HIMatrix® F

Safety-Related Controller

Manual

F30 03

SAFETY
NONSTOP

HIMA

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Original document	Description
HI 800 472 D, Rev. 3.00 (1627)	English translation of the German original document

Table of Contents

1 Introduction 5

1.1 Structure and Use of this Manual 5

1.2 Target Audience 5

1.3 Writing Conventions 6

1.3.1 Safety Notices 6

1.3.2 Operating Tips 7

2 Safety 8

2.1 Intended Use 8

2.1.1 Environmental Conditions 8

2.1.2 ESD Protective Measures 8

2.2 Residual Risk 8

2.3 Safety Precautions 8

2.4 Emergency Information 8

3 Product Description 9

3.1 Safety Function 9

3.1.1 Safety-Related Digital Inputs 9

3.1.1.1 Reaction in the Event of a Fault 10

3.1.1.2 Line Control 10

3.1.2 Safety-Related Digital Outputs 11

3.1.2.1 Reaction in the Event of a Fault 11

3.2 Equipment, Scope of Delivery 12

3.2.1 IP Address and System ID (SRS) 12

3.3 Type Label 12

3.4 Structure 13

3.4.1 LED Indicators 14

3.4.1.1 Operating voltage LED 14

3.4.1.2 System LEDs 15

3.4.1.3 Communication LEDs 16

3.4.1.4 I/O LEDs 16

3.4.1.5 Fieldbus LEDs 16

3.4.2 Communication 17

3.4.2.1 Connections for Ethernet Communication 17

3.4.2.2 Network Ports in Use for Ethernet Communication 18

3.4.2.3 Connections for Fieldbus Communication 18

3.4.3 Reset Key 19

3.4.4 Hardware Clock 19

3.5 Product Data 20

3.5.1 Product Data F30 034 21

3.6 Certified F30 03 HIMatrix 21

4 Start-Up 22

4.1 Installation and Mounting 22

4.1.1 Connecting the Digital Inputs 22

4.1.1.1 Surges on Digital Inputs 23

4.1.2 Connecting the Digital Outputs 23
4.1.3 Cable Plugs 24
4.1.4 Mounting the Controller in Zone 2 24
4.2 Sequence of Events Recording (SOE) 25
4.3 Configuration with SILworX 26
4.3.1 Processor Module 26
4.3.1.1 Tab **Module** 26
4.3.1.2 Tab **Routings** 28
4.3.1.3 Tab **Ethernet Switch** 29
4.3.1.4 Tab **VLAN** (Port-Based VLAN) 29
4.3.1.5 Tab **LLDP** 30
4.3.1.6 Tab **Mirroring** 30
4.3.2 Communication Module 30
4.3.3 Parameters and Error Codes for the Inputs and Outputs 30
4.3.4 Digital Inputs for F30 31
4.3.4.1 Tab **Module** 31
4.3.4.2 Tab **DI 20: Channels** 32
4.3.5 Digital Outputs for F30 33
4.3.5.1 Tab **Module** 33
4.3.5.2 Tab **DO 8: Channels** 34
5 Operation 35
5.1 Handling 35
5.2 Diagnosis 35
6 Maintenance 36
6.1 Faults 36
6.2 Maintenance Measures 36
6.2.1 Loading the Operating System 36
6.2.2 Proof Test 36
7 Decommissioning 37
8 Transport 38
9 Disposal 39
Appendix 41
Glossary 41
Index of Figures 42
Index of Tables 43
Index 44

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 in SILworX.

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

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

Additionally, the following documents must be taken into account:

Document	Content	Document number
HIMatrix system manual	Hardware description of the HIMatrix compact systems and the F60 modular system.	HI 800 141 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
Communication manual	Description of the communication protocols, ComUserTask and their configuration in SILworX.	HI 801 101 E
SILworX online help	Instructions on how to use SILworX.	-
SILworX first steps manual	Introduction to SILworX using the HIMax system as an example.	HI 801 103 E

Table 1: Additional Relevant Documents

The latest manuals can be downloaded from the HIMA website at www.hima.de and 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 plants and systems. Specialized knowledge of safety-related automation systems is required.

1.3 Writing Conventions

To ensure improved readability and comprehensibility, the following writing conventions 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 states are designated by capitals.
Chapter 1.2.3	Cross-references are hyperlinks even if 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 notices and operating tips are particularly marked.

1.3.1 Safety Notices

The safety notices are represented as described below.

They must be strictly observed to ensure the lowest possible operating risk. 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 situations which, if not avoided, could result in death or serious injury.
- Caution indicates hazardous situations 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.

NOTICE

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 for additional information is located here.

Useful tips and tricks appear as follows:

TIP The tip text is located here.

2 Safety

All safety information, notices 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.

The product is operated with SELV or PELV. No imminent risk results from the product itself. The use in the Ex zone is only 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 Conditions

All the environmental conditions specified in this manual must be observed when operating the HIMatrix system. The environmental requirements are listed in the product data.

2.1.2 ESD Protective Measures

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

NOTICE

Damage to the HIMatrix system 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 components are protected from electrostatic discharge, e.g., by storing them in their packaging.**

2.2 Residual Risk

No imminent risk results from a HIMA system itself.

Residual risk may result from:

- Faults related to engineering.
- Faults in 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 HIMA system is a part of the safety equipment of a plant. If the controller fails, the system enters the safe state.

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

3 Product Description

The safety-related **F30 03** controller is a compact system in a metal housing with 20 digital inputs and 8 digital outputs.

The controller is available in various model variants, see Table 2.

The configuration is performed using SILworX, see Chapter 4.2.

The controller is suitable for sequence of events recording (SOE), see Chapter 4.2. The controller supports multitasking and reload. For more details, refer to the system manual (HI 800 141 E).

i A license is required to use the events recording, the multitasking and the reload features.

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 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 controller is equipped with safety-related digital inputs and outputs.

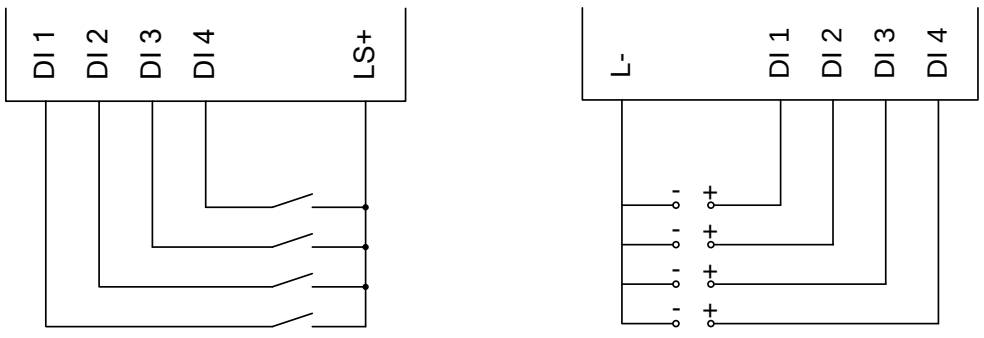
3.1.1 Safety-Related Digital Inputs

The controller is equipped with 20 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-energize 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-energize to trip principle.

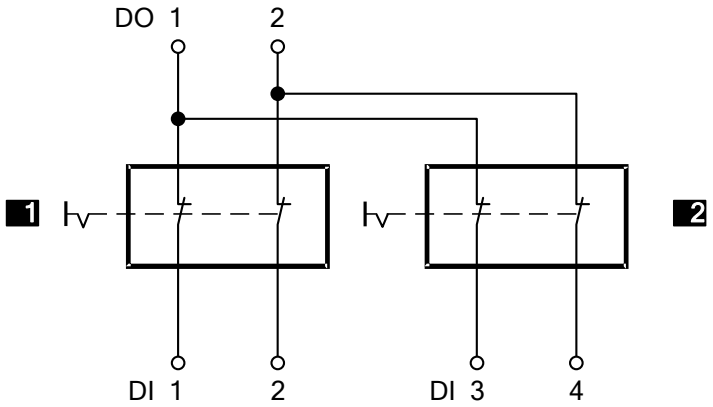
The device activates the *FAULT* LED.

For diagnostic purposes, the signal value of the channel as well as the corresponding error code must be evaluated in the user program. Using the error code, the user can 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 F30 system, 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 DO 1...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 switches in accordance with EN 60947-5-1 and EN 60947-5-5

Figure 2: Line Control

The controller pulses the digital 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. The pulsed outputs can be assigned to any digital inputs.

An (evaluable) error code is created, if the following errors occur.

- Cross-circuit between two parallel wires.
- Invalid connections of two lines (e.g., DO 2 to DI 3).
- Earth fault on one wire (with earthed ground only).
- Open-circuit or open contacts.

Refer to the HIMatrix system manual (HI 800 141 E) for a description of and further details on line control.

3.1.2 Safety-Related Digital Outputs

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

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.

Within a temperature range of 60…70 °C, all outputs of the F30 034 can be loaded with 0.5 A, see Table 14.

If an overload occurs, one or all digital outputs are switched off. If the overload is removed, the 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.

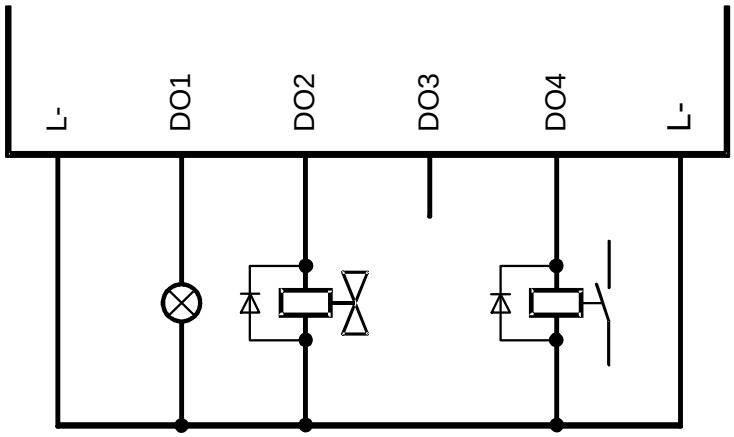


Figure 3: Connection of Actuators to Outputs

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

⚠ WARNING

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 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 device activates the *FAULT* LED.

For diagnostic purposes, the signal value of the channel as well as the corresponding error code must be evaluated in the user program. Using the error code, the user can configure additional fault reactions in the user program.

3.2 Equipment, Scope of Delivery

The following table specifies the available controller variants:

Designation	Description
F30 03 SILworX	Controller (20 digital inputs, 8 digital outputs) Ambient temperature: 0...+60 °C
F30 034 SILworX	Controller (20 digital inputs, 8 digital outputs) Ambient temperature: -25...+70 °C (temperature class T1) Vibration and shock tested according to EN 50125-3 and EN 50155, class 1B according to IEC 61373

Table 2: Available Variants

3.2.1 IP Address and System ID (SRS)

A transparent label for specifying the IP addresses of the CPU and the COM and the system ID (SRS, System.Rack.Slot) after a change, is delivered with the device.

Default value for CPU IP address:	192.168.0.99
Default value for COM IP address:	192.168.0.100
Default value for SRS:	60 000.0.0

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

Refer to the SILworX first steps manual for more information on how to modify the IP address and the system ID.

3.3 Type Label

The type label specifies the following details:

- Product name
- Bar code (1D or 2D code)
- Part no.
- Production year
- Hardware revision index (HW-Rev.)
- Firmware revision index (OS-Rev.)
- Operating voltage
- Mark of conformity

Figure 4: Sample Type Label

3.4 Structure

This chapter describes the layout and function of the controller and the connections for communication.

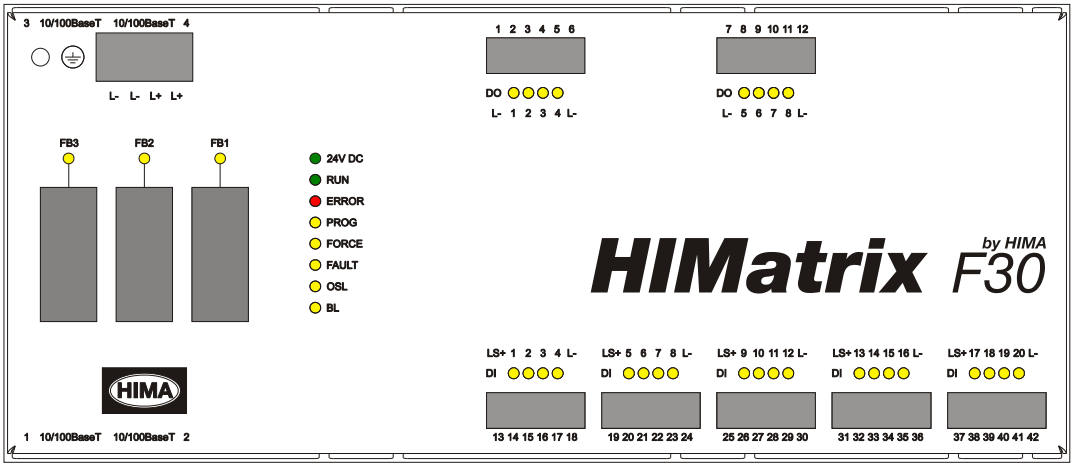
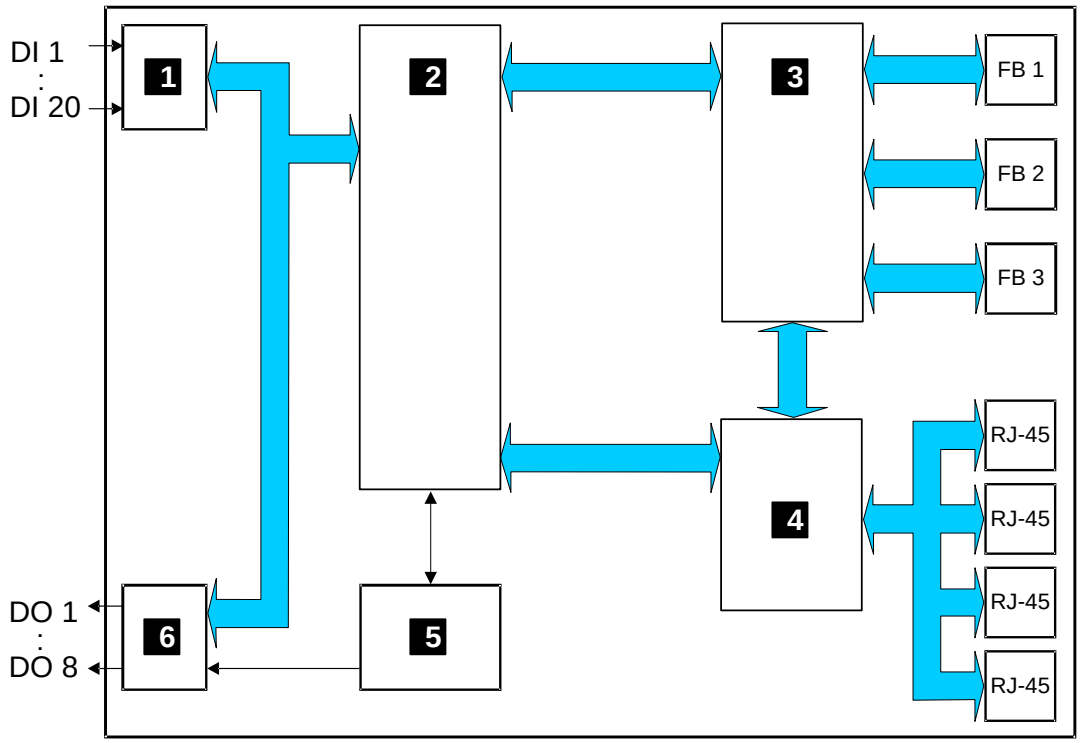


Figure 5: Front View



1 Digital inputs
2 Safety-related processor system (CPU)
3 Communication system (COM)
4 Switch
5 Watchdog
6 Digital outputs

Figure 6: Block Diagram

3.4.1 LED Indicators

The light-emitting diodes (LEDs) indicate the operating state of the controller. The LEDs are classified as follows:

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

When the supply voltage is switched on, an LED test is performed and all LEDs are briefly lit.

Definition of blinking frequencies

The following table defines the blinking frequencies of the LEDs:

Definition	Blinking frequencies
Blinking1	Long (approx. 600 ms) on, long (approx. 600 ms) off
Blinking-x	Ethernet communication: Blinking synchronously with data transfer

Table 3: Blinking Frequencies of LEDs

3.4.1.1 Operating voltage LED

The LED signals the following states:

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

Table 4: 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 processed. ▪ The emergency loader active.
		Blinking1	▪ Device in STOP. ▪ A new operating system is being loaded.
		Off	The device is not in the RUN or STOP state.
ERR	Red	On	System warning, for example: ▪ No license for additional functions (communication protocols, re-load), test mode. ▪ Temperature warning.
		Blinking1	System error, for example: ▪ The device is in the ERROR STOP state. Internal faults detected by self-tests, e.g., hardware or voltage supply faults. The processor system can only be restarted with a command from the PADT (reboot). ▪ Fault while loading the operating system. ▪ The emergency loader active.
		Off	No faults detected.
PROG	Yellow	On	▪ The emergency loader active. ▪ A new configuration is being loaded into the device. ▪ A new operating system is being loaded. ▪ Change to watchdog time or safety time. ▪ Detection of duplicate IP address. ▪ SRS change.
		Blinking1	▪ Reload is being performed. ▪ A duplicate IP address was detected. [1)] ▪ PROFINET has received an identify request. [1)]
		Off	None of the described events occurred.
FORCE	Yellow	On	▪ Forcing prepared, but no local or global variables are currently being forced. Example: the force switch for a variable is set, the force main switch is still deactivated. The device is in the RUN or STOP state. ▪ The emergency loader active.
		Blinking1	▪ Forcing is active: At least one local or global variable has adopted the corresponding force value. ▪ A duplicate IP address was detected. [1)] ▪ PROFINET has received an identify request. [1)]
		Off	None of the described events occurred.
FAULT	Yellow	On	▪ The emergency loader active. ▪ There is a warning related to the field zone.
		Blinking1	▪ The new operating system is corrupted (after OS download). ▪ Fault while loading a new operating system. ▪ The loaded configuration is not valid. ▪ At least one fault related to the field level has occurred. ▪ A duplicate IP address was detected. [1)] ▪ PROFINET has received an identify request. [1)]
		Off	None of the described faults occurred.

LED	Color	Status	Description
OSL	Yellow	Blinking1	▪ Operating system emergency loader active. ▪ A duplicate IP address was detected. [1)] ▪ PROFINET has received an identify request. [1)]
		Off	None of the described events occurred.
BL	Yellow	On	Warning related to external process data communication.
		Blinking1	▪ OS and OSL binary defective or hardware fault, INIT_FAIL. ▪ Fault in the external process data communication. ▪ A duplicate IP address was detected. [1)] ▪ PROFINET has received an identify request. [1)]
		Off	None of the described events occurred.
[1)] If all the LEDs PROG, FORCE, FAULT, OSL and BL are blinking simultaneously.			

Table 5: System LEDs

3.4.1.3 Communication LEDs

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

LED	Status	Description
Green	On	Full duplex operation.
	Blinking1	IP address conflict, all communication LEDs are blinking.
	Blinking-x	Collision.
	Off	Half duplex operation, no collision.
Yellow	On	Connection available.
	Blinking1	IP address conflict, all communication LEDs are blinking.
	Blinking-x	Interface activity.
	Off	No connection available.

Table 6: Ethernet Indicators

3.4.1.4 I/O LEDs

The LEDs signal the following states:

LED	Color	Status	Description
DI 1…20	Yellow	On	The related channel is active (energized).
		Off	The related channel is inactive (de-energized).
DO 1…8	Yellow	On	The related channel is active (energized).
		Off	The related channel is inactive (de-energized).

Table 7: I/O LEDs

3.4.1.5 Fieldbus LEDs

LEDs FB1…FB3 are used to display the state of communication occurring via the serial interfaces. The function of the LED depends on the used protocol.

Refer to the communication manual (HI 801 101 E) for a functional description.

3.4.2 Communication

The controller communicates with remote I/Os via safe**ethernet**. Characteristics and configuration of safe**ethernet** are described in the communication manual (HI 801 101 E).

3.4.2.1 Connections for Ethernet Communication

Property	Description
Port	4 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: safeethernet, PROFIsafe ▪ Standard protocols: Programming and debugging tool (PADT), OPC, Modbus TCP, TCP SR, SNTP, ComUserTask, PROFINET
[1)] The general rules for assigning IP address and subnet masks must be adhered to	

Table 8: Ethernet Interface Properties

Two RJ-45 connectors with integrated LEDs are located on the top and on the bottom left-hand side of the housing. Refer to Chapter 16 for a description of the LEDs' function.

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

CPU and COM have their own MAC addresses. The CPU MAC address is specified on a label located above the two RJ-45 connectors (1 and 2).

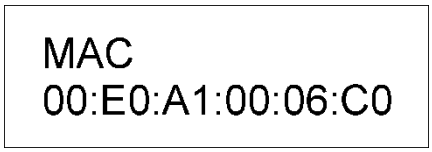


Figure 7: Sample MAC Address Label

The COM MAC address corresponds to the CPU MAC address, except for the last byte which is increased by 1.

Example:

CPU MAC address: 00:E0:A1:00:06:C0

COM MAC address: 00:E0:A1:00:06:C1

The controller is equipped with an integrated switch for Ethernet communication. For further information on switches and safe**ethernet**, refer to the system manual (HI 800 141 E).

3.4.2.2 Network Ports in Use for Ethernet Communication

UDP ports	Use
123	SNTP (time synchronization between PES and remote I/O, PES and external devices)
502	Modbus salve (can be changed by the user)
6010	safeethernet and OPC
6005 / 6012	If TCS_DIRECT was not selected in the HH network
8000	Programming and operation with SILworX
8004	Configuration of the remote I/Os using the PES (SILworX)
34 964	PROFINET endpoint mapper (required for establishing the connection)
49 152	PROFINET RPC server
49 153	PROFINET RPC client

Table 9: Network Ports (UDP Ports) in Use

TCP ports	Use
502	Modbus salve (can be changed by the user)
xxx	TCP SR assigned by the user

Table 10: Network Ports (TCP Ports) in Use

i The ComUserTask can use any port if it is not already used by another protocol.

3.4.2.3 Connections for Fieldbus Communication

The three 9-pole D-sub connectors are located on the front plate of the housing.

The fieldbus interfaces FB1 and FB2 can be equipped with fieldbus submodules. The fieldbus submodules are optional and must be installed by the manufacturer. The available fieldbus submodules are described in the communication manual (HI 801 101 E).

The fieldbus interfaces are not operational without fieldbus submodule.

Factory-made, the fieldbus interface FB3 is equipped with RS485 for Modbus (master or slave) or ComUserTask.

3.4.3 Reset Key

The controller 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 controller 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 controller.

The reset is only effective if the controller 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.

⚠ CAUTION

Fieldbus communication may be disturbed!

Prior to switching on the controller with the reset key engaged, all device fieldbus connectors must be unplugged to ensure that the fieldbus communication among other stations is not disturbed.

The fieldbus plugs may only be plugged in again when the controller is in the RUN or STOP state.

Properties and behavior of the controller 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 standard account *Administrator* with empty password.
- Loading a user program or operating system with standard connection parameters is inhibited!

  Loading is only allowed after the connection parameters and the account have been configured on the controller and the controller has been rebooted.

After a new reboot with unengaged reset key, the following 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.

3.4.4 Hardware Clock

In case of loss of operating voltage, the power provided by an integrated gold capacitor is sufficient to buffer the hardware clock for approximately one week.

3.5 Product Data

General	
Supply voltage L+	24 VDC, -15...+20 %, $r_P \leq 5$ % from a power supply unit with safe insulation in accordance with IEC 61131-2
Maximum supply voltage	30 V
Current consumption	max. 8 A (with maximum load) Idle: 0.5 A at 24 V
Fuse (external)	10 A time-lag (T)
Microprocessor	PowerPC
Total program and data memory for all user programs	5 MB less 64 kB for CRCs
Data memory for retain variables	Up to CPU OS V10.16: 8 kBytes CPU OS V10.32 and higher: 32 kBytes
Response time	≥ 6 ms.
Ethernet interfaces	4 x RJ-45, 10BASE-T/100BASE-Tx with integrated switch
Fieldbus Interfaces	3 x 9-pole D-sub FB1 and FB2 with fieldbus submodule pluggable FB3 with RS485 for Modbus (master or slave) or ComUserTask
Buffer for date/time	min. 5 days, gold capacitor
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
Degree of protection	IP20
Max. dimensions (without plug)	Width: 257 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 66 mm (with earthing screw)
Weight	approx. 1.2 kg

Table 11: Product Data

Digital inputs	
Number of inputs	20 (non-galvanically separated)
High level: Voltage Current consumption	15...30 VDC ≥ 2 mA at 15 V
Low level: Voltage Current consumption	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 Digital Inputs

Digital outputs	
Number of outputs	8 (non-galvanically separated)
Output voltage	≥ L+ minus 2 V
Output current	Channels 1...3 and 5...7: 0.5 A at ≤ 60 °C The output current of the channels 4 and 8 depends on the ambient temperature. Ambient temperature / Output current < 50 °C / 2 A 50…60 °C / 1 A
Minimum load	2 mA for each channel
Internal voltage drop	max. 2 V at 2 A
Leakage current (with low level)	max. 1 mA at 2 V
Behavior upon overload	The affected output is switched off and cyclically switched on again.
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 F30 034

The F30 034 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

F30 034	
Ambient temperature	-25…+70 °C (temperature class T1 [1)])
Output current of the digital outputs	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. Ambient temperature / Output current < 50 °C / 2 A 50…60 °C / 1 A > 60 °C / 0.5 A
Weight	approx. 1.2 kg
[1)] For more temperature classes, refer to the HIMatrix safety manual for railway applications (HI 800 437 E)	

Table 14: Product Data F30 034

The F30 034 controller meets the vibration and shock requirements in accordance with EN 61373, Category 1, Class B.

3.6 Certified F30 03 HIMatrix

Refer to the HIMatrix safety manual for more information on the standards used to certify the HIMatrix system.

The certificate and the EC type test certificate are available on the HIMA website.

4 Start-Up

To start up the controller, it must be installed, connected and configured in SILworX.

4.1 Installation and Mounting

The HIMatrix is mounted on a 35 mm (DIN) rail such as described in the HIMatrix system manual (HI 800 141 E).

When laying cables (long cables, in particular), take appropriate measures to avoid interference, e.g., by separating the signal lines from the supply 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
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
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
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
31	LS+	Sensor supply of the inputs 13...16
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
37	LS+	Sensor supply of the inputs 17...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 15: Terminal Assignment for the Digital Inputs

4.1.1.1 Surges on Digital Inputs

Due to the short cycle times of the HIMatrix systems, the digital inputs can read in a surge pulse in accordance with EN 61000-4-5 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. This measure increases the maximum response time!

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

In particular, the design must include protective measures with respect to overvoltage, lightning, earthing and plant wiring in accordance with the relevant standards and the instructions specified in the system manual (HI 800 141 E).

4.1.2 Connecting the Digital Outputs

Use the following terminals to connect the digital outputs:

Terminal	Designation	Function
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
7	L-	Ground channel group
8	5	Digital output 5
9	6	Digital output 6
10	7	Digital output 7
11	8	Digital output 8 (for increased load)
12	L-	Ground channel group

Table 16: Terminal Assignment for the Digital Outputs

4.1.3 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	4 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 17: Power Supply Cable Plug Properties

Connection to the field zone	
Number of cable plugs	7 piece, 6 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 18: Input and Output Cable Plug Properties

4.1.4 Mounting the Controller in Zone 2

The controller is suitable for mounting in the explosive atmospheres of zone 2. The special conditions X specified in the HIMatrix safety manual (HI 800 023 E) must be observed for use in zone 2.

These conditions require the controller to be mounted in an enclosure that is able to safely dissipate the generated heat.

Depending on the output load and supply voltage, the HIMatrix F30 03 has a power dissipation ranging between 12 W and 33 W.

The remote I/O must be labeled with the following Ex marking:

 II 3G Ex nA IIC T4 Gc

i When using the controller in zone 2, the permissible ambient temperature must be observed, see Chapter 3.5.

4.2 Sequence of Events Recording (SOE)

The global variables of the controller can be monitored using sequence of events recording. Global variables to be monitored are configured using SILworX; refer to the online help and the communication manual (HI 801 101 E) for further details. Up to 4000 events can be configured.

An event is composed of:

Entry data	Description
Event ID	The event ID is assigned by the PADT
Timestamp	Date (e.g., 21/11/2008) Time (e.g., 9:31:57.531)
Event state	Alarm/Normal (boolean event) LL, L, N, H, HH (scalar event)
Event quality	Quality good/ Quality bad, see www.opcfoundation.org

Table 19: Event Description

Events are recorded within the cycle of the user program. The processor system uses global variables to create the events and stores them in its non-volatile event buffer.

The event buffer includes 1000 events. If the event buffer is full, an overflow system event entry is created. Thereafter, events are no longer recorded until existing events have been read and space is once again available in the event buffer.

4.3 Configuration with SILworX

In the Hardware Editor, the controller is represented like a base plate equipped with the following modules:

- Processor module (CPU).
- Communication module (COM).
- Input module (DI 20).
- Output module (DO 8).

Double-click the module to open the Detail View with the corresponding tabs. The tabs of the I/O modules are used to assign the global variables configured in the user program to the system variables.

4.3.1 Processor Module

The following tables present the parameters for the processor module (CPU) in the same order as given in the Hardware Editor.

4.3.1.1 Tab **Module**

The **Module** tab contains the following parameters:

Parameter	Description
Name	Module name.
Activate Max. µP Budget for HH Protocol	▪ Activated: Use CPU load limit from the *Max. µP Budget for HH Protocol [%]* field. ▪ Deactivated: Do not use the CPU load limit for IP data transfer. Default setting: Deactivated
Max. µP Budget for HH Protocol [%]	Maximum module's CPU load that can be used for processing the IP data transfer. i The maximum load must be distributed among all the implemented protocols that use this communication module.
Code Generation	Up to V6: Setting compatible with existing projects. V6 and higher: Setting recommended for new projects to support safe**ethernet** reload. Default setting: V6 and higher
IP Address	IP address of the Ethernet interface. Default value: 192.168.0.99
Subnet Mask	32-bit address mask to split up the IP address in network and host address. Default value: 255.255.252.0
Standard Interface	Activated: the interface is used as standard interface for system login. Default setting: Deactivated
Default Gateway	IP address of the default gateway. Default value: 0.0.0.0

Parameter	Description
ARP Aging Time [s]	A processor or COM module stores the MAC addresses of the communication partners in a MAC/IP address assignment table (ARP cache). The MAC address remains stored in the ARP cache, if messages from the communication partner are received in a period of 1x...2x *ARP Aging Time*. The MAC address is erased from the ARP cache, if no messages from the communication partner are received in a period of 1x...2x *ARP Aging Time*. The typical value for the *ARP Aging Time* in a local network ranges from 5...300 s. The user cannot read the contents of the ARP cache. Range of values: 1...3600 s. Default value: 60 s. **Notice:** If routers or gateways are used, the *ARP Aging Time* must be adjusted (increased) due to the additional time required for two-way transmission. If the *ARP Aging Time* is too low, the processor or the COM module deletes the MAC address of the communication partner from the ARP cache and communication is either delayed or breaks down entirely. For an efficient performance, the *ARP Aging Time* value must be greater than the receive timeout set for the protocols in use.
MAC Learning	*MAC Learning* and *ARP Aging Time* are used to set how quick the Ethernet switch should learn the MAC address. The following settings are possible: ▪ Conservative (recommended): If the ARP cache already contains MAC addresses of communication partners, these are locked and cannot be replaced by other MAC addresses for at least 1 *ARP Aging Time* and a maximum of 2 *ARP Aging Time* periods. This ensures that data packets cannot be intentionally or unintentionally forwarded to external network subscribers (ARP spoofing). ▪ Tolerant: When a message is received, the IP address contained in the message is compared to the data in the ARP cache and the MAC address stored in the ARP cache is immediately overwritten with the MAC address from the message. The *Tolerant* setting must be used if the availability of communication is more important than the authorized access to the controller. Default setting: Conservative.
IP Forwarding	The function is not supported. Default setting: Deactivated

Parameter	Description
ICMP Mode	ICMP (Internet Control Message Protocol) allows the higher protocol layers to detect error states on the network layer and optimize the transmission of data packets. Message types of ICMP supported by the processor module: ▪ No ICMP Responses All the ICMP commands are deactivated. This ensures a high degree of safety against potential sabotage that might occur over the network. ▪ Echo Response If Echo Response is activated, the node responds to a ping command. It is thus possible to determine if a node can be reached. Safety is still high. ▪ Host Unreachable Not important for the user. Only used for testing at the manufacturer's facility. ▪ All Implemented ICMP Responses All ICMP commands are activated. This allows a more detailed diagnosis of network malfunctions. Default setting: Echo Response

Table 20: CPU and COM Configuration Parameters, **Module** Tab

4.3.1.2 Tab **Routings**

The **Routings** tab contains the routing table. This table is empty if the module is new. A maximum of 8 routing entries are possible.

Parameter	Description
Name	Denomination of the routing settings.
IP Address	Target IP address of the communication partner (with direct host routing) or network address (with subnet routing). Range of values: 0.0.0.0...255.255.255.255 Default value: 0.0.0.0
Subnet Mask	Define the target address range for a routing entry. 255.255.255.255 (with direct host routing) or subnet mask of the addressed subnet. Range of values: 0.0.0.0...255.255.255.255 Default value: 255.255.252.0
Gateway	IP address of the gateway to the addressed network. Range of values: 0.0.0.0...255.255.255.255 Default value: 0.0.0.1

Table 21: Routing Parameters for CPU and COM

4.3.1.3 Tab **Ethernet Switch**

The **Ethernet Switch** tab contains the following parameters:

Parameter	Description
Name	Name of the port (Eth1...Eth4) as printed on the housing; per port, only one configuration may exist.
Speed [MBit/s]	10: Data rate 10 Mbit/s 100: Data rate 100 Mbit/s Autoneg: Automatic baud rate setting. Default value: Autoneg
Flow Control	Full duplex: Simultaneous communication in both directions. Half duplex: Communication in one direction. Autoneg: Automatic communication control. Default value: Autoneg
Autoneg also with fixed values	The *Advertising* function (forwarding the speed and flow control properties) is also performed if the parameters *Speed* and *Flow Control* have fixed values. This allows other devices with ports set to *Autoneg* to recognize the HIMax port settings. Default setting: Activated
Limit	Limit the inbound multicast and/or broadcast packets. Off: No limitation Broadcast: Limit broadcast (128 kbit/s) Multicast and broadcast: Limit multicast and broadcast (1024 kbit/s). Default value: Broadcast

Table 22: Ethernet Switch Parameters

4.3.1.4 Tab **VLAN** (Port-Based VLAN)

For configuring the use of port-based VLAN.

i Should VLAN be supported, port-based VLAN should be off to enable each port to communicate with the other switch ports.

For each switch port, the user can define which other switch ports received Ethernet frames may be sent to, refer to Figure 6.

The table in the VLAN tab contains entries through which the connection between two ports can be set to active or inactive.

	Eth1	Eth2	Eth3	Eth4	COM
Eth1					
Eth2	Active				
Eth3	Active	Active			
Eth4	Active	Active	Active		
COM	Active	Active	Active	Active	
CPU	Active	Active	Active	Active	Active

Table 23: **VLAN** Tab

4.3.1.5 Tab **LLDP**

LLDP (Link Layer Discovery Protocol) periodically sends information per multicast via the own device (e.g., MAC address, device name, port number) and receives the same information from the neighboring devices.

LLDP uses the following values depending on whether PROFINET is configured on the communication module:

PROFINET on the COM module	Chassis ID	TTL (Time to Live)
Used	Device name	20 s
Not used	MAC address	120 s

Table 24: Values for LLDP

The processor and communication modules support LLDP on the Eth1, Eth2, Eth3 and Eth4 ports.

The following parameters define how a given port should work:

Off	LLDP is disabled on this port.
Send	LLDP sends LLDP Ethernet frames, received LLDP Ethernet frames are deleted without being processed.
Receive	LLDP sends no LLDP Ethernet frames, but received LLDP Ethernet frames are processed.
Send/Receive	LLDP sends and processes received LLDP Ethernet frames.

Default setting: Off.

4.3.1.6 Tab **Mirroring**

Mirroring is used to configure whether the module should duplicate Ethernet packets on a given port such that they can be read from a device connected to that port, e.g., for test purposes.

The following parameters define how a given port should work:

Off	This port does not participate to the mirroring process.
Egress	Outgoing data of this port are duplicated.
Ingress/Egress	Incoming and outgoing data of this port are duplicated.
Dest Port	This port is used to send duplicated data.

Default setting: Off.

4.3.2 Communication Module

The communication module contains the **Module** and the **Routings** tabs. Their content is identical to those of the processor module, see Table 20 and Table 21.

4.3.3 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.

4.3.4 Digital Inputs for F30

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

4.3.4.1 Tab **Module**

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

System parameters	Data type	R/W	Description
DI Number of Pulsed Outputs	USINT	W	CPU OS V11 and higher: Without function Up to CPU OS V10: Number of pulsed outputs (supply outputs) Coding / Description: 0 – No pulsed output planned for detection of SC/OC [1)] 1 – Pulsed output 1 planned for detection of SC/OC [1)] 2 – Pulsed outputs 1 and 2 planned for detection of SC/OC [1)] … – … 8 – Pulsed output 1...8 planned for detection of SC/OC [1)] **Pulsed outputs must not be used as safety-related outputs!**
DI Pulse Slot	UDINT	W	Pulse module slot (detection of SC/OC [1]), set the value to 3
DI Pulse Delay [µs]	UINT	W	Waiting time for line control (detection of short-circuits or cross-circuits) Range of values 0...2000 µs Default value: 0 µs, waiting time: 400 µs
DI.Error Code	WORD	R	Error codes for all digital inputs 0x0001 – Fault within the digital inputs 0x0002 – Test of test pattern faulty
Module Error Code	WORD	R	Module error code 0x0000 – I/O processing, if required with errors See other error codes 0x0001 – No I/O processing (CPU not in RUN) 0x0002 – No I/O processing during the booting test 0x0004 – Manufacturer interface operating 0x0010 – No I/O processing: invalid configuration 0x0020 – No I/O processing: fault rate exceeded 0x0040/ 0x0080 – No I/O processing: configured module not plugged in
Module SRS	UDINT	R	Slot number (System.Rack.Slot)
Module Type	UINT	R	Type of module, setpoint: 0x00A5 [165_{dec}]

[1)] SC/OC (SC = short-circuit, OC = open-circuit)

Table 25: System Parameter for Digital Inputs, **Module** Tab

4.3.4.2 Tab **DI 20: Channels**

The **DI 20: Channels** tab contains the following system parameters.

<table>
<tr><th>System parameters</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, preset and not changeable</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 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 DO and digital input DI, for instance:
▪ Open-circuit
▪ Open switch
▪ L+ undervoltage</td></tr>
<tr><td>0x90</td><td>Cross-circuit</td></tr>
</table></td></tr>
<tr><td>-> Value [BOOL]</td><td>BOOL</td><td>R</td><td>Input values for the digital input channels
0 = input de-energized
1 = input energized</td></tr>
<tr><td>Pulsed Output [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 26: System Parameters for Digital Inputs, **DI 20: Channels** Tab

4.3.5 Digital Outputs for F30

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

4.3.5.1 Tab **Module**

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

System parameters	Data type	R/W	Description
DO.Error Code	WORD	R	Error codes for all digital outputs Coding: Description 0x0001: Fault within the digital outputs 0x0002: Test of safety shutdown returns a fault [1)] 0x0004: Test of auxiliary voltage returns a fault [1)] 0x0008: Test of test pattern faulty. 0x0010: Test of output switch test pattern faulty [1)] 0x0020: Test of output switch test pattern (shutdown test of the outputs) faulty [1)] 0x0040: Test: Active shutdown via WD faulty [1)] 0x0200: All outputs switched off, total current exceeded 0x0400: Test: 1st temperature threshold exceeded 0x0800: Test: 2nd temperature threshold exceeded 0x1000: Test: Monitoring of auxiliary voltage 1: Undervoltage
Module 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
Module SRS	UDINT	R	Slot number (System.Rack.Slot)
Module Type	UINT	R	Type of module, setpoint: 0x00B4 [180_{dec}]
[1)] If the error or fault is present for longer than 24 h, the safety-related reaction is triggered			

Table 27: System Parameter for Digital Outputs, **Module** Tab

4.3.5.2 Tab **DO 8: Channels**

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

System parameters	Data type	R/W	Description
Channel no.	---	R	Channel number, preset and not changeable
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: 0x01 – Fault in the digital output module 0x02 – Channel shutdown due to overload 0x04 – Error while reading back the digital outputs 0x08 – Error while reading back the status of the digital outputs
Value [BOOL] ->	BOOL	W	Output value for DO channels: 1 = output energized 0 = output de-energized **Pulsed outputs must not be used as safety-related outputs!**

Table 28: System Parameters for Digital Outputs, **DO 8: Channels** Tab

5 Operation

The controller F30 is ready for operation. No specific monitoring is required for the controller.

5.1 Handling

Handling of the controller during operation is not required.

5.2 Diagnosis

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

The device diagnostic history can also be read using SILworX.

6 Maintenance

No maintenance measures are required during normal operation.

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

Only the manufacturer is authorized to repair the device or module.

6.1 Faults

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

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

If the test harness detects 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.
- Performing the proof test.

6.2.1 Loading the Operating System

HIMA is continuously improving the operating system of the devices.

HIMA recommends using system downtimes to load a current version of the operating system into the devices.

Refer to the release list to check the impact 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.

Refer to the system manual (HI 800 141 E) for further details on how to load the operating systems.

6.2.2 Proof Test

HIMatrix devices and modules must be subject 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, the components must be transported in packaging.

Always store the components in their original product packaging. This packaging also provides protection against electrostatic discharge (ESD). Notice that the product packaging alone is not suitable for transport.

9 Disposal

Industrial customers are responsible for correctly disposing of decommissioned 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
AI	Analog input
AO	Analog output
ARP	Address resolution protocol, network protocol for assigning the network addresses to hardware addresses
COM	Communication module
CRC	Cyclic redundancy check
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European norm
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
HW	Hardware
ICMP	Internet control message protocol, network protocol for status or error messages
IEC	International electrotechnical commission
Interference-free	Inputs are designed for interference-free operation and can be used in circuits with safety functions
MAC	Media access control address, hardware address of one network connection
PADT	Programming and debugging tool (in accordance with IEC 61131-3), PC with SILworX
PE	Protective earth
PELV	Protective extra low voltage
PES	Programmable electronic system
R	Read, the variable is read out
R/W	Read/Write (column title for system variable type)
r_P	Peak value of a total AC component
SC/OC	Short-circuit/open-circuit
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
SNTP	Simple network time protocol (RFC 1769)
SRS	System.Rack.Slot, addressing of a module
SW	Software
TMO	Timeout
W	Write, the variable receives a value, e.g., from the user program
WD	Watchdog, device for monitoring the system's correct operation Signal for fault-free process
WDT	Watchdog time

Index of Figures

Figure 1: Connections to Safety-Related Digital Inputs 9
Figure 2: Line Control 10
Figure 3: Connection of Actuators to Outputs 11
Figure 4: Sample Type Label 12
Figure 5: Front View 13
Figure 6: Block Diagram 13
Figure 7: Sample MAC Address Label 17

Index of Tables

Table 1:	Additional Relevant Documents	5
Table 2:	Available Variants	12
Table 3:	Blinking Frequencies of LEDs	14
Table 4:	Operating Voltage LED	14
Table 5:	System LEDs	16
Table 6:	Ethernet Indicators	16
Table 7:	I/O LEDs	16
Table 8:	Ethernet Interface Properties	17
Table 9:	Network Ports (UDP Ports) in Use	18
Table 10:	Network Ports (TCP Ports) in Use	18
Table 11:	Product Data	20
Table 12:	Specifications for Digital Inputs	20
Table 13:	Specifications for the Digital Outputs	21
Table 14:	Product Data F30 034	21
Table 15:	Terminal Assignment for the Digital Inputs	23
Table 16:	Terminal Assignment for the Digital Outputs	23
Table 17:	Power Supply Cable Plug Properties	24
Table 18:	Input and Output Cable Plug Properties	24
Table 19:	Event Description	25
Table 20:	CPU and COM Configuration Parameters, Module Tab	28
Table 21:	Routing Parameters for CPU and COM	28
Table 22:	Ethernet Switch Parameters	29
Table 23:	VLAN Tab	29
Table 24:	Values for LLDP	30
Table 25:	System Parameter for Digital Inputs, Module Tab	31
Table 26:	System Parameters for Digital Inputs, DI 20: Channels Tab	32
Table 27:	System Parameter for Digital Outputs, Module Tab	33
Table 28:	System Parameters for Digital Outputs, DO 8: Channels Tab	34

Index

Block diagram 13
Diagnosis 35
Fault reactions
  Digital inputs 10
  Digital outputs 11
Front view 13
Line Control 10
safe**ethernet** 17
Safety function 9
Specifications 20
SRS 12
Surge 23

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