Manual

HIMax®

X-MIO 7/6 01
Overspeed Trip Module

All the current manuals can be obtained upon request by sending an e-mail to: documentation@hima.com.

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HI 801 304 D, Rev. 10.00 (1903)	German original document
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Table of Contents

1 Introduction

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

1.1 Structure and Use of This Manual

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

This manual contains the following main chapters:

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

Additionally, the following documents must be taken into account:

Document	Content	Document no.
HIMax system manual	Hardware description of the HIMax system	HI 801 001 E
HIMax safety manual	Safety functions of the HIMax system	HI 801 003 E
Communication manual	Description of communication and protocols	HI 801 101 E
SILworX online help (OLH)	Instructions on how to use SILworX	-
SILworX first steps manual	Introduction to SILworX	HI 801 103 E

Table 1: Additional Applicable Manuals

The current manuals can be obtained upon request by sending an e-mail to: documentation@hima.com. For registered HIMA customers, the product documentation is available at https://www.hima.com/en/downloads/.

1.2 Target Audience

This document is aimed at the planners, design engineers and programmers of automation systems as well as the persons authorized to start up, operate and maintain the devices and systems concerned. 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	Parameters and system variables, references.
`Courier`	Literal user inputs.
RUN	Operating states are designated by capitals.
Chapter 1.2.3	Cross-references are hyperlinks even if they are not specially marked. In the electronic document (PDF): 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 specially marked.

1.3.1 Safety Notices

Safety notices must be strictly observed to ensure the lowest possible risk.

The safety notices are represented as described below.

- Signal word: warning, caution, notice.
- 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 situation which, if not avoided, could result in minor or moderate injury.
- Notice indicates a hazardous situation which, if not avoided, could result in property damage.

⚠ SIGNAL WORD

Type and source of risk!

Consequences arising from non-observance.

Risk prevention.

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 giving additional information is located here.

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

1.4 Safety Lifecycle Services

HIMA provides support throughout all the phases of the plant's safety lifecycle, from planning and engineering through commissioning to maintenance of safety and security.

HIMA's technical support experts are available for providing information and answering questions about our products, functional safety and automation security.

To achieve the qualification required by the safety standards, HIMA offers product or customer-specific seminars at HIMA's training center or on site at the customer's premises. The current seminar program for functional safety, automation security and HIMA products can be found on HIMA's website.

Safety Lifecycle Services:	
Onsite+ / On-Site Engineering	In close cooperation with the customer, HIMA performs changes or extensions on site.
Startup+ / Preventive Maintenance	HIMA is responsible for planning and executing preventive maintenance measures. Maintenance actions are carried out in accordance with the manufacturer's specifications and are documented for the customer.
Lifecycle+ / Lifecycle Management	As part of its lifecycle management processes, HIMA analyzes the current status of all installed systems and develops specific recommendations for maintenance, upgrading and migration.
Hotline+ / 24 h Hotline	HIMA's safety engineers are available by telephone around the clock to help solve problems.
Standby+ / 24 h Call-Out Service	Faults that cannot be resolved over the phone are processed by HIMA's specialists within the time frame specified in the contract.
Logistics+/ 24 h Spare Parts Service	HIMA maintains an inventory of necessary spare parts and guarantees quick, long-term availability.

Contact details:	
Safety Lifecycle Services	https://www.hima.com/en/about-hima/contacts-worldwide/
Technical Support	https://www.hima.com/en/products-services/support/
Seminar Program	https://www.hima.com/en/products-services/seminars//

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.

The product is operated with SELV or PELV. No imminent risk results from the product itself. Use in the Ex zone is only permitted if additional measures are taken.

2.1 Intended Use

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

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

2.1.1 Environmental Requirements

All the environmental conditions specified in this manual must be observed when operating the HIMax 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 HIMax system due to electrostatic discharge!

- **When performing the work, make sure that the workspace is free of static, and wear a grounding 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

X-MIO 7/6 01 is an overspeed trip module intended for use in the programmable electronic system (PES) HIMax.

The module is intended for monitoring the turbine's speed and emergency shutdown (trip function). The module is equipped with the following inputs and outputs:

Inputs/outputs	Number	Task
Safety-related measuring inputs	3	Speed measurement (frequency) 0…35 kHz
Safety-related inputs for rotation direction	3	Reading in of static rotation direction signals
Safety-related digital input	1	External reset input, turbine start, reset after emergency shutdown (trip function)
Safety-Related Digital Inputs	3	Trip signals from external protection devices such as machine monitoring systems
Safety-Related Digital Outputs	5	Triggering of actuators, e.g., solenoid valves
Relay output (not safety-related)	1	Potential-free signaling contact (change-over contact), warning signal relay

Table 2: Module Inputs and Outputs

Only sensors (pulse generators) that provide pulses or pulses with a static rotation direction may be connected to the measuring inputs. HIMA recommends using sensors of the same type to reduce divergences among the measured values to the greatest extent possible.

The module monitors a turbine's rotational speed and, optionally, the acceleration with respect to configurable limit values. It also shuts down the turbine through the trip function when the limits are violated, see Chapter 4.4.2 and Chapter 4.4.3 for details.

The trip function is implemented in the module's operating system. It operates interference-free and independently of the HIMax overall system and the user program. The trip function is triggered within the module cycle if the evaluation of the measuring inputs or digital inputs results in a trip condition, see Chapter 4.4.4.

The module can be used to implement applications in accordance with API 670. The module meets the turbine requirements for rotational speed monitoring and trip routines defined in API 670. The speed monitoring and the trip routines are independent of the overall HIMax system and the user program.

The trip function meets the requirements defined in the Machinery Directive.

The module has been certified by the TÜV for safety-related applications up to SIL 3 (IEC 61508, IEC 61511, IEC 62061 and EN 50156) as well as Cat. 4 and PL e (EN ISO 13849-1).

Refer to the HIMA website and the HIMax safety manual (HI 801 003 E) for more information on the standards used to test and certify the module and the HIMax system.

The module is inserted in redundant connector boards to increase availability. To this purpose, at least two adjacent slots must be available in the base plate.

The module can be inserted into any of the base plate slots with the exception of the slots reserved for system bus modules. Refer to the system manual (HI 801 001 E) for details.

3.1 Safety Function

The module monitors a turbine's rotational speed independently of the HIMax overall system and the user program. The module trips the turbine via the digital outputs.

Depending on the measuring input, the module determines the rotational speed or direction of a sensor (pulse generator) with safety-related accuracy. To determine the speed, one turbine is equipped with three sensors. The speed values from the three sensors are used for a 2oo3 evaluation and thus for determining the rotational speed of the turbine.

The module performs a 2oo3 evaluation of the digital input signals and provides the result to the safety-related processor system and the user program, refer to Chapter 4.4.1 for details.

The module uses three switches connected in series on each channel to ensure the safety function of the outputs. Each output is thus two-fault-tolerant with respect to the switch. Each switch of a channel can be individually switched off via the system bus (I/O bus) or via the second independent shutdown option (watchdog).

The safety function of the inputs and outputs is performed in accordance with SIL 3. The exception is the relay output, which is implemented as a potential-free signaling contact (change-over contact).

3.1.1 Response in the Event of a Fault

If the safety-related processor system of the module detects a module fault during operation, the module adopts the safe state:

- 0 is issued for the *Speed* parameter and 0 (0 = unequal) for the *Rotation Direction* parameter. The parameters *Peak Hold Max* and *Peak Hold Min* retain their current values.
- All the assigned input variables transmit the initial value to the user program. The initial values must be set to 0 to ensure that the input variables transmit the value 0 to the user program if a fault occurs.
- All the outputs are de-energized in accordance with the de-energize to trip principle.

If the system buses fail, the outputs are de-energized. The module activates the *Error* LED on the front plate.

3.2 Scope of Delivery

To operate, the module must be installed on a matching connector board. If a field termination assembly (FTA) is used, a system cable is required to connect the connector board to the FTA. Connector boards, system cables and FTAs are not included within the scope of delivery.

The connector boards are described in Chapter 3.6, the system cables are described in Chapter 3.7. The FTAs are described in separate manuals.

3.3 Type Label

The type label specifies the following important details:

- Product name
- Mark of conformity
- Bar code (2D or 1D code)
- Part number (Part-No.)
- Hardware revision index (HW-Rev.)
- Operating system revision index (OS-Rev.)
- Supply voltage (Power)
- Ex specifications (if applicable)
- Production year (Prod-Year:)

Figure 1: Sample Type Label

3.4 Structure

The chapter is structured as follows:

- Description of the inputs and outputs.
- Block diagram.
- Indicators (module).
- Specifications.
- Connector boards.
- System cables.

The safety-related 1oo2 processor system in the I/O module performs the following functions:

- Trip function.
- 2oo3 evaluation of the values sampled for the rotational speed and direction.
- 2oo3 evaluation of the digital inputs.
- Control and monitoring of the I/O level.

The data and states of the I/O module are provided to the processor modules via the redundant system bus. The system bus has a redundant structure for reasons of availability. Redundancy is only ensured if both system bus modules are inserted in the base plates and configured in SILworX.

3.4.1 Measuring Inputs and Rotation Direction Inputs

The overspeed trip module is equipped with three measuring inputs and three rotation direction inputs. These use signals from three independent sensors (pulse generators) to determine a turbine's speed and rotation direction.

To supply the sensors (pulse generators), a short-circuit-proof supply is assigned to each measuring input. The supply voltages are monitored for undervoltage. The hardware ensures that the supply voltage is not exceeded.

The supplies of the measuring inputs are monitored for the configured load current, refer to Chapter 4.3 for details.

3.4.2 Digital Inputs

The overspeed trip module is equipped with three digital inputs (DI 02…DI 04) that evaluate external trip signals. Each digital input is assigned a short-circuit-proof and current-limited supply that is used to feed control circuit devices of type 3.

3.4.3 Reset Input

The module is equipped with a digital reset input (DI 01).

The reset input is used for the following purposes:

- To reset the module after the trip function was triggered.

  A rising edge at the reset input resets the trip function. The module functions are activated and the actuators on the outputs DO 01…DO 05 can be energized.
- To start the turbine when the voltage is connected

  A HIGH level on the reset input activates the module functions and the actuators on the outputs DO 01…DO 05 can be energized.

  A LOW level on the reset input prevents the actuators on the outputs from being energized. They remain de-energized until the level changes from LOW to HIGH.

The two functions can only be performed if the *Allow Trip Reset* parameter is set to TRUE.

If the module is in proper working order, the reset input has no effects on the module's function.

3.4.4 Digital Outputs

The overspeed trip module is equipped with 5 digital outputs. These outputs are used to trigger actuators. The outputs are not galvanically separated from one another and from the supply voltage. The supply voltage minus internal voltage drop is present on the outputs.

The outputs are protected against overload. If an overload is detected, the corresponding output is switched off and switched on again after one second. If the overload is still present, the output is switched off again for one second. This process is repeated as long as the overload is present. To avoid the cyclic switch-on after an overload, the user program must be configured accordingly.

The maximum total current of the 5 outputs is 12 A and must not be exceeded.

3.4.5 Relay Output

The module is equipped with a non-safety-related relay output. This is implemented as a signaling contact (change-over contact). The contacts can be used to connect optical and acoustic detectors with a current consumption of up to 180 mA.

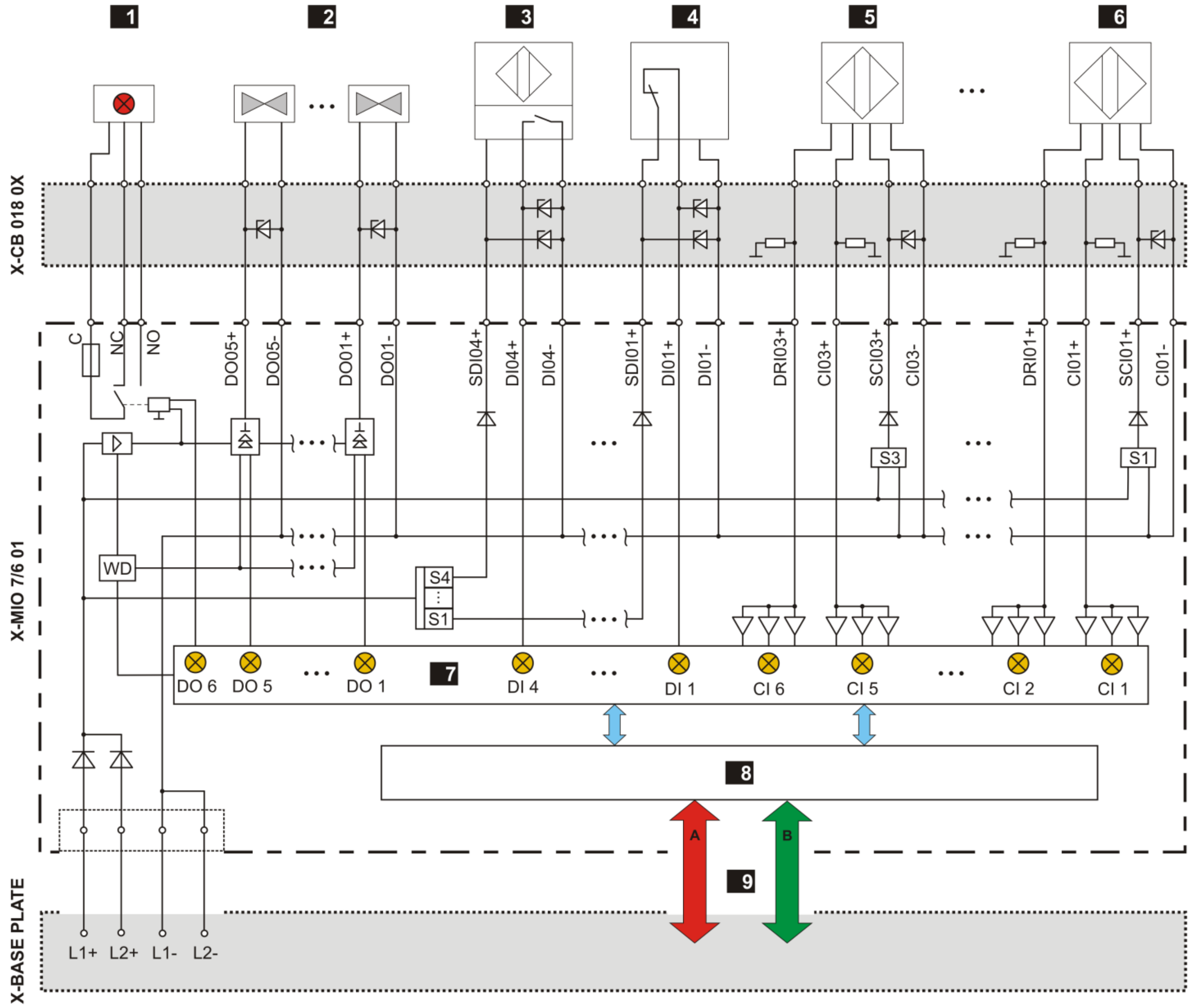
The relay is energized during fault-free operation and drops out whenever a warning or error message is displayed, e.g.:

- A speed value from the 2oo3 evaluation differs from the other two measured values beyond the tolerance value (warning message).
- Only two of the measured values are valid for the 2oo3 speed evaluation (warning message).
- Only two of the values available for the 2oo3 evaluation of the digital inputs are valid (warning message).
- In case of module faults, the relay is energized once the fault has been removed.
- Emergency shutdown (trip function) triggered, rising edge on the reset input is required to restart the turbine.

The relay output is protected against contact welding caused by short-circuits. The relay output must be protected with an external fuse < 1 A. The fuse must be adjusted to the network to be connected.

3.4.6 Block Diagram

The following block diagram shows the structure of the overspeed trip module:



1 Field level: Signaling equipment
2 Field level: Actuators, e.g., solenoid valves
3 Field level: Switching devices of type 3
4 Field level: Reset
5 Field level: Sensors on measuring input 3
6 Field level: Sensors on measuring input 1
7 Interface
8 Safety-related processor system
9 System buses

Figure 2: Block Diagram

3.4.7 Indicators

The following figure shows the indicators of the module (LEDs).

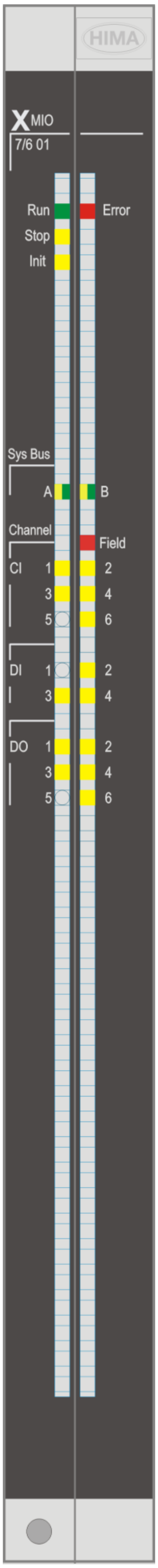


Figure 3: Indicators

The light-emitting diodes (LEDs) indicate the operating state of the output module.

The LEDs on the module are divided into three groups:

- Module status indicators (Run, Error, Stop, Init)
- System bus indicators (A, B)
- I/O indicators (CI 1…CI 6, DI 1…DI 4, DO 1…DO 6, Field)

When the supply voltage is connected, 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 (600 ms) on, long (600 ms) off
Blinking2	Short (200 ms) on, short (200 ms) off, short (200 ms) on, long (600 ms) off
Blinking-x	Ethernet communication: Blinking synchronously with data transfer

Table 3: Blinking Frequencies of LEDs

3.4.8 Module Status Indicators

These LEDs are located on the upper part of the front plate.

LED	Color	Status	Description
RUN	Green	On	Module in the RUN state, normal operation.
		Blinking1	Module state STOP / LOADING OS
		Off	Module not in the RUN state, observe the other status LEDs.
ERROR	Red	On	System warning, for example: ▪ No license for additional functions (e.g., communication protocols), test mode. ▪ Temperature warning
		Blinking1	System error, for example: ▪ Internal module faults detected by self-tests, e.g., hardware or voltage supply faults. ▪ Fault while loading the operating system.
		Off	No faults detected
STOP	Yellow	On	Module state STOP / VALID CONFIGURATION
		Blinking1	The module is in one of the following states: ▪ STOP / INVALID CONFIGURATION ▪ STOP / LOADING OS
		Off	Module not in the STOP state, observe the other status LEDs.
Init	Yellow	On	Module state: INIT
		Blinking1	The module is in one of the following states: ▪ LOCKED ▪ STOP / LOADING OS
		Off	Module is in none of the states described, observe the other status LEDs.

Table 4: Module Status Indicators

3.4.9 System Bus Indicators

The system bus indicator LEDs are labeled *Sys Bus.*

LED	Color	Status	Description
A	Green	On	Physical and logical connection to the system bus module in slot 1.
		Blinking1	No physical connection to the system bus module in slot 1.
	Yellow	Blinking1	The physical connection to the system bus module in slot 1 has been established. No connection to a (redundant) processor module running in system operation.
W	Green	On	Physical and logical connection to the system bus module in slot 2.
		Blinking1	No physical connection to the system bus module in slot 2.
	Yellow	Blinking1	The physical connection to the system bus module in slot 2 has been established. No connection to a (redundant) processor module running in system operation.
A+B	Off	Off	Neither physical nor logical connection to the system bus modules in slot 1 and slot 2.

Table 5: System Bus Indicators

3.4.10 I/O Indicators

The LEDs of the I/O indicators are labeled *Channel*. LEDs CI 1 + CI 2, CI 3 + CI 4 and CI 5 + CI 6 belong together. The LED with odd number outputs the frequency while the LED with even number outputs the rotation direction.

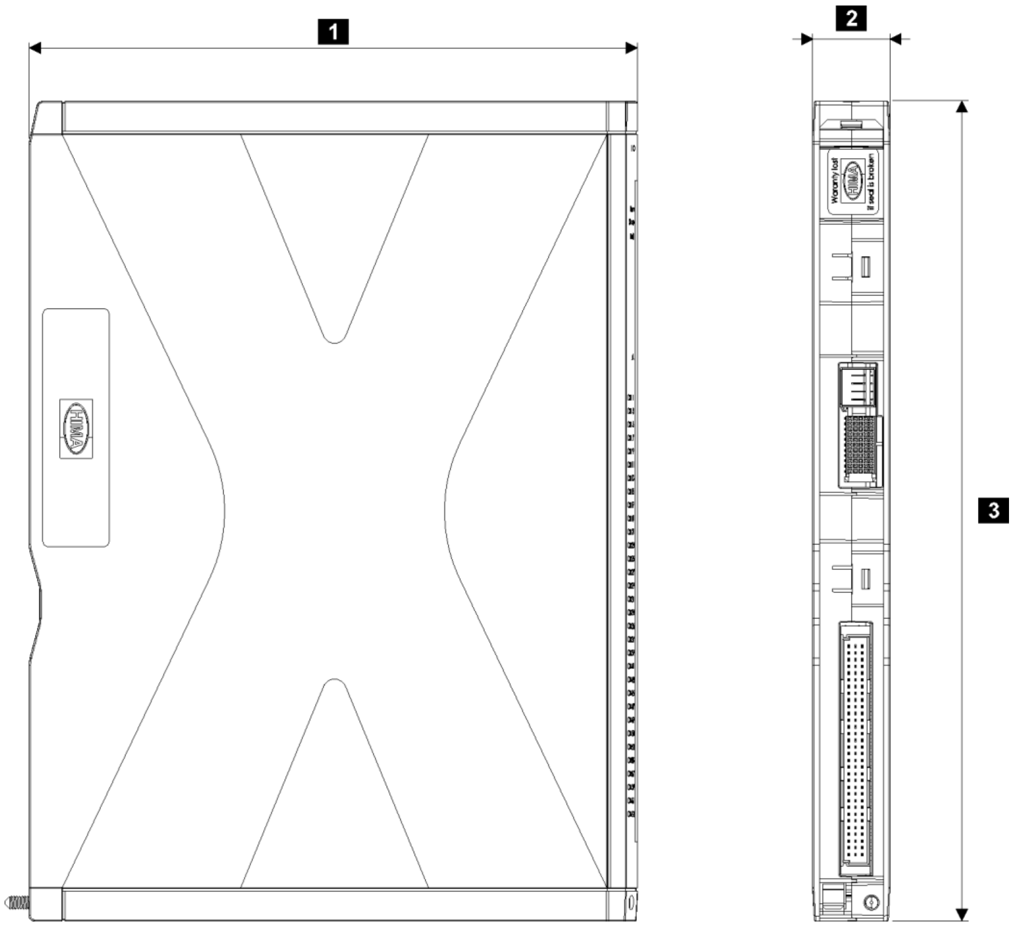
LED	Color	Status	Description
CI 1, CI 3, CI 5	Yellow	On	Frequency < 20 Hz with high level Frequency > 20 Hz with high and low level: No distinction between high and low level is made for the LED.
		Blinking2	Channel fault
		Off	Frequency < 20 Hz with low level Channel not configured.
CI 2, CI 4, CI 6	Yellow	On	Rotation direction, leading
		Off	Rotation direction, lagging
DI 1…DI 4	Yellow	On	High level present
		Blinking2	Channel fault
		Off	Low level present
DO 1… DO 5	Yellow	On	The corresponding channel is active (energized)
		Blinking2	Channel fault
		Off	The corresponding channel is not active (de-energized)
DO 6	Yellow	On	Relay energized
		Off	Relay de-energized
Field	Red	Blinking2	Field fault on at least one channel, e.g., open-circuit, short-circuit, overcurrent.
		Off	No faults at the field level

Table 6: I/O Indicators

3.5 Product Data

General	
Supply voltage	24 VDC, -15…+20 %, r_p ≤ 5 % SELV, PELV
Maximum supply voltage	30 VDC
Current consumption	0.5 A at 24 VDC without load Max. 12 A (when the max. output current is applied to the supplies)
Module cycle time	2 ms
Protection class	Protection class III in accordance with IEC/EN 61131-2.
Ambient temperature	0…+60 °C
Transport and storage temperature	-40…+85 °C
Humidity	Max. 95 % relative humidity, non-condensing
Pollution	Pollution degree II in accordance with IEC/EN 61131-2
Altitude	< 2000 m
Degree of protection	IP20
Dimensions (H x W x D) in mm	310 x 29.2 x 230
Weight	Approx. 1.0 kg

Table 7: Product Data



1 Depth: 230 mm
2 Width: 29.2 mm
3 Height: 310 mm

Figure 4: Views

Inputs for measuring the frequency	
Number of measuring inputs CI01+…CI03+	Groups of 3, with common reference potential CI- (galvanically separated from the system bus) switching devices of type 3 in accordance with EN 61131-2
Number of inputs, static rotation direction signal DRI01+…DRI03+	
Frequency	0…35 kHz
Measured value resolution	32-bit
Evaluation	1 phase / 1 edge 2 phases / 1 edge
Accuracy of speed measurement (frequency)	±0.1 % of the measured value, min. ±1 Hz
Specified accuracy for the 2oo3 evaluation (frequency)	±0.1 % of the measured value and the configurable parameter *Maximum Allowed Speed Deviation in 1/min*, refer to Chapter 4.5.1 for details.
Maximum allowed speed deviation in 1/min	The maximum speed deviation allowed between the 3 speed sensors can be configured, refer to Chapter 4.5.1 for details.
Switching devices in accordance with EN 61131-2	
Basic load	Typ. 5.45 mA at 24 VDC
Cable length	1000 m, shielded, twisted pair wires
Switch-on threshold Low → High	> 10 V
Switch-off threshold High → Low	< 8 V

Table 8: Specifications for the Measuring Inputs

Supply for inputs for measuring the frequency	
Number of supplies	3, short-circuit-proof
Output voltage (depending on the sensor)	24 VDC, -15…+20 %
Max. output current for each supply	80 mA
OC/SC detection is based on configurable current values	0…80 mA ±10 %
Nominal short-circuit current per channel (supply to input)	5.45 mA at 24 V
Nominal short-circuit current per channel (supply to L-)	Typ. 160 mA The channel is shutdown if an overload occurs. The affected channel is switched off and cyclically switched on again.
Supply monitoring	The module monitors the supplies for undervoltage. If the *Sup. Used* parameter is activated, a supply fault results in a channel fault (*Channel OK* = FALSE)
Assignment of supply outputs	
The supply output assigned to each input must be used for power supply.	
SCI01+…SCI03+	CI01+…CI03+ DRI01+…DRI03+

Table 9: Specifications for the Measuring Input Supplies

Digital inputs	
Number of inputs (number of channels)	3 + 1 reset input, unipolar reference pole L-, non-galvanically separated from one another
Type of input	Current sinking logic, 24 V, type 3 in accordance with IEC 61131-2
Rated input voltage	0…24 V
Input voltage operating range	-3…30 V (current limited to approx. 2.6 mA)
Voltage range low level	-3…5 V
Voltage range high level	11…30 V
Switching point	Typ. 9.3 V ± 0.4 V (2.1 mA ± 0.15 mA)
Measured value refresh (in the user program)	Cycle time of the user program

Table 10: Specifications for Digital Inputs

Digital input supply	
Number of supplies	4
Output voltage	Supply voltage - 2.5 V L- reference pole
Max. output current for each supply	25 mA
Nominal short-circuit current per channel (sensor's short-circuit)	2.5 mA at 24 V
Supply monitoring	The module monitors the supplies for overvoltage and undervoltage. If the *Sup. Used* parameter is activated, a supply fault results in a channel fault (*Channel OK* = FALSE)
Assignment of supply outputs	
The supply output assigned to each input must be used for power supply.	
SDI01+…SDI04+	DI01+…DI04+

Table 11: Supply Specifications for the Digital Inputs

Digital outputs	
Number of outputs (number of channels)	5, unipolar with reference pole L- Not galvanically separated
Output voltage	≥ L+ minus internal voltage drop
Voltage drop (with high level)	2.2 V at 2 A output current
Nominal rated current (with high level)	1.6 A, range 0.01…2 A
Total permissible current	12 A
Leakage current (with low level)	Max. 1 mA
Current limiting in the event of a short-circuit	Approx. 4.33 A per channel
Ohmic load	To nominal rated current 2 A
Inductive load	Max. 10 H
Capacitive load	Inrush current of max. 3 A for t < 2.5 s
SC threshold	3.3 A for t > 6 ms 2.1 A for t > 2.5 s
Overload protection of the outputs, transient	33 V (max. 43 V)
Switching time of the channels (with ohmic load)	≤ 100 µs
Test pulse (with ohmic load)	typ. 250 µs
Behavior upon overload	The affected output is switched off and cyclically switched on again

Table 12: Specifications for the Digital Outputs

Relay output	
Number of outputs (channels)	1, potential-free, Not safety-related
Switching voltage	5…30 V
Switching current	1…180 mA
Switching time (make contact closed)	4 ms
Reset time (break contact closed, without wiring)	4 ms
Make contact bounce time	2 ms
Contact material	AgNi + Au
Lifetime ▪ mechanical ▪ electrical	 ≥ 10 x 10^8 switching operations ≥ 2 x 10^5 switching operations with ohmic full load

Table 13: Specifications for Relay Outputs

3.6 Connector Boards

A connector board connects the overspeed trip module to the field level. Module and connector board together form a functional unit. Insert the connector board into the appropriate slot prior to mounting the module.

The following connector boards are available for the overspeed trip module:

Connector board	Description	Number of slots
X-CB 018 02	Redundant connector board with screw terminals	2
X-CB 018 06	Triple redundant connector board with screw terminals	3
X-CB 018 04	Redundant connector board with cable plug	2
X-CB 018 07	Triple redundant connector board with cable plug	3

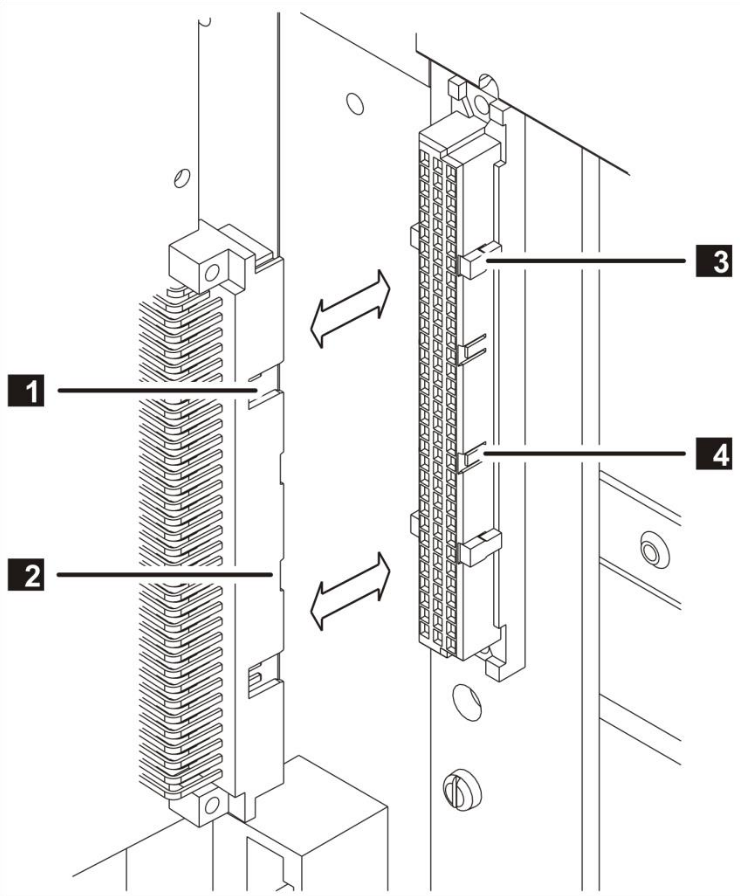
Table 14: Available Connector Boards

3.6.1 Mechanical Coding of Connector Boards

I/O modules and connector boards are mechanically coded starting from hardware revision index (HW-Rev.) 10. Coding avoids installation of improper I/O modules thus preventing negative effects on redundant modules and the field level.
Apart from that, improper equipment has no effect on the HIMax system since only I/O modules properly configured in SILworX can enter the RUN state.

I/O modules and the corresponding connector boards have a mechanical coding in the form of wedges. The coding wedges in the female connector of the connector board match with the male connector recesses of the I/O module plug, see Figure 5.

Coded I/O modules can only be plugged in to the corresponding connector boards.



1 Male connector recess
2 Prepared male connector recess
3 Coding wedge
4 Guideway for coding wedge

Figure 5: Coding Example

Coded I/O modules can be plugged in to uncoded connector boards. Uncoded I/O modules cannot be plugged in to coded connector boards.

3.6.2 Coding of X-CB 018 0X Connector Boards

The following table specifies the position of the coding wedges on the I/O module plug:

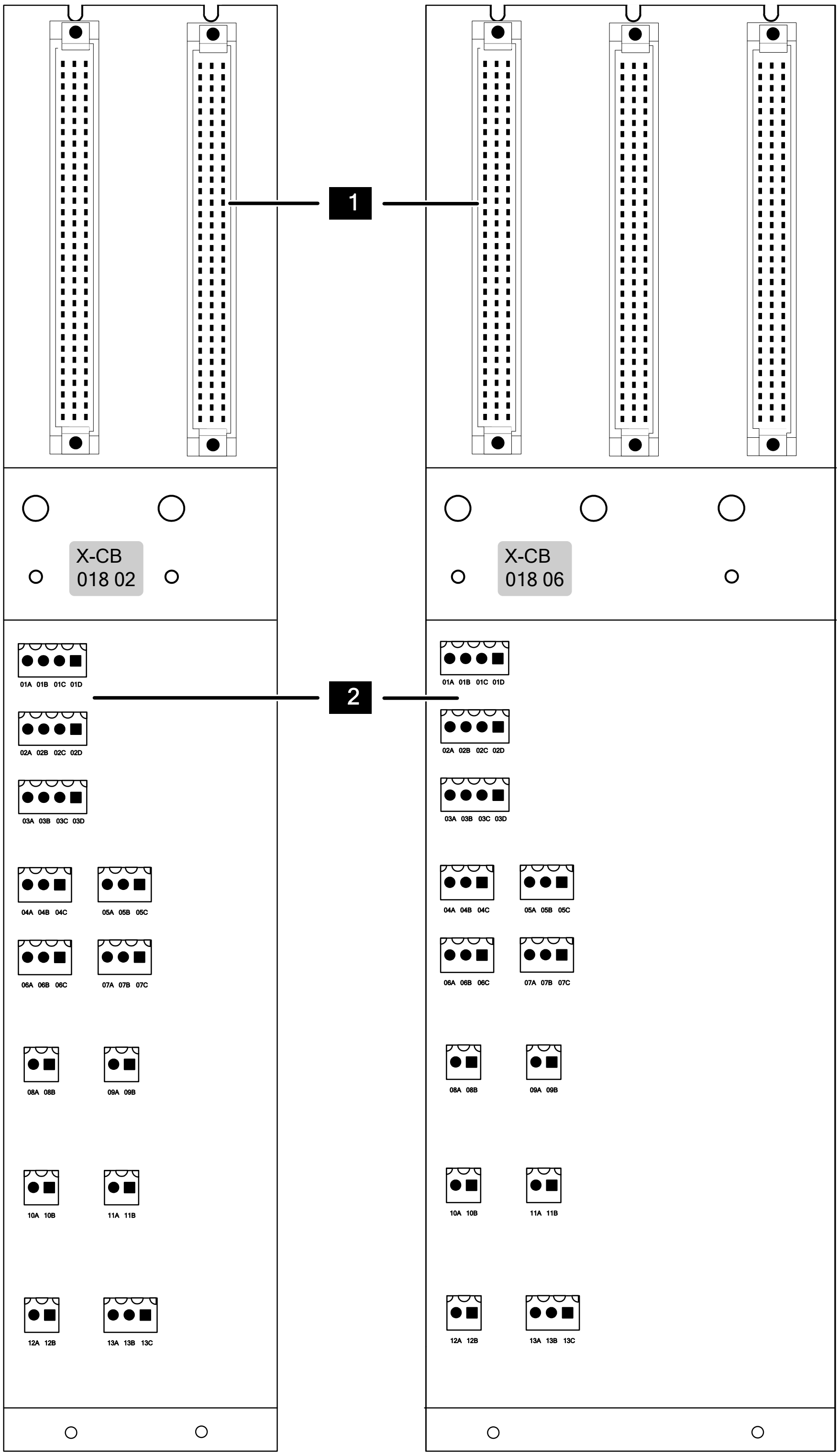
a7	a13	a20	a26	c7	c13	c20	c26
X		X	X	X			

Table 15: Position of Coding Wedges

3.6.3 Connector Boards with Screw Terminals

Redundant X-CB 018 02

Triple redundant X-CB 018 06



1 I/O module plug

2 Connection to the field level (screw terminals)

Figure 6: Connector Boards with Screw Terminals

3.6.4 Terminal Assignment for Connector Boards with Screw Terminals

Designation	Signal		
01a	SCI01+		
01b	CI01+		
01c	DRI01+		
01d	CI01-		
Designation	Signal		
02a	SCI02+		
02b	CI02+		
02c	DRI02+		
02d	CI02-		
Designation	Signal		
03a	SCI03+		
03b	CI03+		
03c	DRI03+		
03d	CI03-		
Designation	Signal	Designation	Signal
04a	SDI01+	05a	SDI02+
04b	DI01+	05b	DI02+
04c	DI01-	05c	DI02-
Designation	Signal	Designation	Signal
06a	SDI03+	07a	SDI04+
06b	DI03+	07b	DI04+
06c	DI03-	07c	DI04-
Designation	Signal	Designation	Signal
08a	DO01+	09a	DO02+
08b	DO01-	09b	DO02-
Designation	Signal	Designation	Signal
10a	DO03+	11a	DO04+
10b	DO03-	11b	DO04-
Designation	Signal	Designation	Signal
12a	DO05+	13a	C
12b	DO05-	13b	NC
		13c	NO

Table 16: Terminal Assignment for Connector Boards with Screw Terminals

Cable plugs attached to the connector board pin headers are used to connect to the field level.

The cable plugs feature the following characteristics:

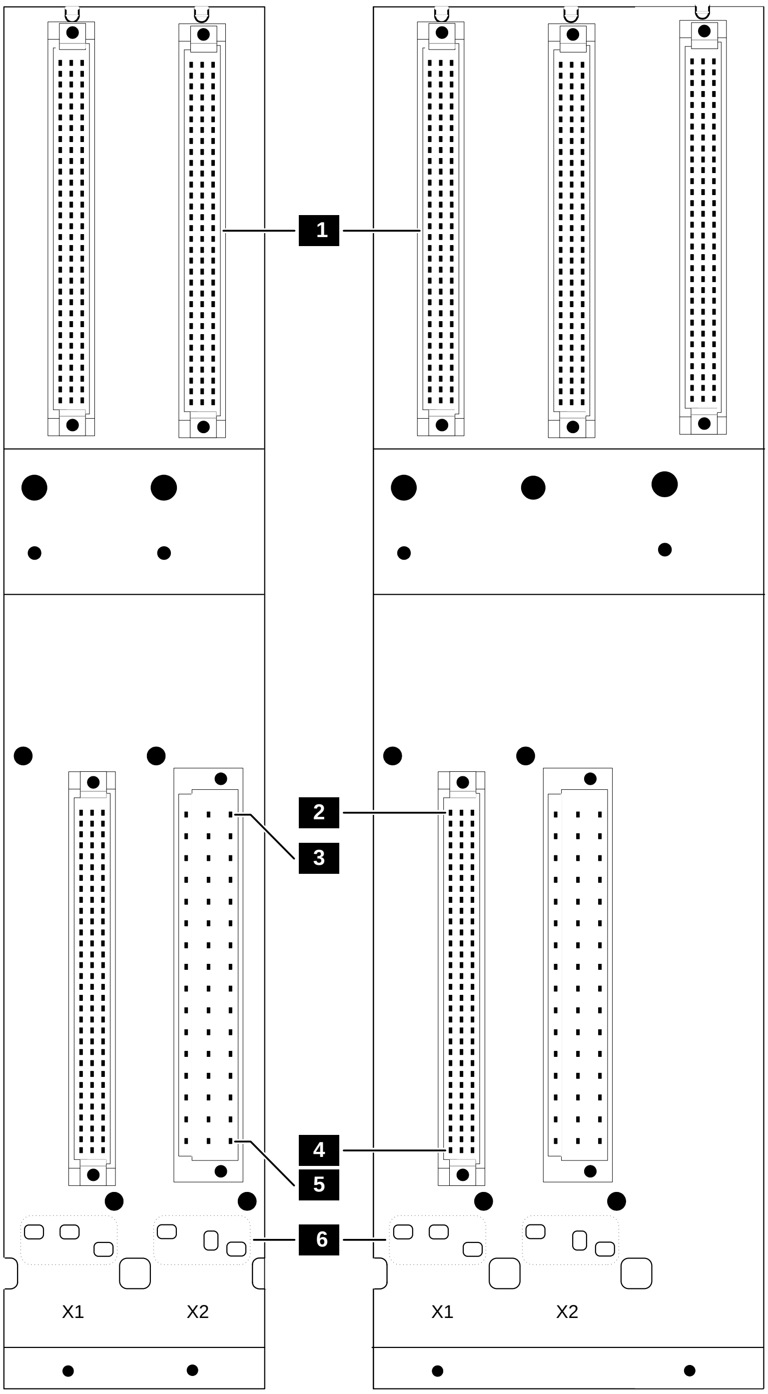
Connection to the field level	
Cable plugs	13 pieces, with 2 to 4 poles
Wire cross-section	0.2…1.5 mm^2 (single-wire) 0.2…1.5 mm^2 (finely stranded) 0.2…1.5 mm^2 (with wire end ferrule)
Stripping length	6 mm
Screwdriver	Slotted 0.4 x 2.5 mm
Tightening torque	0.2…0.25 Nm

Table 17: Cable Plug Characteristics

3.6.5 Connector Boards with Cable Plug

Redundant **Triple redundant**

X-CB 018 04 X-CB 018 07



- **1** I/O module plug
- **2** Connection to the field level, left cable plug X1 in row 1
- **3** Connection to the field level, right cable plug X2 in row 2
- **4** Connection to the field level, left cable plug X1 in row 32
- **5** Connection to the field level, right cable plug X2 in row 32
- **6** Coding of cable plugs

Figure 7: Connector Boards with Cable Plug

3.6.6 Pin Assignment for Connector Boards with Cable Plug

HIMA provides ready-made system cables for use with these connector boards, see Chapter 3.7. The cable plug and the connector boards are coded.

i **Connector pin assignment!**

The following table describes the connector pin assignment of the system cable plug.

The wire color coding complies with IEC 60304. The color abbreviations used are in accordance with IEC 60757.

3.6.6.1 Cable Plug X1

Connect system cable X-CA 005 to cable plug X1.

Row	c		b		A	
	Signal	Color	Signal	Color	Signal	Color
1	-	PKBN [1)]	-	WHPK [1)]	Internal use [2)]	YEBU [1)]
2	-	GYBN [1)]	-	WHGY [1)]		GNBU [1)]
3	-	YEBN [1)]	-	WHYE [1)]		YEPK [1)]
4	-	BNGN [1)]	-	WHGN [1)]		PKGN [1)]
5	-	RDBU [1)]	-	GYPK [1)]	-	
6	-	VT [1)]	-	BK [1)]	-	
7	-	RD [1)]	-	BU [1)]	-	
8	-	PK [1)]	-	GY [1)]	-	
9	SDI04+	YE [1)]	-	GN [1)]	-	
10	SDI03+	BN [1)]	-	WH [1)]	-	
11	SDI02+	RDBK	-	BUBK	-	
12	SDI01+	PKBK	-	GYBK	-	
13	-	PKRD	DIO4+	GYRD	-	
14	-	PKBU	DIO3+	GYBU	-	
15	-	YEBK	DIO2+	GNBK	-	
16	-	YERD	DIO1+	GNRD	-	
17	-	YEBU	-	GNBU	-	
18	-	YEPK	-	PKGN	-	
19	-	YEGY	-	GYGN	-	
20	-	BNBK	-	WHBK	-	
21	-	BNRD	-	WHRD	-	
22	-	BNBU	-	WHBU	-	
23	-	PKBN	-	WHPK	-	
24	-	GYBN	-	WHGY	-	
25	-	YEBN	-	WHYE	GND	YEGY [1)]
26	-	BNGN	-	WHGN	GND	GYGN [1)]
27	SCI03+	RDBU	DRI03+	GYPK	GND	BNBK [1)]
28	SCI03+	VT	CI03+	BK	GND	WHBK [1)]
29	SCI02+	RD	DRI02+	BU	GND	BNRD [1)]
30	SCI02+	PK	CI02+	GY	GND	WHRD [1)]
31	SCI01+	YE	DRI01+	GN	GND	BNBU [1)]
32	SCI01+	BN	CI01+	WH	GND	WHBU [1)]

[1)] Additional orange ring if one wire color is repeated for the first time.

[2)] The wires must be isolated individually! No other use is permitted!

Table 18: Pin Assignment for the System Cable Plug X1

3.6.6.2 Cable Plug X2

Connect system cable X-CA 008 to cable plug X2.

Pin assignment						
Row	e		c		A	
	Signal	Number	Signal	Number	Signal	Color
2	-	-	-	-	Internal use [1)]	YE
4	-	-	-	-		GN
6	-	-	-	-		BN
8	-	-	-	-		WH
10	DO1+	1	DO1-	2	-	-
12	DO2+	3	DO2-	4	-	-
14	DO3+	5	DO3-	6	-	-
16	DO4+	7	DO4-	8	-	-
18	DO5+	9	DO5-	10	-	-
20	-	11	-	12	-	-
22	-	13	-	14	-	-
24	-	15	-	16	-	-
26	-	17	-	18	-	-
28	C	19	-	20	-	-
30	NC	21	-	22	-	-
32	NO	23	-	24	-	-
[1)] The wires must be isolated individually! No other use is permitted!						

Table 19: Pin Assignment for the System Cable Plug X2

3.7 System Cables

The following system cables are required for cable plugs X1 and X2:

Cable plug	System cables
X1, left cable plug (Figure 7)	X-CA 005
X2, right cable plug (Figure 7)	X-CA 008

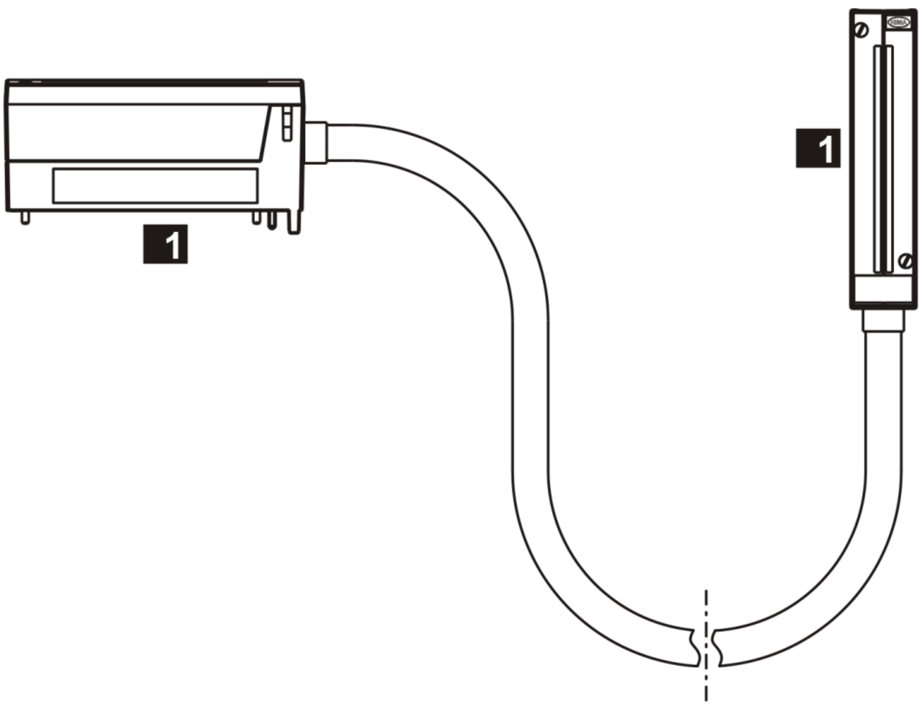
Table 20: Required System Cables

3.7.1 System Cable X-CA 005

System cable X-CA 005 is used to wire the X-CB 018 04/07 connector board (cable plug X1) to the field termination assembly.

General	
Cable	LIYCY-TP 38 x 2 x 0.25 mm² (shielded)
Wire	Finely stranded
Average outer diameter (d)	Approx. 16.8 mm Max. 20 mm for all types of system cables
Minimum bending radius Fixed installation Flexible application	 5 x d 10 x d
Burning behavior	Flame resistant and self-extinguishing in accordance with IEC 60332-1-2, IEC 60332-2-2
Length	8…30 m
Color coding	Based on DIN 47100, see Table 18.

Table 21: Cable Data X-CA 005



1 Identical cable plugs

Figure 8: System Cable X-CA 005 01 n

The system cable is available in the following standard lengths:

System cables	Description	Length	Weight
X-CA 005 01 8	Coded cable plugs on both sides.	8 m	4.25 kg
X-CA 005 01 15		15 m	8 kg
X-CA 005 01 30		30 m	16 kg

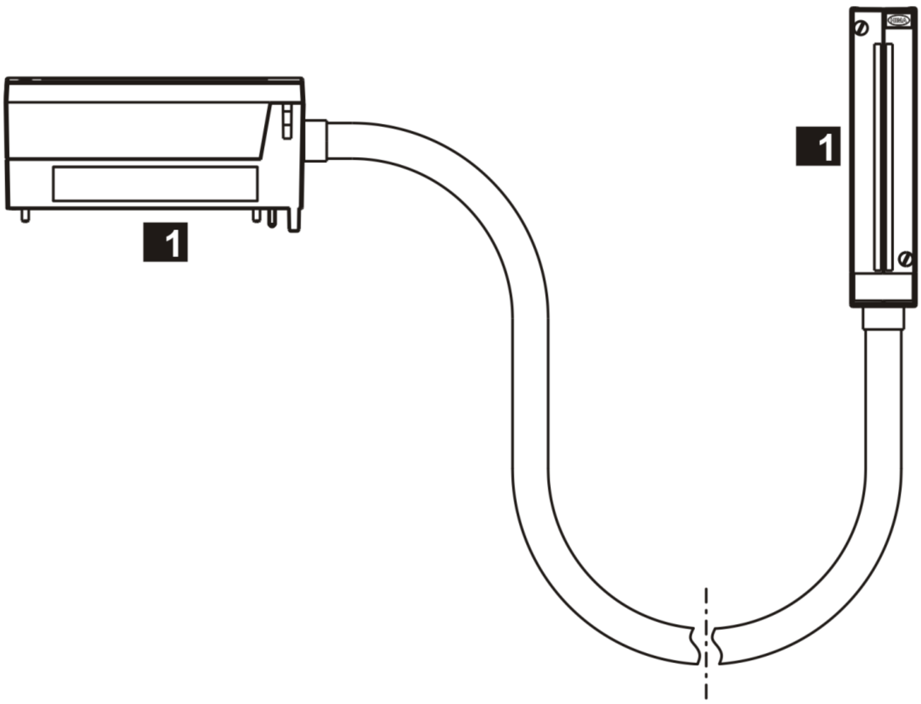
Table 22: Available System Cables X-CA 005 01

3.7.2 System Cable X-CA 008

System cable X-CA 008 is used to wire the X-CB 018 04/07 connector board (cable plug X2) to the field termination assembly.

General	
Cable	LIYY 24 x 1.5 mm² + 2 x 2 x 0.14 mm²
Wire	Finely stranded
Average outer diameter (d)	Approx. 15.7 mm Max. 20 mm for all types of system cables
Minimum bending radius Fixed installation Flexible application	 5 x d 10 x d
Burning behavior	Flame resistant and self-extinguishing in accordance with IEC 60332-1-2, IEC 60332-2-2
Length	8…30 m
Color coding	Based on DIN 47100, see Table 19.

Table 23: Cable Data X-CA 008



1 Identical cable plugs

Figure 9: System Cable X-CA 008 01 n

The system cable is available in the following standard lengths:

System cables	Description	Length	Weight
X-CA 008 01 8	Coded cable plugs on both sides.	8 m	5.75 kg
X-CA 008 01 15		15 m	11 kg
X-CA 008 01 30		30 m	22 kg

Table 24: Available System Cables X-CA 008 01

3.7.3 Cable Plug Coding

The cable plugs are equipped with three coding pins. Therefore, cable plugs only match connector boards and FTAs encoded accordingly, see Figure 7.

4 Start-Up

This chapter describes how to install, configure and connect the module. For further details, refer to the HIMax system manual (HI 800 001 E).

i The safety-related application (SIL 3 in accordance with IEC 61508) of the inputs and the connected sensors must comply with the safety requirements. For further details, refer to the HIMax safety manual (HI 801 003 E).

4.1 Mounting

Observe the following points when mounting the module:

- Only operate the module with the appropriate fan components. For further details, see the system manual (HI 801 001 E).
- Only operate the module with the suitable connector board. For further details, see Chapter 3.6.
- The module, including its connected components, must be installed to ensure compliance with the requirements for degree of protection IP20 or higher in accordance with EN 60529:1991 + A1:2000.

NOTICE

Damage due to incorrect wiring!

Failure to comply with these instructions can damage the electronic components.

Observe the following points.

- Plugs and terminals connected to the field level.
  - Take the appropriate grounding measures when connecting the plugs and terminals to the field level.
  - If shielded cables are used, connect the shielding on both sides. On the module side, the shielding must be connected to the cable shield rail (use SK 20 shield connection terminal block or similar).
  - If finely stranded wires are used, HIMA recommends fastening ferrules to the wire ends. The terminals must be suitable for fastening the cross-sections of the cables in use.
- Use the supply assigned to the corresponding input (e.g., SCI01+ with CI01+). Failure of an external supply or measurement unit can lead to overload and damage of the affected input on the module.
- The inputs may be wired redundantly using the corresponding connector boards. For further details, see Chapters 3.6 and 4.5.

4.1.1 Wiring Unused Inputs

Inputs that are not being used may stay open and need not be terminated. However, to prevent short-circuits, never connect a wire to a connector board if it is open on the field level.

4.2 Mounting and Removing the Module

This chapter describes how to replace an existing module or mount a new one.

When removing the module, the connector board remains in the HIMax base plate. This saves additional wiring effort at the clamp terminals since all field terminals are connected via the connector board of the module.

4.2.1 Mounting a Connector Board

Tools and utilities:

- Screwdriver, cross PH 1 or slotted 0.8 x 4.0 mm.
- Matching connector board.

To install the connector board

1. Insert the connector board into the guiding rail with the groove facing upwards (see following drawing). Fit the groove into the guiding rail pin.
2. Place the connector board on the cable shield rail.
3. Secure the captive screws to the base plate. First screw in the lower screws than the upper ones.

To remove the connector board

1. Release the captive screws from the base plate.
2. Carefully lift the lower section of the connector board from the cable shield rail.
3. Remove the connector board from the guiding rail.

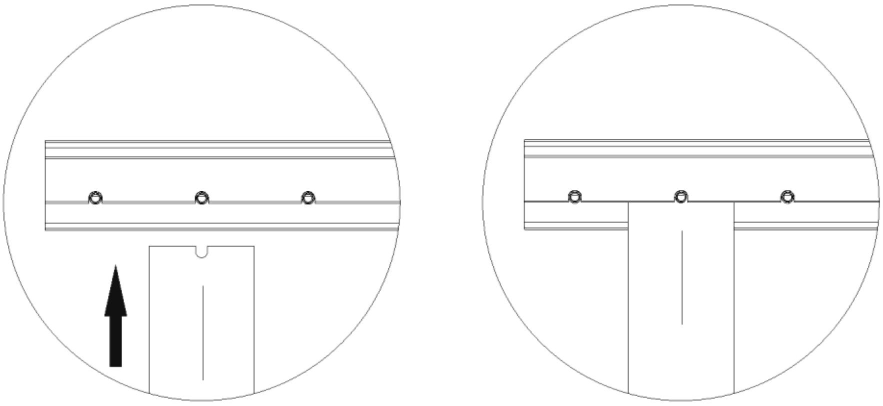


Figure 10: Example of how to Insert the Mono Connector Board

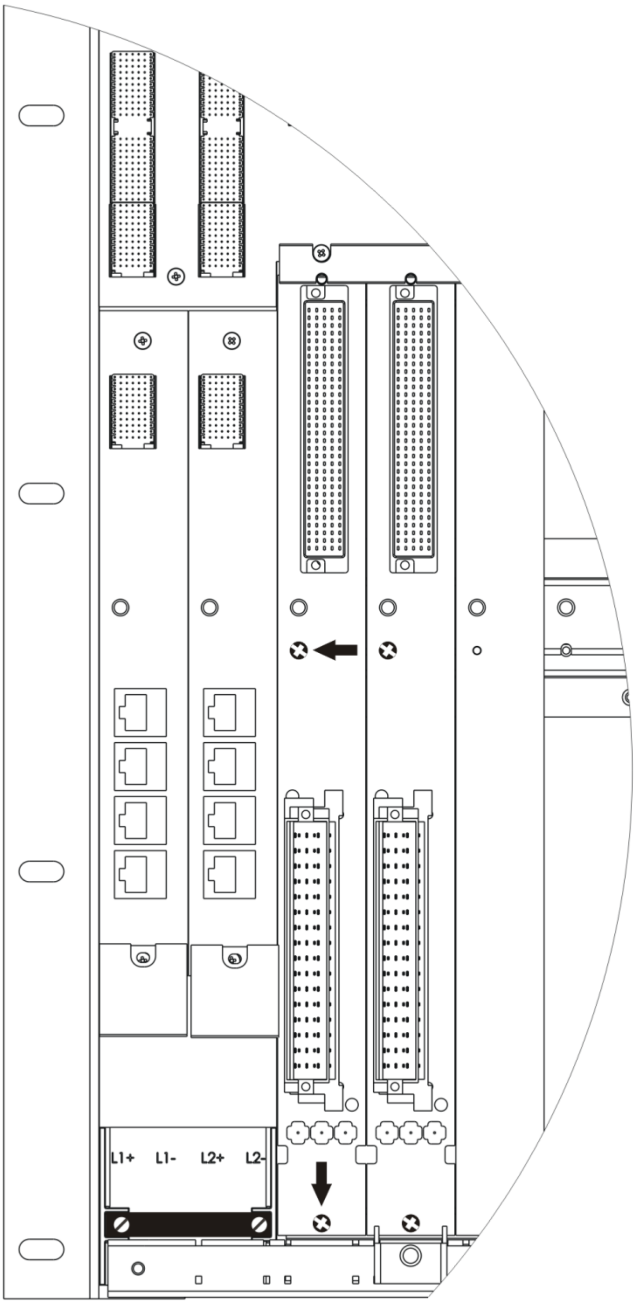


Figure 11: Example of how to Secure the Mono Connector Board with Captive Screws

i These instructions also apply for redundant connector boards. The number of used slots varies in accordance with the connector board type. The number of captive screws depends on the connector board type.

4.2.2 Mounting and Removing a Module

This chapter describes how to mount and remove the HIMax module. A module can be mounted and removed while the HIMax system is operating.

NOTICE

Damage to bus and power sockets due to module jamming!
Failure to comply with these instructions can damage the controller.
Always insert the module in the base plate carefully.

Tools and utilities:

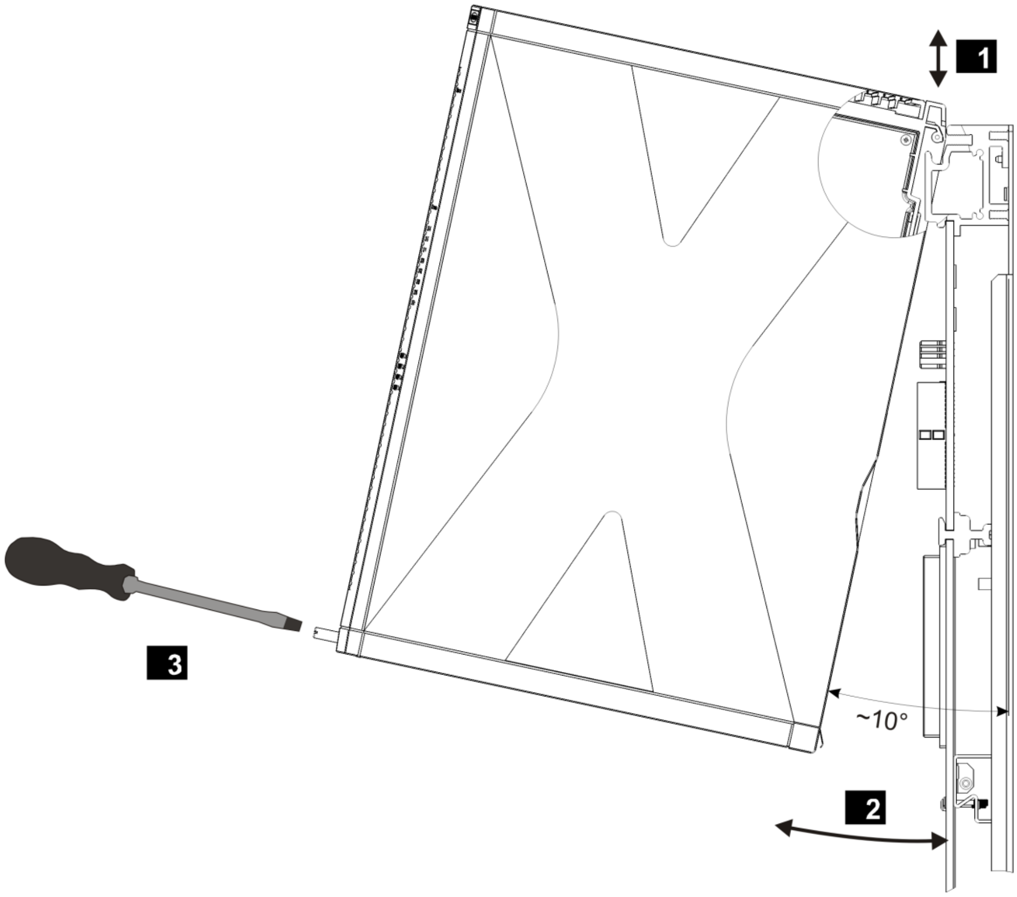
- Screwdriver, slotted 0.8 x 4.0 mm.
- Screwdriver, slotted 1.2 x 8.0 mm.

To insert the modules

1. Open the cover plate on the fan rack:
   ☑ Move the locks to the *open* position.
   ☑ Lift the cover plate and insert it into the fan rack.
2. Insert the top of the module into the hook-in rail, see **1**.
3. Swivel the lower edge of the module towards the base plate and apply light pressure to snap it into place, see **2**.
4. Tighten the screws, see **3**.
5. Pull the cover plate out of the fan rack and close it.
6. Lock the cover plate.

To remove the modules

1. Open the cover plate on the fan rack:
   ☑ Move the locks to the *open* position.
   ☑ Lift the cover plate and insert it into the fan rack.
2. Release the screw, see **3**.
3. Swivel the lower edge of the module away from the base plate. Lift and apply light pressure to remove the module from the hook-in rail, see **2** and **1**.
4. Pull the cover plate out of the fan rack and close it.
5. Lock the cover plate.



1 Inserting and removing a module
2 Swiveling the module in and out
3 Securing and releasing a module

Figure 12: Mounting and Removing a Module

i If the HIMax system is operating, do not open the cover plate of the fan rack for more than a few minutes (< 10 min) since this affects the forced cooling.

4.3 Line Monitoring (Short-Circuits and Open-Circuits)

The module monitors the sensors (pulse generators) connected to the measuring inputs for short-circuits (SC) and open-circuits (OC) by monitoring the currents of the sensor supplies.

To this end, the parameters *SC Limit [mA]* and *OC Limit [mA]* must be configured in accordance with the sensors used. The parameters *SC Limit [mA]* and *OC Limit [mA]* apply to all three measuring input supplies, see Table 25.

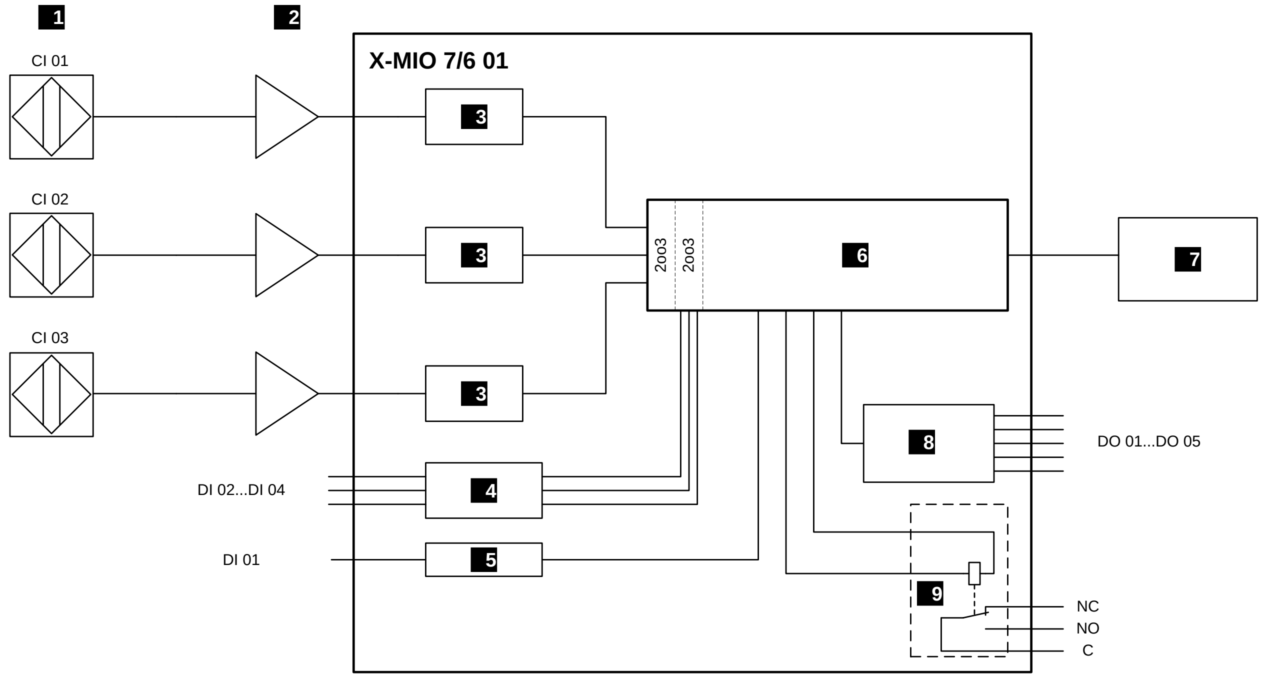
If the -> *SC Limit* value is overrun, a short-circuit (SC) is diagnosed and the -> *SC* variable is set to TRUE. If the -> *OC Limit* value is underrun, an open-circuit (OC) is diagnosed and the -> *OC* variable is set to TRUE. If the *Supply Used* parameter is activated, a detected overrun or underrun of the parameter values results in a channel fault (-> *Channel OK* = FALSE). If the supplies are not used, the *Supply Used* parameter must be deactivated. In doing so, overrunning or underrunning the load current does not result in a channel fault (-> *Channel OK* = TRUE).

The module monitors the energized digital outputs for short-circuits. Inrush current of 2.1…3.3 A can be present at the outputs for no longer than 2.5 s. The short-circuit threshold for the outputs is preset, see Table 12. If a short-circuit is detected, the -> *SC* variable is set to TRUE and the *Field* LED and the LED of the affected channel start blinking. Since SC monitoring is only active if the outputs are energized, the fault is still reported even if the channel is de-energized while the short-circuit is present. If the output is energized again and the short-circuit is no longer present, the following actions are performed:

- The -> *SC* variable changes to FALSE
- The *Field* LED no longer blinks
- The LED for the affected channel is lit

4.4 Overspeed Trip Module Sampling

The following chapters describe how the input signals are sampled. The overspeed detection and subsequent triggering of the trip function is independent of the overall HIMax system and the user program.



1 Sensors (pulse generators)
2 Input signal
3 Measuring facility (SIL 3)
4 Input for external trip signals
5 Reset input
6 Safety-related processor system
7 Processor module (X-CPU)
8 Triggering of solenoid valves
9 Warning signal relay

Figure 13: Evaluation of Input Signals

The input signals 2 from three independent sensors 1 are sampled by one measuring facility each 3 in accordance with SIL 3 and provided to the safety-related processor system. For each channel, the speed and rotation direction values sampled by the measuring facilities are outpu to the parameters -> *Rotational Speed [mHz] [DINT]* and -> *Rotation Direction [USINT]* in the SILworX Hardware Editor, see Table 32.

A 2oo3 evaluation of the speed and rotation direction values is performed in the safety-related processor system. The mean of the rotational speed values is calculated and output to the *Rotational Speed, Raw* parameter, see Table 26. The 2oo3 evaluation is used to determine the rotation direction based on the rotation direction values. The rotation direction is output to the *Rotation Direction* parameter. The processor module 7 reads the parameters *Rotational Speed, Raw* and *Rotation Direction* cyclically and processes them in the user program.

In addition to speed and rotation direction, the acceleration values are sampled for each channel from the input signals of the sensors and are output to the -> *Increase, Raw [DINT]* parameter, see Table 26.

4.4.1 2oo3 Evaluation

For the 2oo3 evaluation, at least two of the three input signals must be sampled without errors. The following actions are performed if one of the input signals cannot be sampled without errors:

- The *Warning Available* parameter is set to TRUE.
- The warning relay is de-energized.
- A diagnostic entry is written.

If only one or no input signal could be detected without error, the trip function is triggered!

The detected speed values are compared to one another to ensure that the limit values for safety-related accuracy (±0.1 % of the measured value) and the parameter *Maximum Allowed Speed Deviation [1/min]* are not exceeded. The largest of the two limit values is decisive for evaluation.

The actions previously described occur if one of the two speed values diverges from the other two values beyond the limits. If more than one speed value is outside these limits, the trip function is triggered.

When setting the parameter *Max. Allowed Speed Deviation [1/min],* take the following into account: The larger the parameter is selected, the longer the response time until shutdown (delay). If the parameter *Max. Allowed Speed Deviation [1/min]* is decisive for evaluation, the delay (t_V) is calculated as follows:

$$t_v[s] = \frac{Max. Allowed\ Speed\ Deviation\ \left[\frac{1}{min}\right]}{Acceleration\ \left[\frac{1/min}{s}\right]} + Trip\ Noise\ Blanking\ Time\ in\ (s)$$

If the safety-related accuracy (±0.1 % of the measured value) is decisive for evaluation, the delay (t_V) is calculated as follows:

$$t_v[s] = \frac{Safety\ Related\ Accuracy\ in\ (\frac{1}{min})}{Acceleration\ \left[\frac{1/min}{s}\right]} + Trip\ Noise\ Blanking\ Time\ in\ (s)$$

For the digital inputs DI 02…DI 04, at least two of the three input signals must be sampled without errors or the trip function is triggered.

4.4.2 Threshold Monitoring

The module is equipped with a gradient monitoring function. It monitors the rotational speed for violation of the configurable thresholds *Upper Limit [1/min]* and *Lower Limit [1/min],* which define the turbine's rotational speed range.

Using the *Activation Threshold [1/min]* parameter, lower limit monitoring is only activated when the rotational speed overruns the activation threshold. Afterwards, if the rotational speed underruns the activation threshold, the lower limit monitoring function remains active.

The following conditions must apply for the activation threshold: Activation threshold ≥ lower limit and activation threshold ≤ upper limit.

The trip function is performed if the configured threshold is overrun.

4.4.3 Gradient Monitoring

The module is equipped with an optional gradient monitoring function that can be activated or deactivated via the *Gradient Monitoring* parameter. The parameters for gradient monitoring, *Max. Increase, Positive [1/min^2]* and *Max. Increase, Negative [1/min^2]* are set to the maximum values allowed and therefore not active. The limit values allowed for the turbines must be used for gradient monitoring.

The measuring facility **3** evaluates the acceleration values. The 2oo3 evaluation within the safety-related processor system forms the arithmetic mean of the acceleration values. The determined acceleration value is issued as *Increase, Raw*.

If the increase raw value overruns the value of *Max. Increase, Positive [1/min^2]* or *Max. Increase, Negative [1/min^2],* the trip function is performed.

Exceeding the value of one channel during the 2oo3 evaluation causes the frequency of the arithmetic mean to change in the next cycle, which, in turn, causes the gradient to change and may lead to a shutdown, depending on the setting of the parameters *Max. Increase Positive [1/min^2]* and *Max. Increase Negative [1/min^2].*

4.4.4 Trip Function

The trip function evaluates the external and internal trip signals. The internal trip signals are generated if the limits set for the turbine speed and acceleration are violated. The external trip signals are signals that are read at the digital inputs (DI02…DI04) and generated by external devices, e.g., machine monitoring systems. If the trip signal provides a trip condition, an emergency shutdown (trip function) is triggered taking the trip noise blanking time into account. The digital outputs are de-energized causing the turbine to trip.

An emergency shutdown (trip function) can also be performed through the user program. To this end, the parameter *Trigger Trip* is available in the SILworX programming tool.

4.5 Configuring the Overspeed Trip Module in SILworX

The module is configured in the Hardware Editor of the SILworX programming tool.

Observe the following points when configuring the module:

- To diagnose the module and channels, both the statuses and the measured value can be evaluated within the user program. For further details on the statuses and parameters, refer to the tables starting with Chapter 4.5.1.
- A global variable must be assigned to each input and output in use.
- The supplies for the measuring inputs are monitored for undervoltage.

  If the *Supply Used* parameter is activated, a supply fault results in a channel fault (-> *Channel OK* = FALSE). The values of the faulty channel are not integrated in the 2oo3 evaluation; the module responds as described in Chapter 4.4.1. If the supplies are not used, the *Supply Used* parameter must be deactivated. In doing so, a supply error does not result in a channel fault (-> Channel OK = TRUE). To diagnose the supply, evaluate the *Supply OK* parameter in the user program. Refer to Table 31 for more details on the *Supply OK* parameter.
- The supplies for the digital inputs are monitored for undervoltage.

  If the *Sup. Used* parameter is activated, a supply fault results in a channel fault (-> *Channel OK* = FALSE). The faulty channel is not used for the 2oo3 evaluation. If the supplies are not used, the *Sup. Used* parameter must be deactivated. In doing so, a supply error does not result in a channel fault (-> Channel OK = TRUE). To diagnose the supply, evaluate the *Supply OK* parameter in the user program. Refer to Table 29 for more details on the *Supply OK* parameter.
- The supplies of the measuring inputs is monitored for the acceptable load current (SC/OC), refer to Chapter 4.3 for details.
- To increase availability through module redundancy, a redundancy group created in SILworX is always initially composed of two modules. Additionally, the redundancy group can be expanded with a third module as follows:
  - Right-click to open the context menu of the redundancy group. Select *Extend Redundancy Group* and choose an available slot, on the left or right side of the redundancy group, in the *Create Redundancy Group* dialog box. Click **OK** to confirm. A third module is created.
- The redundancy behavior of the modules must be defined through the user program.

  The *Redundancy* tab lists all the existing redundancy groups and the modules they contain.

  The detail view for the redundancy group displays the configurable settings. These settings apply to all modules within the redundancy group.

  The detail view for the modules displays the parameters for the individual modules. Global variables can be assigned to these parameters.

4.5.1 The **Module** Tab in the Detail View for the Redundancy Group

The **Module** tab contains the following system parameters for the overspeed trip module:

System parameter	Data type	S [1)]	R/W	Description
Name	---	---	W	Module name.
Spare Module	BOOL	Y	W	Activated: Missing modules in the redundancy group are not considered a fault, even if none of the modules is inserted in the base plate. ▪ The *System* LED on the processor module (X-CPU) is not lit. ▪ Missing modules are not marked as missing (red) in the Hardware Editor. ▪ Error counter is not incremented. Deactivated: It is considered a fault if a module of the redundancy group is missing in the base plate Default setting: Deactivated
Noise Blanking	BOOL	Y	W	Allow noise blanking performed by the process module (activated/deactivated). Default setting: Activated. The processor module delays its response to transient interference until the safety time. The user program retains its last valid process value. Refer to the system manual (HI 801 001 E) for more details on noise blanking.
System parameters	Data type	S [1)]	R/W	Description
SC Limit [mA]	UDINT	Y	W	Value at which the measuring input supplies should signal a short-circuit (SC). Default value: 0 Range of values: 0…80 mA
OC Limit [mA]	UDINT	Y	W	Value at which the measuring input supplies should signal an open-circuit (OC). Default value: 0 Range of values: 0…80 mA
Gear Wheel Teeth	UINT	Y	W	Number of gear wheel teeth. Default value: 60 Range of values: 1…500
Scaling Factor	LREAL	Y	R	$\text{Scaling Factor} = \frac{60}{\text{Gear Wheel Teeth*1000}}$ The scaling factor depends on the value specified in *Gear Wheel Teeth*.
Lower Limit [1/min]	UDINT	Y	W	Lower limit for the rotational speed monitoring. Default value: 0
Lower Limit [mHz]	UDINT	Y	R	$= \frac{\text{Lower Limit [1/min]}}{\text{Scaling Factorr}}$
Upper Limit [1/min]	UDINT	Y	W	Upper limit for the rotational speed monitoring. Default value: 0
Upper Limit [mHz]	UDINT	Y	R	$= \frac{\text{Upper Limit [1/min]}}{\text{Scaling Factor}}$
Activation Threshold [1/min]	UDINT	Y	W	If the threshold is exceeded, the *Lower Limit [1/min]* parameter is activated. Default value: 0
Activation Threshold [mHz]	UDINT	Y	R	$= \frac{\text{Activation Threshold [1/min]}}{\text{Scaling Factor}}$

System parameter	Data type	S [1)]	R/W	Description
Max. Increase, Positive [1/min²]	UDINT	Y	W	Threshold for the acceleration (gradient monitoring) Default setting: 128 849 018 Range of values: 0 … 128 849 018, depending on the scaling factor.
Max. Increase, Positive [mHz/s]	UDINT	Y	R	$= \frac{\text{Max. Increase, Positive } [1/\text{min}^2]/60}{\text{Scaling Factor}}$
Max. Increase, Negative [1/min²]	UDINT	Y	W	Threshold for the delay (gradient monitoring) Default setting: 128 849 018 Range of values: 0 … 128 849 018, depending on the scaling factor.
Max. Increase, Negative [mHz/s]	UDINT	Y	R	$= \frac{\text{Max. Increase, Negative } [1/\text{min}^2]/60}{\text{Scaling Factor}}$
Trip Noise Blanking Time [µs]	UDINT	Y	W	Noise blanking time for trip triggering Granularity: 2000 µs, e.g., 0, 2000, 4000, … Default value: 0
Max. Allowed Speed Deviation [1/min]	UDINT	Y	W	Maximum speed deviation allowed between the 3 speed sensors. Default setting: 2 Range of values: 1…UDINT max., depending on the scaling factor (Chapter 4.4.1).
Max. Allowed Speed Deviation [mHz]	UDINT	Y	R	$= \frac{\text{Max. Allowed Speed Deviation } [1/\text{min}]}{\text{Scaling Factor}}$
Gradient Monitoring	BOOL	Y	W	Activates or deactivates monitoring of the acceleration (*Max. Increase Positive [1/min^2] / Max. Increase Negative [1/min^2]).* Default setting: Activated.
[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 25: The **Module** Tab in the Hardware Editor (Redundancy Group)

4.5.2 The **Module** Tab in the Detail View for the Individual Modules

The **Module** tab contains the following system parameters for the overspeed trip module:

<table>
<tr><th>System parameter</th><th>Data type</th><th>S 1)</th><th>R/W</th><th>Description</th></tr>
<tr><td>Name</td><td>---</td><td>---</td><td>W</td><td>Module name</td></tr>
<tr><th>System parameters</th><th>Data type</th><th>S 1)</th><th>R/W</th><th>Description</th></tr>
<tr><td colspan="5">The following statuses and parameters can be assigned global variables and used in the user program.</td></tr>
<tr><td>Diagnostic Request</td><td>DINT</td><td>N</td><td>W</td><td>To request a diagnostic value, the appropriate ID must be sent to the module using the parameter Diagnostic Request (for coding details, see Chapter 4.5.13).</td></tr>
<tr><td>Diagnostic Response</td><td>DINT</td><td>N</td><td>R</td><td>As soon as Diagnostic Response returns the ID of Diagnostic Request (for coding details, see Chapter 4.5.13), Diagnostic Status contains the diagnostic value requested.</td></tr>
<tr><td>Diagnostic Status</td><td>DWORD</td><td>N</td><td>R</td><td>Requested diagnostic value in accordance with Diagnostic Response.
The IDs of Diagnostic Request and Diagnostic Response can be evaluated in the user program. Diagnostic Status only contains the requested diagnostic value when both Diagnostic Request and Diagnostic Response have the same ID.</td></tr>
<tr><td>Rotation Direction</td><td>USINT</td><td>Y</td><td>R</td><td>Rotation direction resulting from the 2oo3 evaluation:
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>0</td><td>Unequal, measuring inputs indicate different rotation directions</td></tr>
<tr><td>1</td><td>Undefined rotation direction (no evaluation of the rotation direction possible)</td></tr>
<tr><td>2</td><td>Lagging</td></tr>
<tr><td>3</td><td>Leading</td></tr>
</table>
Default setting: 0 (unequal rotation direction)</td></tr>
<tr><td>Rotational Speed, Raw</td><td>DINT</td><td>Y</td><td>R</td><td>Rotational speed value in mHz sampled based on 2oo3 evaluation of the individual measuring inputs.</td></tr>
<tr><td>Rotational Speed, Scaled</td><td>REAL</td><td>Y</td><td>R</td><td>$= \text{Scaling Factor}*\text{Rotational Speed, Raw}$
Determined speed in 1/min.</td></tr>
<tr><td>Threshold Monitoring, Minimum</td><td>BOOL</td><td>Y</td><td>W</td><td>TRUE: Speed monitoring activated for lower limit.
FALSE: Speed monitoring deactivated for lower limit.
Default setting: TRUE</td></tr>
<tr><td>Background Test Error</td><td>BOOL</td><td>J</td><td>R</td><td>TRUE: Background test is faulty.
FALSE: Background test is free of faults.</td></tr>
<tr><td>Module OK</td><td>BOOL</td><td>Y</td><td>R</td><td>TRUE: Faultless.
FALSE: Module fault, channel fault on one channel (no external faults) or the module is not inserted.
Observe the Module Status parameter!</td></tr>
</table>

<table>
<tr><th>System parameter</th><th>Data type</th><th>S [1]</th><th>R/W</th><th>Description</th></tr>
<tr><td>Module Status</td><td>DWORD</td><td>Y</td><td>R</td><td>Status of the module
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x00000001</td><td>Module fault. [2]</td></tr>
<tr><td>0x00000002</td><td>Temperature threshold 1 exceeded.</td></tr>
<tr><td>0x00000004</td><td>Temperature threshold 2 exceeded.</td></tr>
<tr><td>0x00000008</td><td>Incorrect temperature value.</td></tr>
<tr><td>0x00000010</td><td>Voltage on L1+ is defective.</td></tr>
<tr><td>0x00000020</td><td>Voltage on L2+ is defective.</td></tr>
<tr><td>0x00000040</td><td>Internal voltage is defective.</td></tr>
<tr><td>0x80000000</td><td>No connection to the module or module in STOP state [2]</td></tr>
<tr><td colspan="2">[2] These faults affect the Module OK status and need not be separately evaluated in the user program.</td></tr>
</table></td></tr>
<tr><td>Peak Hold Max</td><td>DINT</td><td>Y</td><td>R</td><td>Maximum value sampled for the rotational speed in mHz since the last Reset Peak Hold.</td></tr>
<tr><td>Peak Hold Min</td><td>DINT</td><td>Y</td><td>R</td><td>Minimum value sampled for the rotational speed in mHz since the last Reset Peak Hold.</td></tr>
<tr><td>Reset Peak Hold</td><td>BOOL</td><td>Y</td><td>W</td><td>TRUE: Reset Peak Hold Max and Min.
FALSE: Do not reset Peak Hold Max and Min.
Default setting: FALSE</td></tr>
<tr><td>Restart on Error</td><td>BOOL</td><td>Y</td><td>W</td><td>The Restart on Error parameter can be used to cause any I/O module that is shut down permanently due to errors to re-adopt the RUN state. To do so, set the Restart on Error parameter from FALSE to TRUE.
The I/O module performs a complete self-test and only enters the RUN state if no faults are detected.
Default setting: FALSE</td></tr>
<tr><td>Increase, Raw</td><td>DINT</td><td>Y</td><td>R</td><td>Positive or negative acceleration value (delay) resulting from the 2oo3 evaluation of the CI inputs.</td></tr>
<tr><td>Trigger Trip</td><td>BOOL</td><td>Y</td><td>W</td><td>TRUE: Trigger the trip through the user program.
FALSE: Do not trigger the trip through the user program.
Default setting: FALSE</td></tr>
<tr><td>Allow Trip Reset</td><td>BOOL</td><td>Y</td><td>W</td><td>Trip reset through the user program.
TRUE: Allow reset.
FALSE: Do not allow reset.
Trip function reset is only possible with TRUE and rising edge at reset input DI 01.</td></tr>
<tr><td>Trip Available</td><td>BOOL</td><td>Y</td><td>R</td><td>TRUE: Trip function triggered.
FALSE: Trip function not triggered.</td></tr>
</table>

System parameter	Data type	S [1)]	R/W	Description
Trip State	DWORD	Y	R	For details on the trip state, see Chapter 4.5.9.
Warning Available	BOOL	Y	R	TRUE: Warning active, DO 06 relay de-energized. FALSE: No warning, DO 06 relay energized.
Timestamp [µs]	DWORD	N	R	Microsecond fraction of the timestamp. Time of sampling by the processor system of the I/O module.
Timestamp [s]	DWORD	N	R	Second fraction of the timestamp. Time of sampling by the processor system of the I/O module.
[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 26: The **Module** Tab in the Hardware Editor (Individual Module)

4.5.3 The **I/O Submodule DI 02** Tab

The **I/O Submodule DO 02** tab contains the following system parameters:

System parameter	Data type	S [1)]	R/W	Description
Name	---	---	W	Module name
Output Noise Blanking	BOOL	Y	W	Allow output noise blanking by the output module (Activated/Deactivated). Default setting: Deactivated (**recommended**) If the channel's default and read-back values are not consistent, the channel switch-off is suppressed. **It is only displayed in the redundancy group tab!**
System parameter	Data type	S [1)]	R/W	Description
The following statuses and parameters can be assigned global variables and used in the user program.				
Submodule OK	BOOL	Y	R	TRUE: No submodule fault, no channel faults. FALSE: Submodule fault, channel faults (external faults included).
Submodule Status	DWORD	Y	R	Bit-coded submodule status. (For coding details, see Chapter 4.5.9).
1) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 27: The **I/O Submodule DO 02** Tab in the Hardware Editor

4.5.4 The **I/O Submodule DO 02 Channels** Tab

The **I/O Submodule 02: Channels** tab contains the following system parameters for each digital output.
Global variables can be assigned to the system parameters with **->** and used in the user program. The value without **->** must be directly entered.

System parameters	Data type	S [1)]	R/W	Description
Channel no.	---	---	R	Channel number, preset and cannot be changed.
Channel Value [BOOL] ->	BOOL	Y	W	Binary value in accordance with the switching levels LOW (dig) and HIGH (dig). TRUE: Channel energized FALSE: Channel de-energized
-> Channel OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. The channel value is valid. FALSE: Faulty channel. The digital output is de-energized.
-> SC	BOOL	Y	R	TRUE: Short-circuit FALSE: No short-circuit SC has no effects on the -> *Channel OK* parameter
1) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 28: The **I/O Submodule DO 02: Channels** Tab in the Hardware Editor

4.5.5 The **I/O Submodule DI 02** Tab

The **I/O Submodule DI 02** tab contains the following system parameters.

System parameters	Data type	S [1]	R/W	Description
Name	---	---	W	Module name
System parameters	Data type	S [1]	R/W	Description
The following statuses and parameters can be assigned global variables and used in the user program.				
Supply 1 OK	BOOL	Y	R	The supplies are monitored for undervoltage. TRUE: The supply is faultless. FALSE: The supply is faulty.
Supply 2 OK	BOOL	Y	R	Such as *Supply 1 OK.*
Supply 3 OK	BOOL	Y	R	Such as *Supply 1 OK.*
Supply 4 OK	BOOL	Y	R	Such as *Supply 1 OK.*
Submodule OK	BOOL	Y	R	TRUE: No submodule fault, no channel faults. FALSE: Submodule fault, channel faults (external faults included).
Submodule Status	DWORD	Y	R	Bit-coded submodule status. (For coding details, see Chapter 4.5.11).
[1] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 29: The **I/O Submodule DI 02** Tab in the Hardware Editor

4.5.6 The **I/O Submodule DI 02 Channels** Tab

The **I/O Submodule DI 02: Channels** tab contains the following system parameters for each analog input:
Global variables can be assigned to the system parameters with **->** and used in the user program. The value without **->** must be directly entered.

System parameters	Data type	S 1)	R/W	Description
Channel no.	---	---	R	Channel number, preset and cannot be changed.
T on [µs]	UDINT	Y	W	Time on Delay The module only indicates a level change from LOW to HIGH if the HIGH level is present for longer than the configured time t_{on}. The time on delay cannot be extended by more than the cycle time of the module. This also results in a delayed evaluation of the -> *Channel Value [BOOL]* parameter. Range of values: 0…(2^{31} - 1) Granularity: 1000 µs, e.g., 0, 1000, 2000, … Default value: 0 **It is only displayed in the redundancy group tab!**
T off [µs]	UDINT	Y	W	Time off delay The module only indicates a level change from HIGH to LOW if the LOW level is present for longer than the configured time t_{off}. The time off delay cannot be extended by more than the cycle time of the module. This also results in a delayed evaluation of the -> *Channel Value [BOOL]* parameter. Range of values: 0…(2^{31} - 1) Granularity: 1000 µs, e.g., 0, 1000, 2000, … Default value: 0 **It is only displayed in the redundancy group tab!**
Sup. Used	BOOL	Y	W	Activated: DI supply error affecting the -> *Channel OK* parameter. Deactivated: DI supply error not affecting the -> *Channel OK* parameter. Default setting: Activated. **It is only displayed in the redundancy group tab!**
-> Channel Value [BOOL]	BOOL	Y	R	Binary value in accordance with the switching levels LOW (dig) and HIGH (dig). TRUE: Channel energized FALSE: Channel de-energized
-> Channel OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. The channel value is valid. FALSE: Faulty channel. The channel value is set to FALSE.
1) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 30: The **I/O Submodule DI 02: Channels** Tab in the Hardware Editor

4.5.7 The **I/O Submodule CT 03** Tab

The **I/O Submodule CT 03** tab contains the following system parameters:

System parameter	Data type	S [1)]	R/W	Description
Name	---	---	W	Module name
Supply Used	BOOL	Y	W	Activated: CI supply error affecting the -> *Channel OK* parameter. Deactivated: CI supply error not affecting the -> *Channel OK* parameter. Default setting: Activated. **It is only displayed in the redundancy group tab!**
System parameter	Data type	S [1)]	R/W	Description
The following statuses and parameters can be assigned global variables and used in the user program.				
Supply 1 OK	BOOL	Y	R	The CI supplies are monitored for undervoltage TRUE: The supply is faultless. FALSE: The supply is faulty.
Supply 2 OK	BOOL	Y	R	Such as *Supply 1 OK.*
Supply 3 OK	BOOL	Y	R	Such as *Supply 1 OK.*
Submodule OK	BOOL	Y	R	TRUE: No submodule fault, no channel faults. FALSE: Submodule fault, channel faults (external faults included).
Submodule Status	DWORD	Y	R	Bit-coded submodule status. (For coding details, see Chapter 4.5.12).
1) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 31: The **I/O Submodule CT 03** Tab in the Hardware Editor

4.5.8 The **I/O Submodule CT 03 Channels** Tab

The **I/O Submodule CT 03: Channels** tab contains the following system parameters for each counter input:
Global variables can be assigned to the system parameters with **->** and used in the user program. The value without **->** must be directly entered.

System parameters	Data type	S [1)]	R/W	Description
Channel no.	---	---	R	Channel number, preset and cannot be changed.
-> Rotational Speed [mHz] [DINT]	DINT	Y	R	Unhandled value measured for the channel 0…35 000 000 mHz, (speed 1000 = 1 Hz) Default value: 0
-> Rotation Direction [USINT]	USINT	Y	R	0 : Undefined rotation direction 1 : Lagging 2 : Leading Default value: 0
-> Rot. Speed (scaled) [REAL]	REAL	Y	R	$= \mathrm{Skalierungsfaktor}^*\mathrm{Drehzahl}\ [\mathrm{mHz}]$
-> Increase, Raw [mHz/s] [DINT]	DINT	Y	R	Positive or negative acceleration value (delay) expressed in mHz/s. Default value: 0
-> Channel OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. The process value is valid. FALSE: Faulty channel. Rotational speed (frequency) is set to 0 and the measured value is frozen.
-> OC [BOOL]	BOOL	Y	R	TRUE: Open-circuit FALSE: No open-circuit
-> SC [BOOL]	BOOL	Y	R	TRUE: Short-circuit FALSE: No short-circuit
-> Counter Input Level [BOOL]	BOOL	Y	R	TRUE: High level present. FALSE: Low level present.
-> Rotation Direction Input Level [BOOL]	BOOL	Y	R	TRUE: High level present. FALSE: Low level present.
1) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 32: The **I/O Submodule CT 03: Channels** Tab in the Hardware Editor

4.5.9 Description of **Submodule Status Trip State[DWORD]**

The trip state is stored permanently when a trip occurs (frozen). A new trip state can only be detected after a trip reset, see *Allow Trip Reset* parameter.

The following table specifies the coding of the *Trip State* parameter:

Coding	Description
0x00000002	Trip triggered: The speed value resulting from the 2oo3 evaluation exceeds or lies below one of the two speed limit values *Upper Limit* or *Lower Limit*.
0x00000004	Trip triggered: The acceleration value resulting from the 2oo3 evaluation exceeds or lies below one of the two acceleration limit values *Max. Increase Positive or Max. Increase Negative*.
0x00000008	Trip triggered: At least 2 of the 3 digital inputs are defective or return FALSE.
0x00000010	Trip triggered through the user program.
0x00000020	Trip triggered: Only one or no speed input could be detected for gradient monitoring (acceleration).
0x00000040	Trip triggered: After transition from STOP to RUN (initial state). The module remains in the trip state to prevent the turbine from restarting automatically!
0x00000080	Trip triggered: Only one or no speed input could be detected or the maximum speed deviation allowed for the speed inputs is exceeded on more than one speed input.

Table 33: Coding of *Trip State [DWORD]*

4.5.10 Description of **Submodule Status DO 02 [DWORD]**

The following table specifies the coding of the *Submodule Status* parameter:

Coding	Description
0x00000001	Fault in hardware unit (submodule)
0x00000002	Reset of an E/A bus
0x00000004	Fault detected while configuring the hardware
0x00000080	Reset of CS monitoring (Chip Select monitoring)
0x00800000	Voltage monitoring of WD1: voltage error
0x01000000	Voltage monitoring of WD2: voltage error
0x02000000	Voltage monitoring of L1+ HIGH voltage defective
0x04000000	Voltage monitoring of L1+ LOW voltage defective
0x08000000	Voltage monitoring of L2+ HIGH voltage defective
0x10000000	Voltage monitoring of L2+ LOW voltage defective
0x20000000	Error while reading back the relay voltage
0x40000000	Error while reading back the outputs, safety switch activated
0x80000000	Error while reading back the outputs, watchdog triggered

Table 34: Coding of *Submodule Status [DWORD]*

4.5.11 Description of **Submodule Status DI 02 [DWORD]**

The following table specifies the coding of the *Submodule Status* parameter:

Coding	Description
0x00000001	Fault in hardware unit (submodule)
0x00000002	Reset of an E/A bus
0x00800000	Module fault connected with reference voltage A
0x01000000	Fault connected with reference voltage A (overvoltage)
0x02000000	Fault connected with reference voltage B (undervoltage)
0x04000000	Module fault connected with reference voltage B
0x08000000	Fault connected with auxiliary voltage
0x10000000	Fault connected with reference voltage A (low voltage)
0x20000000	Fault connected with reference voltage B (overvoltage)
0x40000000	Fault connected with chip select monitoring A
0x80000000	Fault connected with chip select monitoring B

Table 35: Coding of *Submodule Status [DWORD]*

4.5.12 Description of **Submodule Status CT 03 [DWORD]**

The following table specifies the coding of the *Submodule Status* parameter:

Coding	Description
0x00000001	Fault in hardware unit (submodule).
0x00000004	Fault detected while configuring the hardware.
0x00010000	Internal warning!
0x00020000	Internal warning!
0x00040000	Internal warning!
0x00080000	Internal warning!
0x00200000	Internal warning, the supply is being checked!
0x00400000	Internal warning, the supply voltage is being checked
0x00800000	Internal warning, the safety switches are being checked!
0x01000000	Internal warning!
0x02000000	Internal warning!
0x04000000	Internal warning!
0x08000000	Internal warning!
0x40000000	The supply voltage is outside the specified range.
0x80000000	The module is not properly plugged in

Table 36: Coding of *Submodule Status [DWORD]*

4.5.13 Description of **Diagnostic Status [DWORD]**

The following table specifies the coding of the *Diagnostic Status* parameter:

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>0</td><td>Diagnostic values are indicated consecutively.</td></tr>
<tr><td>100</td><td>Bit-coded temperature status
0 = normal
Bit0 = 1: Temperature threshold 1 has been exceeded
Bit1 = 1: Temperature threshold 2 has been exceeded
Bit2 = 1 : Fault in temperature measurement</td></tr>
<tr><td>101</td><td>Measured temperature (10 000 digits/ °C).</td></tr>
<tr><td>200</td><td>Bit-coded voltage status.
0 = normal
Bit0 = 1 : L1+ (24 V) is faulty
Bit1 = 1 : L2+ (24 V) is faulty</td></tr>
<tr><td>201…207</td><td>Internal error!</td></tr>
<tr><td>300</td><td>Value of 24 V power supply is below 24 V(BOOL). (BOOL)</td></tr>
<tr><td>1001…1003</td><td>Channel status of measuring inputs 1…3, I/O unit: = 0
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule)</td></tr>
<tr><td>0x0100</td><td>Channel fault, defective supply status</td></tr>
<tr><td>0x0800</td><td>No value exists for the rotation direction</td></tr>
<tr><td>0x1000</td><td>Process values cannot be created</td></tr>
<tr><td>0x2000</td><td>Edge distance error</td></tr>
<tr><td>0x8000</td><td>Warning: Only two of the sampled input values are error-free and available for the 2oo3 evaluation.</td></tr>
</table></td></tr>
<tr><td>1101…1103</td><td>Supply channel status, measuring inputs 1…3, I/O unit: = 1
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule)</td></tr>
<tr><td>0x0010</td><td>Short-circuit detected</td></tr>
<tr><td>0x0020</td><td>Open-circuit detected</td></tr>
<tr><td>0x0100</td><td>Channel fault, defective supply status</td></tr>
<tr><td>0x0200</td><td>Line monitoring fault occurred</td></tr>
<tr><td>0x0400</td><td>Undervoltage or overvoltage (supply)</td></tr>
</table></td></tr>
<tr><td>1201…1204</td><td>Channel status of digital inputs 1…4, I/O unit: = 2
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule)</td></tr>
<tr><td>0x0800</td><td>Channel fault, defective supply status</td></tr>
<tr><td>0x1000</td><td>Faulty connection to I/O bus A.</td></tr>
<tr><td>0x2000</td><td>Faulty connection to I/O bus B.</td></tr>
<tr><td>0x4000</td><td>Channel fault while testing digital input circuit A.</td></tr>
<tr><td>0x8000</td><td>Channel fault while testing digital input circuit B.</td></tr>
</table></td></tr>
<tr><td>1301…1304</td><td>Supply channel status of digital inputs 1…4, I/O unit: = 3
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule)</td></tr>
<tr><td>0x8000</td><td>Undervoltage or overvoltage (supply)</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>1401…1406</td><td>Channel status of digital outputs 1…5 + relay output, I/O unit: = 4
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule)</td></tr>
<tr><td>0x0008</td><td>Hardware fault.
Read-back value = 0 with setpoint = 1</td></tr>
<tr><td>0x0040</td><td>Hardware fault.
Read-back value = 1 with setpoint = 0</td></tr>
<tr><td>0x0400</td><td>Trip due to overcurrent threshold 1</td></tr>
<tr><td>0x0800</td><td>Trip due to overcurrent threshold 2</td></tr>
</table></td></tr>
<tr><td>1501</td><td>For details on the trip state, see Chapter 4.5.9.
Is stored permanently when a trip occurs (frozen). A new trip state can only be detected after a trip reset, see Allow Trip Reset parameter.</td></tr>
<tr><td>1502</td><td>Trip status warnings: Value constantly refreshed (in contrast to the trip state, which is stored permanently).
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x00000002</td><td>Trip warning: The speed value resulting from the 2oo3 evaluation exceeds or lies below one of the two speed limit values Upper Limit or Lower Limit.</td></tr>
<tr><td>0x00000004</td><td>Trip warning: The acceleration value resulting from the 2oo3 evaluation exceeds or lies below one of the two acceleration limit values Max. Increase Positive or Max. Increase Negative, or only one or no speed input could be detected.</td></tr>
<tr><td>0x00000008</td><td>Trip warning: At least one of the 3 digital inputs is defective or returns FALSE.</td></tr>
<tr><td>0x00000080</td><td>Trip warning: At least one of the speed inputs could not be detected or the maximum speed deviation allowed for the speed inputs is exceeded on at least one speed input.</td></tr>
</table></td></tr>
</table>

Table 37: Coding of *Diagnostic Status [DWORD]*

4.6 Variants

This chapter describes the proper wiring of the module in safety-related applications. The following connection variants are permitted.

The module is wired via connector boards.

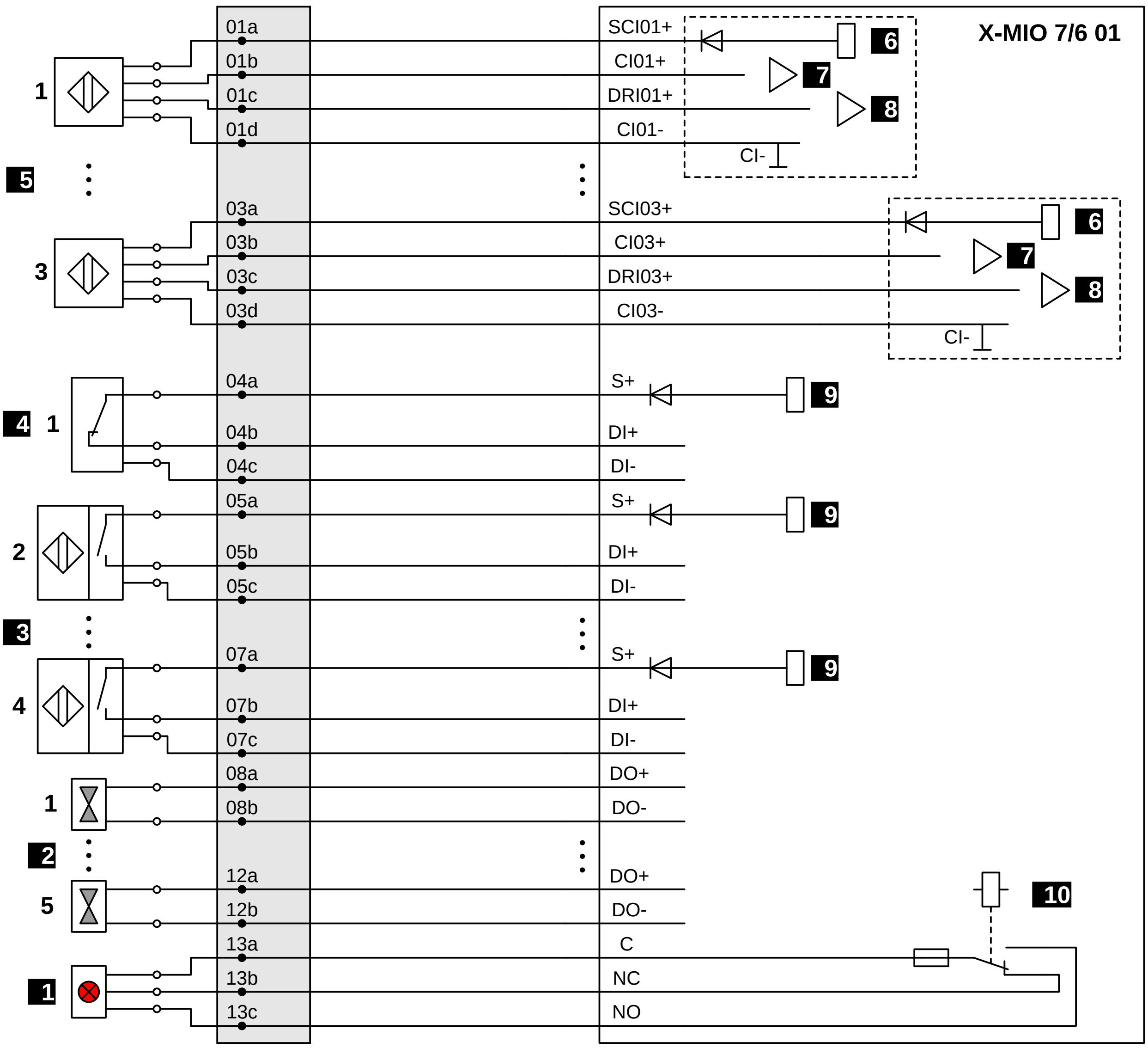
NOTICE

Damage to the module!

Reverse polarity of the inputs and outputs damages the module and thus must be avoided under all circumstances.

4.6.1 Wiring the Modules via Connector Boards X-CB 018 02 and X-CB 018 06

The following figure only depicts the wiring for one module. The inputs and outputs of the redundant modules are connected in parallel to the sensors and actuators via connector boards.

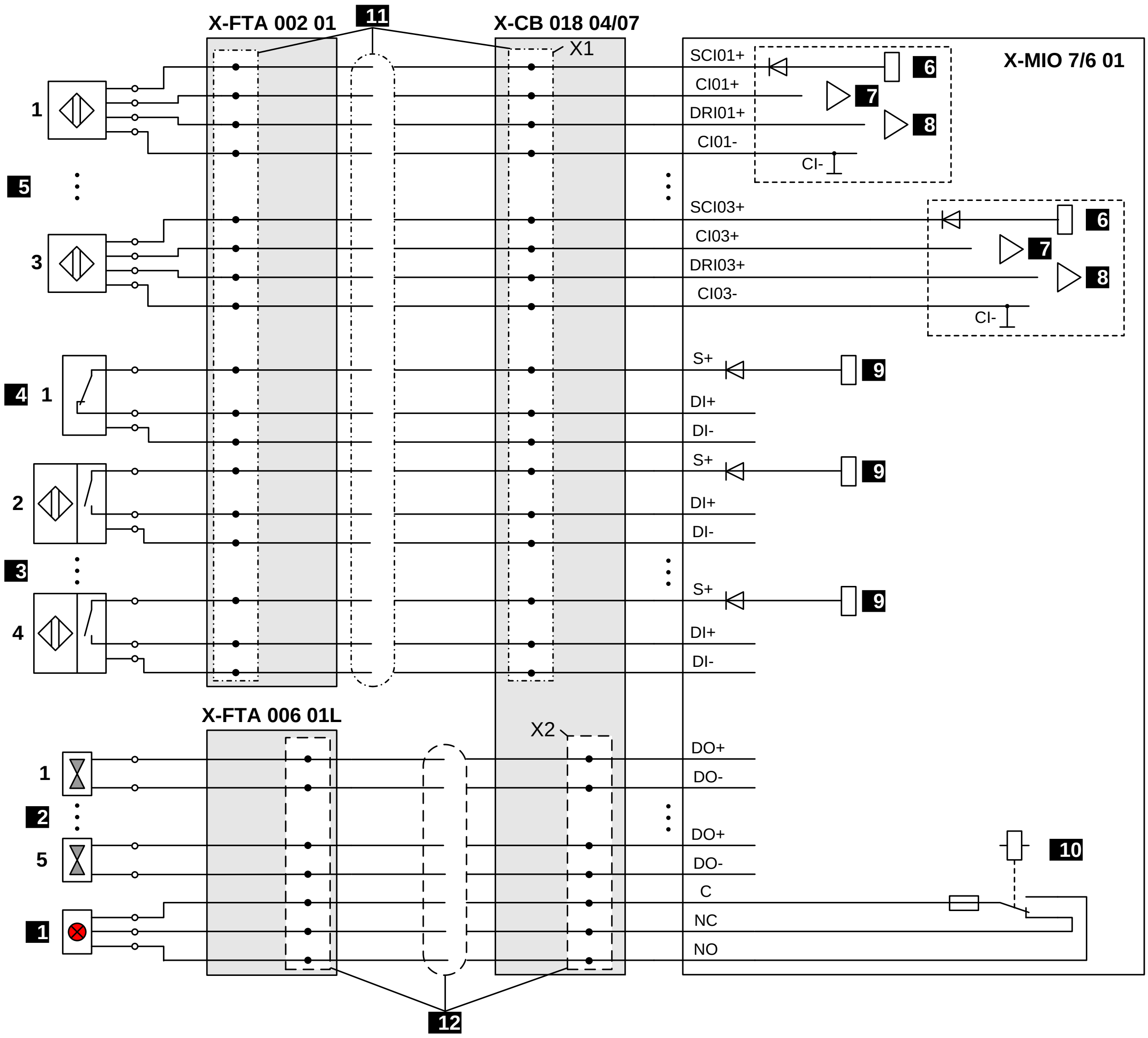


- **1** Warning signal equipment
- **2** Actuators DO01…DO05, e.g., solenoid valves
- **3** Switching devices of type 3, DI02…DI04
- **4** Reset input
- **5** Sensors CI01…CI03
- **6** Supply for the measuring input
- **7** Input for speed measuring
- **8** Input for rotation direction measuring
- **9** Supply for digital inputs
- **10** Warning signal relay

Figure 14: Wiring for X-MIO 7/6 01

4.6.2 Wiring the Modules via FTA using System Cables

The following figure only depicts the wiring for one module. The inputs and outputs of the redundant modules are connected in parallel to the sensors and actuators via connector boards.



1	Warning signal equipment	7	Input for speed measuring
2	Actuators DO01…DO05, e.g., solenoid valves	8	Input for rotation direction measuring
3	Switching devices of type 3, DI02…DI04	9	Supply for digital inputs
4	Reset input	10	Warning signal relay
5	Sensors CI01…CI03	11	System cable X-CA 005 (X1)
6	Supply for the measuring input	12	System cable X-CA 008 (X2)

Figure 15: Wiring via X-FTA

5 Operation

The module runs within a HIMax base plate and does not require any specific monitoring.

5.1 Handling

Direct handling of the module is not foreseen.

The module is operated from within the PADT, e.g., for forcing the measuring inputs. For further details, refer to the SILworX documentation.

5.2 Diagnostics

LEDs on the front side of the module indicate the module state, see Chapter 3.4.7.

The diagnostic history of the module can also be read using SILworX. Chapters 4.5.9 through 4.5.13 describe the most important module-specific diagnostic messages.

i If a module is plugged in to a base plate, it generates diagnostic messages during its initialization phase indicating faults such as incorrect voltage values.

These messages only indicate a module fault if they occur after the system starts operation.

6 Maintenance

Defective modules must be replaced with modules of the same type or with approved replacement models. Only the manufacturer is authorized to repair the modules.

When replacing modules, observe the instructions specified in the HIMax system manual (HI 801 001 E) and HIMax safety manual (HI 801 003 E).

6.1 Maintenance Measures

The following maintenance measures can be implemented for the modules:

- Proof testing.
- Loading of enhanced operating system versions.

6.1.1 Proof Test

The proof test interval for HIMax modules must be in accordance with the interval required by the application-specific safety integrity level (SIL). For further details, refer to the safety manual (HI 801 003 E).

6.1.2 Loading of Enhanced Operating System Versions

As part of product maintenance, HIMA is continuously improving the operating systems of the modules. HIMA recommends using system downtimes to load the current operating system versions into the modules.

i The current operating system versions of modules are displayed in the SILworX Control Panel. The type label specifies the delivered module version, see Chapter 3.3.

Before loading operating systems into the modules, check the system compatibilities and restrictions of the operating system versions. To this end, use the applicable release notes. Use SILworX to load the operating systems into the modules and ensure that these are in the STOP state.

7 Decommissioning

To decommission the module, remove it from the base plate. For more details, refer to Chapter *Mounting and Removing the Module*.

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). Note that the product packaging alone is not sufficient 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 standard
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
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
Rack ID	Base plate identification (number)
r_P	Peak value of a total AC component
SB	System bus (module)
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

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