Manual

HIMax®

X-AI 32 01

Analog Input Module

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Document designation	Description
HI 801 020 D, Rev. 10.00 (1907)	German original document
HI 801 021 E, Rev. 10.00.00 (1920)	English translation of the German original document

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 mouse pointer 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 an overall system. If the controller fails, the system enters the safe state.

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

3 Product Description

The X-AI 32 01 is an analog input module intended for use in the programmable electronic system (PES) HIMax.

The module is used to evaluate up to 32 analog input signals.

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.

The module is interference-free. In particular with respect to EMC, electrical safety, communication to the X-SB and X-CPU modules, and the user program.

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).

3.1 Safety Function

The module measures the current of the connected devices with the specified accuracy, providing the transmitter supply with a guaranteed minimum voltage.

The safety function is performed in accordance with SIL 3.

3.1.1 Response in the Event of a Fault

If a fault occurs, the module adopts the safe state and the assigned input variables transmit the initial value (default value = 0) 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. If the raw value is evaluated instead of the process value, the user must program the monitoring function and the value in the event of faults from within the user program.

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 3.7, the system cables are described in Chapter 3.8. The FTAs are described in separate manuals.

3.3 X-AI 32 01 Certification

Refer to 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 certificates and the EU type test certificate are available on the HIMA website.

3.4 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

3.5 Structure

The module has 32 analog current inputs (0/4…20 mA), each input is measured and functionally tested using two internal measuring devices. A short-circuit-proof transmitter supply is assigned to each input.

The 32 analog inputs can be used to evaluate the values measured for the transmitters and safety transmitters. 2-wire or 3-wire transmitters with a maximum supply current of 30 mA can be connected to the module.

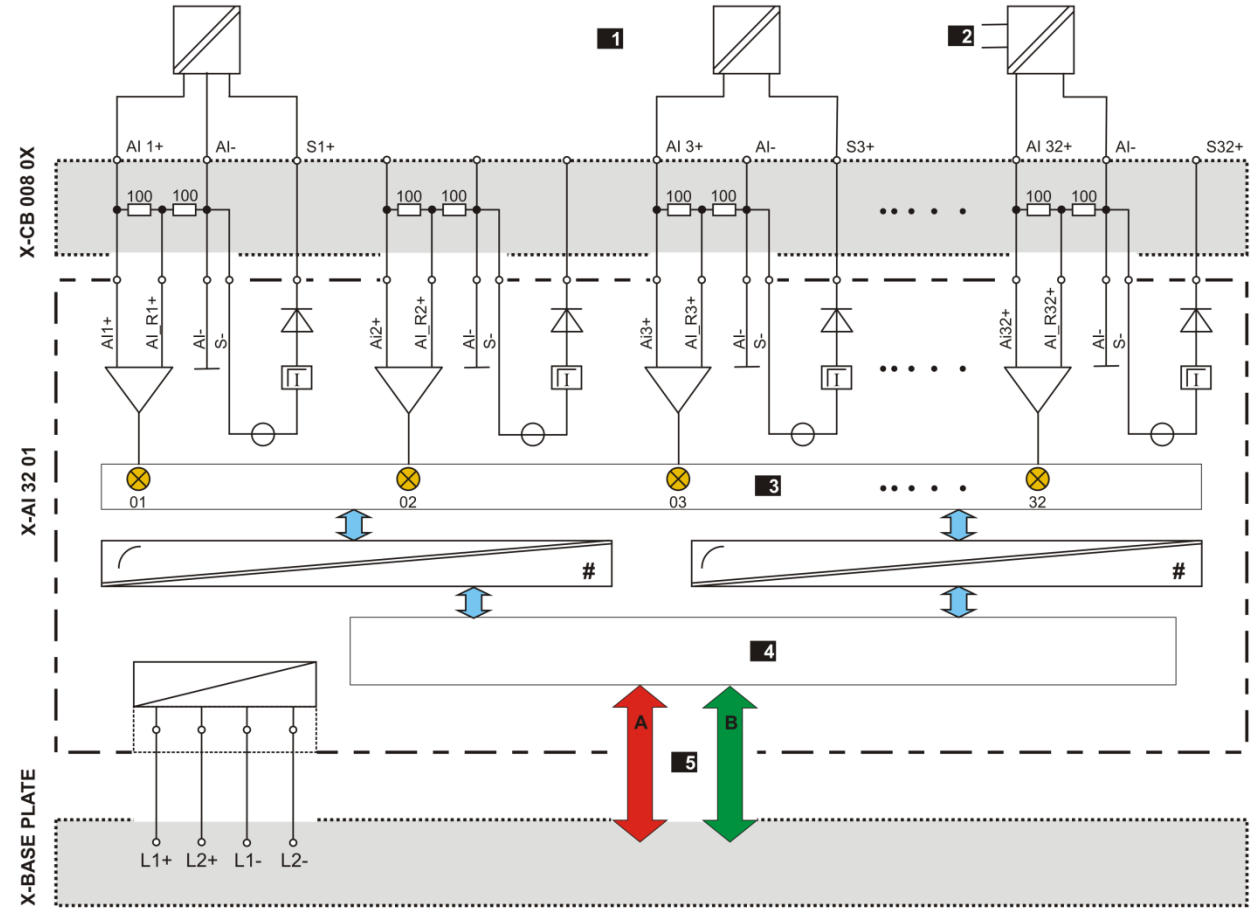
The functional units are galvanically separated for interference-free measurement of the analog input signals.

The 1oo2 processor system within the I/O module controls and monitors 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.

The module is equipped with LEDs to indicate the status of the analog inputs, see Chapter 3.5.2.

3.5.1 Block Diagram

The following block diagram illustrates the structure of the module.



1 Field level: Transmitter
2 External transmitter supply
3 Interface
4 Safety-related processor system
5 System buses

Figure 2: Block Diagram

3.5.2 Indicators

The following figure shows the front view of the module with the LEDs.

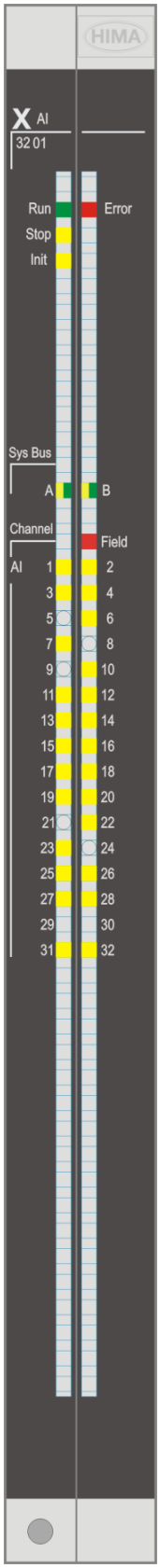


Figure 3: Front View

The LEDs indicate the operating state of the 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 (AI 1…32, Field)

After connecting the supply voltage, an LED test is performed and all the LEDs are lit for at least 2 s. The color of two-color LEDs changes once during the test.

Definition of blinking frequencies

The following table defines the blinking frequencies:

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 transmission.

Table 2: Blinking Frequencies of the LEDs

Some LEDs can report warnings (On) and faults or errors (Blinking1), see the following tables. The indication of errors or faults has priority over the indication of warnings. Warnings cannot be reported if errors or faults are being signaled.

3.5.3 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 3: Module Status Indicators

3.5.4 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.
B	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 4: System Bus Indicators

3.5.5 I/O Indicators

The LEDs of the I/O indicators are labeled *Channel*.

LED	Color	Status	Description
AI 1…32	Yellow	On	The input current is > 4 mA or greater than the HIGH switching point (dig) configured in SILworX.
		Blinking2	Channel fault (module field or hardware fault). Input current > 20 mA
		Off	The input current is < 4 mA or less than the LOW switching point (dig) configured in SILworX.
Field	Red	Blinking2	Field fault on at least one channel or supply (open-circuit, short-circuit, over-current, etc.) Depending on the configured current thresholds.
		Off	No faults at the field level

Table 5: I/O Indicators

3.6 Product Data

General	
Supply voltage	24 VDC, -15…+20 %, $r_p \leq 5$ % SELV, PELV
Current consumption	500 mA at 24 VDC (without channels or transmitter supplies) Max. 1.5 A (if the max. output current is applied to the transmitter supplies)
Module cycle time	2 ms
Protection class	Protection class III in accordance with IEC/EN 61131-2
Operating temperature	0…+60 °C
Storage temperature	-40…+85 °C
Humidity	Max. 95 % relative humidity, non-condensing
Pollution	Pollution degree II in accordance with IEC/EN 60664-1
Altitude	< 2000 m
Degree of protection	IP20
Dimensions (H x W x D) in mm	310 x 29.2 x 230
Weight	Approx. 1.4 kg

Table 6: Product Data

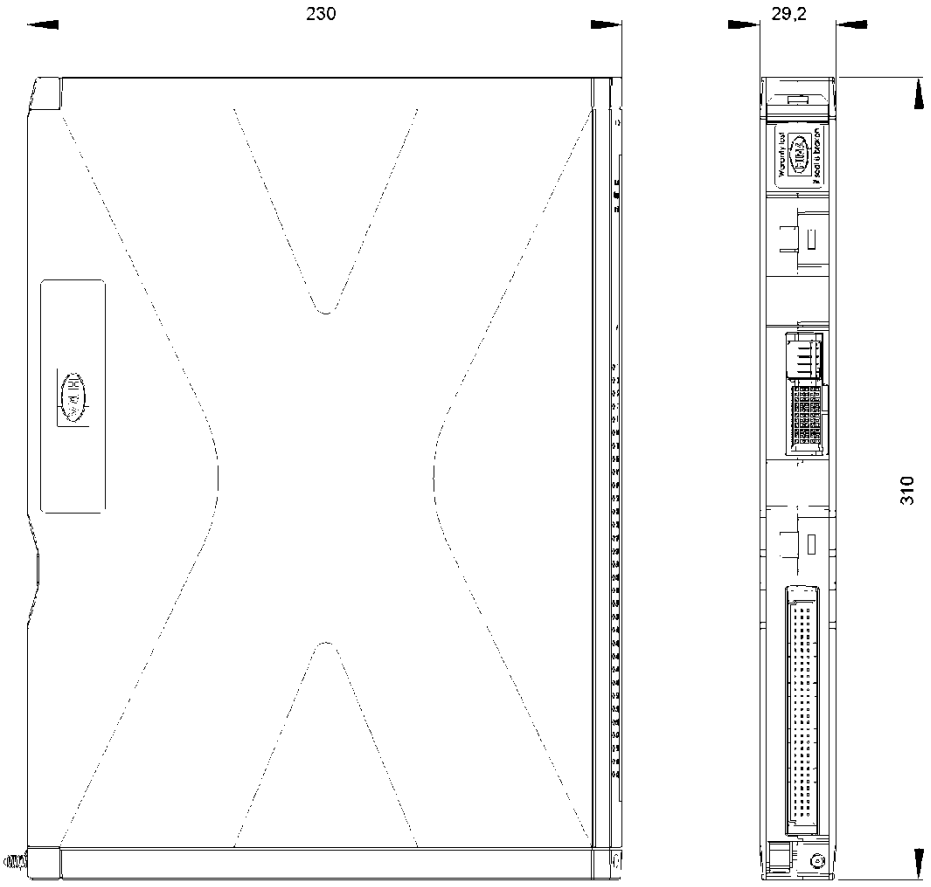


Figure 4: Views

Analog inputs	
Number of inputs (number of channels)	32 with common ground AI- (galvanic separation from the system bus and the 24 VDC supply voltage).
Nominal range	0/4…20 mA
Operating range	0…22.5 mA
Digital resolution	12-bit
Shunt for current measurement	200 Ω
Maximum permitted current via shunt	50 mA
Withstand voltage of the input	≤ 10 VDC
Interference voltage suppression	> 60 dB (common mode 50/60 Hz)
Measured value refresh (in the user program)	Cycle time of the user program
Metrological accuracy	
Metrological accuracy at 25 °C	Type: ±0.1 % of full scale Max. ±0.2 % of full scale
Metrological accuracy across the entire temperature range	Type: ±0.15 % of full scale Max. ±0.3 % of full scale
Settling time to 99 % of the process value when the input signal changes	15 ms

Table 7: Specifications for the Analog Inputs

Transmitter supply	
Number of transmitter supplies	32
Output voltage for transmitter supply	26.5 VDC +0/-15 %
Output current of transmitter supply	Max. 30 mA
Transmitter supply monitoring	Undervoltage: 22.5 VDC Overvoltage: 30 VDC
Max. number of transmitter supplies that may be simultaneously short-circuited.	12 If more than 12 supplies are short-circuited for longer than 3 s, the entire transmitter supply is switched off. If the overload disappears, the transmitter supply is switched on again within 30 s.
Maximum connectable load (transmitter + wire)	≤ 750 Ω at 22.5 mA

Table 8: Specifications for the Transmitter Supply

3.7 Connector Boards

A connector board connects the 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 module:

Connector board	Description
X-CB 008 01	Connector board with screw terminals
X-CB 008 02	Redundant connector board with screw terminals
X-CB 008 03	Connector board with cable plug
X-CB 008 04	Redundant connector board with cable plug
X-CB 008 05	Redundant connector board with cable plug, redundant field termination assembly

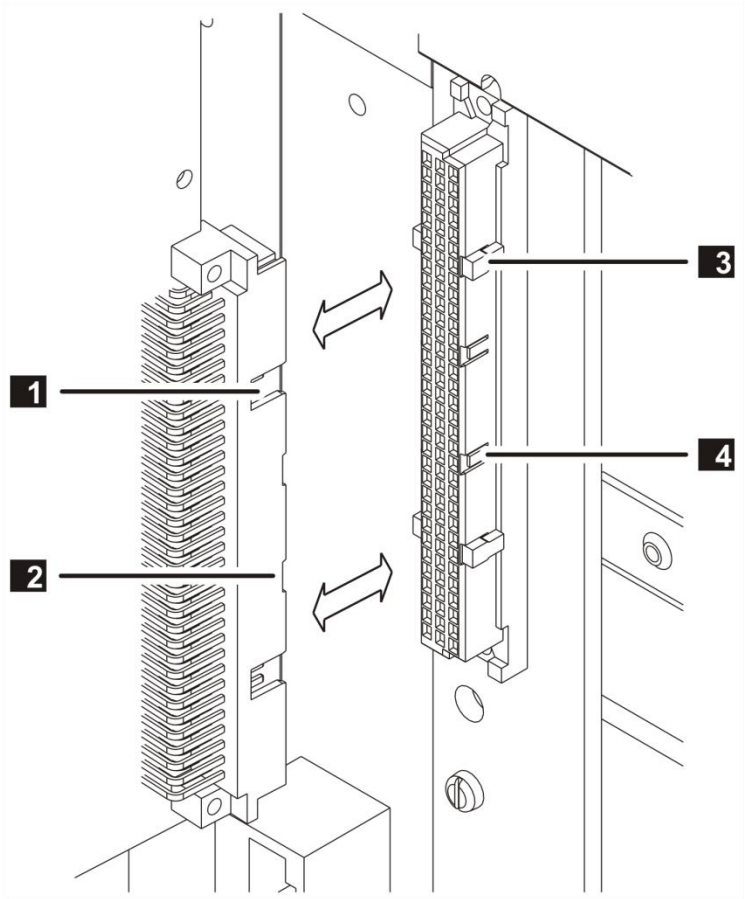
Table 9: Available Connector Boards

3.7.1 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.

3.7.2 Coding of X-CB 008 0X Connector Boards

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

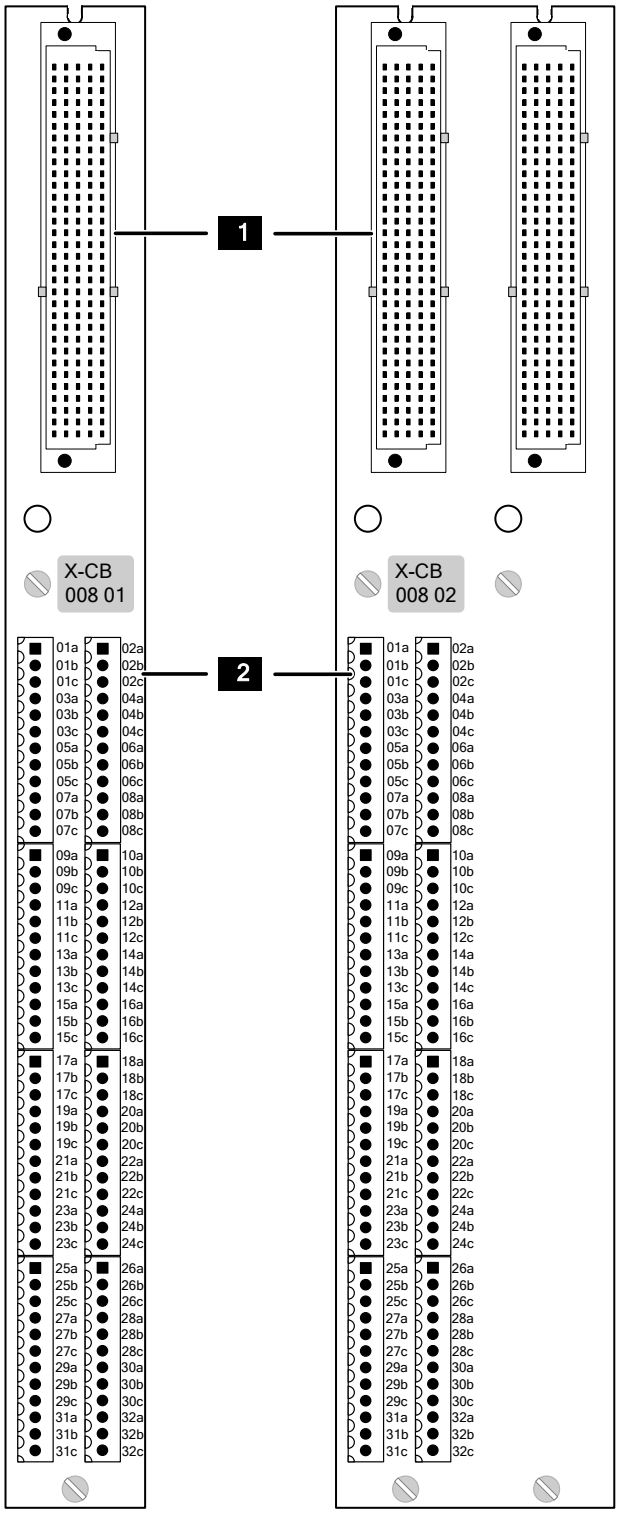
a7	a13	a20	a26	e7	e13	e20	e26
		X		X		X	

Table 10: Position of Coding Wedges

3.7.3 Pin Assignment for Connector Boards with Screw Terminals

Mono X-CB 008 01

Redundant X-CB 008 02



1 I/O module plug

2 Connection to the field level (screw terminals)

Figure 6: Connector Boards with Screw Terminals

3.7.4 Terminal Assignment for Connector Boards with Screw Terminals

Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	01a	S1+	1	02a	S2+
2	01b	AI1+	2	02b	AI2+
3	01c	AI1-	3	02c	AI2-
4	03a	S3+	4	04a	S4+
5	03b	AI3+	5	04b	AI4+
6	03c	AI3-	6	04c	AI4-
7	05a	S5+	7	06a	S6+
8	05b	AI5+	8	06b	AI6+
9	05c	AI5-	9	06c	AI6-
10	07a	S7+	10	08a	S8+
11	07b	AI7+	11	08b	AI8+
12	07c	AI7-	12	08c	AI8-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	09a	S9+	1	10a	S10+
2	09b	AI9+	2	10b	AI10+
3	09c	AI9-	3	10c	AI10-
4	11a	S11+	4	12a	S12+
5	11b	AI11+	5	12b	AI12+
6	11c	AI11-	6	12c	AI12-
7	13a	S13+	7	14a	S14+
8	13b	AI13+	8	14b	AI14+
9	13c	AI13-	9	14c	AI14-
10	15a	S15+	10	16a	S16+
11	15b	AI15+	11	16b	AI16+
12	15c	AI15-	12	16c	AI16-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	17a	S17+	1	18a	S18+
2	17b	AI17+	2	18b	AI18+
3	17c	AI17-	3	18c	AI18-
4	19a	S19+	4	20a	S20+
5	19b	AI19+	5	20b	AI20+
6	19c	AI19-	6	20c	AI20-
7	21a	S21+	7	22a	S22+
8	21b	AI21+	8	22b	AI22+
9	21c	AI21-	9	22c	AI22-
10	23a	S23+	10	24a	S24+
11	23b	AI23+	11	24b	AI24+
12	23c	AI23-	12	24c	AI24-

Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	25a	S25+	1	26a	S26+
2	25b	AI25+	2	26b	AI26+
3	25c	AI25-	3	26c	AI26-
4	27a	S27+	4	28a	S28+
5	27b	AI27+	5	28b	AI28+
6	27c	AI27-	6	28c	AI28-
7	29a	S29+	7	30a	S30+
8	29b	AI29+	8	30b	AI30+
9	29c	AI29-	9	30c	AI30-
10	31a	S31+	10	32a	S32+
11	31b	AI31+	11	32b	AI32+
12	31c	AI31-	12	32c	AI32-

Table 11: 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:

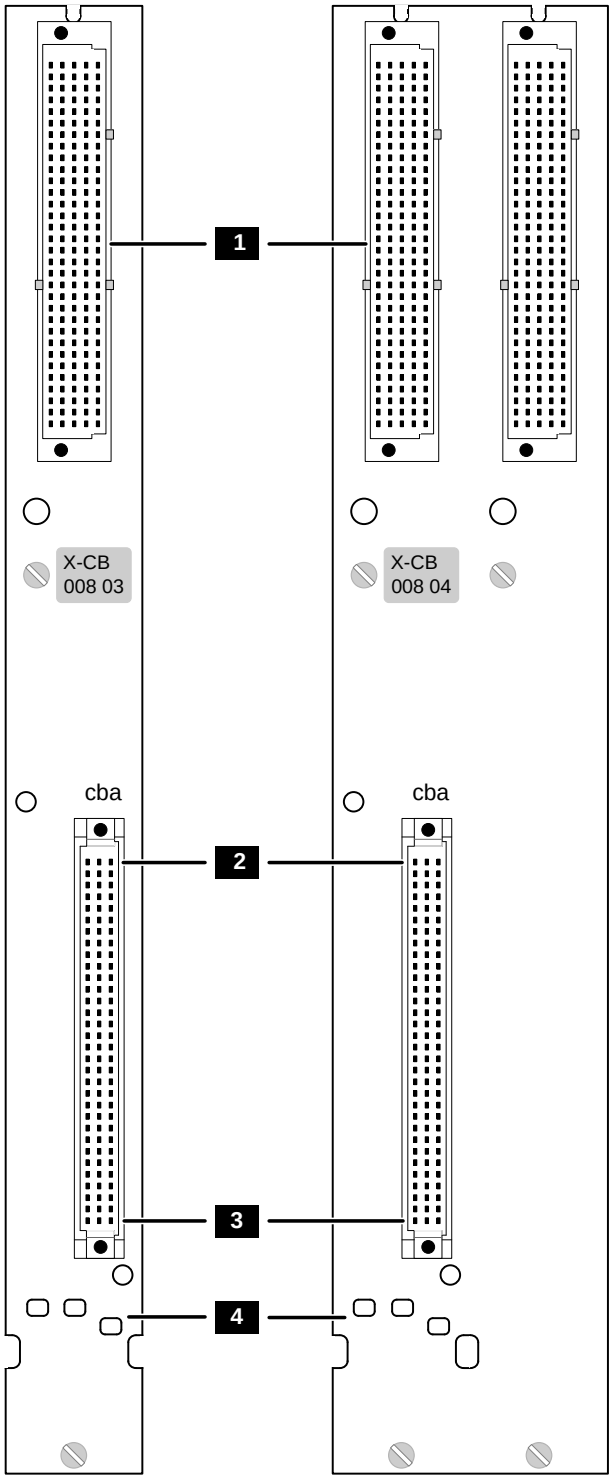
Connection to the field level	
Cable plugs	8 pieces, with 12 poles
Wire cross-section	0.2…1.5 mm^2 (single-wire) 0.2…1.5 mm^2 (finely stranded) 0.2…1.5 mm^2 (with wire end ferrule)
Stripping length	6 mm
Screwdriver	Slotted 0.4 x 2.5 mm
Tightening torque	0.2…0.25 Nm

Table 12: Cable Plug Characteristics

3.7.5 Pin Assignment for Connector Boards with Cable Plug

Mono **Redundant**

X-CB 008 03 X-CB 008 04



1 I/O module plug

2 Connection to the field level (cable plug in row 1)

3 Connection to the field level (cable plug in row 32)

4 Coding of cable plugs

Figure 7: Connector Boards with Cable Plug

3.7.6 Pin Assignment for Connector Boards with Cable Plug

HIMA provides ready-made system cables for use with these connector boards, see Chapter 3.8. The cable plug and the connector boards are coded.

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.

The following table applies to system cables X-CA 005:

Row	c		b		a	
	Signal	Color	Signal	Color	Signal	Color
1	S32+	PKBN 1)	AI32+	WHPK 1)	Internal use 2)	YEBU 1)
2	S31+	GYBN 1)	AI31+	WHGY 1)		GNBU 1)
3	S30+	YEBN 1)	AI30+	WHYE 1)		YEPK 1)
4	S29+	BNGN 1)	AI29+	WHGN 1)		PKGN 1)
5	S28+	RDBU 1)	AI28+	GYPK 1)	AI-	
6	S27+	VT 1)	AI27+	BK 1)	AI-	
7	S26+	RD 1)	AI26+	BU 1)	AI-	
8	S25+	PK 1)	AI25+	GY 1)	AI-	
9	S24+	YE 1)	AI24+	GN 1)	AI-	
10	S23+	BN 1)	AI23+	WH 1)	AI-	
11	S22+	RDBK	AI22+	BUBK	AI-	
12	S21+	PKBK	AI21+	GYBK	AI-	
13	S20+	PKRD	AI20+	GYRD	AI-	
14	S19+	PKBU	AI19+	GYBU	AI-	
15	S18+	YEBK	AI18+	GNBK	AI-	
16	S17+	YERD	AI17+	GNRD	AI-	
17	S16+	YEBU	AI16+	GNBU	AI-	
18	S15+	YEPK	AI15+	PKGN	AI-	
19	S14+	YEGY	AI14+	GYGN	AI-	
20	S13+	BNBK	AI13+	WHBK	AI-	
21	S12+	BNRD	AI12+	WHRD	AI-	
22	S11+	BNBU	AI11+	WHBU	AI-	
23	S10+	PKBN	AI10+	WHPK	AI-	
24	S9+	GYBN	AI9+	WHGY	AI-	
25	S8+	YEBN	AI8+	WHYE	AI-	YEGY 1)
26	S7+	BNGN	AI7+	WHGN	AI-	GYGN 1)
27	S6+	RDBU	AI6+	GYPK	AI-	BNBK 1)
28	S5+	VT	AI5+	BK	AI-	WHBK 1)
29	S4+	RD	AI4+	BU	AI-	BNRD 1)
30	S3+	PK	AI3+	GY	AI-	WHRD 1)
31	S2+	YE	AI2+	GN	AI-	BNBU 1)
32	S1+	BN	AI1+	WH	AI-	WHBU 1)

1) For repeated wire color coding: Additional orange ring.

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

Table 13: Pin Assignment for the Cable Plugs of System Cable X-CA 005

The following table applies to system cables X-CA 016:

Row	c		b		a	
	Signal	Color	Signal	Color	Signal	Color
1			AI32+	WHPK [1)]		
2			AI31+	WHGY [1)]		
3			AI30+	WHYE [1)]		
4			AI29+	WHGN [1)]		
5			AI28+	GYPK [1)]	AI- (a5)	See also Table 15
6			AI27+	BK [1)]	AI27-	VT [1)]
7			AI26+	BU [1)]	AI26-	RD [1)]
8			AI25+	GY [1)]	AI25-	PK [1)]
9			AI24+	GN [1)]	AI24-	YE [1)]
10			AI23+	WH [1)]	AI23-	BN [1)]
11			AI22+	BUBK	AI22-	RDBK
12			AI21+	GYBK	AI21-	PKBK
13			AI20+	GYRD	AI20-	PKRD
14			AI19+	GYBU	AI19-	PKBU
15			AI18+	GNBK	AI18-	YEBK
16			AI17+	GNRD	AI17-	YERD
17			AI16+	GNBU	AI16-	YEBU
18			AI15+	PKGN	AI15-	YEPK
19			AI14+	GYGN	AI14-	YEGY
20			AI13+	WHBK	AI13-	BNBK
21			AI12+	WHRD	AI12-	BNRD
22			AI11+	WHBU	AI11-	BNBU
23			AI10+	WHPK	AI10-	PKBN
24			AI9+	WHGY	AI9-	GYBN
25			AI8+	WHYE	AI8-	YEBN
26			AI7+	WHGN	AI7-	BNGN
27			AI6+	GYPK	AI6-	RDBU
28			AI5+	BK	AI5-	VT
29			AI4+	BU	AI4-	RD
30			AI3+	GY	AI3-	PK
31			AI2+	GN	AI2-	YE
32			AI1+	WH	AI1-	BN
[1)] For repeated wire color coding: Additional orange ring.						

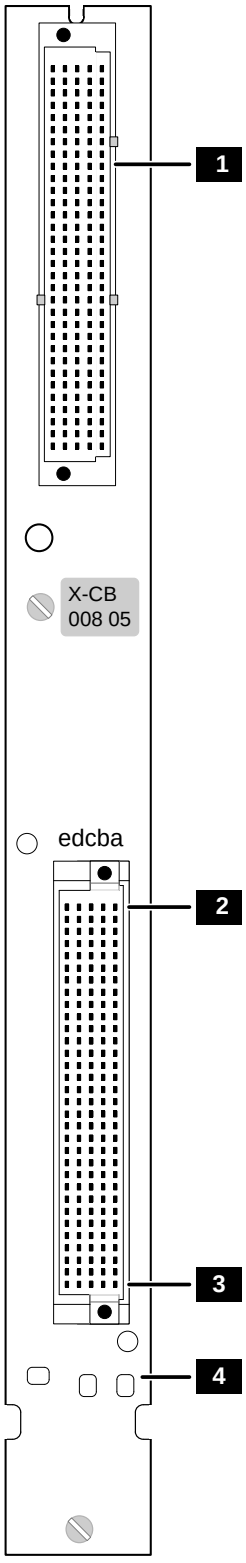
Table 14: Pin Assignment for the Cable Plugs of System Cable X-CA 016

Signals AI28-…AI32- are combined in the cable plug, see Table 15.

Row	Signal	Color
a5 (AI-)	AI32-	PKBN [1)]
	AI31-	GYBN [1)]
	AI30-	YEBN [1)]
	AI29-	BNGN [1)]
	AI28-	RDBU [1)]
[1)] For repeated wire color coding: Additional orange ring.		

Table 15: AI- Used with Five Wires

3.7.7 Connector Board Redundancy using two Base Plates



1 I/O module plug

2 Connection to the field level (cable plug in row 1)

3 Connection to the field level (cable plug in row 32)

4 Coding of cable plugs

Figure 8: Connector Board with Cable Plug, Variant X-CB 008 05

3.7.8 Pin Assignment for X-CB 008 05

HIMA provides ready-made system cables for use with this connector board, see Chapter 3.8. The cable plug and the connector board are coded.

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.

The following table applies to system cables X-CA 009:

Row	e		d		c		b		a	
	Signal	Color	Signal	Color	Signal	Color	Signal	Color	Signal	Color
1	S32+	RD 2)	AI_R32+	PKBN 1)	AI32+	WHBK 1)				YEGY 2)
2	S31+	BU 2)	AI_R31+	GYBN 1)	AI31+	WHGY 1)			Internal use 2)	GYGN 2)
3	S30+	PK 2)	AI_R30+	YEBN 1)	AI30+	WHYE 1)				BNBK 2)
4	S29+	GY 2)	AI_R29+	BNGN 1)	AI29+	WHGN 1)				WHBK 2)
5	S28+	YE 2)	AI_R28+	RDBU 1)	AI28+	GYPK 1)				
6	S27+	GN 2)	AI_R27+	VT 1)	AI27+	BK 1)				
7	S26+	BN 2)	AI_R26+	RD 1)	AI26+	BU 1)				
8	S25+	WH 2)	AI_R25+	PK 1)	AI25+	GY 1)				
9	S24+	RDBK 1)	AI_R24+	YE 1)	AI24+	GN 1)				
10	S23+	BUBK 1)	AI_R23+	BN 1)	AI23+	WH 1)				
11	S22+	PKBK 1)	AI_R22+	RDBK	AI22+	BUBK				
12	S21+	GYBK 1)	AI_R21+	PKBK	AI21+	GYBK				
13	S20+	PKRD 1)	AI_R20+	PKRD	AI20+	GYRD				
14	S19+	GYRD 1)	AI_R19+	PKBU	AI19+	GYBU				
15	S18+	PKBU 1)	AI_R18+	YEBK	AI18+	GNBK				
16	S17+	GYBU 1)	AI_R17+	YERD	AI17+	GNRD				
17	S16+	YEBK 1)	AI_R16+	YEBU	AI16+	GNBU	S-	BNRD 2)		
18	S15+	GNBK 1)	AI_R15+	YEPK	AI15+	PKGN	S-	WHRD 2)		
19	S14+	YERD 1)	AI_R14+	YEGY	AI14+	GYGN	S-	BNBU 2)		
20	S13+	GNRD 1)	AI_R13+	BNBK	AI13+	WHBK	S-	WHBU 2)		
21	S12+	YEBU 1)	AI_R12+	BNRD	AI12+	WHRD	S-	PKBN 2)		
22	S11+	GNBU 1)	AI_R11+	BNBU	AI11+	WHBU	S-	WHPK 2)		
23	S10+	YEPK 1)	AI_R10+	PKBN	AI10+	WHPK	S-	GYBN 2)		
24	S9+	PKGN 1)	AI_R9+	GYBN	AI9+	WHGY	S-	WHGY 2)		
25	S8+	YEGY 1)	AI_R8+	YEBN	AI8+	WHYE	AI-	YEBN 2)		
26	S7+	GYGN 1)	AI_R7+	BNGN	AI7+	WHGN	AI-	WHYE 2)		
27	S6+	BNBK 1)	AI_R6+	RDBU	AI6+	GYPK	AI-	BNGN 2)		
28	S5+	WHBK 1)	AI_R5+	VT	AI5+	BK	AI-	WHGN 2)		
29	S4+	BNRD 1)	AI_R4+	RD	AI4+	BU	AI-	RDBU 2)		
30	S3+	WHRD 1)	AI_R3+	PK	AI3+	GY	AI-	GYPK 2)		
31	S2+	BNBU 1)	AI_R2+	YE	AI2+	GN	AI-	YT 2)		
32	S1+	WHBU 1)	AI_R1+	BN	AI1+	WH	AI-	BK 2)		

1) For the first repeated wire color coding: Additional orange ring.

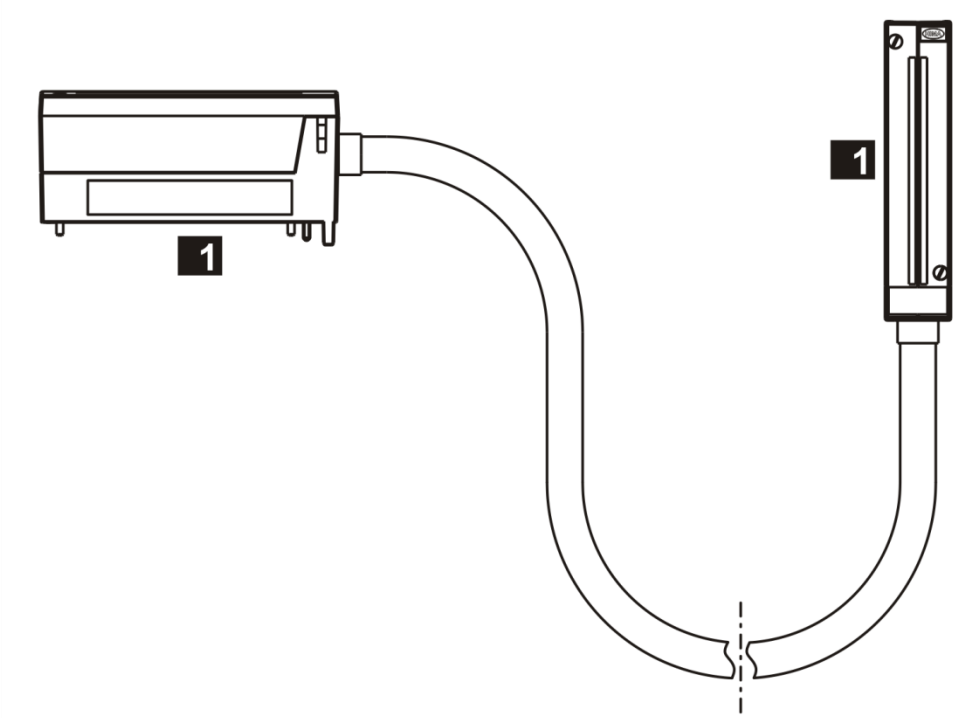
2) For the second repeated wire color coding: Additional violet ring.

3) The wires must be isolated individually! No other use is permitted!

Table 16: Pin Assignment for the Cable Plugs of System Cable X-CA 009

3.8 System Cables

The system cables connect the connector boards to the field termination assemblies. Depending on the type of connector board, several different types of system cables are available. System cable X-CA 016 with a reduced number of wires and open wire ends is available for applications with active transmitters.



1 Identical cable plugs

Figure 9: System Cable with Cable Plug on Both Sides

3.8.1 System Cable X-CA 005

System cable X-CA 005 is used to connect the X-CB 008 03/04 connector board to one 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
Color coding	Based on DIN 47100, see Table 13

Table 17: Cable Data X-CA 005

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 18: Available Standard System Cables X-CA 005

3.8.2 System Cable X-CA 009

System cable X-CA 009 is used to connect the X-CB 008 05 connector board to one field termination assembly.

General	
Cable	LIYCY-TP 58 x 2 x 0.14 mm² (shielded)
Wire	Finely stranded
Average outer diameter (d)	Approx. 18.3 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
Color coding	Based on DIN 47100, see Table 16

Table 19: Cable Data X-CA 009

The system cable is available in the following standard lengths:

System cables	Description	Length	Weight
X-CA 009 01 8	Coded cable plugs on both sides.	8 m	4.25 kg
X-CA 009 01 15		15 m	8 kg
X-CA 009 01 30		30 m	16 kg

Table 20: Available Standard System Cables X-CA 009

3.8.3 System Cable X-CA 016

If no transmitter supply is required, system cable X-CA 016 can be used for connection to active transmitters. System cable X-CA 016 is implemented with a reduced number of wires and open wire ends. The open wire ends must be connected to terminals.

The system cable is available as standard type (X-CA 016 02) and as halogen-free, UL/CSA certified type (X-CA 016 04) in the following standard lengths:

System cables	Description	Length	Weight
X-CA 016 02 5	Cable plug coded on one side, with open wire ends.	5 m	2 kg
X-CA 016 02 8		8 m	3.25 kg
X-CA 016 02 15		15 m	6 kg
X-CA 016 02 30		30 m	12 kg
X-CA 016 04 5	Cable plug coded on one side, with open wire ends, halogen-free.	5 m	1.75 kg
X-CA 016 04 8		8 m	2.75 kg
X-CA 016 04 15		15 m	5.25 kg
X-CA 016 04 30		30 m	10.5 kg

Table 21: Available Standard System Cables X-CA 016

X-CA 016 02	
Cable	LIYCY-TP 32 x 2 x 0.25 mm² (shielded)
Wire	Finely stranded
Average outer diameter (d)	Approx. 17.0 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
Color coding	Based on DIN 47100, see Table 14

Table 22: Cable Data X-CA 016 02

X-CA 016 04	
Cable	LIYHCH-TP 32 x 2 x 0.25 mm² (shielded)
Wire	Finely stranded
Average outer diameter (d)	Approx. 15.8 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 retardant in accordance with IEC 60332-1-2, IEC 60332-2-2 IEC 61034-1/IEC 61034-2 (smoke density) UL c/us 758/1581 CSA FT2 UL c/us 20549/10493
Halogen-free	In accordance with IEC 60754-1
Color coding	Based on DIN 47100, see Table 14

Table 23: Cable Data X-CA 016 04

3.8.4 Cable Plug Coding

The cable plugs are equipped with three coding pins. Therefore, cable plugs only match connector boards and FTAs with the corresponding recesses, see Figure 7 and Figure 8.

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 EN).

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 3.7.
- 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.
  - Use shielded cables with twisted pairs.
  - Use one twisted pair of shielded cables for each measurement inputs.
  - The shielding must be connected 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.
- If the transmitter supply is used, use the supply assigned to the input, e.g., S1+ with AI1+.
- HIMA recommends using the transmitter supply of the module.
  If an external current source is malfunctioning, the affected module's measurement input can be overloaded and damaged. If an external current source is used, the zero and final values must be checked after a non-transient overload occurred at the measuring inputs.
- The inputs may be wired redundantly using the corresponding connector boards. For further details, see Chapters 3.7 and 4.3.1.

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.

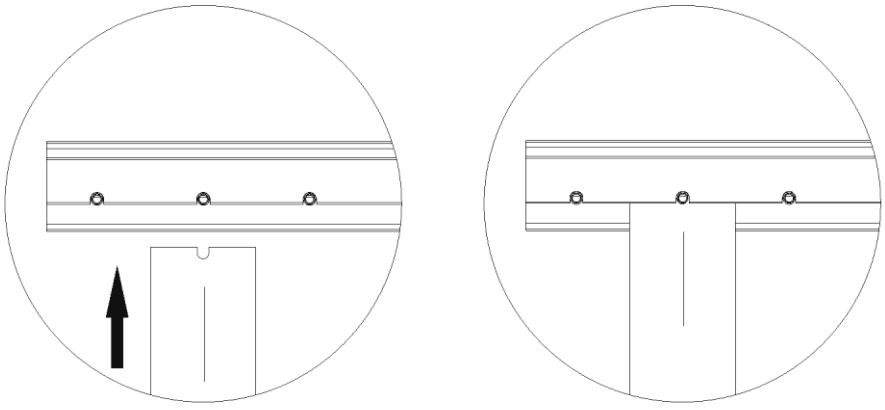


Figure 10: Example of how to Insert the Mono Connector Board

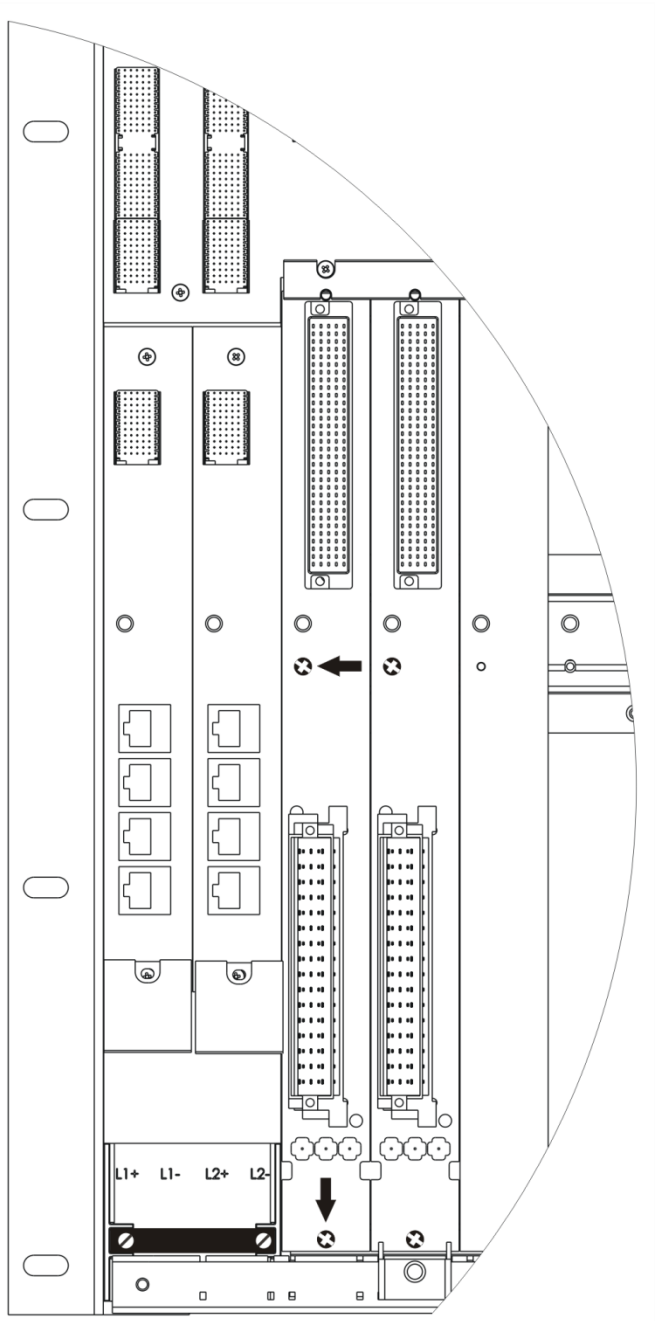


Figure 11: Example of how to Secure the Mono Connector Board with Captive Screws

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:

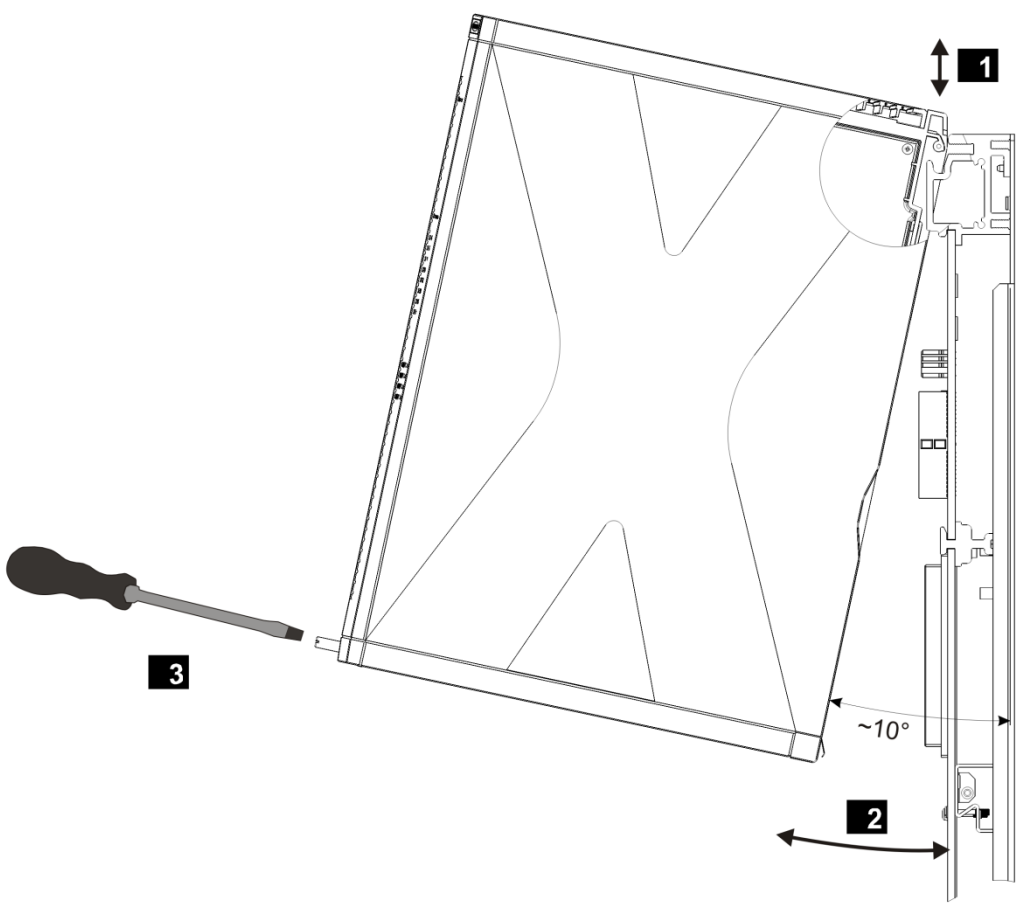
- Screwdriver, slotted 0.8 x 4.0 mm.
- Screwdriver, slotted 1.2 x 8.0 mm.

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 Configuring the 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 system parameters, refer to the following tables.
- If the 0 value is within the valid measuring range, the user program must evaluate the -> *Channel OK [BOOL]* status in addition to the -> *Raw Value [DINT].*
  This and other diagnostic statuses (such as short-circuits and open-circuits) provide additional options for diagnosing the external wiring and configuring proper fault response in the user program.
- When scaling the input value -> *Raw Value [DINT],* users must make sure that the scaling result is within the range of values for the REAL data type. Representation of the scaling result must be possible with a REAL variable.
- For short-circuit and open-circuit monitoring, two thresholds are detected by the module. The switching thresholds can be set in SILworX in the module configuration. By default, the limits are set to the OC/SC values specified in NAMUR, Recommendation NE 43.
- If the transmitter supply of the module is used (i.e., *Supply ON* parameter), the *Sup. Used* parameter must also be activated for the corresponding channel. To diagnose the transmitter supply in use, evaluate the *Sup. Used* parameter in the user program.
  For further details on these system parameters, refer to Table 25 and Table 26.
- If a redundancy group is created, its configuration is defined in the tabs. The tabs specific to the redundancy group differ from those of the individual modules, see the following tables. Each module must be evaluated individually. Extended redundant system variables are provided as additional information.

The transmitter supply is monitored.

If a fault occurs in the transmitter supply, the module reports a channel fault and sets the process value to the initial value of the connected global variables.

To evaluate the system parameters in the user program, they must be assigned to global variables. Perform this step in the Hardware Editor using the module's detail view.

The following tables present the system parameters for the module in the same order as in the SILworX Hardware Editor.

TIP A scientific calculator such as the Windows® calculator with the corresponding view can be used to convert hexadecimal values to bit strings.

4.3.1 The **Module** Tab

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

System parameters	Data type	S [1]	R/W	Description
Name	---	---	W	Module name
Spare Module	BOOL	N	W	Activated: It is not considered a fault if a module of the redundancy group is missing in the base plate. Deactivated: It is considered a fault if a module of the redundancy group is missing in the base plate. Default setting: Deactivated. **It is only displayed in the redundancy group tab!**
Noise Blanking	BOOL	N	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 further details on noise blanking.
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.				
Module OK	BOOL	Y	R	TRUE: No module fault. FALSE: It may refer to: • Short-circuit or open-circuit. • Channel fault on at least one channel. • Module fault. • The module is not inserted. Observe the *Module Status* parameter! For redundancy groups, the *Module OK* parameter of the individual modules are grouped to a higher-level *Module OK* parameters following the OR logic.
Module Status	DWORD	Y	R	Status of the module 0x00000001: Module fault. [2] 0x00000002: Temperature threshold 1 exceeded. 0x00000004: Temperature threshold 2 exceeded. 0x00000008: Incorrect temperature value. 0x00000010: Voltage on L1+ is defective. 0x00000020: Voltage on L2+ is defective. 0x00000040: Internal voltage is defective. 0x80000000: No connection to the module. [2] [2] These faults affect the *Module OK* status and need not be separately evaluated in the user program.
Timestamp [µs]	DWORD	N	R	Microsecond fraction of the timestamp. Point in time at which the analog inputs were measured.
Timestamp [s]	DWORD	N	R	Second fraction of the timestamp. Point in time at which the analog inputs were measured.
[1]) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 24: The **Module** Tab in the Hardware Editor

4.3.2 The **I/O Submodule AI32_01** Tab

The **I/O Submodule AI32_01** tab contains the following system parameters:

System parameters	Data type	S [1)]	R/W	Description
Name	---	---	W	Module name
Supply ON	BOOL	N	W	Use the transmitter supplies of the module. Activated: Transmitter supplies for channels 1…32 are activated. Deactivated: Transmitter supplies for channels 1…32 are deactivated. Default setting: Activated.
Show Signal Overflow	BOOL	N	W	The *Field* LED displays any signal overflow. Activated: The *Show Signal Overflow* option is activated. Deactivated: The Show Signal Overflow option is deactivated. Default setting: Activated.
Show Supply Overcurrent	BOOL	N	W	Show supply overcurrent with *Field* LED. Activated: The *Show Supply Overcurrent* option is activated. Deactivated: The Show *Supply Overcurrent* option is deactivated. Default setting: Activated.
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.				
Diagnostic Request	DINT	N	W	To request a diagnostic value, the appropriate ID must be sent to the module using the parameter *Diagnostic Request* (for coding details, see Chapter 4.3.5).
Diagnostic Response	DINT	N	R	As soon as *Diagnostic Response* returns the ID of *Diagnostic Request* (for coding details, see Chapter 4.3.5), *Diagnostic Status* contains the diagnostic value requested.
Diagnostic Status	DWORD	N	R	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.
Background Test Error	BOOL	N	R	TRUE: Background test is faulty. FALSE: Background test is free of faults.
Restart on Error	BOOL	Y	W	The *Restart on Error* parameter can be used to cause any I/O module that is shut down permanently due to errors or faults to once again enter 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

System parameters	Data type	S [1)]	R/W	Description
Submodule OK	BOOL	Y	R	TRUE: It may refer to: • No submodule fault. • No channel fault. FALSE: It may refer to: • Short-circuit or open-circuit. • Channel fault on at least one channel. • Submodule fault. Observe the *Submodule Status* parameter! For redundancy groups, the *Submodule OK* parameters of the individual modules are grouped to a higher-level *Submodule OK* parameter following the OR logic.
Submodule Status	DWORD	N	R	Bit-coded submodule status. (For coding details, see Chapter 4.3.4).
[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 25: The **I/O Submodule AI32_01** Tab in the Hardware Editor

4.3.3 The **I/O Submodule AI32_01: Channels** Tab

The **I/O Submodule AI32_01: 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.
-> Process Value [REAL]	REAL	Y	R	Process value determined using the data points 4 mA and 20 mA.
4 mA	REAL	Y	W	Data point used to calculate the process value at the lowest full scale (4 mA) of the channel. Default setting: 4.0
20 mA	REAL	Y	W	Data point used to calculate the process value at the upper full scale (20 mA) of the channel. Default setting: 20.0
-> Raw Value [DINT]	DINT	N	R	Unprocessed measured value of the channel: 0…200 000 (0…20 mA). If the raw value is evaluated instead of the process value, the user must program the monitoring function and the value in the event of faults from within the user program.
-> Channel OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. The input value is valid. FALSE: Faulty channel. The input value is set to 0.
Sup. Used	BOOL	Y	W	Activated: If a fault occurs in the transmitter supply, the module reports a channel fault and sets the input value to 0. Deactivated: If a fault occurs in the transmitter supply, the module reports no channel fault and the input value is undefined. Default setting: Activated.
-> Supply OK [BOOL]	BOOL	Y	R	TRUE: The transmitter supply is fault-free. FALSE: The transmitter supply is faulty.
OC Limit	DINT	Y	W	Threshold in mA for detecting an open-circuit. If the analog measured value falls under *OC Limit*, the module detects an open-circuit and switches off the *Channel* LED for this channel. Default setting: 36 000 (3.6 mA)
-> OC [BOOL]	BOOL	Y	R	TRUE: Open-circuit present. FALSE: No open-circuit present. Defined through *OC Limit*
SC Limit	DINT	Y	W	Threshold in mA for detecting a short-circuit. If the measured analog value exceeds *SC Limit*, the module detects a short-circuit and sets the *Channel* LED for this channel to *Blinking2*. Default setting: 213 000 (21.3 mA)
-> SC [BOOL]	BOOL	Y	R	TRUE: Short-circuit present. FALSE: No short-circuit present. Defined through *SC Limit*

System parameters	Data type	S [1)]	R/W	Description
SP LOW	DINT	Y	W	Low level upper limit. *SP LOW* (switching point LOW) is the limit value: if this limit is exceeded, the module detects LOW and switches off the *Channel* LED. Restriction: *SP LOW ≤ SP HIGH* Default setting: 39 500 (3.95 mA)
SP HIGH	DINT	Y	W	High level lower limit. *SP HIGH* (switching point HIGH) is the limit value: if this limit is exceeded, the module detects a HIGH and switches on the *Channel* LED. Restriction: *SP LOW ≤ SP HIGH* Default setting: 40 500 (4.05 mA)
-> Channel Value [BOOL]	BOOL	Y	R	Boolean channel value in accordance with the limits. *SP LOW* and *SP HIGH*
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}. Important: The maximum response time T_R (worst case) for this channel is extended by the configured delay, since a signal change is not detected until the configured delay has expired. For blanking surge pulses in accordance with EN 61000-4-5, a time-on delay of 2000 µs must be configured. Range of values: 0…(2^{32} - 1) Granularity: 1000 µs, e.g., 0, 1000, 2000, … Default setting: 0
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}. Important: The maximum response time T_R (worst case) for this channel is extended by the configured delay, since a signal change is not detected until the configured delay has expired. For blanking surge pulses in accordance with EN 61000-4-5, a time off delay of 2000 µs must be configured. Range of values: 0…(2^{32} - 1) Granularity: 1000 µs, e.g., 0, 1000, 2000, … Default setting: 0
-> State LL [BOOL]	BOOL	Y	R	TRUE: Value within the LL event state. FALSE: Value outside the LL event state.
-> State L [BOOL]	BOOL	Y	R	TRUE: Value within the L event state. FALSE: Value outside the L event state.
-> State N [BOOL]	BOOL	Y	R	TRUE: Value within the N (normal) event state. FALSE: Value outside the N (normal) event state.
-> State H [BOOL]	BOOL	Y	R	TRUE: Value within the H event state. FALSE: Value outside the H event state.

-> State HH [BOOL]	BOOL	Y	R	TRUE: Value within the HH event state. FALSE: Value outside the HH event state.

System parameters	Data type	S [1)]	R/W	Description
Redund.	BOOL	Y	W	Requirement: The redundant module must be created. Activated: The channel redundancy for this channel is active. Deactivated: The channel redundancy for this channel is not active. Default setting: Deactivated.
Redundancy Value	BYTE	Y	W	Settings for determining the redundancy value: ▪ *Min* ▪ *Max* ▪ *Average* Default setting: *Max* If a module error occurs, the default setting applies. **It is only displayed in the redundancy group tab!**
[1]) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 26: The **I/O Submodule AI32_01: Channels** Tab in the Hardware Editor

4.3.4 Description of **Submodule Status [DWORD]**

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

Coding	Description
0x00000001	Fault in hardware unit (submodule).
0x00000002	Reset of an I/O bus.
0x00000004	Fault detected while initializing the hardware.
0x00000008	Fault detected while checking the coefficients.
0x10000000	Fault during A/D conversion (conversion end).
0x20000000	Operating voltages faulty.
0x40000000	Fault during A/D conversion (conversion begin).
0x80000000	Test function of transmitter monitoring overvoltage.

Table 27: Coding of *Submodule Status [DWORD]*

4.3.5 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</td><td>Not used!</td></tr>
<tr><td>202</td><td>Actual value of the internal core voltage.</td></tr>
<tr><td>203</td><td>Actual value of the internal core voltage.</td></tr>
<tr><td>204…207</td><td>Not used!</td></tr>
<tr><td>300</td><td>Comparator 24 V undervoltage (BOOL).</td></tr>
<tr><td>1001…1032</td><td>Status of the channels 1…32
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault occurred in hardware unit (submodule).</td></tr>
<tr><td>0x0002</td><td>Channel fault due to internal fault.</td></tr>
<tr><td>0x0400</td><td>SC / OC limits violated or channel/module fault.</td></tr>
<tr><td>0x0800</td><td>Measured values invalid (potential measurement system fault).</td></tr>
<tr><td>0x1000</td><td>Measured value not compliant with the specified accuracy.</td></tr>
<tr><td>0x2000</td><td>Underflow or overflow of the measured value.</td></tr>
<tr><td>0x4000</td><td>Channel not configured.</td></tr>
<tr><td>0x8000</td><td>Independent measurements of both measurement systems malfunctioning.</td></tr>
</table></td></tr>
<tr><td>2001…2032</td><td>Fault status of the power sources 1…32
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Module fault.</td></tr>
<tr><td>0x1000</td><td>Undervoltage of transmitter monitoring.</td></tr>
<tr><td>0x2000</td><td>Max. number of transmitter supplies that are simultaneously short-circuited.</td></tr>
<tr><td>0x4000</td><td>Undervoltage of transmitter supply.</td></tr>
<tr><td>0x8000</td><td>Overvoltage of transmitter supply.</td></tr>
</table></td></tr>
</table>

Table 28: Coding of *Diagnostic Status [DWORD]*

4.4 Connection Variants

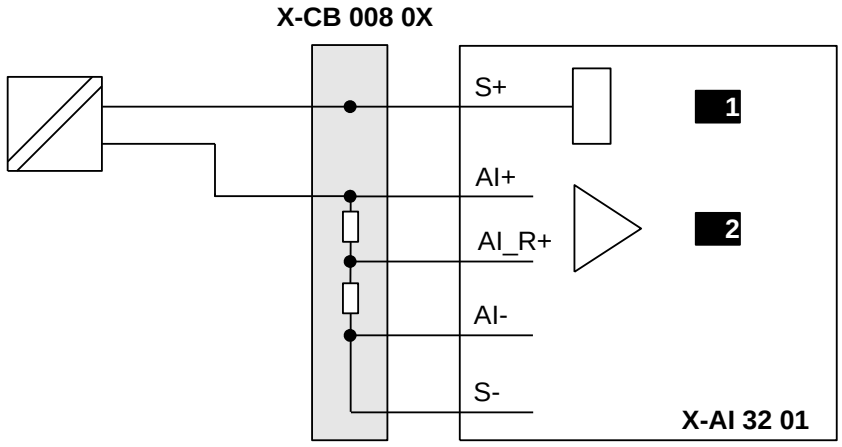
This chapter describes the proper wiring of the module in safety-related applications. The following connection variants are permitted.

4.4.1 Input Wiring Variants

The inputs are wired via connector boards. Special connector boards are available for redundantly wiring the modules.

The transmitter supplies are decoupled using diodes. This ensures that the transmitter supplies of two modules can supply one transmitter if the modules are redundant to one another.

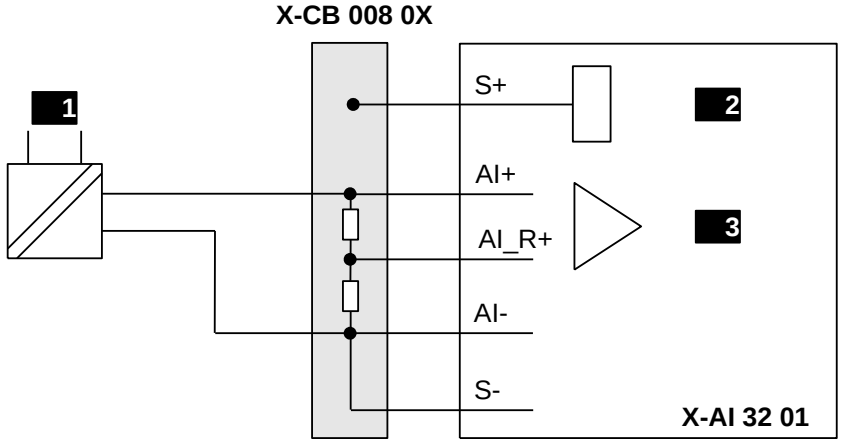
Connector boards X-CB 008 01 (with screw terminals) or X-CB 008 03 (with cable plug) can be used to perform the wiring such as described in Figure 13 and Figure 14.



1 Transmitter supply

2 Analog input

Figure 13: Single-Channel Connection to Passive 2-Wire Transmitter



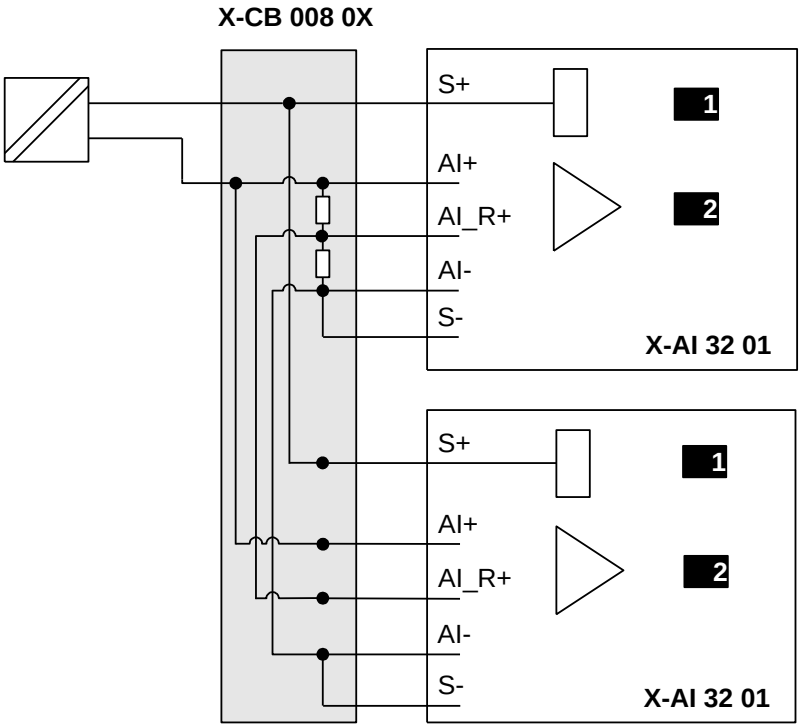
1 External transmitter supply

2 Transmitter supply

3 Analog input

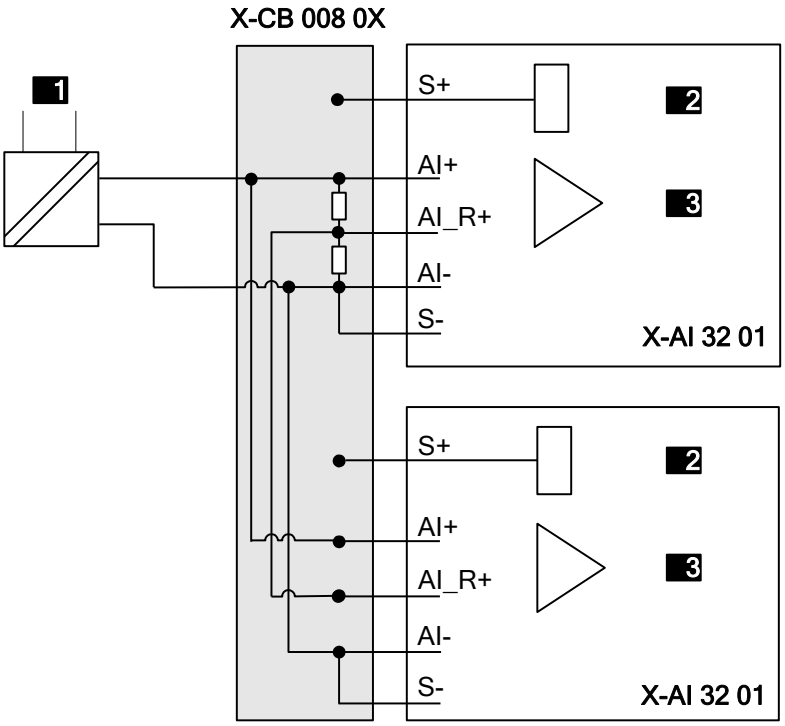
Figure 14: Single-Channel Connection to Active 2-Wire Transmitter

When redundantly wired as specified in Figure 15 and Figure 16, the modules are inserted in the base plate next to each other and on a common connector board. Connector boards X-CB 008 02 (with screw terminals) or X-CB 008 04 (with cable plug) can be used.



1 Transmitter supply 2 Analog input

Figure 15: Redundant Connection to Passive 2-Wire Transmitter

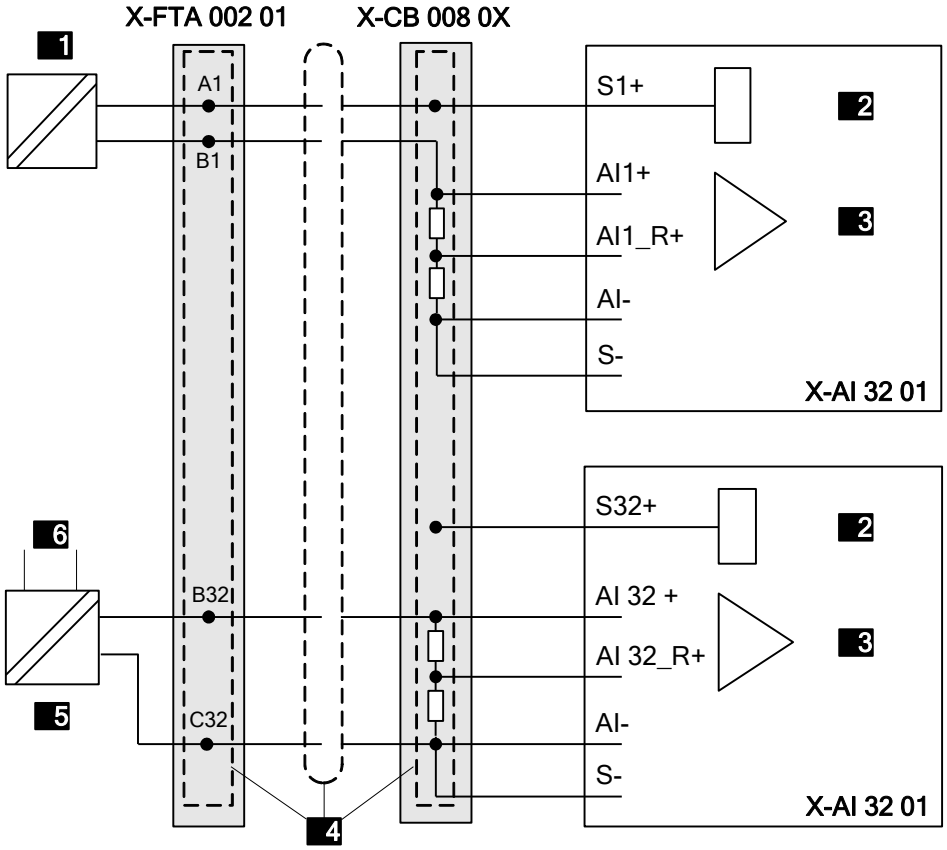


1 External transmitter supply
2 Transmitter supply
3 Analog input

Figure 16: Redundant Connection to Active 2-Wire Transmitter

4.4.2 Wiring Transmitters via Field Termination Assembly

The connection to passive and active 2-wire transmitters via the X-FTA 002 01 is performed as described in Figure 17. For further information, refer to the X-FTA 002 01 manual (HI 801 117 E).

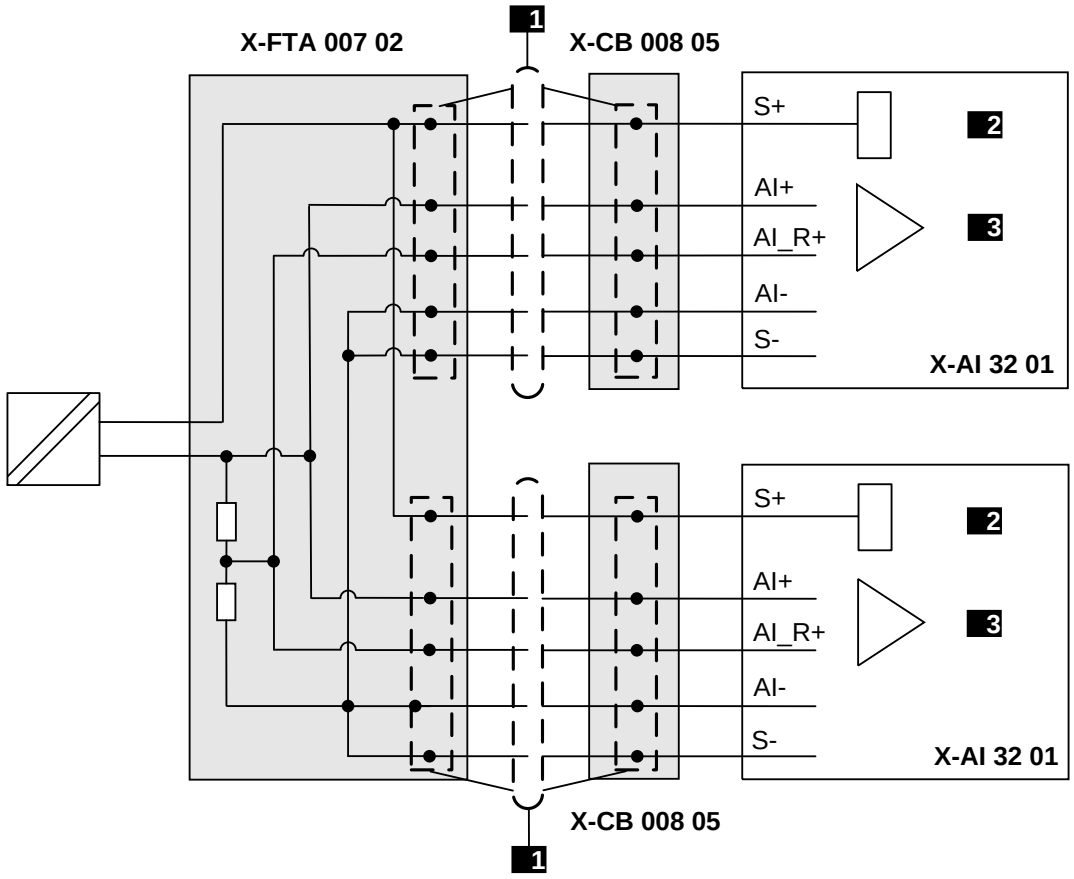


1 Passive 2-wire transmitter
2 Transmitter supply
3 Analog input
4 System cable with cable plug
5 Active 2-wire transmitter
6 External transmitter supply

Figure 17: Connection via Field Termination Assembly

4.4.3 Redundant Connection via Two Base Plates

The figure shows the connection of one transmitter if the redundant modules are inserted in different base plates or not located adjacently in the rack. The measuring shunts are placed on the field termination assembly.

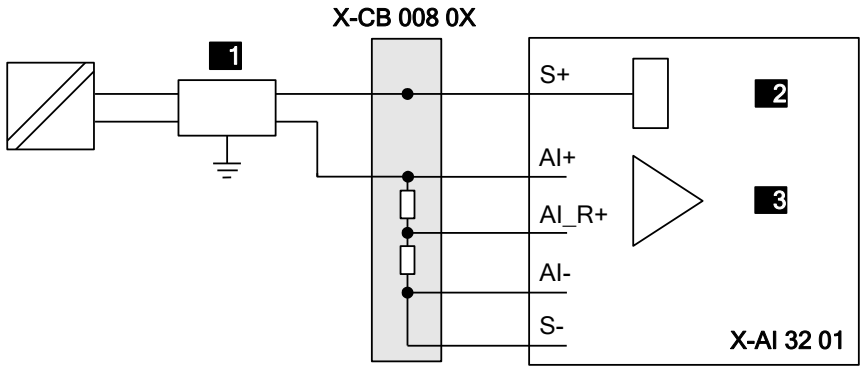


1 System cable X-CA 009 01
2 Transmitter supply
3 Analog input

Figure 18: Redundant Connection via Two Base Plates

4.4.4 Ex Protection with Zener Barriers

Zener barriers can be used for Ex protection, e.g., barriers from MTL, type 7787+ or Pepperl+Fuchs, type Z787.

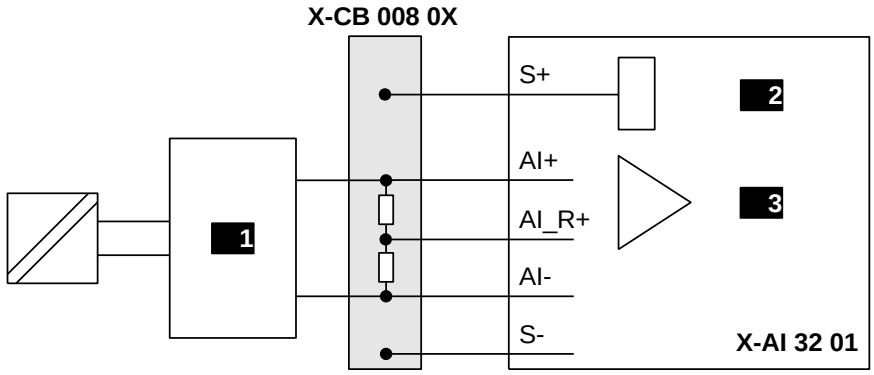


1 Barriers
2 Transmitter supply
3 Analog input

Figure 19: Single-Channel Transmitter Connection with Barrier

4.4.5 Ex Protection with Repeater Power Supply

Repeater power supply can be used for Ex protection, e.g., the analog repeater power supply H 6200A from HIMA. The module's transmitter supply is not used when analog repeater power supply isolator is wired.



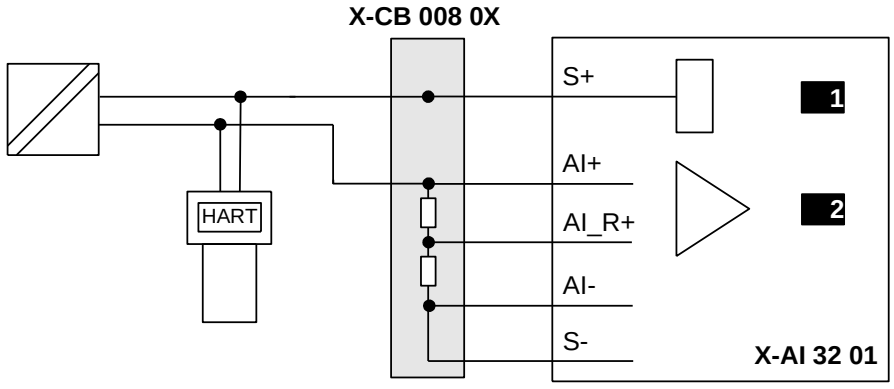
1 Analog repeater power supply
2 Transmitter supply
3 Analog input

Figure 20: Single-Channel Wiring of Analog Repeater Power Supply

4.4.6 Behavior during HART Communication

To ensure HART communication, a HART handheld can be connected in parallel to the transmitter. Filters in the analog input are used to filter out the current fluctuations caused by the HART communication, so that the residual error of the analog measurement is 1 %.

i Increased residual error in HART communication. Remove the HART terminal immediately after diagnosis!



1 Transmitter supply 2 Analog input

Figure 21: HART Handheld in Parallel to the Transmitter and Input Module

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 analog 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 3.5.2.

The diagnostic history of the module can also be read using SILworX. Chapters 4.3.4 through 4.3.5 describe the most important diagnostic statuses.

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.

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 must 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 3.4.

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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