></table>Pulsed outputs must not be used as safety-related outputs!</td></tr>
<tr><td>DI Pulse Slot</td><td>UDINT</td><td>W</td><td>Pulse module slot: Value 2...7, according to the actual slot on the right of the CPU</td></tr>
<tr><td>DI Pulse Delay [µs]</td><td>UINT</td><td>W</td><td>Waiting time for line control (detection of short-circuits or cross-circuits)
Range of values: 0...2000 µs
Default value: 400 µs</td></tr>
<tr><td>DI.Error Code</td><td>WORD</td><td>R</td><td>Error codes for all digital inputs
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x0001</td><td>Module fault</td></tr><tr><td>0x0002</td><td>FTT test of test pattern faulty</td></tr></table></td></tr>
</table>

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>DO.Error Code</td><td>WORD</td><td>R</td><td>Error codes for all digital outputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0002</td><td>Safety switch 1 faulty</td></tr>
<tr><td>0x0004</td><td>Safety switch 2 faulty</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Test of the read back channels faulty</td></tr>
<tr><td>0x0020</td><td>Active shutdown faulty</td></tr>
<tr><td>0x0100</td><td>FTT test of CS (chip select) signals faulty</td></tr>
<tr><td>0x0200</td><td>All outputs are switched off, total current exceeded</td></tr>
<tr><td>0x0400</td><td>FTT test: 1st temperature threshold exceeded</td></tr>
<tr><td>0x0800</td><td>FTT test: 2nd temperature threshold exceeded</td></tr>
<tr><td>0x1000</td><td>FTT test: Monitoring of auxiliary voltage 1: Undervoltage</td></tr>
<tr><td>0x2000</td><td>Status of safety switches</td></tr>
</table></td></tr>
<tr><td>Module Error Code</td><td>[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>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: 0xFE01 [65 025$_{dec}$]</td></tr>
<tr><td colspan="4">[1)] SC/OC (SC = short-circuit, OC = open-circuit)</td></tr>
</table>

Table 15: SILworX - System Parameters for Digital Outputs and Inputs, **Module** Tab

4.3.2.2 Tab: **DIO 24/16 01_1: DO Channels**

The **DIO 24/16 01_1: DO Channels** tab contains the following system variables:

System parameter	Data type	R/W	Description
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: 0x01 – Fault in the digital output module 0x02 – Channel shutdown due to overload 0x04 – Error while reading back the digital outputs
Value [BOOL] ->	BOOL	W	Output values of the digital output channels 0 = output de-energized 1 = output energized

Table 16: SILworX - System Parameters for Digital Outputs, **DIO 24/16 01_1: DO Channels** Tab

4.3.2.3 Tab: **DIO 24/16 01_1: DI Channels**

The **DIO 24/16 01_1: DI Channels** tab contains the following system variables:

System parameter	Data type	R/W	Description
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: 0x01 – Fault in the digital input module 0x10 – Short-circuit of the channel 0x80 – Intermittence between pulsed output DO and digital input DI, e.g., ▪ Open-circuit ▪ Open switch ▪ L+ undervoltage
-> Value [BOOL]	BOOL	R	Input values for the digital input channels 0 = input de-energized 1 = input energized
Pulsed Output [USINT] ->	USINT	W	Source channel for pulsed supply Coding: 0 – Input channel 1 – Pulse of the 1st DO channel 2 – Pulse of the 2nd DO channel … 8 – Pulse of the 8th DO channel

Table 17: SILworX - System Parameters for Digital Inputs, **DIO 24/16 01_1: DI Channels** Tab

4.4 Configuration with ELOP II Factory

4.4.1 Configuring the Inputs and Outputs

The signals previously defined in the Signal Editor (Hardware Management) are assigned to the individual channels (inputs and outputs) 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 and Outputs

The following tables specify the system signals that can be read and set for the inputs and outputs, 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 Digital 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: 0xFE01 [65 025$_{dez}$]</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>DI.Error Code [WORD]</td><td>R</td><td>Error codes for all digital inputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0002</td><td>FTT test of test pattern faulty</td></tr>
</table></td></tr>
<tr><td>DI[xx].Error Code [BYTE]</td><td>R</td><td>Error codes for the digital input channels
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the digital input module</td></tr>
<tr><td>0x10</td><td>Short-circuit of the channel</td></tr>
<tr><td>0x80</td><td>Intermittence between pulsed output DO and digital input DI, e.g.,
▪ Open-circuit
▪ Open switch
▪ L+ undervoltage</td></tr>
</table></td></tr>
<tr><td>DI[xx].Value [BOOL]</td><td>R</td><td>Input values for the digital input channels
0 = input de-energized
1 = input energized</td></tr>
</table>

<table>
<tr><th>System signal</th><th>R/W</th><th>Description</th></tr>
<tr><td>DI Number of Pulsed Channels [USINT]</td><td>W</td><td>Number of pulsed outputs (supply outputs)
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0</td><td>No output planned for SC/OC[1)] detection</td></tr><tr><td>1</td><td>Output channel 1 planned for SC/OC[1)] detection</td></tr><tr><td>2</td><td>Output channels 1...2 planned for SC/OC[1)] detection</td></tr><tr><td>…</td><td>…</td></tr><tr><td>8</td><td>Output channels 1...8 planned for SC/OC[1)] detection</td></tr></table>Pulsed outputs must not be used as safety-related outputs!</td></tr>
<tr><td>DI Pulse.Slot [UDINT]</td><td>W</td><td>Pulse module slot: Value 1...6, according to the actual slot on the right of the CPU</td></tr>
<tr><td>DI[xx].Pulsed Channel [USINT]</td><td>W</td><td>Source channel for pulsed supply
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0</td><td>Input channel</td></tr><tr><td>1</td><td>Pulse of the 1st DO channel</td></tr><tr><td>2</td><td>Pulse of the 2nd DO channel</td></tr><tr><td>…</td><td></td></tr><tr><td>8</td><td>Pulse of the 8th DO channel</td></tr></table></td></tr>
<tr><td>DI Pulse Delay [10E-6 s] [UINT]</td><td>W</td><td>Waiting time for line control (detection of short-circuits or cross-circuits)
Range of values: 0...2000 µs
Default value: 400 µs</td></tr>
<tr><td colspan="3">[1)] SC/OC (SC = short-circuit, OC = open-circuit)</td></tr>
</table>

Table 18: ELOP II Factory - Digital Input System Signals

4.4.4 Digital Outputs

<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: 0xFE01 [65 025$_{dez}$]</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>DO.Error Code [WORD]</td><td>R</td><td>Error codes for all digital outputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0002</td><td>Safety switch 1 faulty</td></tr>
<tr><td>0x0004</td><td>Safety switch 2 faulty</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Test of the read back channels faulty</td></tr>
<tr><td>0x0020</td><td>Active shutdown faulty</td></tr>
<tr><td>0x0100</td><td>FTT test of CS (chip select) signals faulty</td></tr>
<tr><td>0x0200</td><td>All outputs are switched off, total current exceeded</td></tr>
<tr><td>0x0400</td><td>FTT test: 1st temperature threshold exceeded</td></tr>
<tr><td>0x0800</td><td>FTT test: 2nd temperature threshold exceeded</td></tr>
<tr><td>0x1000</td><td>FTT test: Monitoring of auxiliary voltage 1:
Undervoltage</td></tr>
<tr><td>0x2000</td><td>Status of safety switches</td></tr>
</table></td></tr>
<tr><td>DO[xx].Error Code [BYTE]</td><td>R</td><td>Error codes for the digital output channels
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the digital output module</td></tr>
<tr><td>0x02</td><td>Channel shutdown due to overload</td></tr>
<tr><td>0x04</td><td>Error while reading back the digital outputs</td></tr>
</table></td></tr>
<tr><td>DO[xx].Value [BOOL]</td><td>W</td><td>Output values of the digital output channels
0 = output de-energized
1 = output activated</td></tr>
</table>

Table 19: ELOP II Factory - Digital Output 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 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 inputs.

Refer to Chapter 3.1.2.1, for more information on the fault reaction of the outputs.

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

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