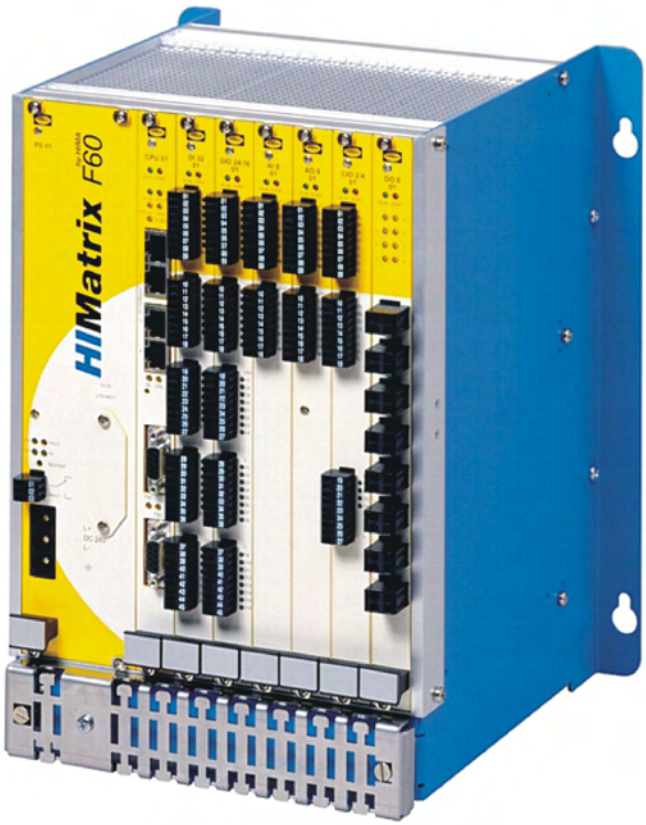
HIMatrix

Safety-Related Controller

CIO 2/4 01 Manual



HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

Rev. 2.00

HI 800 199 E

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Revision index	Revisions	Type of change	
		technical	editorial
1.00	Added: Configuration with SILworX	X	X
2.00	Added: CIO 2/4 014, 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

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

i 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 CIO 2/4 01 is a module for the modular F60 HIMatrix system.

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 CIO 2/4 01 has 2 counters and 4 digital outputs, which are galvanically separated from the I/O bus. The status of the output signals is displayed by LEDs located on the front plate next to the terminal plugs.

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 50129).
Further safety standards, application standards and test standards are specified in the certificates available on the HIMA website.

3.1 Safety Function

If a module fault occurs, the affected outputs are de-energized.

3.1.1 Safety-Related Outputs

The user program controls the 4 safety-related digital outputs of the module.

Connections are provided on the output terminals for the common ground L-.

If an output channel is overloaded, it is switched off for 10 s until the overload is no longer present. If all 4 outputs of the module have a total load of more than 2 A, they are all switched off for 10 s.

3.1.1.1 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.

3.1.2 Safety-Related Counters

The module is equipped with 2 independent counters with inputs that can be configured for 5 V or 24 V level.

The required voltage level is determined by the user program with the *Counter[0x].5/24V Mode* system parameter.

Input A is the counter input, B is the count direction input and input Z (zero track) is used to reset. All inputs, including C, are 4-bit Gray code inputs (with decoder operation, see below).

Alternatively, all inputs are 4-bit Gray code inputs (with decoder operation).

The following modes of operation can be implemented:

- Counter function 1 (depending on the count direction input signal)
- Counter function 2 (irrespective of the count direction input signal)
- Decoder operation with attached rotary transducer

Refer to Chapter 3.4.5 for more details on how to configure the counters.

The safety-related counter has a 24-bit resolution, the maximum counter reading is $2^{24} – 1$ (= 16 777 215).

3.1.2.1 Reaction in the Event of a Fault

If the module detects a fault in the counter section, a status bit is set for evaluation in the user program.

In all these cases, the module activates the *ERR* LED.

In addition to the status bit, 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.

3.2 Equipment, Scope of Delivery

The following table specifies the available module variants:

Designation	Description
CIO 2/4 01	Module with 2 counter inputs and 4 digital outputs
CIO 2/4 014	Module with 2 counter inputs and 4 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

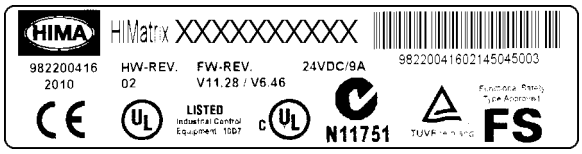
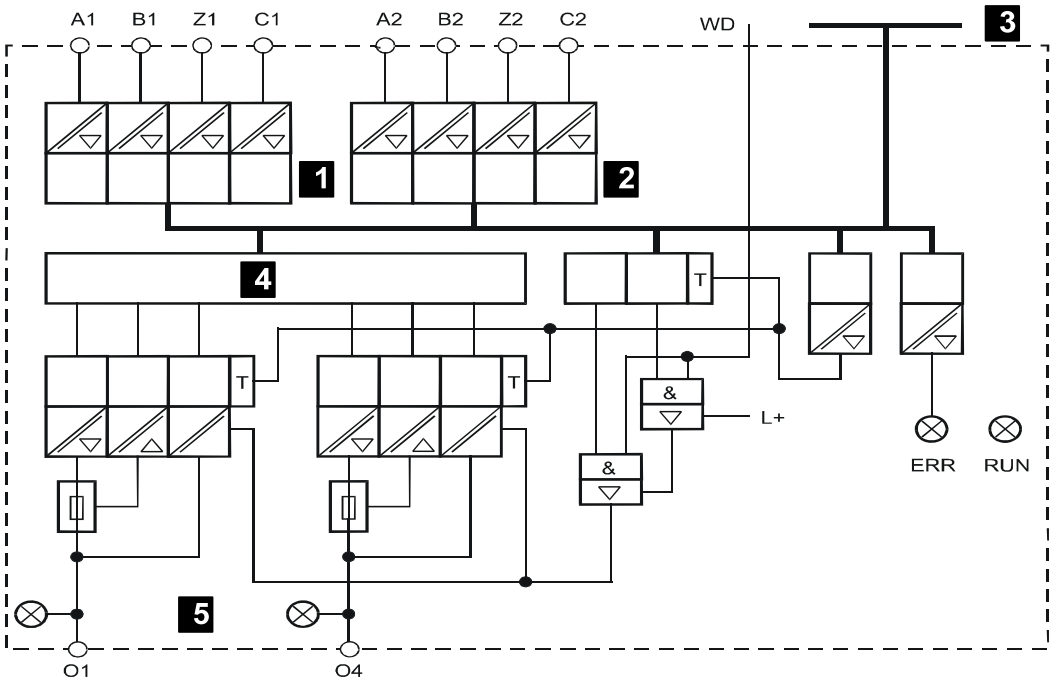


Figure 1: Sample Type Label

3.4 Assembly

This chapter describes the layout and function of the module.

3.4.1 Block Diagram



1 Counter, Channel 1
2 Counter, Channel 2
3 I/O Bus
4 Internal Logic
5 4 Outputs

Figure 2: Block Diagram

3.4.2 Front View

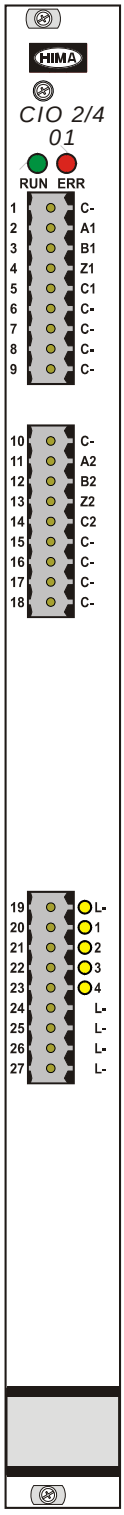


Figure 3: Front View

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
1...4	Yellow	On	The related output is active (energized).
		Off	The related output is inactive (de-energized).

Table 6: I/O LEDs

3.4.5 Mode of Operation of the Counters

Both counters of the CIO 2/4 01 must be configured using system parameters, see Chapter 4.3.1 and Chapter 4.4.1.

The following modes of operation can be implemented:

- Counter function 1 (depending on the count direction input signal)
- Counter function 2 (irrespective of the count direction input signal)
- Decoder operation with attached rotary transducer

3.4.5.1 Counter Function 1 (Depending on the Count Direction Input Signal)

Counter[0x].Auto. Detection of Rotation Direction system parameter set to TRUE, counting with falling edge on input A1 (A2)

Low level on count direction input B1 (B2) increments (increases) the counter value,
High level on count direction input B1 (B2) decrements (decreases) the counter value.

For this mode of operation, the Z1 input (Z2) must be set to low level. The counter can be reset with a short-time high level.

Input C1 (C2) has no function.

The counter can be reset within the programming tool using the *Counter[0x].Reset* system parameter.

Configuration of counter function 1:

System parameter	Description	Value
Counter[0x].5/24V Mode	Inputs 24 V 5 V	TRUE FALSE
Counter[0x].Auto. Detection of Rotation Direction	Counter function 1 active	TRUE
Counter[0x].Direction	No function	FALSE
Counter[0x].Gray Code	Pulse operation active	FALSE
Counter[0x].Reset	Standard Reset short-time	TRUE FALSE

Table 7: Configuration of Counter Function 1

3.4.5.2 Counter Function 2 (Irrespective of the Count Direction Input Signal)

Counter[0x].Auto. Detection of Rotation Direction system parameter set to FALSE, counting with falling edge on input A1 (A2).

The counter increment or decrement is not controlled externally via the input B1 (B2), but by the user program.

Counter[0x].Direction system parameter is set to FALSE: increment (increase) of the counter value,

Counter[0x].Direction system parameter is set to TRUE: decrement (decrease) of the counter value

Input B1 (B2) has no function.

The counter can be reset using the *Counter[0x].Reset* system parameter.

Configuration of counter function 2:

System parameter	Description	Value
Counter[0x].5/24V Mode	Inputs 24 V 5 V	TRUE FALSE
Counter[0x].Auto. Detection of Rotation Direction	Counter function 2 active	FALSE
Counter[0x].Direction	Incrementing Decrementing	FALSE TRUE
Counter[0x].Gray Code	Pulse operation active	FALSE
Counter[0x].Reset	Standard Reset short-time	TRUE FALSE

Table 8: Configuration of Counter Function 2

3.4.5.3 Decoder Operation with Attached Rotary Transducer

The 4-bit Gray Code of a rotary transducer connected to the inputs A1, B1, Z1, C1 (A2, B2, Z2, C2) is evaluated.

In the user program, use the *Counter[0x].Gray Code* system parameter to define this mode of operation individually.

Configuration of decoder operation:

System parameter	Description	Value
Counter[0x].5/24V Mode	Inputs 24 V 5 V	TRUE FALSE
Counter[0x].Auto. Detection of Rotation Direction	Counter function 1 passive	FALSE
Counter[0x].Direction	No function	FALSE
Counter[0x].Gray Code	Decoder operation active	TRUE
Counter[0x].Reset	Default (no function)	TRUE

Table 9: Configuration of Decoder Operation

3.4.5.4 Comparing the Codes Used

When the counter is operated as a decoder in Gray code, only 1 bit may change if a value on the inputs changes.

4-bit Gray code	Decimal value	Counter[0x].Value
0000	0	0
0001	1	1
0011	2	3
0010	3	2
0110	4	6
0111	5	7
0101	6	5
0100	7	4
1100	8	12
1101	9	13
1111	10	15
1110	11	14
1010	12	10
1011	13	11
1001	14	9
1000	15	8

Table 10: Comparison of the Codes Used

3.5 Product Data CIO 2/4 01

Counter module	
Input voltages	5 V or 24 V
Input current	≤ 3 mA
Input resistance	3.7 kΩ
Count frequency	0...1 MHz
Resolution	24-bit
Accuracy of time base	0.2 %
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 / 0.1 A plus output load 3.3 VDC / 0.8 A 5 VDC / 0.1 A
Ambient temperature	0...+60 °C
Storage temperature	-40...+85 °C
Space requirement	6 RU, 4 HP
Weight	260 g

Table 11: Counter Module

Digital outputs	
Number of outputs	4 digital outputs
Output voltage	18.4...26.8 VDC
Output current	0.5 A each channel, max. 2 A each module, permanently short-circuit-proof
Internal voltage drop	max. 3 W at 0.5 A
Minimum load	2 mA for each channel
Leakage current (low level)	max. 1 mA at 2 V
Current input	24 VDC / 0.1 A plus output load

Table 12: Digital Outputs

3.5.1 Product Data CIO 2/4 014

The CIO 2/4 014 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

CIO 2/4 014	
Operating temperature	-25…+70 °C (temperature class T1)

Table 13: Product Data CIO 2/4 014

The CIO 2/4 014 module meets the vibration and shock requirements in accordance with EN 61373, Category 1, Class B.

4 Start-up

To start up the module, 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 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 Counters

Only shielded cables with a maximum length of 500 m must be connected to the counter inputs. Each measurement 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 one end to the controller side to form a Faraday cage.

All C- terminals are interconnected and have the same voltage.

NOTE

Using the invalid terminal plugs may damage the module, the sensors or encoders connected to it!

The counters are connected to the following terminals:

Terminal	Designation	Function
01	C-	Common ground
02	A1	Input A1 or bit 1
03	B1	Input B1 or Bit 2
04	Z1	Input Z1 or bit 3
05	C1	Input C1 or bit 4
06	C-	Common ground
07	C-	Common ground
08	C-	Common ground
09	C-	Common ground
Terminal	Designation	Function
10	C-	Common ground
11	A2	Input A2 or bit 1
12	B2	Input B2 or bit 2
13	Z2	Input Z2 or bit 3
14	C2	Input C2 or bit 4
15	C-	Common ground
16	C-	Common ground
17	C-	Common ground
18	C-	Common ground

Table 14: Terminal Assignment for the Counters

Inputs that are not being used need not be terminated.

4.1.3 Connecting the Digital Outputs

The use of shielded cables for the outputs is not mandatory, 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.

Use the following terminals to connect the digital outputs:

Terminal	Designation	Function
19	L-	Common ground
20	1	Digital output 1
21	2	Digital output 2
22	3	Digital output 3
23	4	Digital output 4
24	L-	Common ground
25	L-	Common ground
26	L-	Common ground
27	L-	Common ground

Table 15: Terminal Assignment for the 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	3 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 16: Cable Plug Properties

4.1.5 Mounting the CIO 2/4 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. Depending on the output load and supply voltage, the module CIO 2/4 01 has a power dissipation ranging between 7 W and 14 W.
3. Protect the CIO 2/4 01 module with a 10 A time-lag fuse.
   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 module is additionally equipped with the label represented below:

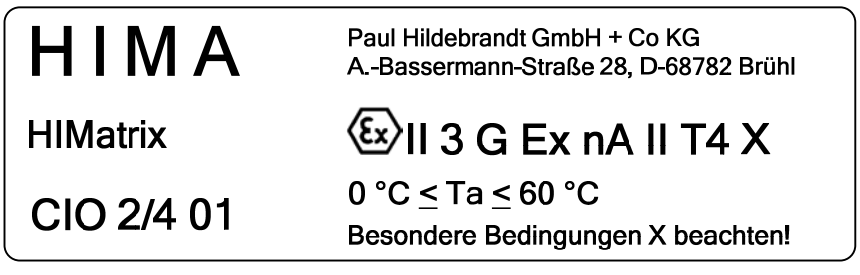


Figure 4: Label for Ex Conditions

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 17: 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 Counter and Outputs CIO 2/4 01

The following tables present the statuses and parameters for the counter and the 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>DO.Error Code [WORD]</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 [WORD]</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 [UDINT]</td><td>UDINT</td><td>R</td><td>Slot number (System.Rack.Slot)</td></tr>
<tr><td>Module Type [UINT]</td><td>UINT</td><td>R</td><td>Type of module, target value: 0xFC03 [64 515$_{dec}$]</td></tr>
</table>

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>Counter.Error Code [WORD]</td><td>WORD</td><td>R</td><td>Error codes both counters
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0002</td><td>Error while comparing the time base</td></tr>
<tr><td>0x0004</td><td>Address error while reading the time base</td></tr>
<tr><td>0x0008</td><td>Parameters for time base faulty</td></tr>
<tr><td>0x0010</td><td>Address error while reading the counter value</td></tr>
<tr><td>0x0020</td><td>Counter configuration corrupted</td></tr>
<tr><td>0x0040</td><td>Address error while reading the Gray code</td></tr>
<tr><td>0x0080</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0100</td><td>FTT test: Fault detected while checking the coefficients</td></tr>
<tr><td>0x0200</td><td>Fault during the initial module configuration</td></tr>
</table></td></tr>
<tr><td>Counter[0x].5/24 V Mode [BOOL]</td><td>BOOL</td><td>R/W</td><td>5 V or 24 V counter input
TRUE 24 V
FALSE 5 V</td></tr>
<tr><td>Counter[0x].Auto. Detection of Rotation Direction [BOOL]</td><td>BOOL</td><td>R/W</td><td>Automatic detection of count direction
TRUE Automatic detection on
FALSE Count direction set manually</td></tr>
<tr><td>Counter[0x].Error Code [BYTE]</td><td>BYTE</td><td>R</td><td>Error codes of counter 1, 2
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Error counter module</td></tr>
<tr><td>0x02</td><td>Error while comparing the counter readings</td></tr>
<tr><td>0x04</td><td>Error while comparing the counter timestamp</td></tr>
<tr><td>0x08</td><td>Error while setting the parameters (reset)</td></tr>
</table></td></tr>
<tr><td>Counter[0x].Gray Code [BOOL]</td><td>BOOL</td><td>R/W</td><td>Decoder / pulse operation
TRUE Gray code decoder
FALSE Pulse operation</td></tr>
<tr><td>Counter[0x].Reset [BOOL]</td><td>BOOL</td><td>R/W</td><td>Counter reset
TRUE No Reset
FALSE Reset</td></tr>
<tr><td>Counter[0x].Direction [BOOL]</td><td>BOOL</td><td>R/W</td><td>Rotation direction of the counter
(only if Counter[0x].Auto. Detection of Rotation Direction FALSE)
TRUE Downwards (decrement)
FALSE Upwards (increment)</td></tr>
<tr><td>Counter[0x].Value [UDINT]</td><td>UDINT</td><td>R</td><td>Content of counters: 24 bit for pulse counter, 4 bit for Gray code</td></tr>
<tr><td>Counter[0x].Value Overflow [BOOL]</td><td>BOOL</td><td>R</td><td>Counter overflow indication
TRUE 24-bit overflow since last cycle (only if Counter[0x].Auto.Detection of Rotation Direction is FALSE)
FALSE No overflow since last cycle</td></tr>
<tr><td>Counter[0x]. Timestamp [UDINT]</td><td>UDINT</td><td>R</td><td>Timestamp for Counter[0x].Value 24 bits, 1 µs time resolution</td></tr>
<tr><td>Counter[0x].Time-Overflow [BOOL]</td><td>BOOL</td><td>R</td><td>Overflow indication for the timestamp of the counters
TRUE 24-bit overflow since last measurement
FALSE No 24-bit overflow since last measurement</td></tr>
</table>

Table 18: SILworX - System Parameters for Counters and Outputs, **Module** Tab

4.3.2.2 Tab **CIO 2/4 01_1: Channels**

The **CIO 2/4 01_1 Channels** tab contains the following system parameters:

System parameter	Data type	R/W	Description
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: 0x01 – Module fault; 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 active

Table 19: SILworX - System Parameters of the Counters and Outputs, **CIO 2/4 01_1: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 CIO 2/4 01 Counter

System signal	R/W	Description
Mod.SRS [UDINT]	R	Slot number (System.Rack.Slot)
Mod. Type [UINT]	R	Type of module, target value: 0xFC03 [64 515_{dec}]
Mod. Error Code [WORD]	R	Module error code 0x0000: I/O processing, if required with errors, see other error codes 0x0001: No I/O processing (CPU not in RUN) 0x0002: No I/O processing during the booting test 0x0004: Manufacturer interface operating 0x0010: No I/O processing: invalid configuration 0x0020: No I/O processing: fault rate exceeded 0x0040/ 0x0080: No I/O processing: configured module not plugged in

<table>
<tr><th>System signal</th><th>R/W</th><th>Description</th></tr>
<tr><td>Counter.Error Code
[WORD]</td><td>R</td><td>Error codes both counters
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x0001</td><td>Module fault</td></tr><tr><td>0x0002</td><td>Error while comparing the time base</td></tr><tr><td>0x0004</td><td>Address error while reading the time base</td></tr><tr><td>0x0008</td><td>Parameters for time base faulty</td></tr><tr><td>0x0010</td><td>Address error while reading the counter value</td></tr><tr><td>0x0020</td><td>Counter configuration corrupted</td></tr><tr><td>0x0040</td><td>Address error while reading the Gray code</td></tr><tr><td>0x0080</td><td>FTT test of test pattern faulty</td></tr><tr><td>0x0100</td><td>FTT test: Fault detected while checking the coefficients</td></tr><tr><td>0x0200</td><td>Fault during the initial module configuration</td></tr></table></td></tr>
<tr><td>Counter[0x].Error Code
[BYTE]</td><td>R</td><td>Error codes of counter 1, 2
<table><tr><th>Coding</th><th>Description</th></tr><tr><td>0x01</td><td>Error counter module</td></tr><tr><td>0x02</td><td>Error while comparing the counter readings</td></tr><tr><td>0x04</td><td>Error while comparing the counter timestamp</td></tr><tr><td>0x08</td><td>Error while setting the parameters (reset)</td></tr></table></td></tr>
<tr><td>Counter[0x].Value
[UDINT]</td><td>R</td><td>Content of counters: 24 bit for pulse counter, 4 bit for Gray code</td></tr>
<tr><td>Counter[0x].
Timestamp [UDINT]</td><td>R</td><td>Timestamp for Counter[0x].Value 24 bits, 1 µs time resolution</td></tr>
<tr><td>Counter[0x].Value
Overflow
[BOOL]</td><td>R</td><td>Counter overflow indication
TRUE 24-bit overflow since last cycle (only if Counter[0x].Auto. Advance Sense is FALSE)
FALSE No overflow since last cycle</td></tr>
<tr><td>Counter[0x].Time-
Overflow
[BOOL]</td><td>R</td><td>Overflow indication for the timestamp of the counters
TRUE 24-bit overflow since last measurement
FALSE No 24-bit overflow since last measurement</td></tr>
<tr><td>Counter[0x].Auto.
Advance Sense
[BOOL]</td><td>R/W</td><td>Automatic detection of count direction
TRUE Automatic detection on
FALSE Count direction set manually</td></tr>
<tr><td>Counter[0x].Reset
[BOOL]</td><td>R/W</td><td>Counter reset
TRUE No Reset
FALSE Reset</td></tr>
<tr><td>Counter[0x].Direction
[BOOL]</td><td>R/W</td><td>Rotation direction of the counter
(only if Counter[0x].Auto. Advance Sense FALSE)
TRUE Downwards (decrement)
FALSE Upwards (increment)</td></tr>
<tr><td>Counter[0x].5/24 V
Mode
[BOOL]</td><td>R/W</td><td>5 V or 24 V counter input
TRUE 24 V
FALSE 5 V</td></tr>
<tr><td>Counter[0x].Gray
Code
[BOOL]</td><td>R/W</td><td>Decoder / pulse operation
TRUE Gray code decoder
FALSE Pulse operation</td></tr>
</table>

Table 20: ELOP II Factory - System Signal for Analog Outputs

4.4.4 Digital Outputs for CIO 2/4 01

<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: 0xFC03 [64 515$_{dec}$]</td></tr>
<tr><td>Mod. Error Code [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>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[0x].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>Module fault</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[0x].Value
[BOOL]</td><td>W</td><td>Output values of the digital output channels
0: Output de-energized
1: Output active</td></tr>
</table>

Table 21: ELOP II Factory - System Signals for Digital Outputs

5 Operation

The module can only operate together with a F60 controller. No specific monitoring is required.

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 digital outputs.

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

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.e., if the system is not operating.

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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