HIMatrix

Safety-Related Controller

F35 01 Manual

HIMA Paul Hildebrandt GmbH + Co KG

Industrial Automation

Rev. 2.00

HI 800 149 E

Contact

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Revision index	Revisions	Type of change	
		technical	editorial
1.00	Added: Configuration with SILworX, Chapter *Connection Variants*	X	X
1.01	Deleted: Chapter *Monitoring the Temperature State* integrated in the system manual		X
1.02	Revised: Chapters 3.1.1, 3.4.2, 3.5 and 4.5 Added: F35 014, SIL 4 certified according to EN 50126, EN 50128 and EN 50129	X	X
2.00	Revised: Chapter 3.4.1 Added: Chapter 4.1.5	X	X

Table of Contents

1 Introduction

This manual describes the technical characteristics of the device and its use. It provides information on how to install, start up and configure the module.

1.1 Structure and Use of this Manual

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

This manual is organized in the following main chapters:

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

HIMatrix controllers are available for the programming tools SILworX and ELOP II Factory. Which programming tool can be used, depends on the processor operating system of the HIMatrix controller, refer to the following table:

Programming tool	Processor operating system	Communication operating system
SILworX	CPU OS V7 and higher	COM OS V12 and higher
ELOP II Factory	CPU OS up to V6.x	COM OS up to V11.x

Table 1: Programming Tools for HIMatrix Controllers

In the manual, the differences are specified by using:

- Separated chapters
- Tables differentiating among the versions

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

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

Additionally, the following documents must be taken into account:

Name	Content	Document number
HIMatrix System Manual Compact Systems	Hardware description of the HIMatrix compact systems	HI 800 141 E
HIMatrix System Manual Modular System F60	Hardware description of the HIMatrix modular system	HI 800 191 E
HIMatrix Safety Manual	Safety functions of the HIMatrix system	HI 800 023 E
HIMatrix Safety Manual for Railway Applications	Safety functions of the HIMatrix system using the HIMatrix in railway applications	HI 800 437 E
SILworX Communication Manual	Description of the communication protocols, ComUserTask and their configuration in SILworX	HI 801 101 E
HIMatrix PROFIBUS DP Master/Slave Manual	Description of the PROFIBUS protocol and its configuration in ELOP II Factory	HI 800 009 E
HIMatrix Modbus Master/Slave Manual	Description of the Modbus protocol and its configuration in ELOP II Factory	HI 800 003 E
HIMatrix TCP S/R Manual	Description of the TCP S/R protocol and its configuration in ELOP II Factory	HI 800 117 E
HIMatrix ComUserTask (CUT) Manual	Description of the ComUserTask and its configuration in ELOP II Factory	HI 800 329 E
SILworX Online Help	Instructions on how to use SILworX	-
ELOP II Factory Online Help	Instructions on how to use ELOP II Factory, Ethernet IP protocol	-
SILworX First Steps	Introduction to SILworX using the HIMax system as an example	HI 801 103 E
ELOP II Factory First Steps	Introduction to ELOP II Factory	HI 800 006 E

Table 2: Additional Relevant Documents

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

1.2 Target Audience

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

1.3 Formatting Conventions

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

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

Safety notes and operating tips are particularly marked.

1.3.1 Safety Notes

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

- Signal word: warning, caution, notice
- Type and source of risk
- Consequences arising from non-observance
- Risk prevention

⚠ SIGNAL WORD

Type and source of risk!
Consequences arising from non-observance
Risk prevention

The signal words have the following meanings:

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

NOTE

Type and source of damage!
Damage prevention

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

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

Useful tips and tricks appear as follows:

TIP The tip text is located here.

2 Safety

All safety information, notes and instructions specified in this document must be strictly observed. The product may only be used if all guidelines and safety instructions are adhered to.

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

2.1 Intended Use

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

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

2.1.1 Environmental Requirements

Requirement type	Range of values [1]
Protection class	Protection class III in accordance with IEC/EN 61131-2
Ambient temperature	0...+60 °C
Storage temperature	-40...+85 °C
Pollution	Pollution degree II in accordance with IEC/EN 61131-2
Altitude	< 2000 m
Housing	Standard: IP20
Supply voltage	24 VDC

[1] The values specified in the technical data apply and are decisive for devices with extended environmental requirements.

Table 3: Environmental Requirements

Exposing the HIMatrix system to environmental conditions other than those specified in this manual can cause the HIMatrix system to malfunction.

2.1.2 ESD Protective Measures

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

NOTE

Device damage due to electrostatic discharge!

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

2.2 Residual Risk

No imminent risk results from a HIMatrix system itself.

Residual risk may result from:

- Faults related to engineering
- Faults related to the user program
- Faults related to the wiring

2.3 Safety Precautions

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

2.4 Emergency Information

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

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

3 Product Description

The safety-related **F35** controller is a compact system in a metal housing with 24 digital inputs, 8 digital outputs, 2 counters and 8 analog inputs.

The controller is available in various model variants for SILworX and ELOP II Factory, see Table 6.

The device is suitable for mounting in Ex-zone 2, see Chapter 4.1.6.

The device is TÜV-certified for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061), Cat. 4 and PL e (EN ISO 13849-1) and SIL 4 (EN 50126, EN 50128 and EN 50129).
Further safety standards, application standards and test standards are specified in the certificates available on the HIMA website.

3.1 Safety Function

The controller is equipped with safety-related digital inputs and outputs, safety-related counters and safety-related analog inputs.

3.1.1 Safety-Related Digital Inputs

The controller is equipped with 24 digital inputs. The state (HIGH, LOW) of each input is signaled by an individual LED.

i The LEDs for the digital inputs are activated by the program if the F35 is in RUN.

The input signals are captured analogically and made available as INT values from 0...3000 (0...30 V) to the program.

i The digital inputs must not be used as safety-related analog inputs!

Configurable thresholds are used to generate BOOL values.

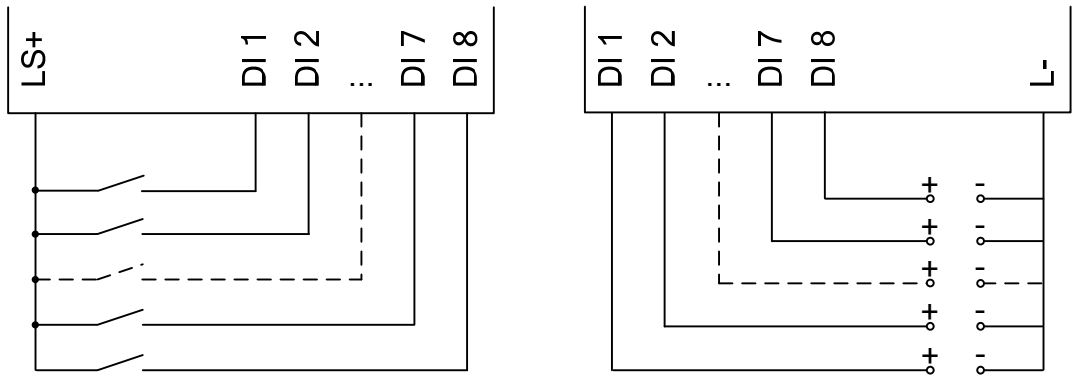
The default setting is:

Low level: < 7 V High level: > 13 V

The thresholds are set using system parameters, see Table 43 and Table 44. A difference of at least 2 V must be maintained between the thresholds.

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 8 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, however, 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

The detection of short-circuits and open circuits cannot be configured for the F35 system, e.g., on EMERGENCY STOP inputs complying with Cat. 4 and PL e in accordance with EN ISO 13849-1.

Line monitoring for digital outputs is possible, see Chapter 3.1.4.1.

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

Within a temperature range of 60…70 °C, all outputs of the F35 014 can be loaded with 0.5 A, see Table 28.

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 24.

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

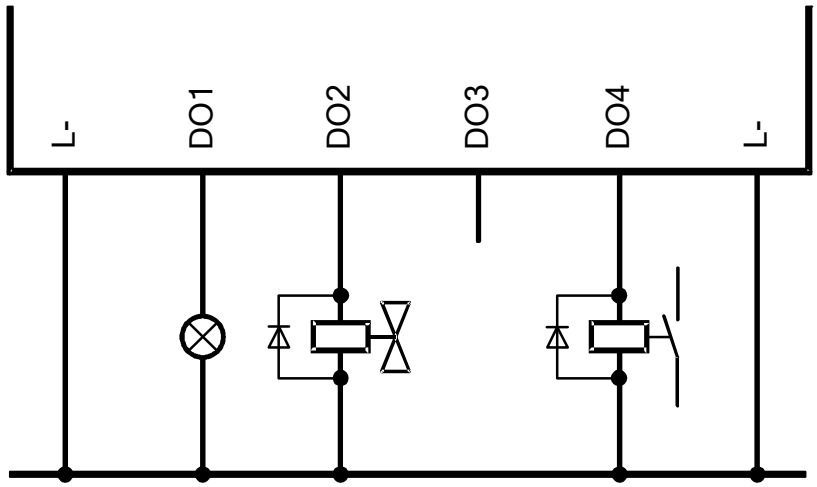


Figure 2: Connection of Actuators to Outputs

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 module output is set to the safe (de-energized) state using the safety switches.

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

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

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

3.1.3 Safety-Related Counters

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

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

Input A is the counter input, B is the count direction input and input Z (zero track) is used to reset.

Alternatively, all inputs are 3-bit Gray code inputs (in decoder operation)

The following modes of operation can be implemented:

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

Refer to Chapter 3.4.3 for more details on how to configure the counters.

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

3.1.3.1 Reaction in the Event of a Fault

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

The device activates the *FAULT* LED.

In addition to the status bit, the user program must also consider the corresponding error code.

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

3.1.4 Safety-Related Analog Inputs

The controller is equipped with 8 analog inputs with transmitter supplies for the unipolar measurement of voltages of 0...10 V, referenced to L-. With a shunt, also currents of 0...20 mA can be measured.

Input channels	Polarity	Current, voltage	Range of values in the application		Safety-related accuracy
			FS1000[1)]	FS2000[1)]	
8	Unipolar	0...+10 V	0…1000	0…2000	2 %
8	Unipolar	0…20 mA	0…500[2)] 0…1000[3)]	0…1000[2)] 0…2000[3)]	2 %

[1)] can be configured by selecting the type in the programming tool
[2)] with external Z 7301 shunt adapter, see 4.1.4.1
[3)] with external Z 7302 shunt adapter, see 4.1.4.1

Table 4: Input Values for the Analog Inputs

The resolution of the voltage and the current values depends on the parameter set in the properties of the controller.

In SILworX, the *FS 1000 / FS 2000* system parameter can be selected in the Module tab (Module of the digital and analog inputs MI 24/8). Depending on the selection, different resolutions result in the user program for the *AI[xx].Value* system parameter, see Chapter 4.3.4.1.
To monitor the *AI[xx].Value* parameter, evaluate the corresponding *AI[xx].Error Code* parameter in the user program.

In ELOP II Factory, set the 1000 resolution (MI 24/8 FS 1000) or 2000 resolution (MI 24/8 FS2000) in the **Type** field (menu: Properties, module: Analog Inputs). Depending on the selection, different resolutions result in the user program for the *AI[xx].Value* system parameter, see Chapter 4.4.4.
To monitor the *AI[xx].Value* parameter, evaluate the corresponding *AI[xx].Error Code* parameter in the user program.

The input signals are evaluated in accordance with the de-energized to trip principle.

Only shielded cables with a length of a maximum of 300 m must be connected to the analog inputs. Each analog input must be connected to a twisted pair of wires. The shielding must be connected to the controller and the sensor housing and earthed on one end to the controller side to form a Faraday cage.

Unused analog inputs must be short-circuited.

If an open-circuit occurs during voltage measurement (the line is not monitored), any input signals are processed on the high-resistance inputs. The value resulting from this fluctuating input voltage is not reliable. Therefore with voltage inputs, the channels must be terminated by a 10 kΩ resistor. The internal resistance of the source must be taken into account.

For a current measurement with the shunt connected in parallel, the 10 kΩ resistor is not required.

The analog inputs have a common ground L-.

The analog inputs are designed to retain the metrological accuracy for 10 years. A proof test must be performed every 10 years.

3.1.4.1 Line Monitoring for Digital Outputs

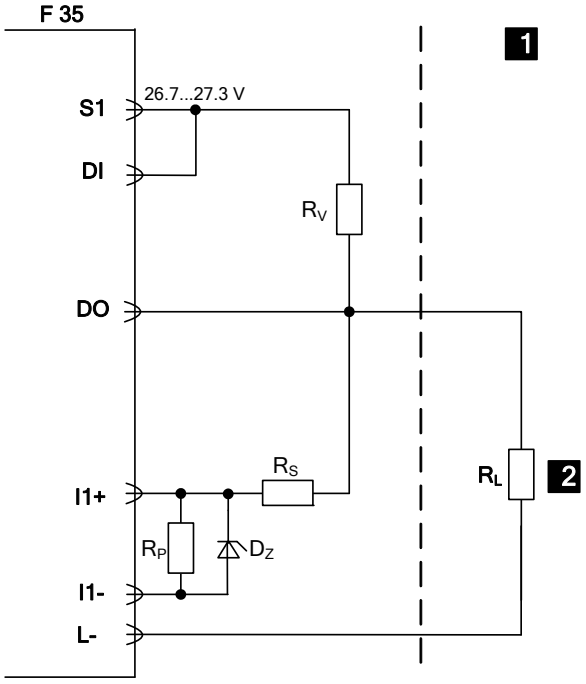
The analog inputs can be used to monitor the digital outputs for short-circuits and open-circuits.

Figure 3 shows a circuitry for line monitoring (open-circuits and short-circuits) that complies with SIL 3. Additionally, the S1 supply voltage is monitored via a digital input DI.

In this application, the actuator (e.g., solenoid valve) is connected to the digital output between DO and L-.

All specified electronic components must be directly attached to the clamps.

The reaction to open-circuits and short-circuits must be configured in the user program.



1 Field Zone 2 Actuator

Figure 3: Circuitry for Line Monitoring

Designation	Value	Description
R_V	2.0 kΩ / 0.5 W	Resistor
R_S	2.0 kΩ / 0.5 W	Resistor
R_P	100 kΩ	Resistor
D_Z	11 V ± 5 % / 0.3 W	Z-diode
R_L	75 Ω	Load resistor (e.g., solenoid valve)

Table 5: Values for Circuitry for Line Monitoring

3.1.4.2 Reaction in the Event of a Fault

If the device detects a fault on an analog input, the *AI.Error Code* parameter is set to a value greater than 0. If a device fault occurred, the SILworX system parameter *Module Error Code* is set to a value greater than 0, or if ELOP II Factory is used, the *Module.Error Code* signal is set to a value greater than 0.

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

In addition to the analog value the the error code must be evaluated. The analog value must be configured to ensure a safety-related reaction.

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

3.2 Equipment, Scope of Delivery

The following table specifies the available controller variants:

Designation	Description
F35 01	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: 0...+60 °C, for ELOP II Factory programming tool
F35 011 (-20 °C)	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -20...+60 °C, for ELOP II Factory programming tool
F35 012 (subsea / -20 °C)	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -20...+60 °C, subsea type approval according to ISO 13628-6, for ELOP II Factory programming tool
F35 014	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -25...+70 °C (temperature class T1), Vibration and shock tested according to I EN 50125-3 and EN 50155, class 1B according to IEC 61373, for ELOP II Factory programming tool
F35 01 SILworX	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: 0...+60 °C, for SILworX programming tool
F35 011 SILworX (-20 °C)	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -20...+60 °C, for SILworX programming tool
F35 012 SILworX (subsea / -20 °C)	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -20...+60 °C, subsea type approval according to ISO 13628-6, for SILworX programming tool
F35 014 SILworX	Controller (24 digital inputs, 8 digital outputs, 2 counters, 8 analog inputs), Operating temperature: -25...+70 °C (temperature class T1), Vibration and shock tested according to EN 50125-3 and EN 50155, class 1B according to IEC 61373, for SILworX programming tool

Table 6: Available Variants

3.2.1 IP Address and System ID (SRS)

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

IP___.___.___.___SRS____.__.__

Default value for IP address:	192.168.0.99
Default value for SRS:	60 000.0.0

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

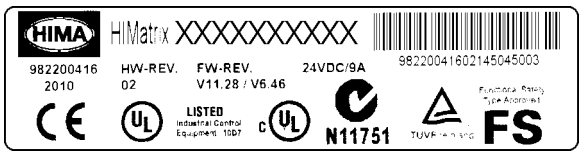


Figure 4: Sample Type Label

3.4 Structure

This chapter describes the layout and function of the controller, and its connection for communication.

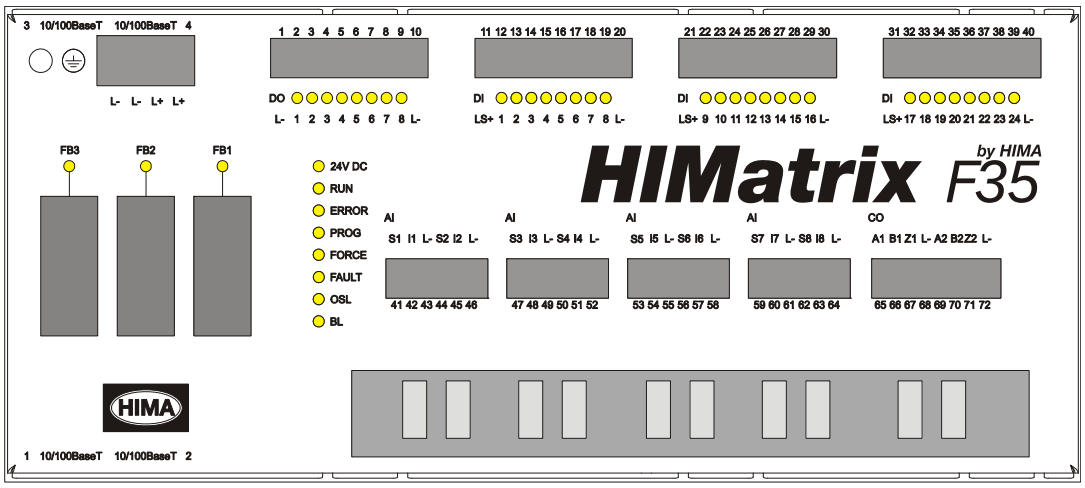
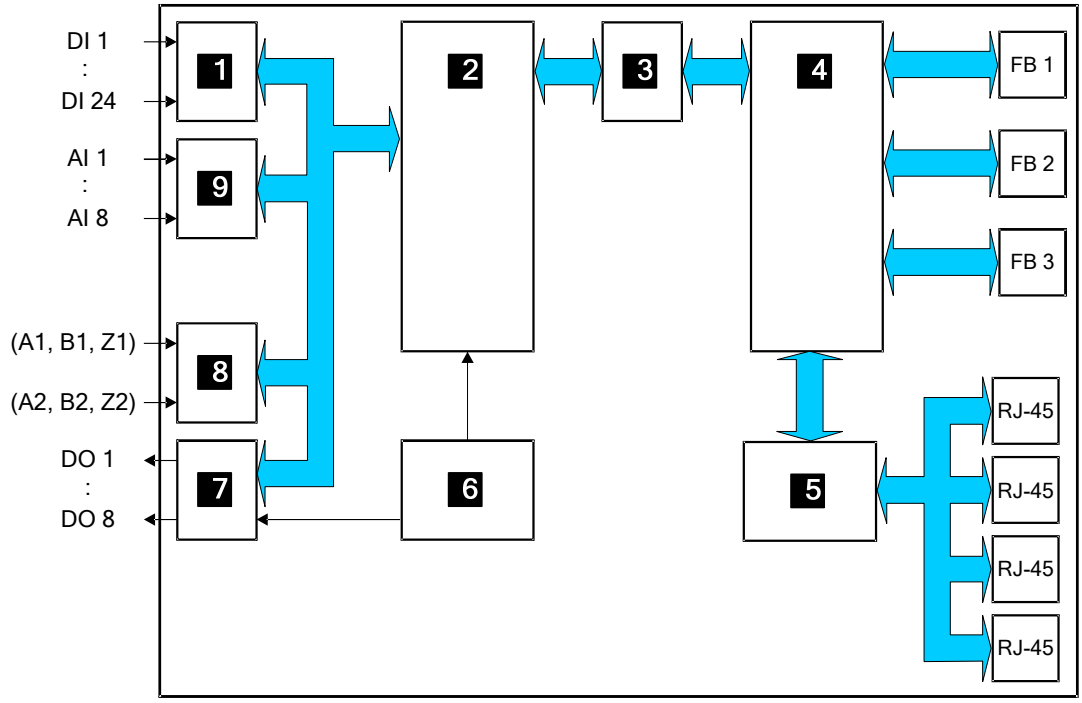


Figure 5: Front View



1 Digital Inputs
2 Safety-Related Processor System (CPU)
3 Dual Port RAM
4 Communication System (COM)
5 Switch
6 Watchdog
7 Digital Outputs
8 Counter, 2 Channels
9 Analog Inputs

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

Function and meaning of the system LEDs and communication LEDs depend on the CPU operating system (and thus on the COM operating system).

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

Definition of Blinking Frequencies

The following table defines the blinking frequencies of the LEDs:

Name	Blinking frequencies
Blinking	Non-specified blinking, with CPU OS up to V7.x
Blinking1	Long (approx. 600 ms) on, long (approx. 600 ms) off, with CPU OS V8 and higher
Blinking-x	Ethernet communication: Blinking synchronously with data transfer, with CPU OS V8 and higher

Table 7: Blinking Frequencies of LEDs

3.4.1.1 Operating Voltage LED

The operating voltage LED does not depend on the CPU operating system in use.

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

Table 8: Operating Voltage LED

3.4.1.2 System LEDs

System LEDs with CPU OS V8 and Higher

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.
		Blinking1	▪ Device in STOP ▪ A new operating system is being loaded.
		Off	The device is not in the RUN or STOP state.
ERROR	Red	On	Missing license for additional functions (communication protocols, reload), test mode.
		Blinking1	▪ The device is in the ERROR STOP state. Internal module faults detected by self-tests, e.g., hardware or voltage supply. The processor system can only be restarted with a command from the PADT (reboot). ▪ Fault while loading the operating system.
		Off	No faults detected.
PROG	Yellow	On	▪ A new configuration is being loaded into the device. ▪ A new operating system is being loaded. ▪ WDT or FTT change ▪ SRS change
		Off	None of the described events occurred.
FORCE	Yellow	On	Forcing prepared: The force switch is set for a variable, the force main switch is still deactivated. The device is in the RUN or STOP state.
		Blinking1	Forcing is active: At least one local or global variable has adopted the corresponding force value.
		Off	Forcing is not activated.
FAULT	Yellow	On/Blinking1	▪ Fault while loading a new operating system ▪ The new operating system is corrupted (after OS download). ▪ The loaded configuration is not valid. ▪ At least one I/O fault has been detected.
		Off	None of the described faults occurred.
OSL	Yellow	Blinking1	Operating system emergency loader active.
		Off	Operating system emergency loader not active.
BL	Yellow	On/Blinking1	▪ OS and OSL binary defective or INIT_FAIL hardware fault. ▪ Fault in the external process data communication.
		Off	None of the described events occurred.

Table 9: System LEDs with CPU OS V8 and Higher

System LEDs with CPU OS up to V6.x

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.
		Blinking	Device in STOP. No user program is being processed.
		Off	The device is in the ERROR STOP state, see ERROR LED.
ERROR	Red	On	Internal module faults detected by self-tests, e.g., hardware or cycle time overrun. The CPU stopped the user program execution, terminated all hardware and software tests and reset all outputs. The processor system can only be restarted with a command from the PADT (reboot).
		Off	No faults detected.
PROG	Yellow	On	A new configuration is being loaded into the device.
		Blinking	A new operating system is being loaded into the flash ROM. The LED also blinks during the device's initialization phase.
		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.
FAULT	Yellow	On	▪ Line control fault indicator ▪ The user program caused a fault. ▪ The device configuration is not valid. ▪ Loading of the new operating system was not successful and the operating system is corrupted.
		Blinking	▪ While the operating system was being updated, a fault occurred during the write cycle of a flash ROM. ▪ 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 not active.
BL	Yellow	Blinking	OS and OSL binary defective or hardware fault, INIT_FAIL.
		Off	None of the described faults occurred.

Table 10: System LEDs with CPU OS up to V6

3.4.1.3 Communication LEDs

All RJ-45 connectors are provided with a small green and a yellow LEDs.

Communication LEDs with CPU OS V8 and Higher

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 11: Ethernet Indicators with CPU OS V8 and Higher

Communication LEDs up to CPU OS V6.x

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 12: Ethernet Indicators up to CPU OS V6.x

3.4.1.4 I/O LEDs

LED	Color	Status	Description
DI 1…24	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 13: I/O LEDs

3.4.1.5 Fieldbus LEDs

LEDs FB1…3 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 corresponding communication manual for more details on the function of the LEDs.

3.4.2 Communication

The controller communicates with remote I/Os via safe**ethernet**.

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: safe**ethernet** ▪ Standard protocols: Programming and debugging tool (PADT), OPC, Modbus TCP, TCP-SR, SNTP, EtherNet/IP[2)]
[1)] The general rules for assigning IP address and subnet masks must be adhered to. [2)] EtherNet/IP is not supported in SILworX.	

Table 14: Ethernet Interfaces 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 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 controller is specified on a label located above the two RJ-45 connectors (1 and 2).

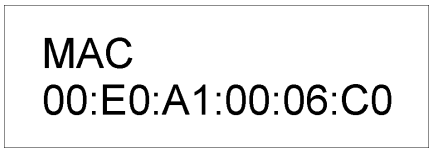


Figure 7: Sample MAC Address Label

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

3.4.2.2 Network Ports Used for Ethernet Communication

UDP ports	Use
8000	Programming and operation with the programing tool
8001	Configuration of the remote I/O using the PES (ELOP II Factory)
8004	Configuration of the remote I/O using the PES (SILworX)
6010	safe**ethernet** and OPC
123	SNTP (time synchronization between PES and remote I/O, PES and external devices)
6005 / 6012	If TCS_DIRECT was not selected in the HH network
502	Modbus (can be modified by the user)
44 818	EtherNet/IP session protocol for device identification
2222	EtherNet/IP Data Exchange

Table 15: Network Ports (UDP Ports) in Use

TCP ports	Use
502	Modbus (can be modified by the user)
xxx	TCP SR assigned by the user
44 818	EtherNet/IP Explicit Messaging Services

Table 16: Network Ports (TCP Ports) in Use

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 mounted by the manufacturer. The available fieldbus submodules are described in the SILworX 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 Mode of Operation of the Counters

Both counters for the F35 are configured via system variables which are described in Chapter 4.3.3 and Chapter 4.4.6.

The following modes of operation can be implemented:

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

3.4.3.1 Counter Function 1 (depending on the count direction input signal)

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

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

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

Configuration of counter function 1:

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

Table 17: Configuration of Counter Function 1

3.4.3.2 Counter Function 2 (irrespective of the count direction input signal)

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

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

Counter[0x].Direction system variable is set to FALSE: counter value increment (higher vale),
Counter[0x].Direction system variable is set to TRUE: counter value decrement (lower value).

Input B1 (B2) has no function.

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

Configuration of counter function 2:

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

Table 18: Configuration of Counter Function 2

3.4.3.3 Decoder Operation for Gray Code

The 3-bit Gray code of a rotary transducer connected to the inputs A1, B1, Z1 (A2, B2, Z2) is evaluated.

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

Configuration of decoder operation:

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

Table 19: Configuration of Decoder Operation

3.4.3.4 Comparing the Codes Used

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

3-bit Gray code	Decimal value	Counter[0x].Value
000	0	0
001	1	1
011	2	3
010	3	2
110	4	6
111	5	7
101	6	5
100	7	4

Table 20: Comparison of the Codes Used

3.4.4 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 default account administrator with empty password.
- With COM operating system version 10.42 and higher, loading a user program or operating system with default connection parameters is inhibited!
  The loading procedure 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 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.

3.4.5 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	
User memory	Versions prior to 6.46: max. 500 kB user program, max. 500 kB user data Version 6.100: max. 2047 kB user program, max. 2047 kB user data Version 7 and higher: max. 1023 kB user program, max. 1023 kB user data
Response time	≥ 20 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
Operating voltage	24 VDC, -15...+20 %, r_{PP} ≤ 15 %, from a power supply unit with safe insulation in accordance with IEC 61131-2
Current input	max. 9 A (with maximum load) Idle: 0.5 A
Fuse (external)	10 A time-lag (T)
Buffer for date/time	Gold capacitor
Operating temperature	0...+60 °C
Storage temperature	-40...+85 °C
Type of protection	IP20
Max. dimensions (without plug)	Width: 257 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 97 mm (with earthing screw)
Weight	approx. 1.2 kg

Table 21: Product Data

Digital Inputs		
Number of inputs		24 (non-galvanically separated)
Type of input		Current sinking logic, 24 V, type 1 in accordance with IEC 61131-2
High level:	Voltage	freely configurable up to 30 VDC
	Current input	approx. 3.5 mA at 24 VDC, approx. 4.5 mA at 30 VDC
Low level:	Voltage	freely configurable up to max. high level -2 V safety distance and min. 2 V
	Current input	max. 1.5 mA (1 mA at 5 V)
Input resistance		< 7 kΩ
Overvoltage protection		-10 V, +35 V
Supply		3 x 20 V / 100 mA, short-circuit-proof
Measurement accuracy at 25 °C, max.		±0.2 % of final value
Metrological accuracy on full temperature, max.		±1 % of final value
Temperature coefficient, max.		±0.023 %/K of final value

Table 22: Specifications for Digital Inputs

Analog inputs	
Number of inputs	8 (unipolar, non-galvanically separated)
External shunt adapter for current measurement	Z 7301 (250 Ω) Z 7302 (500 Ω)
Nominal range	0...+10 VDC, 0...+20 mA with 500 Ω shunt
Operating range	-0.1...+11.5 VDC, -0.4...+23 mA with 500 Ω shunt
Input resistance	1 MΩ
Internal resistance of the signal source	≤ 500 Ω
Digital resolution	12-bit
Measurement accuracy at 25 °C, max.	±0.1 % of final value
Metrological accuracy on full temperature, max.	±0.5 % of final value
Temperature coefficient, max.	±0.011 %/K of full scale
Safety-related accuracy, max.	±2 % of final value
Measured value refresh	once per cycle of the controller
Sampling time	approx. 45 µs
Transmitter supplies	8 x 24...28 V / ≤ 46 mA, short-circuit-proof

Table 23: Specifications for the Analog Inputs

Digital outputs	
Number of outputs	8 (non-galvanically separated, common ground L-)
Output voltage	L+ minus 2 V
Output current	Channels 1...3 and 5...7: 0.5 A up to 60 °C The output current of the channels 4 and 8 depends on the ambient temperature.

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 24: Specifications for the Digital Outputs

Counter	
Number of counters	2 (non-galvanically separated)
Inputs	3 on each (A, B, Z)
Input voltages High level (5 V) High level (24 V) Low level (5 V) Low level (24 V)	5 V and 24 V 4…6 V 13…33 V 0…0.5 V -3…+5 V
Input currents	1.4 mA at 5 V 6.5 mA at 24 V
Input impedance	3.7 kΩ
Counter resolution	24-bit
Min. pulse length	5 µs
Max. input frequency	100 kHz (at 5 V and 24 V input voltage)
Triggered	on negative edge
Edge steepness	1 V/µs
Pulse duty factor	1 : 1 (for 100 kHz)

Table 25: Specifications for the Counters

3.5.1 Product Data HIMatrix F35 011 (-20 °C)

The HIMatrix F35 011 (-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.

HIMatrix F35 011	
Operating temperature	-20…+60 °C
Weight	1.2 kg

Table 26: Product Data F35 011 (-20 °C)

3.5.2 Product Data HIMatrix F35 012 (Subsea / -20 °C)

The HIMatrix F35 012 (subsea/-20 °C) model variant is intended for subsea-use according to ISO 13628 Part 6: Subsea production control systems. The electronic components are coated with a protective lacquer. The housing of the controller is made of V2A stainless steel. The controller is intend for mounting on a mounting plate. The housing is equipped with a massive aluminum plate, see Figure 8. Figure 9 specifies the centre hole distances.

HIMatrix F35 012	
Housing material	V2A stainless steel
Operating temperature	-20…+60 °C
ISO 13628-6: 2006	Shock and vibration tests according to Level Q1 and Q2. Random vibration test, ESS (Environmental stress screening)
Max. dimensions (without connectors and aluminum plate)	Width: 257 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 97 mm (with earthing rail)
Dimensions: Aluminum plate (W x H x D)	(200 x 136 x 6) mm
Weight	1.7 kg

Table 27: Product Data F35 012 (subsea/-20 °C)

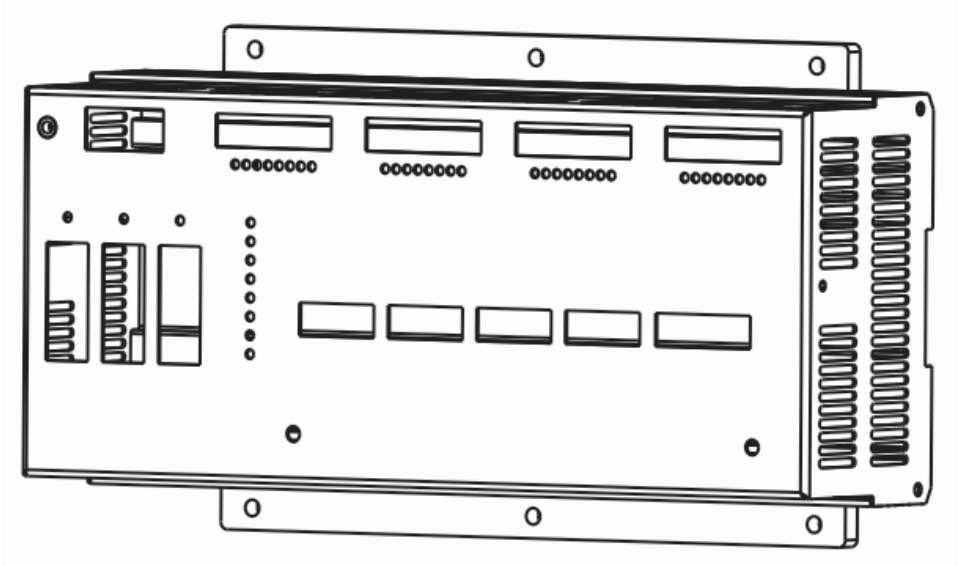


Figure 8: HIMatrix F35 012 with Aluminum Plate

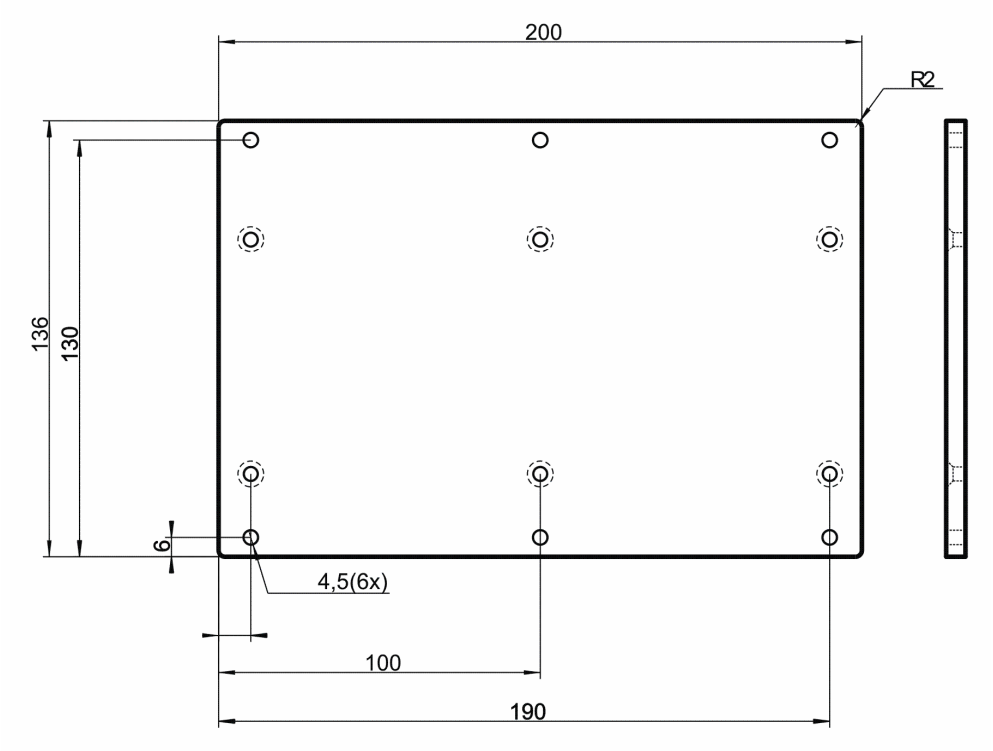


Figure 9: Aluminum Plate with Dimensions

3.5.3 Product Data F35 014

The F35 014 model variant is intended for use in railway applications. The electronic components are coated with a protective lacquer.

F35 014	
Operating temperature	-25…+70 °C (temperature class T1)
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.
Weight	approx. 1.2 kg

Ambient temperature	Output current
< 50 °C	2 A
50…60 °C	1 A
> 60 °C	0.5 A

Table 28: Product Data F35 014

The controller F35 014 meets the conditions for vibrations and shock test according to EN 61373, category 1, class B.

3.6 Certified HIMatrix F35

HIMatrix F35	
CE	EMC, ATEX Zone 2
TÜV	IEC 61508 1-7:2000 up to SIL 3 IEC 61511:2004 EN ISO 13849-1:2008 up to Cat. 4 und PL e
TÜV ATEX	94/9/EG EN 1127-1 EN 61508
Lloyd's Register	Shipping certification ENV1, ENV2 and ENV3. Test Specification Number: 1 - 2002
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
PROFIBUS Nutzerorganisation (PNO)	Test Specification for PROFIBUS DP Slave, Version 3.0 November 2005
TÜV CENELEC	Railway applications EN 50126: 1999 up to SIL 4 EN 50128: 2001 up to SIL 4 EN 50129: 2003 up to SIL 4

Table 29: Certificates

4 Start-up

To start up the controller, it must be mounted, connected and configured in the programming tool.

4.1 Installation and Mounting

The controller is mounted on a 35 mm DIN rail or on a mounting plate for the F35 012 (subsea / -20 °C).

When laying cables (long cables, in particular), take appropriate measures to avoid interference, e.g., by separating the signal lines from the power lines.

When dimensioning the cables, ensure that their electrical properties have no negative impact on the measuring circuit.

4.1.1 Connecting the Digital Inputs

Use the following terminals to connect the digital inputs:

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

Table 30: Terminal Assignment for the Digital Inputs

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	5	Digital output 5
7	6	Digital output 6
8	7	Digital output 7
9	8	Digital output 8 (for increased load)
10	L-	Ground channel group

Table 31: Terminal Assignment for the Digital Outputs

4.1.3 Connecting the Counters

In the safety-related application (SIL 3 in accordance with IEC 61508) of the counters, the overall plant including the sensors or encoders connected must comply with the safety requirements. For more information, refer to the HIMatrix safety manual (HI 800 023 E).

Only shielded cables must be connected to the counter inputs. Each counter input input must be connected to a twisted pair of wires. The shielding must be connected at both ends.

All L- connections are interconnected on the controller as a common ground.

The counters are connected to the following terminals:

Terminal	Designation	Function
65	A1	Input A1 or bit 0 (LSB)
66	B1	Input B1 or bit 1
67	Z1	Input Z1 or bit 2 (MSB)
68	L-	Common ground
69	A2	Input A2 or bit 0 (LSB)
70	B2	Input B2 or bit 1
71	Z2	Input Z2 or bit 2 (MSB)
72	L-	Common ground

Table 32: Terminal Assignment for the Counters

Inputs that are not being used need not be terminated.

NOTE

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

Reverse polarity of the counter inputs is not allowed!

4.1.4 Connecting the Analog Inputs

Only shielded cables must be connected to the analog inputs. Each analog input must be connected to a twisted pair of wires. The shielding must be connected to the controller and the sensor housing and earthed on the controller side to form a Faraday cage.

Use the following terminals to connect the analog inputs:

Terminal	Designation	Function
41	S1	Transmitter supply 1
42	I1	Analog input 1
43	I1-	Ground
44	S2	Transmitter supply 2
45	I2	Analog input 2
46	I2-	Ground
Terminal	Designation	Function
47	S3	Transmitter supply 3
48	I3	Analog input 3
49	I3-	Ground
50	S4	Transmitter supply 4
51	I4	Analog input 4
52	I4-	Ground
Terminal	Designation	Function
53	S5	Transmitter supply 5
54	I5	Analog input 5
55	I5-	Ground
56	S6	Transmitter supply 6
57	I6	Analog input 6
58	I6-	Ground
Terminal	Designation	Function
59	S7	Transmitter supply 7
60	I7	Analog input 7
61	I7-	Ground
62	S8	Transmitter supply 8
63	I8	Analog input 8
64	I8-	Ground

Table 33: Terminal Assignment for the Analog Inputs

4.1.4.1 Shunt Adapter

The shunt adapter is a plug-in module for the analog inputs of the safety-related HIMatrix F35 controller.

Four variants are available:

Model	Equipment
Z 7301	250 Ω shunt
Z 7302	500 Ω shunt
Z 7306	▪ 250 Ω shunt ▪ Overvoltage protection ▪ HART series resistor (current limiting)
Z 7308	▪ Voltage divider ▪ Overvoltage protection

Table 34: Shunt Adapter

Refer to the corresponding manuals for further information on the shunt adapters.

4.1.5 Cable plugs

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

The devices power supply connections feature the following properties:

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

Table 35: Power Supply Cable Plug Properties

Connection to the field zone	
Number of cable plugs	4 pieces, ten poles, screw terminals 1 piece, eight poles, screw terminals 4 pieces, six poles, screw terminals
Wire cross-section	0.2…1.5 mm^2 (single-wire) 0.2…1.5 mm^2 (finely stranded) 0.2…1.5 mm^2 (with wire end ferrule)
Stripping length	6 mm
Screwdriver	Slotted 0.4 x 2.5 mm
Tightening torque	0.2…0.25 Nm

Table 36: Input and Output Cable Plug Properties

4.1.6 Mounting the F35 in Zone 2

(EC Directive 94/9/EC, ATEX)

The controller is suitable for mounting in zone 2. Refer to the corresponding declaration of conformity available on the HIMA website.

When mounting the device, observe the special conditions specified in the following section.

Specific Conditions X

1. Mount the HIMatrix F35 controller in an enclosure that meets the EN 60079-15 requirements and achieves a type of protection of at least IP54, in accordance with EN 60529. Provide the enclosure with the following label:

   Work is only permitted in the de-energized state

   Exception:
   If a potentially explosive atmosphere has been precluded, work can also performed when the controller is under voltage.
2. The enclosure in use must be able to safely dissipate the generated heat. Depending on the output load and supply voltage, the HIMatrix F35 has a power dissipation ranging between 15 W and 29 W.
3. Protect the HIMatrix F35 with a 10 A time-lag fuse.
   The 24 VDC power must come from a power supply unit with safe isolation. Use power supply units of type PELV or SELV only.
4. Applicable standards:

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

Pay particular attention to the following sections:

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

The controller is additionally equipped with the label represented below:

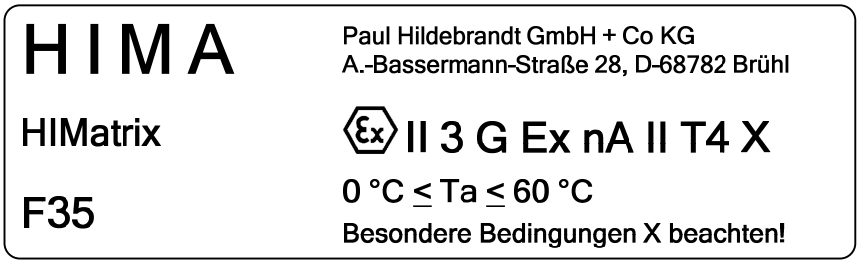


Figure 10: Label for Ex Conditions

4.2 Configuration

The controller can be configured using a programming tool, SILworX or ELOP II Factory. Which programming tool should be used, depends on the revision status of the operating system (firmware):

- SILworX is required for CPU OS V7 and higher.
- ELOP II Factory is required for CPU OS up to V6.x.

i How to switch between operating systems is described in Chapter *Loading Operating Systems* of the system manual for compact systems (HI 800 141 E).

4.3 Configuration with SILworX

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

- Processor module (CPU)
- Communication module (COM)
- Output module (DO 8)
- Counter module (HSC 2)
- Input module (MI 24/8)

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 of the corresponding module.

4.3.1 Parameters and Error Codes for the Inputs and Outputs

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

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

The error codes can also be displayed in SILworX.

4.3.2 Digital Outputs for F35

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

4.3.2.1 Tab **Module**

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

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>DO.Error Code</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>Safety switch 1 faulty</td></tr>
<tr><td>0x0004</td><td>Safety switch 2 faulty</td></tr>
<tr><td>0x0008</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0010</td><td>Output switch test pattern faulty</td></tr>
<tr><td>0x0020</td><td>Output switch test pattern (shutdown test of the outputs) faulty</td></tr>
<tr><td>0x0040</td><td>Active shutdown via WD faulty</td></tr>
<tr><td>0x0200</td><td>All outputs are switched off, total current exceeded</td></tr>
<tr><td>0x0400</td><td>FTT test: 1st temperature threshold exceeded</td></tr>
<tr><td>0x0800</td><td>FTT test: 2nd temperature threshold exceeded</td></tr>
<tr><td>0x1000</td><td>FTT test: Monitoring of auxiliary voltage 1: Undervoltage</td></tr>
</table></td></tr>
<tr><td>Module Error Code</td><td>WORD</td><td>R</td><td>Module error code
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors, see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: invalid configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Module SRS</td><td>UDINT</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module Type</td><td>UINT</td><td>R</td><td>Type of module, target value: 0x00B4 [180_{dec}]</td></tr>
</table>

Table 37: SILworX - System Parameters for Digital Outputs, **Module** Tab

4.3.2.2 Tab **DO 8: Channels**

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

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital output channels Coding: Description 0x01: Fault in the digital output module 0x02: Channel shutdown due to overload 0x04: Error while reading back the digital outputs 0x08: Error while reading back the status of the digital outputs
Value [BOOL] ->	BOOL	W	Output value for DO channels: 1 = output energized 0 = output de-energized

Table 38: SILworX - System Parameters for Digital Outputs, **DO 8: Channels** Tab

4.3.3 Counter F35

The following tables present the statuses and parameters for the counter module (HSC 2) in the same order given in the SILworX Hardware Editor.

4.3.3.1 Tab **Module**

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

<table>
<tr><th>System parameter</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td>Module Error Code</td><td>WORD</td><td>R</td><td>Module error code
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors, see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: invalid configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Module SRS</td><td>UDINT</td><td>R</td><td>Slot number (System Rack Slot)</td></tr>
<tr><td>Module Type</td><td>UINT</td><td>R</td><td>Type of module, target value: 0x0003 [3_{dec}]</td></tr>
<tr><td>Counter.Error Code</td><td>WORD</td><td>R</td><td>Error code for the counter module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Error in counter module</td></tr>
<tr><td>0x0002</td><td>Error while comparing the time base</td></tr>
<tr><td>0x0004</td><td>Address error while reading the time base</td></tr>
<tr><td>0x0008</td><td>Parameters for time base faulty</td></tr>
<tr><td>0x0010</td><td>Address error while reading the counter reading</td></tr>
<tr><td>0x0020</td><td>Counter configuration corrupted</td></tr>
<tr><td>0x0040</td><td>Address error while reading the Gray code</td></tr>
<tr><td>0x0080</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0100</td><td>FTT test: Fault detected while checking the coefficients</td></tr>
<tr><td>0x0200</td><td>Fault during the initial module configuration</td></tr>
</table></td></tr>
</table>

Table 39: SILworX - System Parameters for Counters, **Module** Tab

4.3.3.2 Tab **HSC 2: Channels**

The **HSC 2: Channels** tab contains the following system parameters:

System parameter	Data type	R/W	Description
Counter[0x].5/24V Mode	BOOL	R/W	5 V or 24 V counter input TRUE: 24 V FALSE: 5 V
Counter[0x].Auto. Detection of Rotation Direction	BOOL	R/W	Automatic detection of count direction TRUE: Automatic detection On FALSE: Manual setting of count direction
Counter[0x].Error Code	BYTE	R	Error codes of counter channels 1 and 2 Coding / Description: 0x01 – Error in counter module 0x02 – Error while comparing the counter readings 0x08 – Error while setting the parameters (reset)
Counter[0x].Gray Code	BOOL	R/W	Decoder / pulse operation TRUE: Gray code decoder FALSE: Pulse operation
Counter[0x].Spare1... Counter[0x].Spare3	BOOL	R/W	No function
Counter[0x].Reset	BOOL	R/W	Counter reset TRUE: No reset FALSE: Reset
Counter[0x].Direction	BOOL	R/W	Count direction of the counter (only if *Counter[0x].Auto. Detection of Rotation Direction* = FALSE) TRUE: Downwards (decrement) FALSE: Upwards (increment)
Counter[0x].Value	UDINT	R	Content of counters: 24 bit for pulse counter, 3 bit for Gray code
Counter[0x].Value Overflow	BOOL	R	Counter overflow indication TRUE: 24-bit overflow since last cycle (only if *Counter[0x].Auto. Advance Sense* = FALSE) FALSE: No overflow since last cycle
Counter[0x]. Timestamp	UDINT	R	Timestamp for Counter[0x].Value 24 bits, 1 µs time resolution
Counter[0x].Time Overflow	BOOL	R	Overflow indication for the timestamp of the counters TRUE: 24-bit overflow since last measurement FALSE: No 24-bit overflow since last measurement

Table 40: SILworX - System Parameters for Counters, **HSC 2: Channels** Tab

4.3.4 Analog and Digital Inputs F35

The following tables present the system parameters for the analog and digital input module (MI 24/8) 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 parameter		R/W	Description
Enter these parameters directly in the Hardware Editor.			
FS 1000 / FS 2000		W	Resolution of the -> *Value [INT]* parameter for the analog input channels. FS 1000: 0...1000 (0...10 V) FS 2000: 0...2000 (0...10 V)
System parameter	Data type	R/W	Description
AI.Error Code	WORD	R	Error codes for all analog and digital outputs
Module Error Code	WORD	R	Module error code
Module SRS	UDINT	R	Slot number (System Rack Slot)
Module Type	UINT	R	Type of module, target value: 0x00D2 [210_{dec}]

Error codes for all analog and digital outputs:

Coding	Description
0x0001	Module fault
0x0004	time monitoring of conversion faulty
0x0008	FTT test: Walking bit of data bus faulty
0x0010	FTT test: Error while checking coefficients
0x0020	FTT test: Operating voltages faulty
0x0040	A/D conversion faulty (DRDY_LOW)
0x0080	Cross links of MUX faulty
0x0100	Walking bit of data bus faulty
0x0200	Multiplexer addresses faulty
0x0400	Faulty operating voltages
0x0800	Measuring system (characteristic) faulty (unipolar)
0x1000	Measuring system (final values, zero point) faulty (unipolar)
0x8000	A/D conversion faulty (DRDY_HIGH)

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

Table 41: SILworX - System Parameter for Digital Inputs, **Module** Tab

4.3.4.2 Tab **MI 24/8 FS 1000: AI Channels**

The **MI 24/8 FS1000: AI Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the analog input channels (1...8) Coding / Description 0x01: Fault in the analog input module 0x02: Not used 0x04: A/D converter faulty, measured values invalid 0x08: Measured value out of the safety-related accuracy 0x10: Measured value overflow 0x20: Channel not operating 0x40: Address error of both A/D converters 0x80: Configuration of the hysteresis faulty
-> Value [INT]	INT	R	Analog value of the AI channels (1...8) [INT] from 0...1000 (variant: FS 1000), 0...2000 (variant: FS 2000) (0...+10 V) The validity depends on the *AI.Error Code*.
Channel Used [BOOL] ->	BOOL	W	Configuration of the channels 1...8: 1 = Channel operating 0 = Channel not operating

Table 42: SILworX - System Parameter for Inputs, **MI 24/8 FS1000: AI Channels** Tab

4.3.4.3 Tab **MI 24/8 FS1000: DI Channels**

The **MI 24/8 FS1000: DI Channels** tab contains the following system parameters.

System parameter	Data type	R/W	Description
Channel no.	---	R	Channel number, defined by default
-> Error Code [BYTE]	BYTE	R	Error codes for the digital input channels (1...24). Coding / Description 0x01: Fault in the analog input module 0x02: Not used 0x04: A/D converter faulty, measured values invalid 0x08: Measured value out of the safety-related accuracy 0x10: Measured value overflow 0x20: Channel not operating 0x40: Address error of both A/D converters 0x80: Configuration of the hysteresis faulty
-> Value [BOOL]	BOOL	R	Digital value of the DI channels (1...24) [BOOL] in accordance with the hysteresis. The validity depends on -> *Error Code [BYTE]*.
-> Value - analog [INT]	INT	R	Analog value of the DI channels (1...24) [INT] from 0...3000 (0...30 V). The validity depends on -> *Error Code [BYTE]*.
Channel Used [BOOL] ->	BOOL	W	Configuration of channels 1...24: 1 = Channel operating 0 = Channel not operating
Hysteresis LOW [INT] ->	INT	W	Upper limit of the low level voltage range -> *Value [BOOL]*[1)]
Hysteresis HIGH [INT] ->	INT	W	Lower limit of the high level voltage range -> *Value [BOOL]*[1)]
[1)] Safety distance between the limits of the voltage ranges: min. 2 V			

Table 43: SILworX - System Parameter for Digital Inputs, **MI 24/8 FS1000: DI Channels** Tab

4.4 Configuration with ELOP II Factory

4.4.1 Configuring the Inputs and Outputs

The signals previously defined in the Signal Editor (Hardware Management) are assigned to the individual channels (inputs and outputs) using ELOP II Factory. Refer to the system manual for compact systems or the online help for more details.

The following chapter describes the system signals used for assigning signals in the controller.

4.4.2 Signals and Error Codes for the Inputs and Outputs

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

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

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

4.4.3 Digital Inputs for F35

<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: 0x00D2 [210_{dec}]</td></tr>
<tr><td>Mod. Error Code [WORD]</td><td>R</td><td>Error codes for the module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors
see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: invalid configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>AI.Error Code [WORD]</td><td>R</td><td>Error codes for all analog and digital inputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0004</td><td>Time monitoring of conversion faulty</td></tr>
<tr><td>0x0008</td><td>FTT test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0010</td><td>FTT test: Error while checking coefficients</td></tr>
<tr><td>0x0020</td><td>FTT test: Operating voltages faulty</td></tr>
<tr><td>0x0040</td><td>A/D conversion faulty (DRDY_LOW)</td></tr>
<tr><td>0x0080</td><td>Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>Faulty operating voltages</td></tr>
<tr><td>0x0800</td><td>Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x8000</td><td>A/D conversion faulty (DRDY_HIGH)</td></tr>
</table></td></tr>
<tr><td>DI[xx].Error Code [BYTE]</td><td>R</td><td>Error codes for the digital input channels (1...24)
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the digital input module</td></tr>
<tr><td>0x02</td><td>CPU operating system versions prior to 4: measured values invalid,
CPU operating system version 4 and higher: not used</td></tr>
<tr><td>0x04</td><td>A/D converter faulty,
CPU operating system version 4 and higher: measured values invalid</td></tr>
<tr><td>0x08</td><td>Measured value out of the safety-related accuracy</td></tr>
<tr><td>0x10</td><td>Measured value overflow</td></tr>
<tr><td>0x20</td><td>Channel not operating</td></tr>
<tr><td>0x40</td><td>Address error of both A/D converters</td></tr>
<tr><td>0x80</td><td>Configuration of the hysteresis faulty</td></tr>
</table></td></tr>
<tr><td>DI[xx].Value Analog [INT]</td><td>R</td><td>Analog value of the DI channels (1...24) [INT] from 0...3000 (0...30 V)
The validity depends on DI[xx].Error Code</td></tr>
<tr><td>DI[xx].Value [BOOL]</td><td>R</td><td>Digital value of the DI channels (1...24) [BOOL] in accordance with hysteresis
The validity depends on DI[xx].Error Code</td></tr>
</table>

System signal	R/W	Description
DI[xx].Hysteresis LOW [INT]	W	Upper limit of the low level voltage range *DI[xx].Value* [1)]
DI[xx].Hysteresis HIGH [INT]	W	Low limit of the high level voltage range *DI[xx].Value 1)*
DI[xx].Used [BOOL]	W	Configuration of channels 1...24: 1 = Channel operating 0 = Channel not operating
[1)] Safety distance between the limits of the voltage ranges: min. 2 V		

Table 44: ELOP II Factory - Digital Input System Signals

4.4.4 Analog Inputs F35

<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: 0x00D2 [210_{dec}]</td></tr>
<tr><td>Mod. Error Code [WORD]</td><td>R</td><td>Error codes for the module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors
see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: invalid configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>AI.Error Code [WORD]</td><td>R</td><td>Error codes for all analog and digital inputs
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault</td></tr>
<tr><td>0x0004</td><td>time monitoring of conversion faulty</td></tr>
<tr><td>0x0008</td><td>FTT test: Walking bit of data bus faulty</td></tr>
<tr><td>0x0010</td><td>FTT test: Error while checking coefficients</td></tr>
<tr><td>0x0020</td><td>FTT test: Operating voltages faulty</td></tr>
<tr><td>0x0040</td><td>A/D conversion faulty (DRDY_LOW)</td></tr>
<tr><td>0x0080</td><td>Cross links of MUX faulty</td></tr>
<tr><td>0x0100</td><td>Walking bit of data bus faulty</td></tr>
<tr><td>0x0200</td><td>Multiplexer addresses faulty</td></tr>
<tr><td>0x0400</td><td>Faulty operating voltages</td></tr>
<tr><td>0x0800</td><td>Measuring system (characteristic) faulty (unipolar)</td></tr>
<tr><td>0x1000</td><td>Measuring system (final values, zero point) faulty (unipolar)</td></tr>
<tr><td>0x8000</td><td>A/D conversion faulty (DRDY_HIGH)</td></tr>
</table></td></tr>
<tr><td>AI[xx].Error Code [BYTE]</td><td>R</td><td>Error codes for the analog input channels (1...8)
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Fault in the analog input module</td></tr>
<tr><td>0x02</td><td>CPU operating system versions prior to 4: measured values invalid,
CPU operating system version 4 and higher: not used</td></tr>
<tr><td>0x04</td><td>A/D converter faulty,
CPU operating system version 4 and higher: measured values invalid</td></tr>
<tr><td>0x08</td><td>Measured value out of the safety-related accuracy</td></tr>
<tr><td>0x10</td><td>Measured value overflow</td></tr>
<tr><td>0x20</td><td>Channel not operating</td></tr>
<tr><td>0x40</td><td>Address error of both A/D converters</td></tr>
<tr><td>0x80</td><td>Configuration of the hysteresis faulty</td></tr>
</table></td></tr>
<tr><td>AI[xx].Value [INT]</td><td>R</td><td>Analog value of the AI channels (1...8) [INT] from
0...1000 (variant: FS1000), 0...2000 (variant: FS2000)
(0...+10 V)
The validity depends on AI[xx].Error Code.</td></tr>
</table>

System signal	R/W	Description
AI[xx].Used [BOOL]	W	Configuration of the channels 1...8: 1 = Channel operating 0 = Channel not operating

Table 45: ELOP II Factory - System Signals for the Analog Inputs

4.4.5 Digital Outputs for F35

System signal	R/W	Description
Mod.SRS [UDINT]	R	Slot number (System Rack Slot)
Mod. Type [UINT]	R	Type of module, target value: 0x00B4 [180_{dec}]
Mod. Error Code [WORD]	R	Error codes for the module

Coding	Description
0x0000	I/O processing, if required with errors see other error codes
0x0001	No I/O processing (CPU not in RUN)
0x0002	No I/O processing during the booting test
0x0004	Manufacturer interface operating
0x0010	No I/O processing: invalid configuration
0x0020	No I/O processing: fault rate exceeded
0x0040/ 0x0080	No I/O processing: configured module not plugged in

DO.Error Code [WORD] — R — Error codes for all digital outputs

Coding	Description
0x0001	Fault within the digital outputs
0x0002	Safety switch 1 faulty
0x0004	Safety switch 2 faulty
0x0008	FTT test of test pattern faulty
0x0010	Output switch test pattern faulty
0x0020	Output switch test pattern (shutdown test of the outputs) faulty
0x0040	Active shutdown via WD faulty
0x0200	All outputs are switched off, total current exceeded
0x0400	FTT test: 1st temperature threshold exceeded
0x0800	FTT test: 2nd temperature threshold exceeded
0x1000	FTT test: Monitoring of auxiliary voltage 1: Undervoltage

DO[xx].Error Code [BYTE] — R — Error codes for the digital output channels

Coding	Description
0x01	Fault in the digital input 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

DO[xx].Value [BOOL]	W	Output value for DO channels: 1 = output energized 0 = output de-energized

Table 46: ELOP II Factory - Digital Output System Signals

4.4.6 Counter F35

<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: 0x0003 [3_{dec}]</td></tr>
<tr><td>Mod. Error Code [WORD]</td><td>R</td><td>Error codes for the module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0000</td><td>I/O processing, if required with errors
see other error codes</td></tr>
<tr><td>0x0001</td><td>No I/O processing (CPU not in RUN)</td></tr>
<tr><td>0x0002</td><td>No I/O processing during the booting test</td></tr>
<tr><td>0x0004</td><td>Manufacturer interface operating</td></tr>
<tr><td>0x0010</td><td>No I/O processing: invalid configuration</td></tr>
<tr><td>0x0020</td><td>No I/O processing: fault rate exceeded</td></tr>
<tr><td>0x0040/
0x0080</td><td>No I/O processing: configured module not plugged in</td></tr>
</table></td></tr>
<tr><td>Counter.Error Code [WORD]</td><td>R</td><td>Error code for the counter module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Error in counter module</td></tr>
<tr><td>0x0002</td><td>Error while comparing the time base</td></tr>
<tr><td>0x0004</td><td>Address error while reading the time base</td></tr>
<tr><td>0x0008</td><td>Parameters for time base faulty</td></tr>
<tr><td>0x0010</td><td>Address error while reading the counter reading</td></tr>
<tr><td>0x0020</td><td>Counter configuration corrupted</td></tr>
<tr><td>0x0040</td><td>Address error while reading the Gray code</td></tr>
<tr><td>0x0080</td><td>FTT test of test pattern faulty</td></tr>
<tr><td>0x0100</td><td>FTT test: Fault detected while checking the coefficients</td></tr>
<tr><td>0x0200</td><td>Fault during the initial module configuration</td></tr>
</table></td></tr>
<tr><td>Counter[0x].Error Code [BYTE]</td><td>R</td><td>Error codes of counter channels 1 and 2
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x01</td><td>Error in counter module</td></tr>
<tr><td>0x02</td><td>Error while comparing the counter readings</td></tr>
<tr><td>0x08</td><td>Error while setting the parameters (reset)</td></tr>
</table></td></tr>
<tr><td>Counter[0x].Value [UDINT]</td><td>R</td><td>Content of counters: 24 bit for pulse counter, 3 bit for Gray code</td></tr>
<tr><td>Counter[0x].Timestamp [UDINT]</td><td>R</td><td>Timestamp for Counter[0x].Value 24 bits, 1 µs time resolution</td></tr>
<tr><td>Counter[0x].Value Overflow [BOOL]</td><td>R</td><td>Counter overflow indication
TRUE: 24-bit overflow since last cycle (only if Counter[0x].Auto. Advance Sense = FALSE)
FALSE: No overflow since last cycle</td></tr>
<tr><td>Counter[0x].Time Overflow [BOOL]</td><td>R</td><td>Overflow indication for the timestamp of the counters
TRUE: 24-bit overflow since last measurement
FALSE: No 24-bit overflow since last measurement</td></tr>
<tr><td>Counter[0x].Direction [BOOL]</td><td>R/W</td><td>Count direction of counter
(only if Counter[0x].Auto. AdvanceSense = FALSE)
TRUE: Downwards (decrement)
FALSE: Upwards (increment)</td></tr>
<tr><td>Counter[0x].Auto. Advance Sense [BOOL]</td><td>R/W</td><td>Automatic detection of count direction
TRUE: Automatic detection On
FALSE: Manual setting of count direction</td></tr>
</table>

System signal	R/W	Description
Counter[0x].Reset [BOOL]	R/W	Counter reset TRUE: No reset FALSE: Reset
Counter[0x].5/24 V Mode [BOOL]	R/W	5 V or 24 V counter input TRUE: 24 V FALSE: 5 V
Counter[0x].Gray Code [BOOL]	R/W	Decoder / pulse operation TRUE: Gray code decoder FALSE: Pulse operation

Table 47: ELOP II Factory - Counter System Signals

4.5 Connection Variants

This chapter describes the permissible wiring of the controller in safety-related applications.

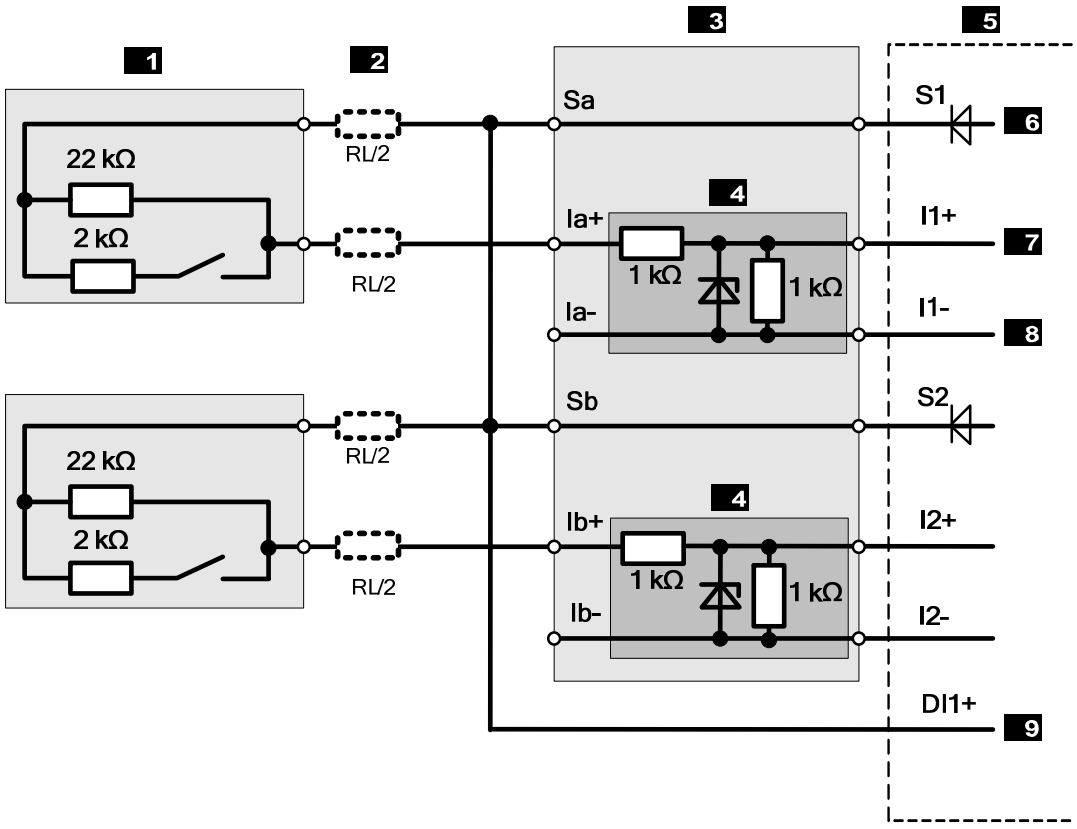
Only the connection variants specified here are permitted for SIL 3 applications.

4.5.1 Wired Mechanical Contacts on Analog Inputs

Wired mechanical contacts are connected to the analog inputs using the Z 7308 shunt adapter, see Figure 11. The shunt adapter protects the analog inputs against overvoltage and short-circuits from the field zone.

Each analog input has a supply output that is fed by a common AI power source. The supply voltage is between 26.7 V and 27.3 V.

The supply of the analog inputs must be monitored. To do so, the used supply outputs (S1...S8) must be connected in parallel and attached to a digital input. The evaluation of the digital input is analog and must be configured in the programming tool accordingly.



1 Wired Mechanical Contact
2 Line Resistance of < 50 Ω
3 Z 7308 Shunt Adapter
4 Protective Circuit within Z 7308
5 F35 Controller
6 26.7...27.3 V Supply
7 Analog Input
8 Ground
9 Digital Input Used for Monitoring

Figure 11: Wired Mechanical Contact on Analog Inputs

4.5.1.1 Switching Thresholds of the Analog Inputs for Mechanical Contacts

For FS 2000 resolution, the switch-on and switch-off thresholds, the open-circuit (OC) and short-circuit (SC) thresholds and the corresponding fault reaction must be configured in the user program.

The values specified in the following table apply for wired mechanical contacts with resistance values of 2 kΩ und 22 kΩ.

Switching thresholds	Range of 2000 digits	Description
Switch-on threshold L → H	6 V [1200 digits]	Transition from Low to High
Switch-off threshold H → L	3 V [600 digits]	Transition from High to Low
OC Limit	≤ 0.5 V [100 digits]	Fault reaction to be configured: Set the input value to faulty.
SC Limit	≥ 8.4 V [1680 digits]	Fault reaction to be configured: Set the input value to faulty.

Table 48: Thresholds for the Analog Inputs

4.5.1.2 Switching Thresholds Used for Monitoring the Supply

For monitoring the supply of the analog inputs must be read back by a digital input. To do so, the following values must be entered in the system parameters for the digital input.

System parameter	Value
Hysteresis LOW [INT] ->	< 26 V [2600 digits]
Hysteresis HIGH [INT] ->	> 28 V [2800 digits]

Table 49: Switching Thresholds for the Digital Inputs Used for Monitoring the Supply

If the supply voltage is outside the limits defined with the system parameters *Hysteresis LOW [INT] ->* and *Hysteresis HIGH [INT] ->,* the value of the measuring inputs must be set to faulty. The values of the mechanical contacts must not be evaluated in the user program.

If the supply voltage is once again within the defined range limits, operations can be resumed.

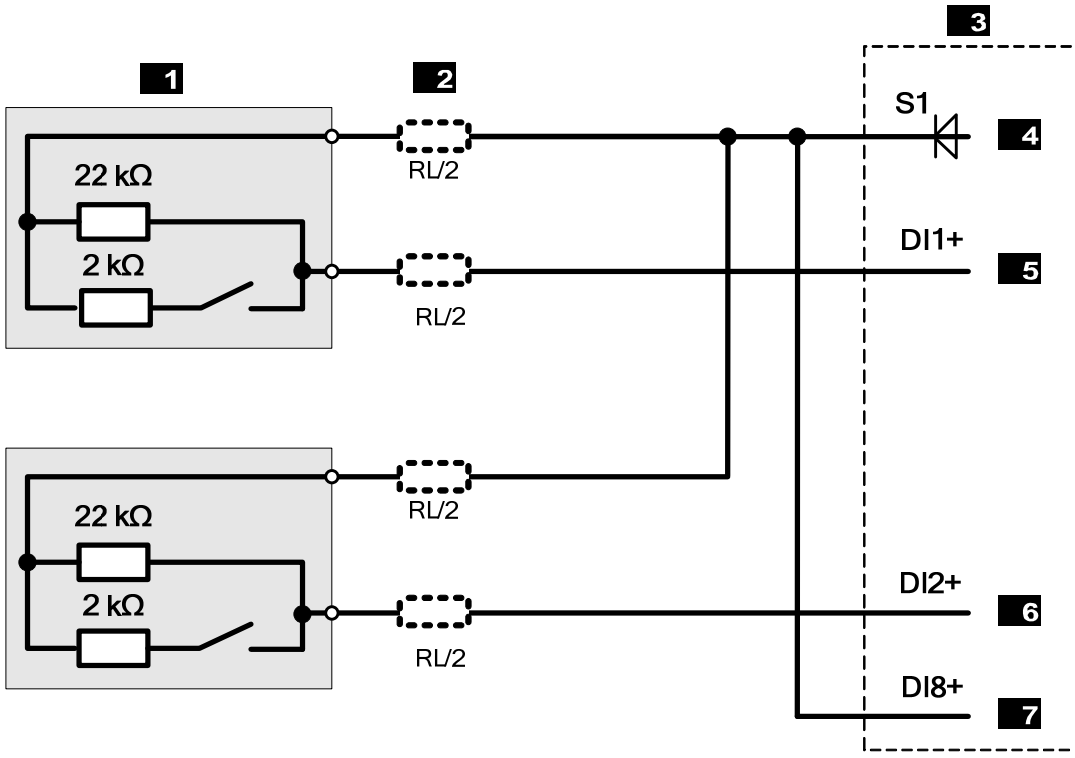
4.5.2 Wired Mechanical Contacts on Digital Inputs

Wired mechanical contacts are connected as described in Figure 12 and Figure 13.

Each of the 3 supply outputs feeds a group of 8 digital inputs. The supply voltage lies between 16.7 V and 26.9 V.

The 3 supply outputs must be monitored. To do so, each of the used supply outputs must be connected with a digital input. The evaluation of the digital input is analog and must be configured in the programming tool accordingly.

4.5.2.1 Wired Mechanical Contacts with Resistance Values of 2 kΩ and 22 kΩ



1 Wired Mechanical Contact
2 Line Resistance of < 50 Ω
3 F35 Controller
4 16.7...26.9 V DI Supply
5 Digital Input Mechanical Contact 1
6 Digital Input Mechanical Contact 2
7 Digital Input Used for Monitoring

Figure 12: Wired Mechanical Contact on Digital Inputs

Switching Thresholds for the Digital Inputs

The switch-on and switch-off thresholds, the open-circuit (OC) and short-circuit (SC) thresholds and the corresponding fault reaction must be configured in the user program. The SC threshold must be determined in the user program by reading back the voltage supply. The SC threshold is equal to the measured supply value minus 1.1 V.

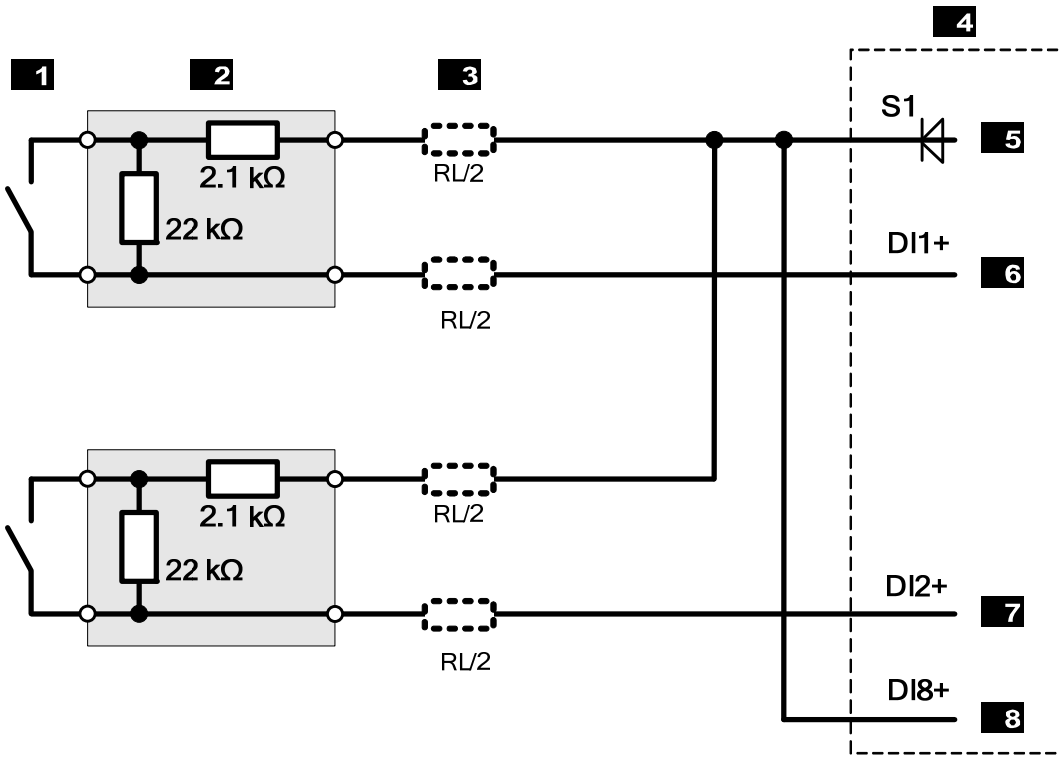
The values specified in the following table apply for wired mechanical contacts with resistance values of 2 kΩ und 22 kΩ:

Switching thresholds	Value	Description
Switch-on threshold L → H	> 12 V [1200 digits]	Transition from Low to High
Switch-off threshold H → L	< 10 V [1000 digits]	Transition from High to Low
OC Limit	< 2 V [200 digits]	Fault reaction to be configured: Set the input value to zero.
SC Limit	Supply - 1.1 V [110 digits]	Fault reaction to be configured: Set the input value to zero.

Table 50: Switching Thresholds for the Digital Inputs for Wired Mechanical Contacts With Resistance Values of 2 kΩ and 22 kΩ

4.5.2.2 Wired Mechanical Contacts with Resistance Values of 2.1 kΩ and 22 kΩ

A BARTEC resistive coupling element (2, HIMA part no. 88 0007829) is connected upstream to the contact maker, see Figure 13.



1 Mechanical Contact
2 Resistive Coupling Element
3 Line Resistance of < 50 Ω
4 F35 Controller
5 16.7...26.9 V DI Supply
6 Digital Input Mechanical Contact 1
7 Digital Input Mechanical Contact 2
8 Digital Input Used for Monitoring

Figure 13: Mechanical Contact with Resistive Coupling Element

Switching Thresholds for the Digital Inputs

The switch-on and switch-off thresholds, the open-circuit (OC) and short-circuit (SC) thresholds and the corresponding fault reaction must be configured in the user program. The SC threshold must be determined in the user program by reading back the voltage supply. The SC threshold is equal to the measured supply value minus 1.1 V.

The value for the switching thresholds specified in Table 51 apply for wired mechanical contacts with resistance values of 2.1 kΩ and 22 kΩ, see Figure 13.

Switching threshold	Value	Description
Switch-on threshold L → H	> 11.5 V [1150 digits]	Transition from Low to High
Switch-off threshold H → L	< 9.5 V [950 digits]	Transition from High to Low
OC Limit	< 2 V [200 digits]	Fault reaction to be configured: Set the input value to zero.
SC Limit	Supply - 1.1 V [110 digits]	Fault reaction to be configured: Set the input value to zero.

Table 51: Switching Thresholds for the Digital Inputs for Mechanical Contacts With Resistive Coupling Element

5 Operation

The controller F35 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 the programming tool.

6 Maintenance

No maintenance measures are required during normal operation.

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

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

6.1 Faults

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

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

Refer to Chapter 3.1.3.1, for more information on the fault reaction of counters.

Refer to Chapter 3.1.4.2, for more information on the fault reaction of analog inputs.

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

6.2 Maintenance Measures

The following measures are required for the device:

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

6.2.1 Loading the Operating System

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

Refer to the release list to check the consequences of the new operation system version on the system!

The operating system is loaded using the programming tool.

Prior to loading the operating system, the device must be in STOP (displayed in the programming tool). Otherwise, stop the device.

For more information, refer to the programming tool documentation.

6.2.2 Proof Test

HIMatrix devices and modules must be subjected to a proof test in intervals of 10 years. For more information, refer to the safety anual (HI 800 023 E).

7 Decommissioning

Remove the supply voltage to decommission the device. Afterwards pull out the pluggable screw terminal connector blocks for inputs and outputs and the Ethernet cables.

8 Transport

To avoid mechanical damage, HIMatrix components must be transported in packaging.

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

9 Disposal

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

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

Appendix

Glossary

Term	Description
ARP	Address resolution protocol: Network protocol for assigning the network addresses to hardware addresses
AI	Analog input
AO	Analog output
COM	Communication module
CRC	Cyclic redundancy check
DI	Digital input
DO	Digital output
ELOP II Factory	Programming tool for HIMatrix systems
EMC	Electromagnetic compatibility
EN	European norm
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
FTT	Fault tolerance time
ICMP	Internet control message protocol: Network protocol for status or error messages
IEC	International electrotechnical commission
MAC address	Media access control address: Hardware address of one network connection
PADT	Programming and debugging tool (in accordance with IEC 61131-3), PC with SILworX or ELOP II Factory
PE	Protective earth
PELV	Protective extra low voltage
PES	Programmable electronic system
R	Read: The system variable or signal provides value, e.g., to the user program
Rack ID	Base plate identification (number)
Interference-free	Supposing that two input circuits are connected to the same source (e.g., a transmitter). An input circuit is termed *interference-free* if it does not distort the signals of the other input circuit.
R/W	Read/Write (column title for system variable/signal type)
SELV	Safety extra low voltage
SFF	Safe failure fraction, portion of faults that can be safely controlled
SIL	Safety integrity level (in accordance with IEC 61508)
SILworX	Programming tool for HIMatrix systems
SNTP	Simple network time protocol (RFC 1769)
SRS	System.rack.slot addressing of a module
SW	Software
TMO	Timeout
W	Write: System variable/signal is provided with value, e.g., from the user program
r_{PP}	Peak-to-peak value of a total AC component
Watchdog (WD)	Time monitoring for modules or programs. If the watchdog time is exceeded, the module or program enters the ERROR STOP state.
WDT	Watchdog time

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SAFETY
NONSTOP

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