HIMatrix

Safety-Related Controller

F3 DIO 8/8 01 Manual

HIMA Paul Hildebrandt GmbH + Co KG

Industrial Automation

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1 Introduction

This manual describes the technical characteristics of the device 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

HIMatrix remote I/Os are 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 remote I/O, refer to the following table:

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

Table 1: Programming Tools for HIMatrix Remote I/Os

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 Compact controllers and remote I/Os are referred to as *devices*.

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 safety-related **F3 DIO 8/8 01** remote I/O is a compact system in a metal housing with 8 digital inputs, 8 digital DO+ outputs (L- ground), 2 digital DO- outputs (S+ ground) and 2 pulsed outputs. The digital outputs DO4+, DO8+, DO4- and DO8- can also be connected as 2-pole connections.

The remote I/O is available in various model variants for SILworX and ELOP II Factory, see Table 4.

Remote I/Os are connected to individual HIMax or HIMatrix controllers via safe**ethernet**. They are used to extend the I/O level, but are not able to run any user program by themselves.

The remote I/O is suitable for mounting in Ex-zone 2, see Chapter 4.1.5.

The device 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

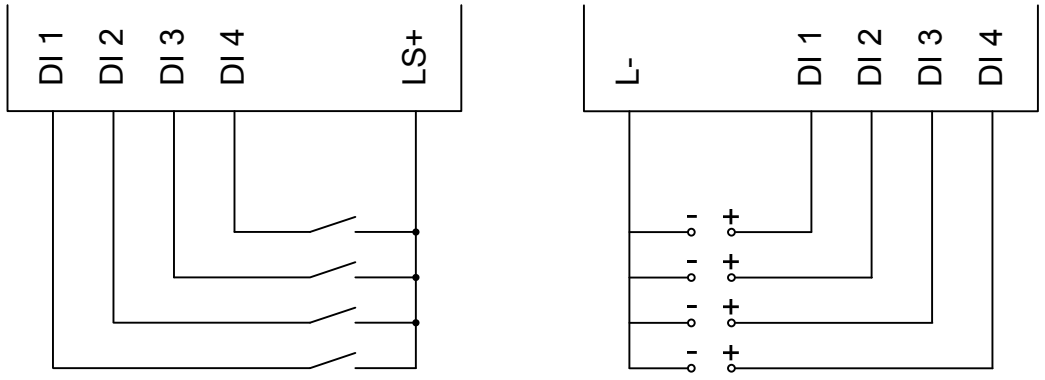
The remote I/O is equipped with safety-related digital inputs and outputs. The input values on the inputs are safely transmitted to the connected controller via safe**ethernet**. The outputs are safely assigned their values by the connected controller via safe**ethernet**.

3.1.1 Safety-Related Digital Inputs

The remote I/O is equipped with 8 digital inputs. The state (HIGH, LOW) of each input is signaled by an individual LED.

Mechanical contacts without own power supply or signal power source can be connected to the inputs. Potential-free mechanical contacts without own power supply are fed via an internal short-circuit-proof 24 V power source (LS+). Each of them supply a group of 4 mechanical contacts. Figure 1 shows how the connection is performed.

With signal voltage sources, the corresponding ground must be connected to the input (L-), see Figure 1.



Connection of potential-free mechanical contacts

Connection of signal power sources

Figure 1: Connections to Safety-Related Digital Inputs

For the external wiring and the connection of sensors, apply the de-energized-to-trip principle. Thus, if a fault occurs, the input signals adopt a de-energized, safe state (low level).

If an external wire is not monitored, an open-circuit is considered as safe low level.

3.1.1.1 Reaction in the Event of a Fault

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

The device activates the *FAULT* LED.

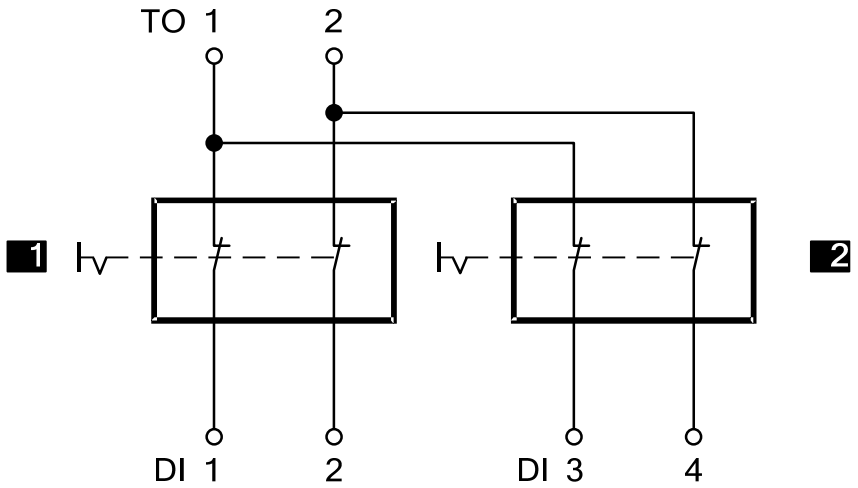
In addition to the channel signal value, the user program must also consider the corresponding error code.

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

3.1.1.2 Line Control

Line control is used to detect short-circuits or open-circuits and can be configured for the remote I/O, e.g., on EMERGENCY STOP inputs complying with Cat. 4 and PL e in accordance with EN ISO 13849-1.

To this end, connect the digital outputs TO 1 through TO 2 of the system to the digital inputs DI of the same system as follows:



1 EMERGENCY STOP 1
2 EMERGENCY STOP 2

EMERGENCY STOP switches in accordance with EN 60947-5-1 and EN 60947-5-5

Figure 2: Line Control

The remote I/O pulses the pulsed outputs to detect short-circuits and open-circuits on the lines connected to the digital inputs. To do so, configure the *Value [BOOL]* -> system variable in SILworX or the *DO[01].Value* system signal in ELOP II Factory. The variables for the pulsed outputs must begin with channel 1 and reside in direct sequence, one after the other.

If the following faults occur, the *FAULT* LED located on the front plate of the device blinks, the inputs are set to low level and an (evaluable) error code is created:

- Cross-circuit between two parallel wires.
- Invalid connections of two lines (e.g., TO 2 to DI 3),
- Earth fault on one wire (with earthed ground only).
- Open-circuit or open contacts, i.e., including when one of the two EMERGENCY STOP switches mentioned above has been engaged, the *FAULT* LED blinks and the error code is created.

3.1.2 Safety-Related Digital Outputs

The remote I/O is equipped with 8 digital outputs DO+ (ground L-) and 2 digital outputs DO- (ground S+). The state (HIGH, LOW) of each output is signaled by an individual LED (HIGH, LOW).

At the maximum ambient temperature, the DO+ outputs 1...3 and 5...7 can be loaded with 0.5 A each, and DO+ outputs 4 and 8 can be loaded with 1 A or with 2 A at an ambient temperature of up to 40 °C.

At the maximum ambient temperature, the DO- outputs 4- and 8- can be loaded with 1 A each or with 2 A at an ambient temperature of up to 40 °C.

Within a temperature range of 60…70 °C, all outputs of the F3 DIO 8/8 014 can be loaded with 0.5 A, see Table 15.

The digital outputs DO4+, DO8+, DO4- and DO8- can be connected as one-pole or 2-pole switching connections. The remaining outputs are only set up for one-pole switching connections.

With 1-pole switching outputs, ensure that the system's L- ground from the corresponding channel group is used for the DO+ outputs and the system's S+ ground is used for the DO- outputs, see Table 18. The S+ ground is limited by the system to a maximum current of 8 A and obtained from the 24 V voltage connection.

The external wire of an output is not monitored, however, a detected short-circuit is signaled.

With 2-pole switching outputs, the L+ switching output DO4+ must be connected to the L- switching output DO4- and the L+ switching output DO8+ to the L- switching output DO8-. This type of connection must be set via the *DO2[xx].2-pole* system parameter.

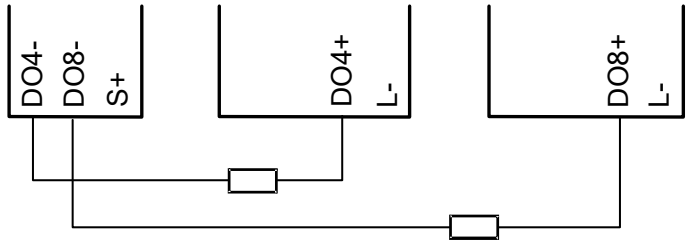


Figure 3: Connection to the 2-Pole Switching Outputs (DO-, DO+)

3.1.2.1 Line Diagnosis

During 2-pole operation, a line diagnosis is performed to detect potential external short-circuits to L+ and L-. Time on delay is required to detect external short-circuits with an inductive or capacitive load or a lamp load. This delay can be configured using the *Time on delay* system parameter. In the range of 0...30 ms, the value can be set in steps of 1 ms.

i

Initial values must be set for all relevant system parameters of the line diagnosis (*DO2[xx].2-Pole, Time on delay*).

Therefore, first set all required system parameters in the programming tool, then compile the user program, and finally, transfer the program to the controller.

The settings for the system parameters configured for line diagnosis cannot be changed during operation!

An external open-circuit will not be detected.

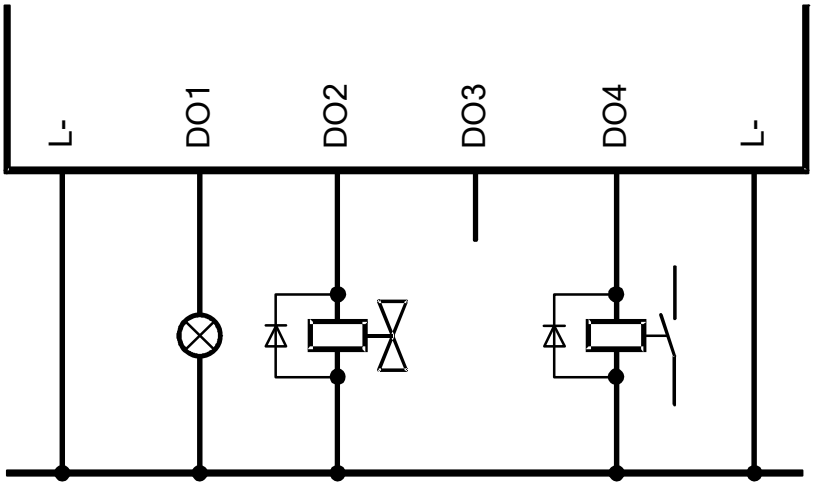


Figure 4: Connection of Actuators to Outputs

The redundant connection of two outputs must be decoupled with diodes. Only 1-pole switching outputs may be connected redundantly.

⚠ CAUTION

For connecting a load to a one-pole switching output, use the corresponding L- ground of the respective channel group (2-pole connection) to ensure that the internal protective circuit can function.

3.1.2.2 Reaction in the Event of a Fault

If the device 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 device fault occurs, all digital outputs are switched off.

In both cases, the devices activates the *FAULT* LED.

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

3.1.3 Pulsed Outputs

The 2 digital pulsed outputs can be used to detect short-circuits and open-circuits on digital inputs, e.g., on EMERGENCY STOP button complying with Cat. 4 and PL e in accordance with EN ISO 13849-1.

i Pulsed outputs must not be used as safety-related outputs (e.g., for activating safety-related actuators)!

3.2 Equipment, Scope of Delivery

The following table specifies the available remote I/O variants:

Designation	Description
F3 DIO 8/8 01	Remote I/O (8 digital inputs, 8 digital outputs, 2 pulsed outputs), Operating temperature: 0...+60 °C, for ELOP II Factory programming tool
F3 DIO 8/8 014	Remote I/O (8 digital inputs, 8 digital outputs, 2 pulsed 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, for ELOP II Factory programming tool
F3 DIO 8/8 01 SILworX	Remote I/O (8 digital inputs, 8 digital outputs, 2 pulsed outputs), Operating temperature: 0...+60 °C, for SILworX programming tool
F3 DIO 8/8 014 SILworX	Remote I/O (8 digital inputs, 8 digital outputs, 2 pulsed 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, for SILworX programming tool

Table 4: Available Variants

3.2.1 IP Address and System ID (SRS)

A transparent label is delivered with the device to allow one to note the IP address and the system ID (SRS for system rack slot) after a change.

IP___.___.___.___SRS____.__.__

Default value for IP address:	192.168.0.99
Default value for SRS:	60 000.200.0 (SILworX)
	60 000.0.0 (ELOP II Factory)

The label must be affixed such that the ventilation slots in the housing are not obstructed.

Refer to the First Steps manual of the programming tool for more information on how to modify the IP address and the system ID.

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

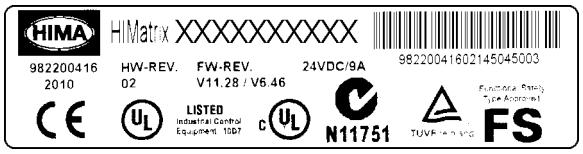


Figure 5: Sample Type Label

3.4 Assembly

This chapter describes the layout and function of the remote I/Os, and their communication via safe**ethernet**.

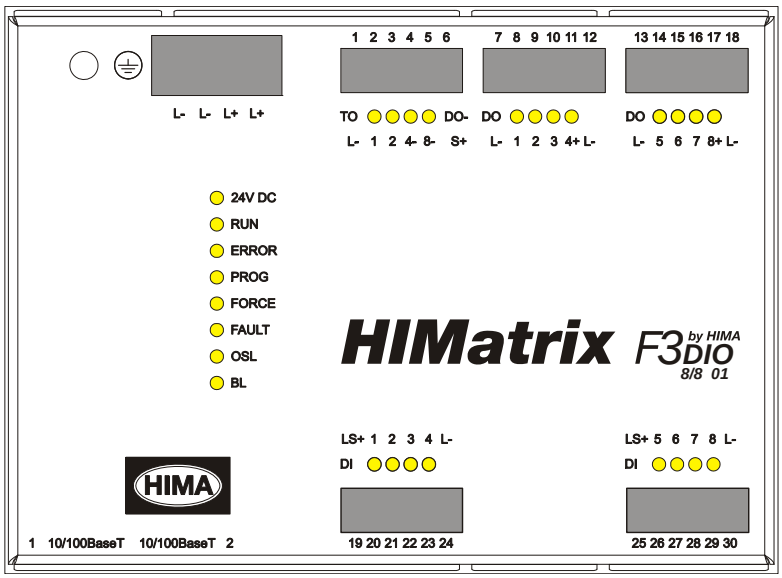
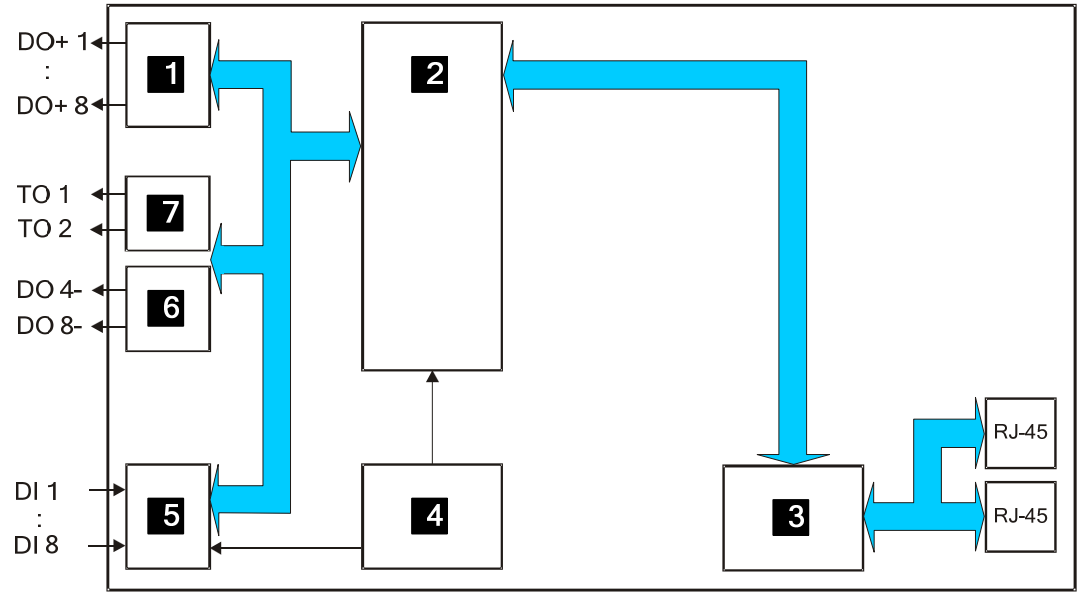


Figure 6: Front View



1 Digital Outputs (L+ Switching)
2 Safety-Related Processor System (CPU)
3 Switch
4 Watchdog
5 Digital Inputs
6 Digital Outputs (L- Switching)
7 Pulsed Outputs

Figure 7: Block Diagram

3.4.1 LED Indicators

The light-emitting diodes (LEDs) indicate the operating state of the remote I/O. The LEDs are classified as follows:

- Operating voltage LED
- System LEDs
- Communication LEDs
- I/O LEDs

3.4.1.1 Operating Voltage LED

LED	Color	Status	Description
24 VDC	Green	On	24 VDC operating voltage present
		Off	No operating voltage

Table 5: Operating Voltage LED

3.4.1.2 System LEDs

While the system is being booted, all LEDs are lit simultaneously.

LED	Color	Status	Description
RUN	Green	On	Device in RUN, normal operation
		Blinking	Device in STOP A new operating system is being loaded.
		Off	The device is not in the RUN state.
ERROR	Red	On	The device is in the ERROR STOP state. Internal fault detected by self-tests, e.g., hardware faults or cycle time overrun. The processor system can only be restarted with a command from the PADT (reboot).
		Blinking	If ERROR blinks and all others LEDs are lit simultaneously, the boot loader has detected an operating system fault in the flash memory and waits for a new operating system to be loaded.
		Off	No faults detected.
PROG	Yellow	On	A new configuration is being loaded into the device.
		Blinking	The device switches from INIT to STOP A new operating system is being loaded into the flash ROM.
		Off	No configuration or operating system is being loaded.
FORCE	Yellow	Off	The FORCE LED of a remote I/O is not functioning. The FORCE LED of the associated controller serves to signal the forcing of a remote I/O.
FAULT	Yellow	On	The loaded configuration is not valid. The new operating system is corrupted (after OS download).
		Blinking	Fault while loading a new operating system One or multiple I/O faults occurred.
		Off	None of the described faults occurred.
OSL	Yellow	Blinking	Operating system emergency loader active.
		Off	Operating system emergency loader inactive.
BL	Yellow	Blinking	OS and OSL binary defective or hardware fault, INIT_FAIL.
		Off	None of the described faults occurred.

Table 6: System LEDs

3.4.1.3 Communication LEDs

All RJ-45 connectors are provided with a small green and a yellow LEDs. The LEDs signal the following states:

LED	Status	Description
Green	On	Full duplex operation
	Blinking	Collision
	Off	Half duplex operation, no collision
Yellow	On	Connection available
	Blinking	Interface activity
	Off	No connection available

Table 7: Ethernet Indicators

3.4.1.4 I/O LEDs

LED	Color	Status	Description
DI 1…8	Yellow	On	The related input is active (energized).
		Off	The related input is inactive (de-energized).
TO 1, TO 2	Yellow	On	Pulsed output activated.
		Off	Pulsed output deactivated.
DO 1…8	Yellow	On	The related output is active (energized).
		Off	The related output is inactive (de-energized).
DO 4-, DO 8-	Yellow	On	The related output is active (energized).
		Off	The related output is inactive (de-energized).

Table 8: I/O LEDs

3.4.2 Communication

The remote I/O communicates with the associated controller via safe**ethernet**.

3.4.2.1 Connections for Ethernet Communication

Property	Description
Port	2 x RJ-45
Transfer standard	10BASE-T/100BASE-Tx, half and full duplex
Auto negotiation	Yes
Auto crossover	Yes
IP address	Freely configurable[1)]
Subnet mask	Freely configurable[1)]
Supported protocols	▪ Safety-related: safe**ethernet** ▪ Standard protocols: Programming and debugging tool (PADT), SNTP
[1)] The general rules for assigning IP address and subnet masks must be adhered to.	

Table 9: Ethernet Interfaces Properties

The two RJ-45 connectors with integrated LEDs are located on the bottom left-hand side of the housing. Refer to Chapter 3.4.1.3 for a description of the LEDs' function.

The connection parameters are read based on the MAC address (media access control address) defined during manufacturing.

The MAC address for the remote I/O is specified on a label located above the two RJ-45 connectors (1 and 2).

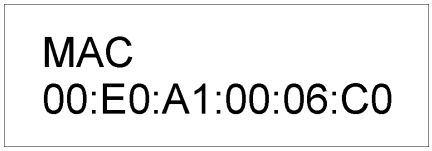


Figure 8: Sample MAC Address Label

The remote I/O is equipped with an integrated switch for Ethernet communication. For further information on the integrated switch and safe**ethernet**, refer to Chapter *Communication* of the system manual for compact systems (HI 800 141 E).

3.4.2.2 Network Ports Used for Ethernet Communication

UDP ports	Use
8000	Programming and operation with the programing tool
8001	Configuration of the remote I/O using the PES (ELOP II Factory)
8004	Configuration of the remote I/O using the PES (SILworX)
6010	safe**ethernet**
123	SNTP (time synchronization between PES and remote I/O, PES and external devices)

Table 10: Network Ports in Use

3.4.3 Reset Key

The remote I/O is equipped with a reset key. The key is only required if the user name or password for administrator access is not known. If only the IP address set for the remote I/O does not match the PADT (PC), the connection can be established with a `Route add` entry on the PC.

i Only the model variants without protective lacquer are equipped with a reset key.

The key can be accessed through a small round hole located approximately 5 cm from the upper left-hand side of the housing. The key is engaged using a suitable pin made of insulating material to avoid short-circuits within the remote I/O.

The reset is only effective if the remote I/O is rebooted (switched off and on) while the key is simultaneously engaged for at least 20 s. Engaging the key during operation has no effect.

Properties and behavior of the remote I/IO after a reboot with engaged reset key:

- Connection parameters (IP address and system ID) are set to the default values.
- All accounts are deactivated except for the *administrator* default account with empty password.

After a new reboot without the reset key engaged, the connection parameters (IP address and system ID) and accounts become effective.

- Those configured by the user.
- Those valid prior to rebooting with the reset key engaged, if no changes were performed.

3.5 Product Data

General	
Response time	≥ 10 ms
Ethernet interfaces	2 x RJ-45, 10BASE-T/100BASE-Tx with integrated switch
Operating voltage	24 VDC, -15...+20 %, r_{PP} ≤ 15 %, from a power supply unit with safe insulation in accordance with IEC 61131-2
Current input	max. 8 A (with maximum load) Idle: approx. 0.4 A at 24 V
Fuse (external)	10 A time-lag (T)
Back-up battery	None
Operating temperature	0...+60 °C
Storage temperature	-40...+85 °C
Type of protection	IP20
Max. dimensions (without plug)	Width: 152 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 66 mm (with earthing screw)
Weight	approx. 1 kg

Table 11: Product Data

Digital inputs		
Number of inputs		8 (non-galvanically separated)
High level:	Voltage Current input	15...30 VDC ≥ 2 mA at 15 V
Low level:	Voltage Current input	max. 5 VDC max. 1.5 mA (1 mA at 5 V)
Switching point		typ. 7.5 V
Supply		2 x 20 V / 100 mA (at 24 V), short-circuit-proof

Table 12: Specifications for Digital Inputs

<table>
<tr><th colspan="2">Digital outputs (DO+ and DO-)</th></tr>
<tr><td>Number of outputs DO+
L+ switching</td><td>8 (non-galvanically separated)
Common ground L-</td></tr>
<tr><td>Number of outputs DO-
L- switching</td><td>2 (non-galvanically separated)
Common ground S+</td></tr>
<tr><td>Output voltage</td><td>≥ L+ minus 2 V</td></tr>
<tr><td>Output current DO+</td><td>Channels 1...3 and 5...7: 0.5 A up to 60 °C
The output current of the channels 4 and 8 depends on the ambient temperature.
<table>
<tr><th>Ambient temperature</th><th>Output current</th></tr>
<tr><td>< 40 °C</td><td>2 A</td></tr>
<tr><td>40…60 °C</td><td>1 A</td></tr>
</table></td></tr>
<tr><td>Output current DO-</td><td>The output current of the channels 4 and 8 depends on the ambient temperature.
<table>
<tr><th>Ambient temperature</th><th>Output current</th></tr>
<tr><td>< 40 °C</td><td>2 A</td></tr>
<tr><td>40…60 °C</td><td>1 A</td></tr>
</table></td></tr>
<tr><td>Lamp load, max.:
DO+ channel 1...3 and 5...7
DO+ channel 4 and 8
DO- channel 4 and 8</td><td>
10 W
25 W
25 W</td></tr>
<tr><td>Inductive load, max.:
DO+ channel 1...3 and 5...7
DO+ channel 4 and 8
DO- channel 4 and 8</td><td>
500 mH
500 mH
500 mH</td></tr>
<tr><td>Minimum load</td><td>2 mA for each channel</td></tr>
<tr><td>Internal voltage drop</td><td>max. 2 V at 2 A</td></tr>
<tr><td>Behavior upon overload</td><td>The affected output is switched off and cyclically switched on again</td></tr>
<tr><td>Total output current</td><td>max. 7 A,
upon overload, all outputs are switched off and cyclically switched on again</td></tr>
</table>

Table 13: Specifications for the Digital Outputs

Pulsed outputs	
Number of outputs	2 (non-galvanically separated)
Output voltage	≥ L+ minus 4 V
Output current	approx. 60 mA
Minimum load	none
Switching time	≤ 100 µs
Behavior upon overload	2 x ≥ 19.2 V, short-circuit current 60 mA at 24 V

Table 14: Specifications for the Pulsed Outputs

3.5.1 Product Data F3 DIO 8/8 014

The F3 DIO 8/8 014 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

F3 DIO 8/8 014	
Operating temperature	-25…+70 °C (temperature class T1)
Output current DO+	Channels 1...3 and 5...7: 0.5 A at ≤ 70 °C The output current of the channels 4 and 8 depends on the ambient temperature.
Output current DO-	The output current of the channels 4 and 8 depends on the ambient temperature.
Weight	approx. 1 kg

Ambient temperature	Output current
< 40 °C	2 A
40…60 °C	1 A
> 60 °C	0.5 A

Table 15: Product Data of F3 DIO 8/8 014

The remote I/O F3 DIO 8/8 014 meets the conditions for vibrations and shock test according to IEC 61373, category 1, class B.

3.6 Certified HIMatrix F3 DIO 8/8 01

HIMatrix F3 DIO 8/8 01	
CE	EMC, ATEX Zone 2
TÜV	IEC 61508 1-7:2000 up to SIL 3 IEC 61511:2004 EN ISO 13849-1:2008 up to Cat. 4 und PL e
UL Underwriters Laboratories Inc.	ANSI/UL 508, NFPA 70 – Industrial Control Equipment CSA C22.2 No.142 UL 1998 Software Programmable Components NFPA 79 Electrical Standard for Industrial Machinery IEC 61508
FM Approvals	Class I, DIV 2, Groups A, B, C and D Class 3600, 1998 Class 3611, 1999 Class 3810, 1989 Including Supplement #1, 1995 CSA C22.2 No. 142 CSA C22.2 No. 213
TÜV CENELEC	Railway application EN 50126: 1999 up to SIL 4 EN 50128: 2001 up to SIL 4 EN 50129: 2003 up to SIL 4

Table 16: Certificates

4 Start-up

To start up the remote I/O, it must be mounted, connected and configured in the programming tool.

4.1 Installation and Mounting

The remote I/O is mounted on a 35 mm DIN rail such as described in the HIMatrix system manual for compact systems.

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 Connecting the Digital Inputs

Use the following terminals to connect the digital inputs:

Terminal	Designation	Function (inputs)
19	LS+	Sensor supply of the inputs 1...4
20	1	Digital input 1
21	2	Digital input 2
22	3	Digital input 3
23	4	Digital input 4
24	L-	Ground
Terminal	Designation	Function (inputs)
25	LS+	Sensor supply of the inputs 5...8
26	5	Digital input 5
27	6	Digital input 6
28	7	Digital input 7
29	8	Digital input 8
30	L-	Ground

Table 17: Terminal Assignment for the Digital Inputs

4.1.1.1 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).

4.1.2 Connecting the Digital Outputs

Use the following terminals to connect the digital outputs:

Terminal	Designation	Function (outputs, DO)
4	4-	Digital output 4- (for increased load)
5	8-	Digital output 8- (for increased load)
6	S+	Ground channel group
Terminal	Designation	Function (outputs, DO+)
7	L-	Ground channel group
8	1	Digital output 1
9	2	Digital output 2
10	3	Digital output 3
11	4+	Digital output 4+ (for increased load)
12	L-	Ground channel group
Terminal	Designation	Function (outputs, DO+)
13	L-	Ground channel group
14	5	Digital output 5
15	6	Digital output 6
16	7	Digital output 7
17	8+	Digital output 8+ (for increased load)
18	L-	Ground channel group

Table 18: Terminal Assignment for the Digital Outputs

4.1.3 Connecting Pulsed Outputs

Terminal	Designation	Function (non-safe pulsed outputs TO)
1	L-	Ground
2	1	Pulsed output 1
3	2	Pulsed output 2

Table 19: Terminal Assignment for the Pulsed Outputs

4.1.4 Cable Plugs

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

The devices power supply connections feature the following properties:

Connection to the power supply	
Cable plugs	four poles, screw terminals
Wire cross-section	0.2…2.5 mm^2 (single-wire) 0.2…2.5 mm^2 (finely stranded) 0.2…2.5 mm^2 (with wire end ferrule)
Stripping length	10 mm
Screwdriver	Slotted 0.6 x 3.5 mm
Tightening torque	0.4…0.5 Nm

Table 20: Power Supply Cable Plug Properties

Connection to the field zone	
Number of cable plugs	5 pieces, six 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 21: Input and Output Cable Plug Properties

4.1.5 Mounting the F3 DIO 8/8 01 in Zone 2

(EC Directive 94/9/EC, ATEX)

The remote I/O 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 remote I/O 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 HIMatrix F3 DIO 8/8 01 has a power dissipation ranging between 9 W and 27 W.
3. Protect the HIMatrix F3 DIO 8/8 01 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 remote I/O is additionally equipped with the label represented below:

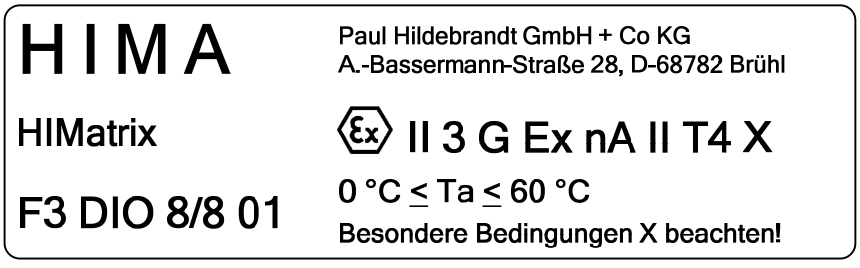


Figure 9: Label for Ex Conditions

4.2 Configuration

The remote I/O 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 compact systems (HI 800 141 E).

4.3 Configuration with SILworX

In the Hardware Editor, the remote I/Os are represented like a base plate equipped with the following modules:

- Processor module (CPU)
- Input module (DI 8 LC) with Line Control
- Output module (DO 2 02)
- Output module (DO 2 01)

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 variables 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 of F3 DIO 8/8 01

The following tables present the statuses and parameters for the input module (DI 8 LC) 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 Channels</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 pulsed output planned for SC/OC[1] detection</td></tr><tr><td>1</td><td>Pulsed output 1 planned for SC/OC[1] detection</td></tr><tr><td>2</td><td>Pulsed output 1 and 2 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 (SC/OC[1] detection), set the value to 3</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)</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>Fault within the digital inputs</td></tr><tr><td>0x0002</td><td>FTT test of test pattern faulty</td></tr></table></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: 0x00A5 [165_{dec}]</td></tr>
<tr><td colspan="4">[1] SC/OC (SC = short-circuit, OC = open-circuit)</td></tr>
</table>

Table 22: SILworX - System Parameters for Digital Inputs, **Module** Tab

4.3.2.2 Tab **DO 8 LC: Channels**

The **DI 8 LC: Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital input channels Coding: 0x01 – Fault in the digital input module Coding: 0x10 – Short-circuit of the channel Coding: 0x80 – Intermittence between pulsed output TO 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 Coding: 1 – Pulse of the 1st TO channel Coding: 2 – Pulse of the 2nd TO channel

Table 23: SILworX - System Parameters for Digital Inputs, **DI 8 LC: Channels** Tab

4.3.3 Digital Outputs of F3 DIO 8/8 01: DO 2 02

The following tables present the statuses and parameters for the output module (DO 2 02) in the same order as given in the Hardware Editor.

4.3.3.1 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>DO1.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>Fault within the digital outputs</td></tr>
<tr><td>0x0002</td><td>Test of safety shutdown returns a fault</td></tr>
<tr><td>0x0004</td><td>Test of auxiliary voltage returns a fault</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>Output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>Active shutdown via WD 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>
</table></td></tr>
<tr><td>DO2.Error Code</td><td>WORD</td><td>R</td><td>see DO1.Error Code</td></tr>
<tr><td>Time on delay</td><td>UINT</td><td>W</td><td>Time on delay for 2-pole tests due to line capacities, inductive and capacitive load, range 0…30 ms, 1 ms steps</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: 0x00B4 [180_{dec}]</td></tr>
</table>

Table 24: SILworX - System Parameters for Digital Outputs DO 2 02, **Module** Tab

4.3.3.2 Tab **DO 2 02: DO1 Channels**

The **DO 2 02: DO1 Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: Description 0x01: Fault in the digital output module 0x02: Channel shutdown due to overload 0x04: Error while reading back the digital outputs 0x08: Error while reading back the status of the digital outputs 0x40: External short-circuit or short-circuit of the EMC protection returns an error 0x80: Channel is switched off due to fault on the corresponding channel
Value [BOOL] ->	BOOL	W	Output value for DO channels: 1 = output energized 0 = output de-energized

Table 25: SILworX - System Parameters for Digital Outputs, **DO 2 02: DO1 Channels** Tab

4.3.3.3 Tab **DO 2 02: DO2 Channels**

The **DO 2 02: DO2 Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: Description 0x01: Fault in the digital output module 0x02: Channel shutdown due to overload 0x04: Error while reading back the digital outputs 0x08: Error while reading back the status of the digital outputs 0x40: External short-circuit or short-circuit of the EMC protection returns an error 0x80: Channel is switched off due to fault on the corresponding channel
Value [BOOL] ->	BOOL	W	Output value for DO channels: 1 = output energized 0 = output de-energized
2-pole [BOOL] ->	UINT	W	Configuration for a 2-Pole channel 1 = DO2[01] and DO1[04] are used as a 2-pole channel or DO2[02] and DO1[08] are used as a 2-pole channel 0 = DO2[xx] is not used as a 2-pole channel.

Table 26: SILworX - System Parameters for Digital Outputs, **DO 2 02: DO2 Channels** Tab

4.3.4 Digital Outputs of F3 DIO 8/8 01: DO 2 01

The following tables present the statuses and parameters for the output module (DO 2 01) in the same order as given in the Hardware Editor.

4.3.4.1 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</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>Fault within the digital outputs</td></tr>
<tr><td>0x0002</td><td>Test of safety shutdown returns a fault</td></tr>
<tr><td>0x0004</td><td>Test of auxiliary voltage returns a fault</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>Output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>Active shutdown via WD 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>
</table></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: 0x00B4 [180_{dec}]</td></tr>
</table>

Table 27: SILworX - System Parameters for Digital Outputs DO 2 01, **Module** Tab

4.3.4.2 Tab **DO 2 01: DO1 Channels**

The **DO 2 01: DO1 Channels** 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>Channel no.</td><td>---</td><td>R</td><td>Channel number, defined by default</td></tr>
<tr><td>-> Error Code [BYTE]</td><td>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>
<tr><td>0x08</td><td>Error while reading back the status of the digital outputs</td></tr>
<tr><td>0x40</td><td>External short-circuit or short-circuit of the EMC protection returns an error</td></tr>
<tr><td>0x80</td><td>Channel is switched off due to fault on the corresponding channel</td></tr>
</table></td></tr>
<tr><td>Value [BOOL] -></td><td>BOOL</td><td>W</td><td>Output value for DO channels:
1 = output energized
0 = output de-energized</td></tr>
</table>

Table 28: SILworX - System Parameters for Digital Outputs, **DO 2 01: DO1 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 compact systems or the online help for more details.

The following chapter describes the system signals used for assigning signals in the remote I/O.

4.4.2 Signals and Error Codes for the Inputs and Outputs

The following tables specify the 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 of F3 DIO 8/8 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: 0x00A5 [165_{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>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>Fault within the digital inputs</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 analog 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 TO 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>
<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 pulsed output planned for SC/OC[1] detection</td></tr>
<tr><td>1</td><td>Pulsed output 1 planned for SC/OC[1] detection</td></tr>
<tr><td>2</td><td>Pulsed output 1 and 2 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 (SC/OC[1] detection), set the value to 3</td></tr>
<tr><td>DI[xx].Pulsed Output [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 TO channel</td></tr>
<tr><td>2</td><td>Pulse of the 2nd TO 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)</td></tr>
<tr><td colspan="3">[1] SC/OC (SC = short-circuit, OC = open-circuit)</td></tr>
</table>

Table 29: ELOP II Factory - Digital Input System Signals

4.4.4 Digital Outputs of F3 DIO 8/8 01, DO+ (DO1), DO- (DO2)

<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: 0x005B [91_{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>DOy.Error Code [WORD]
y = 1 or 2</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>Fault within the digital outputs</td></tr>
<tr><td>0x0002</td><td>Test of safety shutdown returns a fault</td></tr>
<tr><td>0x0004</td><td>Test of auxiliary voltage returns a fault</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>Output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>Active shutdown via WD 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>
</table></td></tr>
<tr><td>DOy[xx].Error Code [BYTE]
y = 1 or 2</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>
<tr><td>0x08</td><td>Error while reading back the status of the digital outputs</td></tr>
<tr><td>0x40</td><td>External short-circuit or short-circuit of the EMC protection returns an error</td></tr>
<tr><td>0x80</td><td>Channel is switched off due to fault on the corresponding channel</td></tr>
</table></td></tr>
<tr><td>DOy[xx].Value [BOOL]
y = 1 or 2</td><td>W</td><td>Output value for DO channels:
1 = output energized
0 = output de-energized</td></tr>
<tr><td>DO2[xx].2-Pole [BOOL]</td><td>W</td><td>Configuration for a 2-Pole channel
1 = DO2[01] and DO1[04] are used as a 2-pole channel
or
DO2[02] and DO1[08] are used as a 2-pole channel
0 = DO2[xx] is not used as a 2-pole channel.</td></tr>
</table>

System Signal	R/W	Description
Time on delay [UINT]	W	Time on delay for 2-pole tests due to line capacities, inductive and capacitive load, range 0…30 ms, 1 ms steps

Table 30: ELOP II Factory - Digital Output System Signals

4.4.5 Pulsed Outputs for F3 DIO 8/8 01

System signal	R/W	Description
Mod.SRS [UDINT]	R	Slot number (System Rack Slot)
Mod. Type [UINT]	R	Type of module, target value: 0x005B [91_{dec}]
Mod. Error Code [WORD]	R	Module error code Coding: Description 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
DO.Error Code [WORD]	R	Error code of the TO unit as a whole Coding: Description 0x0001: Error of the TO unit as a whole:
DO[xx].Error Code [BYTE]	R	Error code of the individual digital pulsed output channels: Coding: Description 0x01: Fault in the digital output module
DO[xx].Value [BOOL]	W	Output value for TO channels: 1 = output energized 0 = output de-energized **Pulsed outputs must not be used as safety-related outputs!**

Table 31: ELOP II Factory - System Signals for the Pulsed Outputs

5 Operation

The remote I/O can only operated together with a controller. No specific monitoring is required for remote I/Os.

5.1 Handling

Handling of the remote I/O during operation is not required.

5.2 Diagnosis

A first diagnosis results from evaluating the LEDs, see Chapter 3.4.1.

The device 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/module.

6.1 Faults

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

Refer to Chapter 3.1.2.2, for more information on the fault reaction of digital outputs.

If the test harnesses detect safety-critical faults, the module enters the STOP_INVALID state and will remain in this state. This means that the input signals are no longer processed by the device and the outputs switch to the de-energized, safe state. The evaluation of diagnostics provides information on the fault cause.

6.2 Maintenance Measures

The following measures are required for the device:

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

6.2.1 Loading the Operating System

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

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 device must be in STOP (displayed in the programming tool). Otherwise, stop the device.

For more information, refer to the programming tool documentation.

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 to decommission the device. 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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