HIMatrix

Safety-Related Controller

F3 DIO 20/8 02 Manual

HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

Rev. 1.01

HI 800 345 E

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All of the instructions and technical specifications in this manual have been written with great care and effective quality assurance measures have been implemented to ensure their validity. For questions, please contact HIMA directly. HIMA appreciates any suggestion on which information should be included in the manual.

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For further information, refer to the CD-ROM and our website http://www.hima.de and http://www.hima.com.

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Revision index	Revisions	Type of Change	
		technical	editorial
1.00	Added: Configuration with SILworX	X	X
1.01	Deleted: Chapter *Monitoring the Temperature State* displaced into system manual		X

Table of Contents

1 Introduction

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

1.1 Structure and Use of this Manual

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

This manual is organized in the following main chapters:

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

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

Programming tool	Processor operating system
SILworX	Versions Beyond 7
ELOP II Factory	Versions Prior to 7

Table 1: HIMatrix System Variants

The manual distinguishes among the different variants using:

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

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

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

Additionally, the following documents must be taken into account:

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

Table 2: Additional Relevant Documents

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

1.2 Target Audience

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

1.3 Formatting Conventions

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

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

Safety notes and operating tips are particularly marked.

1.3.1 Safety Notes

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

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

⚠ SIGNAL WORD

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

The signal words have the following meanings:

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

NOTE

Type and source of damage!
Damage prevention

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

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

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

2 Safety

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

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

2.1 Intended Use

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

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

2.1.1 Environmental Requirements

Requirement type	Range of values [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 HIMax system to environmental conditions other than those specified in this manual can cause the HIMatrix system to malfunction.

2.1.2 ESD Protective Measures

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

NOTE

Device damage due to electrostatic discharge!

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

2.2 Residual Risk

No imminent danger results from a HIMatrix system itself.

Residual risk may result from:

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

2.3 Safety Precautions

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

2.4 Emergency Information

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

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

3 Product Description

The safety-related **F3 DIO 20/8 02** remote I/O is a compact system located in a metal enclosure with 20 digital inputs and 8 digital outputs.

The remote I/O is available in a model variant for SILworX and a model variant for ELOP II Factory, see Chapter 3.2. All variants are described in this manual.

The remote I/O serves to extend the I/O level of HIMax and HIMatrix controllers, and is connected to them via safe**ethernet**. The remote I/O itself is not able to run a user program.

The HIMatrix remote I/Os are not multi-master capable.

The remote I/O is suitable for mounting in Ex-zone 2, see Chapter 4.1.3.

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

3.1 Safety Function

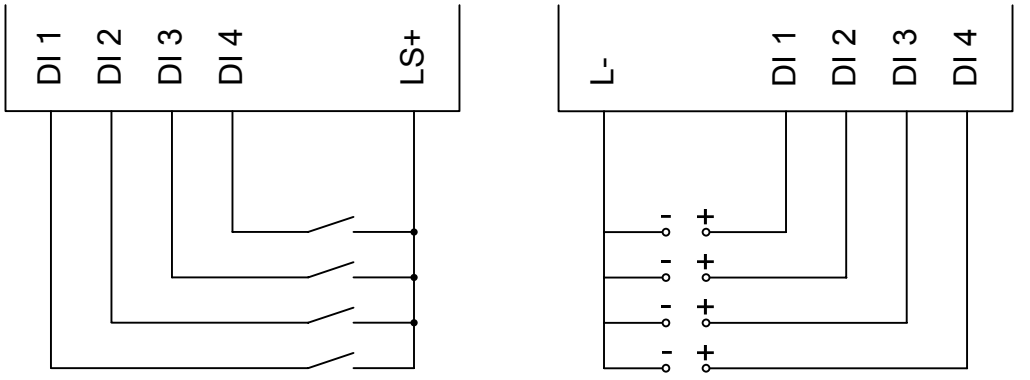
The remote I/O is equipped with safety-related digital inputs and outputs. The input values on the inputs are safely transmitted to the connected controller via safe**ethernet**. The outputs are safely assigned their values by the connected controller via safe**ethernet**.

3.1.1 Safety-Related Digital Inputs

The remote I/O is equipped with 20 digital outputs. The state (HIGH, LOW) of each input is signaled by an 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).

An external wire is not monitored, but 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.

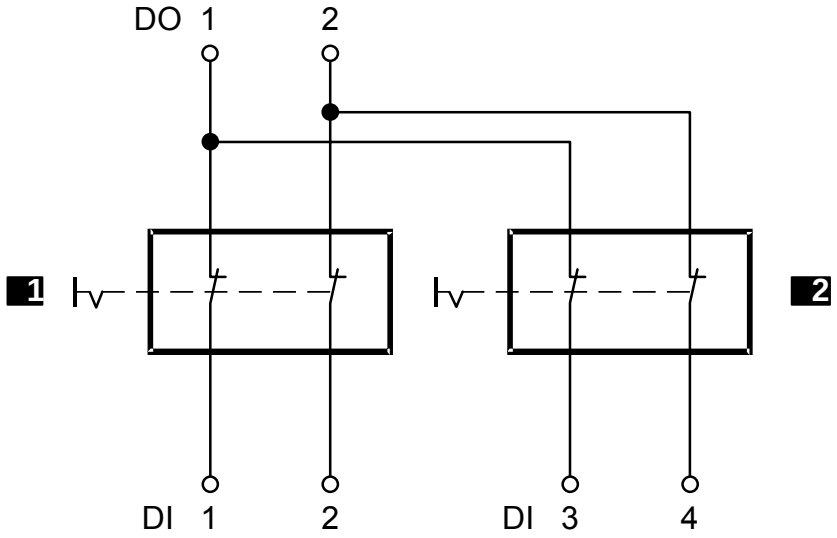
In addition to the channel signal value, the user program must also consider the corresponding error code.

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 in accordance with EN 954-1.

To this end, connect the digital outputs DO 1 through DO 8 of the system to the digital inputs (DI) of the same system as follows:



1 EMERGENCY STOP 1
2 EMERGENCY STOP 2

EMERGENCY STOP devices 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 the short-circuits and open-circuits on the digital inputs. To do so, configure the *Value.[BOOL]* -> system variable in SILworX and the *DO[0x].Value* system signal in ELOP II Factory. The variables 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 displayed:

- Cross-circuit between two parallel lines,
- Improper connections of two lines (e.g., DO 2 after DI 3),
- Earth fault of a line (with earthed ground only),
- Open-circuit or open contacts, i.e., also if one of the two EMERGENCY STOP switches previously mentioned the *FAULT* LED is being engaged.

For more information on how to configure line control in the user program, refer to the HIMatrix Engineering Manual (HI 800 101 E).

3.1.2 Safety-Related Digital Outputs

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

At the maximum ambient temperature, the outputs 1...3 and 5...7 can be loaded with 0.5 A each; and outputs 4 and 8 can be loaded with 1 A or with 2 A at an ambient temperature of up to 50 °C.

If an overload occurs, one or all outputs are switched off. After the overload is removed the corresponding outputs are switched on again automatically, see Table 13

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

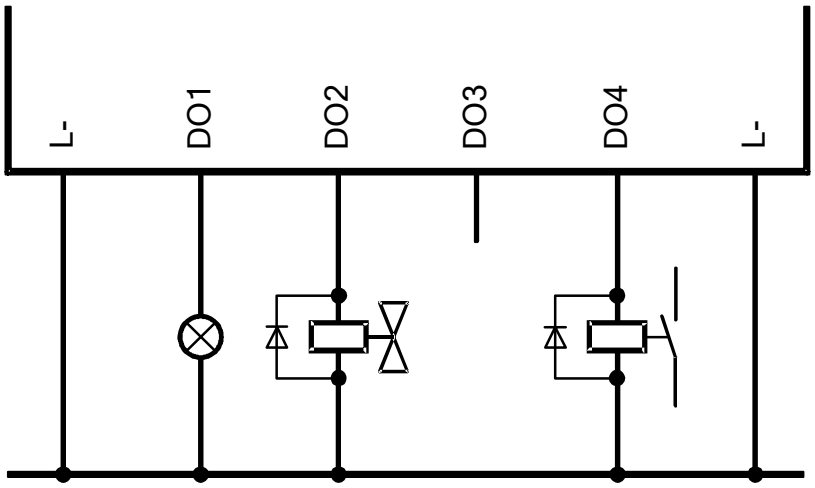


Figure 3: Connection of Actuators to Digital Outputs

The redundant connection of two outputs must be decoupled with diodes.

⚠ CAUTION

For connecting a load to a 1-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.

Inductive loads may be connected with no free-wheeling diode on the actuator. However, HIMA strongly recommends connecting a protective diode directly to the actuator.

3.1.2.1 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 fault in the device 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.

3.1.2.2 Line Control

The digital outputs can be used to detect short-circuits and open-circuits on the inputs, e.g., for an EMERGENCY STOP button complying with Cat. 4 in accordance with EN 954-1. To this end, the outputs are pulsed and connected to the safety-related digital inputs of the same device, see Chapter 3.1.1.2. In this case, the outputs assume the function of pulsed outputs.

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

3.2 Equipment, Scope of Delivery

The available components and their part numbers are listed below:

Designation	Description	Part no.
F3 DIO 20/8 02	Remote I/O with 20 digital inputs and 8 digital outputs. Operating temperature 0...+60 °C, for ELOP II Factory programming tool	98 2200404
F3 DIO 20/8 021 (-20 °C)	Remote I/O with 20 digital inputs and 8 digital outputs. Operating temperature -20...+60 °C, for ELOP II Factory programming tool	98 2200459
F3 DIO 20/8 02 SILworX	Remote I/O with 20 digital inputs and 8 digital outputs. Operating temperature 0...+60 °C, for SILworX programming tool	98 2200484
F3 DIO 20/8 021 SILworX (-20 °C)	Remote I/O with 20 digital inputs and 8 digital outputs. Operating temperature -20...+60 °C, for SILworX programming tool	98 2200490

Table 4: Part Numbers

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:	60000.200.0 (SILworX)
	60000.0.0 (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

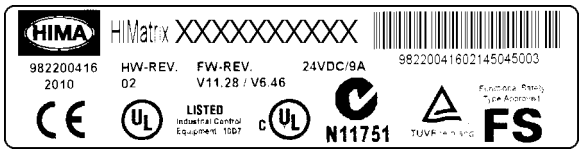


Figure 4: Sample Type Label

3.4 Assembly

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

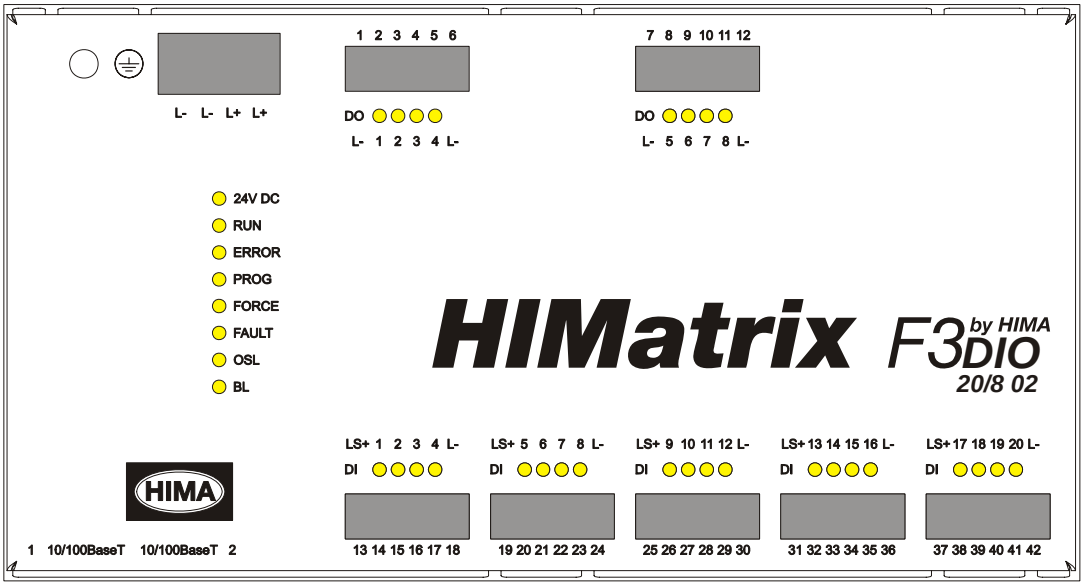
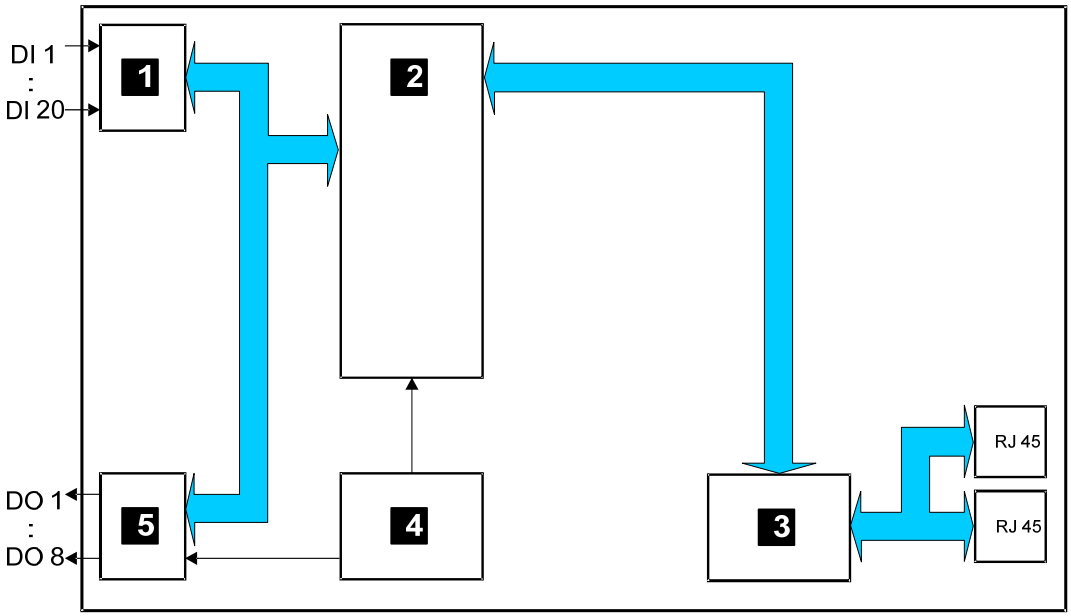


Figure 5: Front View



1 Digital Inputs
2 Safety-Related Processor System
3 Switch
4 Watchdog
5 Digital Outputs

Figure 6: 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 LED
- 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 A loaded user program is being executed (not with remote I/Os).
		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 fault, software error 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	On	The device is in RUN, forcing was activated.
		Blinking	The device is in STOP, forcing has been prepared and is activated when the device is started.
		Off	Forcing is not activated. 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 defective. 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 OLS binary defective or INIT_FAIL hardware fault.
		Off	Boot loader inactive

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…20	Yellow	On	The related input is active (energized).
		Off	The related input is inactive (de-energized).
DO 1…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	10/100/Base-T, half and full duplex
Auto negotiation	Yes
Auto crossover	Yes
Connection socket	RJ-45
IP address	Freely configurable[1)]
Subnet mask	Freely configurable[1)]
Supported protocols	▪ Safety-related: safe**ethernet** ▪ Non-safety-related: 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 enclosure. 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).

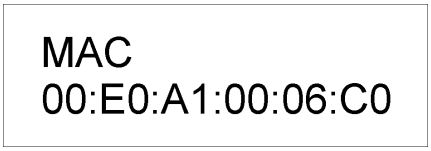


Figure 7: Sample MAC Address Label

The remote I/O is equipped with an integrated switch for safety-related Ethernet communication (safe**ethernet**). For further information on the integrated switch and safe**ethernet,** refer to Chapter C*ommunication* of the System Manual for Compact Systems (HI 800 141 E).

3.4.2.2 Network Ports Used for Ethernet Communication

UDP ports	Usage
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.

The key can be accessed through a small round hole located approximately 5 cm from the upper left-hand side of the enclosure. 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 seconds. 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 default account administrator 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
Interfaces: Ethernet	 2 x RJ-45, 10/100BaseT (with 100 Mbit/s) with integrated switch
Operating voltage	24 VDC, -15 %...+20 %, w_{ss} ≤ 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 °C...+60 °C
Storage temperature	-40 °C...+85 °C
Type of protection	IP20
Max. dimensions (without plug)	Width: 207 mm (with enclosure screws) Height: 114 mm (with fixing bolt) Depth: 66 mm (with earthing screw)
Weight	1.0 kg

Table 11: Product Data

Digital inputs		
Number of inputs		20 (non-galvanically isolated)
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		5 x 20 V / 100 mA (at 24 V), short-circuit-proof

Table 12: Specifications for the Digital Inputs

Digital outputs (DO+ and DO-)	
Number of outputs	8 (non-galvanically isolated)
Output voltage	≥ L+ minus 2 V
Output current	Channels 1...3 and 5...7: 0.5 A at 60 °C Channels 4 and 8: 1 A at 60 °C, 2 A at 50 °C)
Minimum load	2 mA for each channel
Internal voltage drop	max. 2 W at 2 A
Behavior with overload	The affected output is switched off and re-started cyclically.
Total output current	max. 7 A, upon overload, all outputs are switched off and cyclically switched on again

Table 13: Specifications for the Digital Outputs

3.5.1 Product Data of F3 DIO 20/8 02 021 (-20 °C)

The F3 DIO 20/8 02 021 (-20 °C) model variant is intended for use at the extended temperature range of -20…+60 °C. The electronic components are coated with a protective lacquer.

General	
Operating temperature	-20 °C...+60 °C
Weight	1.2 kg

Table 14: Product Data of F3 DIO 20/8 021

3.6 Certified HIMatrix F3 DIO 20/8 02

HIMatrix F3 DIO 20/8 02	
CE	EMC, ATEX Zone 2
TÜV	IEC 61508 1-7:2000 up to SIL 3 IEC 61511:2004 EN 954-1:1996 up to Cat. 4
TÜV ATEX	94/9/EG EN 1127-1 EN 61508
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

Table 15: 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.

4.1.1 Connection of the Digital Inputs

Use the following terminals to connect the digital inputs:

Terminal	Designation	Function (inputs)
13	LS+	Sensor supply of the inputs 1...4
14	1	Digital input 1
15	2	Digital input 2
16	3	Digital input 3
17	4	Digital input 4
18	L-	Ground
Terminal	Designation	Function (inputs)
19	LS+	Sensor supply of the inputs 5...8
20	5	Digital input 5
21	6	Digital input 6
22	7	Digital input 7
23	8	Digital input 8
24	L-	Ground
Terminal	Designation	Function (inputs)
25	LS+	Sensor supply of the inputs 9...12
26	9	Digital input 9
27	10	Digital input 10
28	11	Digital input 11
29	12	Digital input 12
30	L-	Ground
Terminal	Designation	Function (inputs)
31	LS+	Sensor supply of the inputs 13...14
32	13	Digital input 13
33	14	Digital input 14
34	15	Digital input 15
35	16	Digital input 16
36	L-	Ground
Terminal	Designation	Function (inputs)
37	LS+	Sensor supply of the inputs 15...20
38	17	Digital input 17
39	18	Digital input 18
40	19	Digital input 19
41	20	Digital input 20
42	L-	Ground

Table 16: 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. Activate noise blanking: a signal must be present for at least two cycles before it is evaluated.

i Activating noise blanking increases the response time of the HIMatrix system!

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 or HI 800 191).

4.1.2 Connecting the Digital Outputs

Use the following terminals to connect the digital outputs:

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

Table 17: Terminal Assignment for the Digital Outputs

4.1.3 Mounting the F3 DIO 20/8 02 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.

Special 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 be also performed when the device 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 20/8 02 has a power dissipation ranging between 9 W and 25 W.
3. Protect the HIMatrix F3 DIO 20/8 02 with a 10 A time-lag fuse.
   The F3 DIO 20/8 02 must be supplied with 24 VDC from a power supply unit with safe isolation. Use power supply units of type PELV or SELV only.
4. Applicable standards:

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

Pay particular attention to the following sections:

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

The remote I/O is additionally equipped with the label represented below:

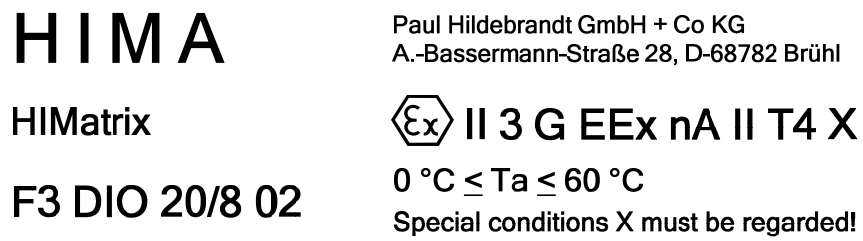


Figure 8: Label for Ex Conditions

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):

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

i ELOP II Factory is required to load a new operating system (version 7 and beyond) into a remote I/O with a CPU operating system version prior to 7. SILworX is then required once the loading procedure is completed.

4.3 Configuring a Remote I/O 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 20)
- Output module (DO 8)

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.

4.3.1 Parameters and Error Codes for the Inputs and Output

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 20/8 02

The following tables present the statuses and parameters for the input module (DI 20) in the same order as given in the Hardware Editor.

4.3.2.1 **Module** Tab

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

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>DI No. of Pulse Channel</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 LS/LB[1)] detection</td></tr>
<tr><td>1</td><td>Pulsed output 1 planned for LS/LB[1)] detection</td></tr>
<tr><td>2</td><td>Pulsed output 1 and 2 planned for LS/LB[1)] detection</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>8</td><td>Pulsed outputs 1..8 planned for LS/LB[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 (LS/LB[1)] detection), set the value to 1</td></tr>
<tr><td>DI Pulse Delay (10E-6s)</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: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/ 0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Module.SRS</td><td>[UDINT]</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module.Type</td><td>[UINT]</td><td>R</td><td>Type of module, target value: 0x00A5 [165_{dec}]</td></tr>
<tr><td colspan="4">[1)] LS/LB (LS = short-circuit, LB = open-circuit)</td></tr>
</table>

Table 18: SILworX - System Parameters for the Digital Inputs, **Module** Tab

4.3.2.2 **DO 20: Channels** Tab

The **DI 20: 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 input channels
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the digital input module</td></tr>
<tr><td>0x10</td><td>Short-circuit of the channel</td></tr>
<tr><td>0x80</td><td>Intermittence between pulsed output DO and digital input DI, e.g.,
▪ Open-circuit
▪ Open switch
▪ L+ low voltage</td></tr>
</table></td></tr>
<tr><td>-> Value [BOOL]</td><td>BOOL</td><td>R</td><td>Iput values for the digital input channels
0 = input de-energized
1 = input energized</td></tr>
<tr><td>Pulse channel [USINT] -></td><td>USINT</td><td>W</td><td>Source channel for pulsed supply
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0</td><td>Input channel</td></tr>
<tr><td>1</td><td>Pulse of the 1st DO channel</td></tr>
<tr><td>2</td><td>Pulse of the 2nd DO channel</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>8</td><td>Pulse of the 8th DO channel</td></tr>
</table></td></tr>
</table>

Table 19: SILworX - System Parameters for the Digital Inputs, **DI 20: Channels** Tab

4.3.3 Digital Outputs of F3 DIO 20/8 02

The following tables present the statuses and parameters for the output module (DO 8) in the same order as given in the Hardware Editor.

4.3.3.1 **Module** Tab

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

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>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>MOT test of safety shutdown provides a fault</td></tr>
<tr><td>0x0004</td><td>MOT test of auxiliary voltage provides a fault</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>MOT test of output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>MOT test of output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>MOT test 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: Low voltage</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: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/ 0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Module SRS</td><td>UDINT</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module Type</td><td>UINT</td><td>R</td><td>Type of module, target value: 0x00B4 [180_{dec}]</td></tr>
</table>

Table 20: SILworX - System Parameters for the Digital Outputs, **Module** Tab

4.3.3.2 **DO 8: Channels** Tab

The **DO 8: 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 21: SILworX - System Parameters for the Digital Outputs, **DO 8: Channels** Tab

4.4 Configuring a Remote I/O Using 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 Controller or the online help for more details.

The system signals available for allocating signals in the remote I/Os are described in the following chapter.

4.4.2 Signals and Error Codes for the Inputs and Output

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

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

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

4.4.3 Digital Inputs of F3 DIO 20/8 02

<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: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>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 digital input module</td></tr>
<tr><td>0x10</td><td>Short-circuit of the channel</td></tr>
<tr><td>0x80</td><td>Intermittence between pulsed output DO and pulsed input DI, e.g.,
▪ Open-circuit
▪ Open switch
▪ L+ low voltage</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 No. of Pulse Channel [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 LS/LB[1)] detection</td></tr>
<tr><td>1</td><td>Pulsed output 1 planned for LS/LB[1)] detection</td></tr>
<tr><td>2</td><td>Pulsed output 1 and 2 planned for LS/LB[1)] detection</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>8</td><td>Pulsed outputs 1..8 planned for LS/LB[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, (LS/LB[1)] detection), set the value to 1</td></tr>
<tr><td>DI[xx].Pulse Channel [USINT]</td><td>W</td><td>Source channel for pulsed supply
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0</td><td>Input channel</td></tr>
<tr><td>1</td><td>Pulse of the 1st DO channel</td></tr>
<tr><td>2</td><td>Pulse of the 2nd DO channel</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>8</td><td>Pulse of the 8th DO channel</td></tr>
</table></td></tr>
</table>

System Signal	R/W	Description
DI Pulse Delay (10E-6s) [UINT]	W	Waiting time for line control (detection of short-circuits or cross-circuits)
[1)] LS/LB (LS = short-circuit, LB = open-circuit)		

Table 22: ELOP II Factory - Digital Input System Signals

4.4.4 Digital Outputs of F3 DIO 20/8 02

<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: 0x00B4 [180_{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: incorrect configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>DOy.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>Fault within the digital outputs</td></tr>
<tr><td>0x0002</td><td>MOT test of safety shutdown provides a fault</td></tr>
<tr><td>0x0004</td><td>MOT test of auxiliary voltage provides a fault</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>MOT test of output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>MOT test of output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>MOT test 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:
Low voltage</td></tr>
</table></td></tr>
<tr><td>DOy[xx].Error Code [BYTE]</td><td>R</td><td>Error codes for the digital output channels
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the digital output module</td></tr>
<tr><td>0x02</td><td>Channel shutdown due to overload</td></tr>
<tr><td>0x04</td><td>Error while reading back the digital outputs</td></tr>
<tr><td>0x08</td><td>Error while reading back the status of the digital outputs</td></tr>
</table></td></tr>
<tr><td>DOy[xx].Value [BOOL]</td><td>W</td><td>Output value for DO channels:
1 = output energized
0 = output de-energized

Pulsed outputs must not be used as safety-related outputs!</td></tr>
</table>

Table 23: ELOP II Factory - Digital Output System Signals

5 Operation

The remote I/O can only operate 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's diagnostic history can also be read using the programming tool.

6 Maintenance

No maintenance measures are required during normal operation.

If a device or module fails, it must be replaced with a faultless device or module of the same type or with an approved replacement model.

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.

6.1.1 Operating System Version 6.42 and Beyond

If the test harnesses detect faults in the processor system, the remote I/O enters the STOP_INVALID state and is restarted (RUN state) by the associated controller. If a further internal fault occurs within the first minute after start-up, the device 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.

6.1.2 Operating System Versions Prior to 6.42

If the test harnesses detect faults in the processor system, the module automatically enters the ERROR STOP 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 processor module:

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

6.2.1 Loading the Operating System

HIMA is continuously improving the operating system of the 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!

Load the operating system 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

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

7 Decommissioning

Remove the supply voltage to decommission the 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 transmission.

9 Disposal

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

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

Appendix

Glossary

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

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