Manual

HIMax®

X-AI 16 51

Analog Input Module

Contact

HIMA Paul Hildebrandt GmbH

P.O. Box 1261

68777 Brühl

Phone: +49 6202 709-0

Fax: +49 6202 709-107

E-mail: info@hima.com

Document designation	Description
HI 801 178 D, Rev. 11.00 (1941)	German original document
HI 801 179 E, Rev. 11.00.00 (1948)	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
HIMax maintenance manual	Description of significant operational and maintenance actions.	HI 801 171 E
Communication manual	Description of safeethernet communication and of the available protocols.	HI 801 101 E
Automation security manual	Description of automation security aspects related to the HIMA systems.	HI 801 373 E
SILworX first steps manual	Introduction to SILworX	HI 801 103 E
SILworX online help (OLH)	Instructions on how to use SILworX	---

Table 1: Additional Applicable Manuals

The current manuals can be obtained upon request by sending an e-mail to: documentation@hima.com. Registered customers can download the product documentation from the HIMA Extranet.

1.2 Target Audience

This document is aimed at the planners, design engineers, programmers and the persons authorized to start up, operate and maintain the automation systems. Specialized knowledge of safety-related automation systems is required.

1.3 Writing Conventions

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

Bold	To highlight important parts. Names of buttons, menu functions and tabs that can be clicked and used in the programming tool.
Italics	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.

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 requirements 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 16 51 is an analog input module is intended for use in the programmable electronic system (PES) HIMax.

The module is used to evaluate up to 16 analog input signals.

The analog inputs can be configured for use in various modes of operation:

- *Voltage/Temperature* (voltage measurement in mV).
- *Thermocouple Type x,* see Table 25.
- *Current.*
- *Pt100* (2-wire circuit, 4-wire circuit).

The module is equipped with two current sources (S1, S2) for measuring the cold junction temperature with a Pt100 (resistance thermometer) and for detecting open-circuits.

The module is designed for operation in accordance with the standards for thermocouples (IEC 60584-1:2013) and Pt100 resistance thermometers (IEC 60751:2008). Table 25 specifies the tolerances for the thermocouples released for this module.

The module has been certified by the TÜV for safety-related applications up to SIL 1 (IEC 61508, IEC 61511 and IEC 62061).

A safety function in accordance with SIL 2 can be achieved with a 1oo2 modules structure (Chapter 4.5.3), while a 1oo3 structure (Chapter 4.5.4) ensures a safety function in accordance with SIL 3.

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.

Module and connector boards are mechanically coded, see Chapter 3.6. Coding prevents installation of unsuitable I/O modules.

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.

Refer to the HIMax safety manual (HI 801 003 E) for further information on the standards used to test and certify the modules and the HIMax system.

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

3.1 Safety Function

The module evaluates the voltage at the inputs and provides the corresponding values to the user program.

The safety function is performed in accordance with SIL 1.

3.1.1 Response in the Event of a Fault

If a fault occurs, the initial value (default value = 0) is transmitted to the user program for the process values. The initial values must be defined by the users. If the raw value is evaluated instead of the process value, users 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 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 contains the following sections:

- Analog measuring Inputs
- Current sources
- Block diagrams
- Indicators (module)
- Product data
- Connector boards
- System cables

The 1oo1 processor system (SIL 1, SIL CL 3) 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.

3.4.1 Analog Measuring Inputs

The module is equipped with 16 analog measuring inputs. Galvanically separated inputs measures the voltage of thermocouples, sensors and a Pt100 (resistance thermometer). The latter is used to determine the cold junction temperature for thermocouples.

To perform measurements with thermocouples, connector board X-CB 024 53 must be used and the mode of operation must be configured in accordance with Chapter 4.2.1 (*Voltage / Temperature*). With connector board X-CB 024 53 open-circuit detection is additionally possible for each channel. If an open-circuit occurred, this induce a voltage exceeding the allowed range. This allows the module to detect a channel fault and safely switch off the affected channel. To allow measurements with thermocouples in connection with open-circuit detection, current source 1 and current source 2 must have been activated in SILworX. If the open-circuit detection function is not required, connector boards X-CB 020 may be used.

To perform measurements with sensors, connector board X-CB 021 must be used and the mode of operation must be configured in accordance with Chapter 4.3 (*Voltage / Temperature*).

The module is equipped with LEDs to indicate the status of the analog inputs, see Chapter 3.4.4.

3.4.2 Current sources

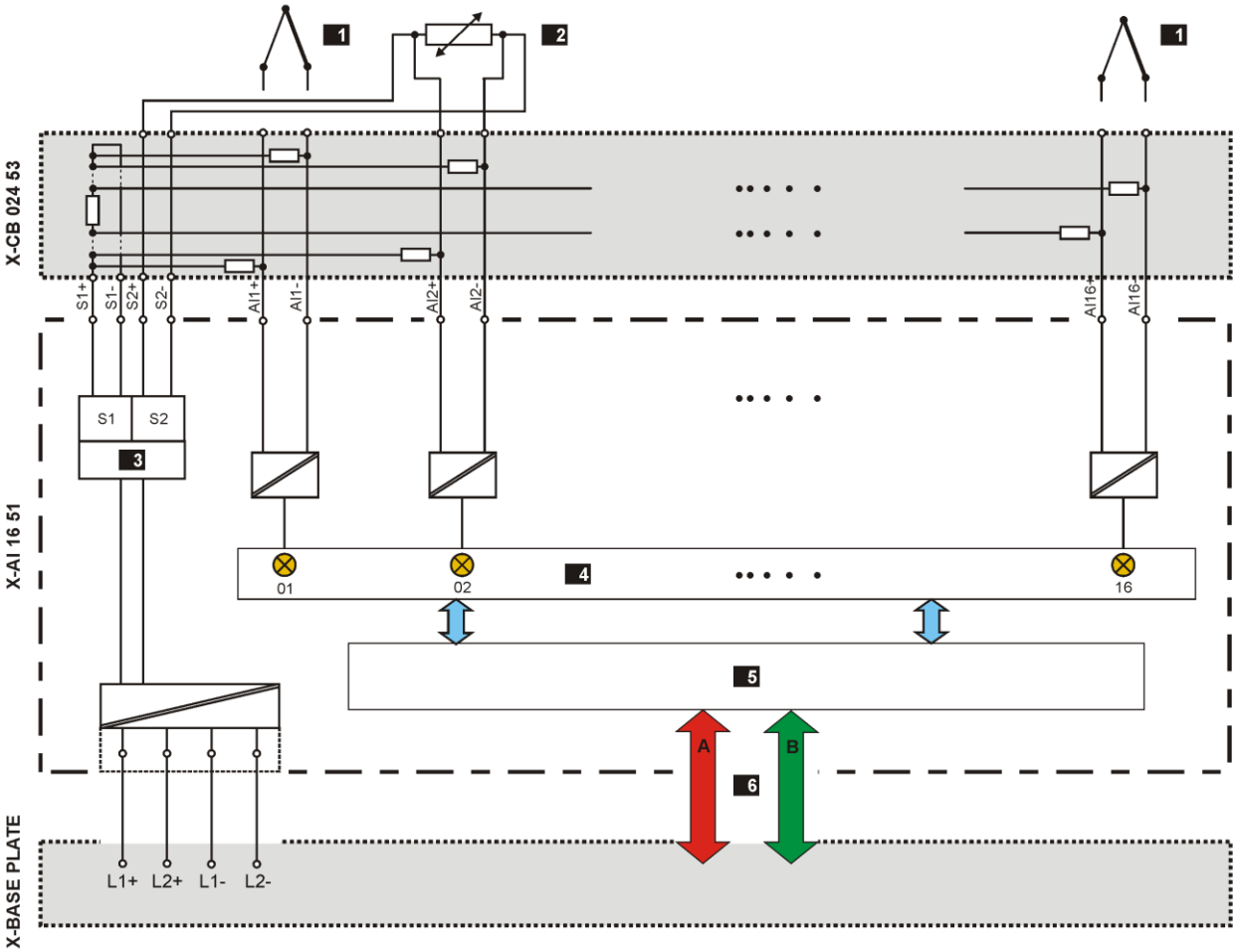
The module is equipped with two current sources (S1, S2), which are not galvanically separated. Current source 1 supplies current to odd inputs. Current source 2 supplies current to even inputs. Additionally, current source 2 supplies the current for measuring the cold junction temperature (Pt100) at the even inputs.

3.4.3 Block Diagrams

The following block diagrams illustrate the structure of the modules.

Block Diagram for Connecting Thermocouples via X-CB 024 53

To connect the thermocouples, use the X-CB 024 53 connector board with resistors for open-circuit detection.

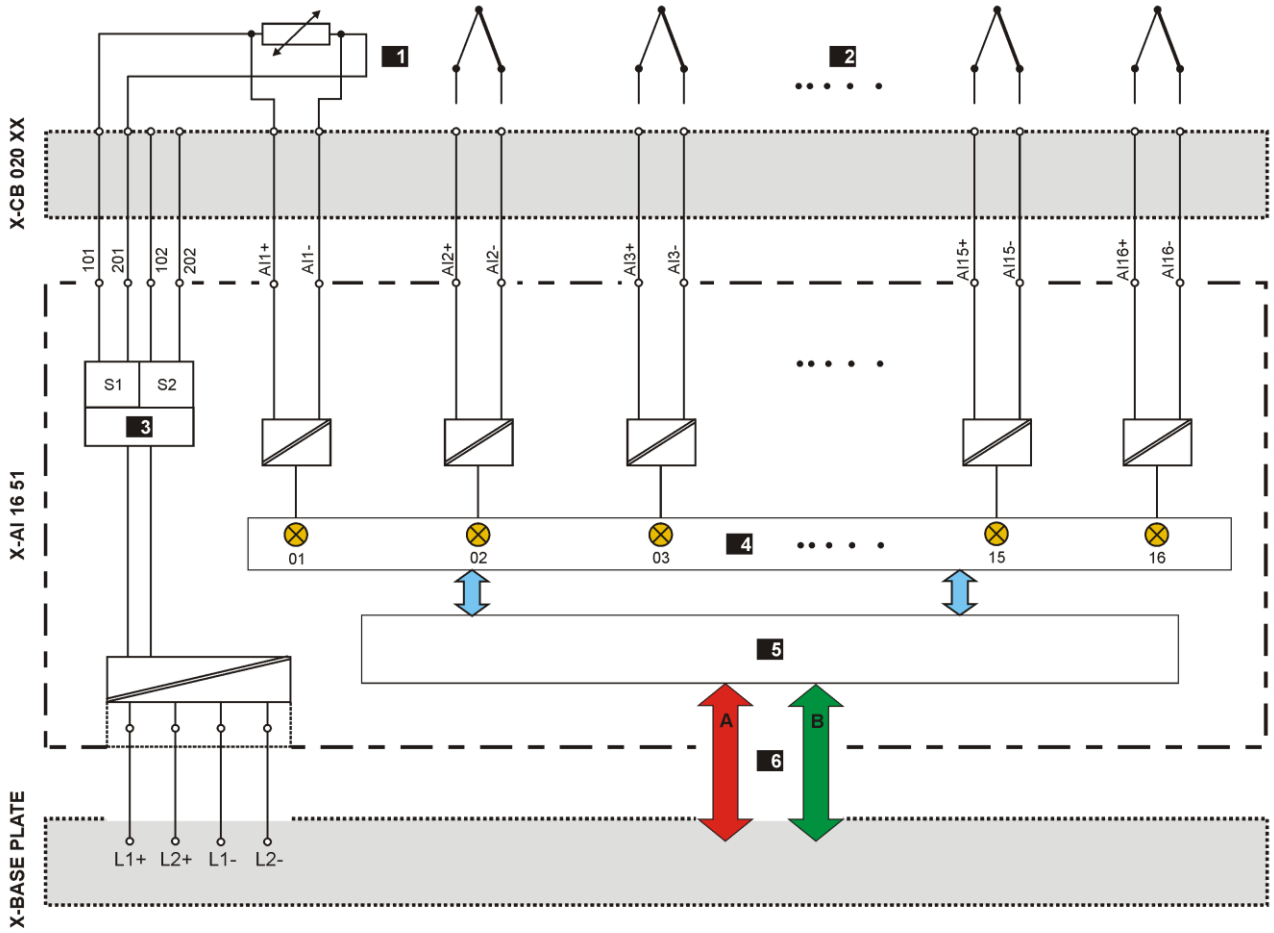


1 Field site: thermocouples
2 Pt100, cold junction temperature
3 Current sources
4 Interface
5 Processor system
6 System buses

Figure 2: Block Diagram for Connecting Thermocouples via X-CB 024 53

Block Diagram for Connecting Thermocouples via X-CB 020 XX

Connection of thermocouples for which the open-circuit detection function need not be used.

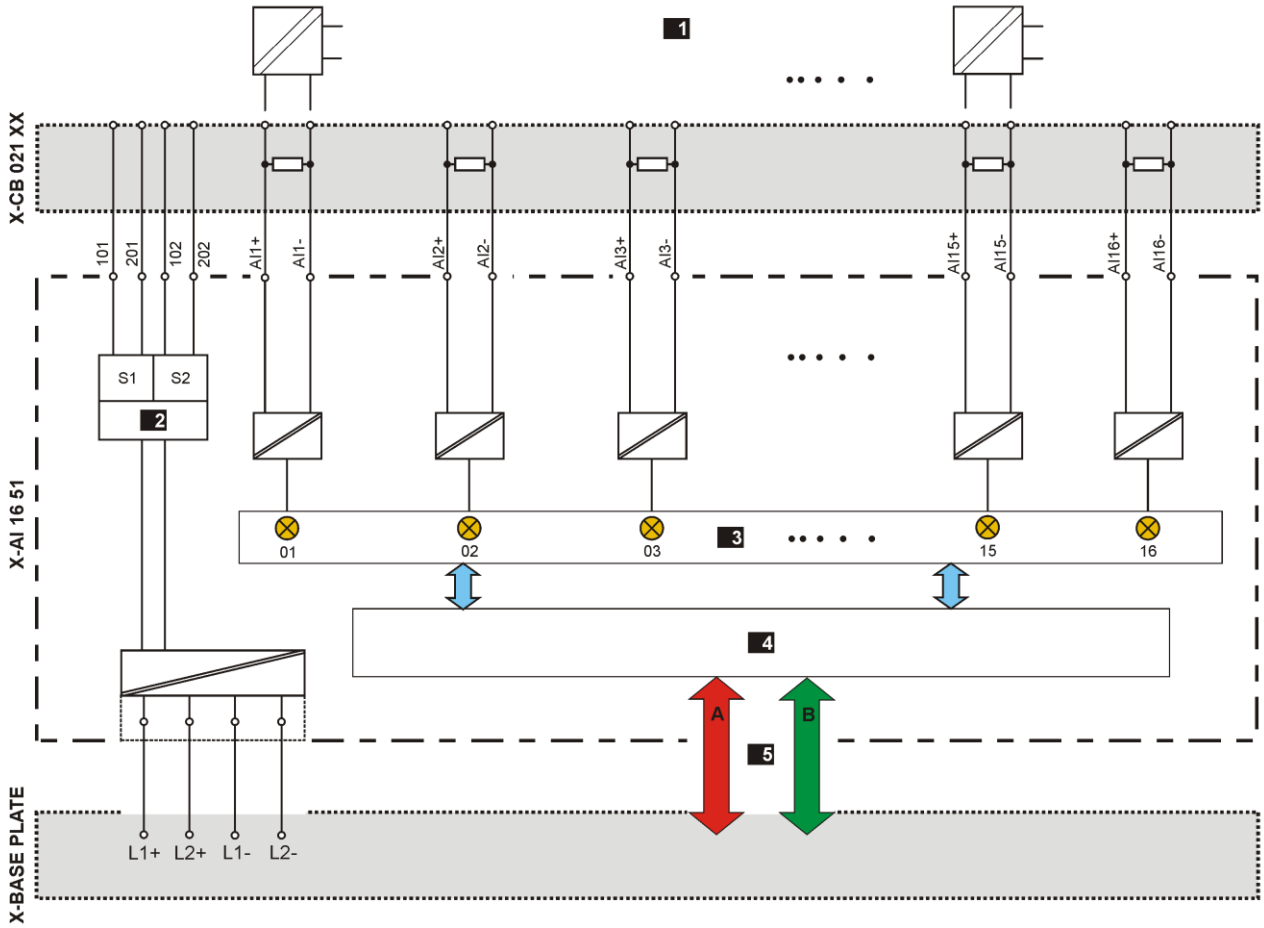


1 Pt100, cold junction temperature
2 Field site: thermocouples
3 Current sources
4 Interface
5 Processor system
6 System buses

Figure 3: Block Diagram for Connecting Thermocouples via X-CB 020 XX

Block Diagram for Connecting Sensors

The X-CB 021 connector boards must be used for connecting sensors.



1 Field side: sensors
2 Current sources
3 Interface
4 Processor system
5 System buses

Figure 4: Block Diagram for Connecting Sensors

3.4.4 Indicators

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

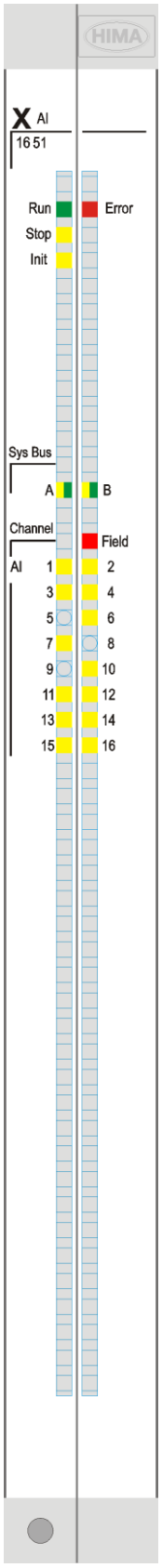


Figure 5: Indicators

The LEDs indicate the operating state of the module. All LEDs should be considered together. The LEDs on the module are divided into the following groups:

- Module status indicators (Run, Error, Stop, Init)
- System bus indicators (A, B)
- I/O indicators (AI 1…16, 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.

3.4.5 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

3.4.6 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

3.4.7 I/O Indicators

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

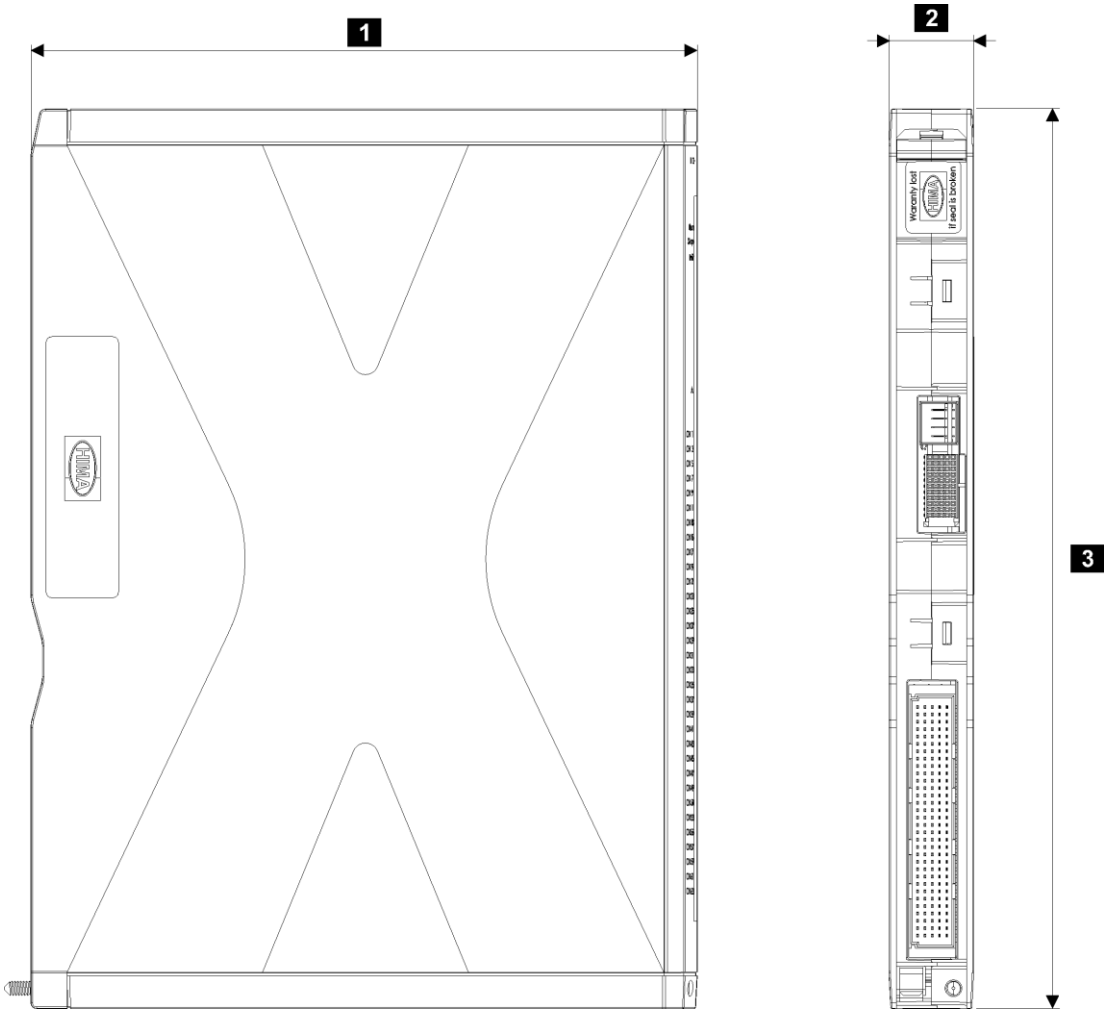
LED	Color	Status	Description
AI 1…16	Yellow	On	Depending on the mode of operation, see Chapter 4.3.
		Blinking2	
		Off	
Field	Red	Blinking2	Field fault on at least one channel, e.g., short-circuit, depending on the configured threshold.
		Off	No faults at the field level

Table 5: I/O Indicators

3.5 Product Data

General information	
Supply voltage	24 VDC, -15…+20 %, $r_p \leq 5$ % SELV, PELV
Current consumption	350 mA at 24 VDC (current sources S1, S2)
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…+70 °C
Humidity	Max. 95 % relative humidity, non-condensing
Pollution	Pollution degree II in accordance with IEC/EN 60664-1
Installation height	< 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



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

Figure 6: Views

Analog inputs	
Number of inputs (number of channels)	16, galvanically separated
Operating range Current measurement Voltage measurement	 0/4…20 mA -280…+280 mV
Digital resolution	16-bit
Shunt for current measurement	12.5 Ω, mounted on connector board X-CB 021
Maximum permitted current via shunt	50 mA
Withstand voltage of the input	30 VDC
Interference voltage suppression	> 60 dB (common mode 50/60 Hz)
Metrological accuracy	
Metrological accuracy across the entire temperature range (-10…+70 °C).	±0.4 % 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

Table 25 specifies the tolerances for the thermocouples released for this module.

Metrological accuracy			
	Temperature range	Tolerance 25 °C	Tolerance (0…60 °C)
Pt100, sensors	-200…+850 °C	±2 °C	±2 °C

Table 8: Metrological Accuracy

Current sources	
Number of current sources	2
Max. output voltage of the current sources	28.5 VDC
Output current, current sources	0.5 mA ±0.015 %

Table 9: Product Data for the Current Sources

3.6 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 board must be used for connecting thermocouples with open-circuit detection function:

Connector board	Description
X-CB 024 53	Mono connector board with cable plug

Table 10: Connector Board for Connecting Thermocouples in Connection with Open-Circuit Detection

The following connector boards may be used for connecting thermocouples if the open-circuit detection function is not required:

Connector board	Description
X-CB 020 51	Mono connector board with screw terminals
X-CB 020 53	Mono connector board with cable plug

Table 11: Connector Boards Available for Connecting Thermocouples

The following connector boards must be used for connecting sensors:

Connector board	Description
X-CB 021 51	Mono connector board with screw terminals
X-CB 021 53	Mono connector board with cable plug

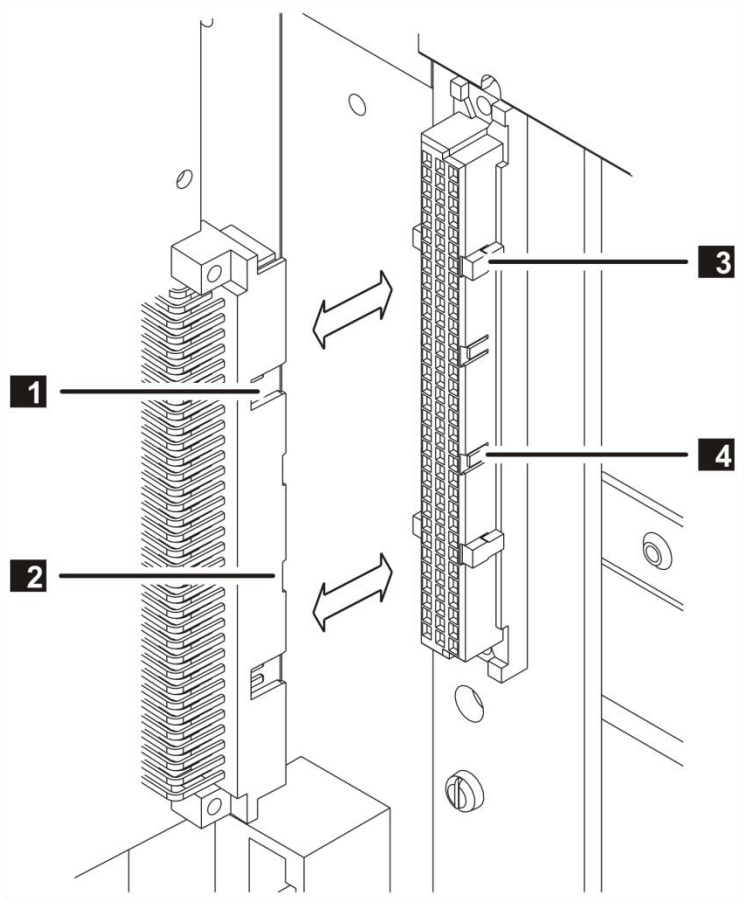
Table 12: Connector Boards Available for Connecting Sensors

3.6.1 Mechanical Coding of Connector Boards

The module and corresponding connector boards are mechanically coded starting with hardware revision index (HW-Rev.) 00. 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 7.

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 7: 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 024 53, X-CB 020 5X and X-CB 021 5X Connector Boards

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

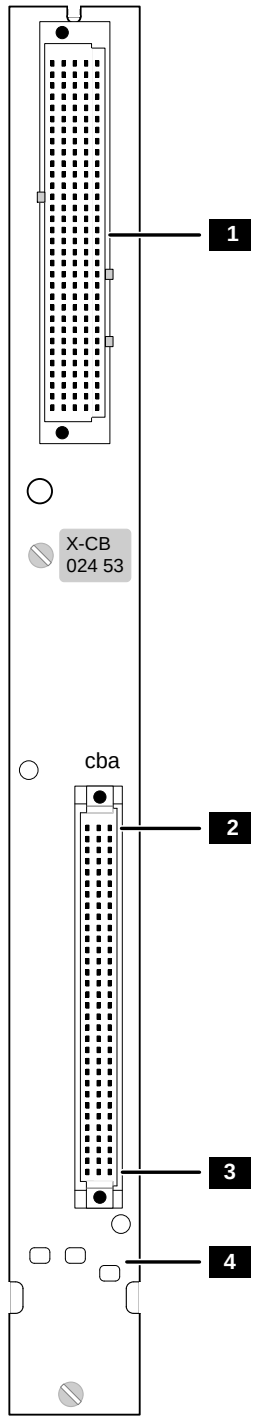
a7	a13	a20	a26	e7	e13	e20	e26
	X					X	X

Table 13: Position of Coding Wedges

3.6.3 Mono Connector Board with Cable Plug, Open-Circuit Detection

Mono

X-CB 024 53



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: X-CB 24 53 Connector Board with Cable Plug

3.6.4 Pin Assignment for X-CB 024 53 Connector Board with Cable Plug

HIMA provides ready-made system cables for use with this connector board, see Chapter 3.7.

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.

Row	c		b		a	
	Signal	Color	Signal	Color	Signal	Color
1					Reserved	PKRD
2					Reserved	GYRD
3					Reserved	PKBU
4					Reserved	GYBU
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17	AI16+	YEBU	AI16-	GNBU		
18	AI15+	YEPK	AI15-	PKGN		
19	AI14+	YEGY	AI14-	GYGN		
20	AI13+	BNBK	AI13-	WHBK		
21	AI12+	BNRD	AI12-	WHRD		
22	AI11+	BNBU	AI11-	WHBU		
23	AI10+	PKBN	AI10-	WHPK		
24	AI9+	GYBN	AI9-	WHGY		
25	AI8+	YEBN	AI8-	WHYE		
26	AI7+	BNGN	AI7-	WHGN		
27	AI6+	RDBU	AI6-	GYPK		
28	AI5+	VT	AI5-	BK		
29	AI4+	RD	AI4-	BU	S2-	YEBK
30	AI3+	PK	AI3-	GY	---	GNBK
31	AI2+	YE	AI2-	GN	S2+	YERD
32	AI1+	BN	AI1-	WH	---	GNRD

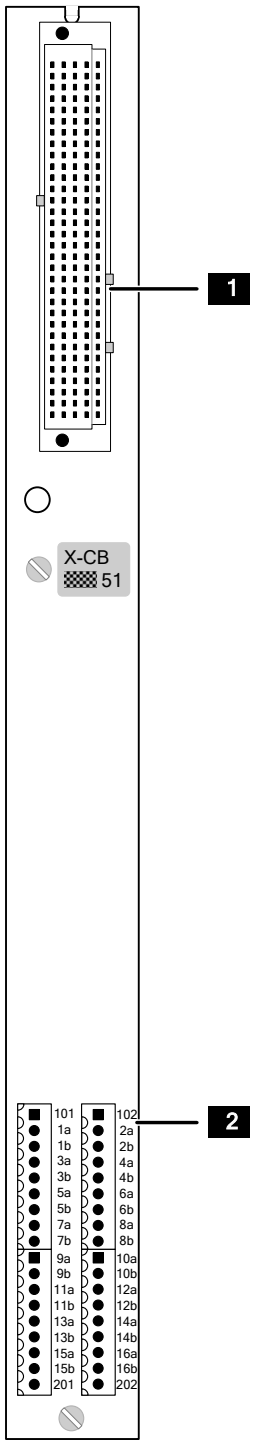
Table 14: Pin Assignment for the System Cable Plug

3.6.5 Mono Connector Boards with Screw Terminals

Mono

X-CB 020 51

X-CB 021 51



1 I/O module plug

2 Connection to the field level (screw terminals)

Figure 9: Connector Board with Screw Terminals

3.6.6 Terminal Assignment for Connector Board with Screw Terminals

Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	101	S1+	1	102	S2+
2	1a	AI1+	2	2a	AI2+
3	1b	AI1-	3	2b	AI2-
4	3a	AI3+	4	4a	AI4+
5	3b	AI3-	5	4b	AI4-
6	5a	AI5+	6	6a	AI6+
7	5b	AI5-	7	6b	AI6-
8	7a	AI7+	8	8a	AI8+
9	7b	AI7-	9	8b	AI8-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	09a	AI9+	1	10a	AI10+
2	09b	AI9-	2	10b	AI10-
3	11a	AI11+	3	12a	AI12+
4	11b	AI11-	4	12b	AI12-
5	13a	AI13+	5	14a	AI14+
6	13b	AI13-	6	14b	AI14-
7	15a	AI15+	7	16a	AI16+
8	15b	AI15-	8	16b	AI16-
9	201	S1-	9	202	S2-

Table 15: Terminal Assignment for Connector Board 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	4 pieces, with 9 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

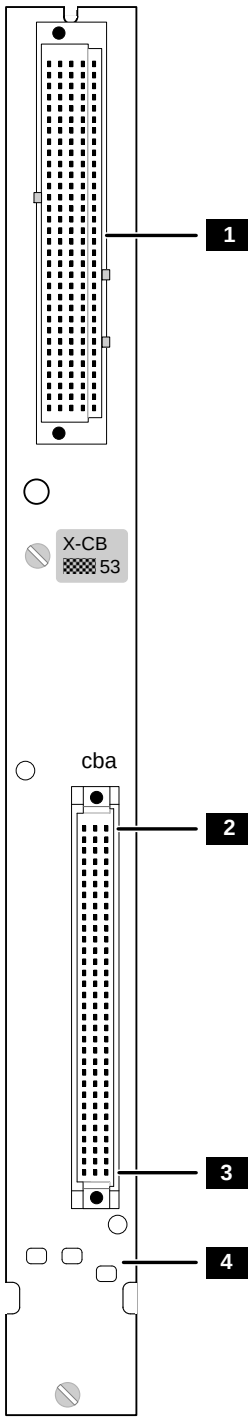
Table 16: Cable Plug Characteristics

3.6.7 Mono Connector Boards with Cable Plug

Mono

X-CB 020 53

X-CB 021 53



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 10: Connector Board with Cable Plug

3.6.8 Pin Assignment for Connector Board with Cable Plug

HIMA provides ready-made system cables for use with these connector boards, see Chapter 3.7.

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.

Row	c		b		a	
	Signal	Color	Signal	Color	Signal	Color
1					Internal use [1)]	PKRD
2						GYRD
3						PKBU
4						GYBU
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17	AI16+	YEBU	AI16-	GNBU		
18	AI15+	YEPK	AI15-	PKGN		
19	AI14+	YEGY	AI14-	GYGN		
20	AI13+	BNBK	AI13-	WHBK		
21	AI12+	BNRD	AI12-	WHRD		
22	AI11+	BNBU	AI11-	WHBU		
23	AI10+	PKBN	AI10-	WHPK		
24	AI9+	GYBN	AI9-	WHGY		
25	AI8+	YEBN	AI8-	WHYE		
26	AI7+	BNGN	AI7-	WHGN		
27	AI6+	RDBU	AI6-	GYPK		
28	AI5+	VT	AI5-	BK		
29	AI4+	RD	AI4-	BU	S2-	YEBK
30	AI3+	PK	AI3-	GY	S1-	GNBK
31	AI2+	YE	AI2-	GN	S2+	YERD
32	AI1+	BN	AI1-	WH	S1+	GNRD

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

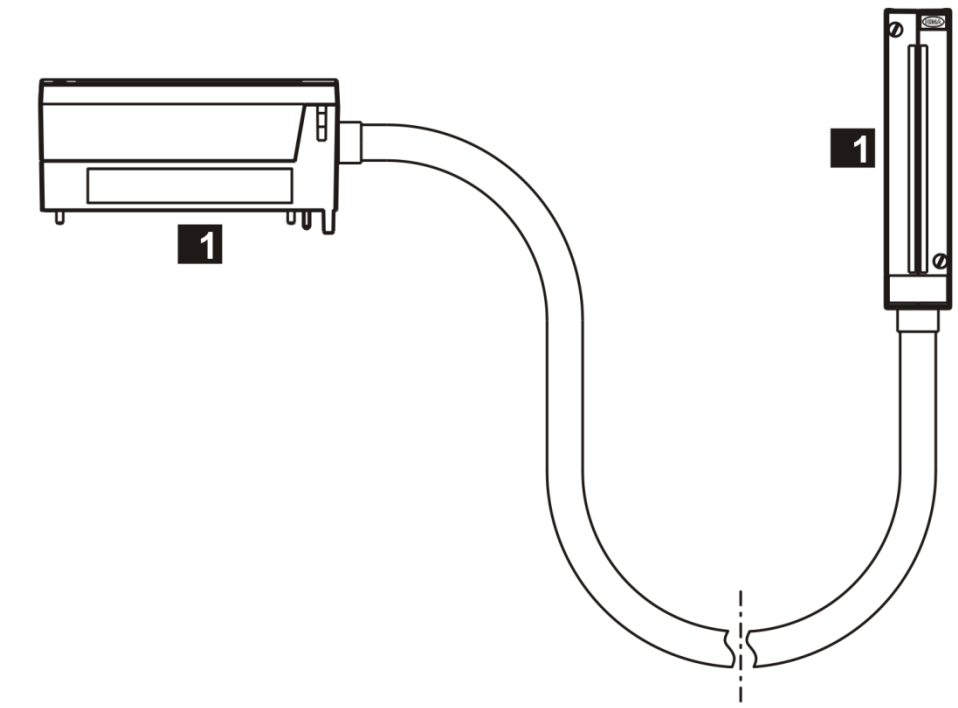
Table 17: Pin Assignment for the System Cable Plug

3.7 System Cable X-CA 014

System cable X-CA 014 is used to connect the X-CB 020 53, X-CB 021 53 and X-CB 024 53 connector boards to the field level via field termination assemblies or inline terminals.

General information	
Cable	LIYDY-CY TP 20 x 2 x 0.25 mm² (shielded).
Wire	Finely stranded
Average outer diameter (d)	Approx. 14.1 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 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 14 and Table 17.

Table 18: Cable Data



1 Identical cable plugs

Figure 11: System Cable X-CA 014 01 n

The system cable is available in the following standard lengths:

System cables	Description	Length	Weight
X-CA 014 01 8	Coded cable plugs on both sides.	8 m	2.5 kg
X-CA 014 01 15		15 m	5 kg
X-CA 014 01 30		30 m	10 kg

Table 19: Available System Cables X-CA 014

3.7.1 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 8 and Figure 10.

4 Start-Up

This chapter describes how to install, configure and connect the module. For further details, refer to the HIMax system manual (HI 801 001 E).

i The module with one channel is only approved for applications operating in low demand mode. Redundancy (1oo2, 1oo3) must be implemented for applications operating in high demand mode.

The safety-related application (SIL 1/SIL 2/SIL 3) of the inputs and the connected sensors must comply with the safety requirements.

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.
  - Use shielded cables with twisted pairs.
  - Use one twisted pair of shielded cables for each measuring 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.
- The range for the cold junction temperature is -40…+80 °C.
- If the current sources are used, the sources assigned to each input must be utilized (e.g., S1+ with AI1+).
- HIMA recommends using the current sources of the module.

  If an external current source is malfunctioning, the affected module's measuring 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 Chapter 3.6 and Chapter 4.4.1.

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.

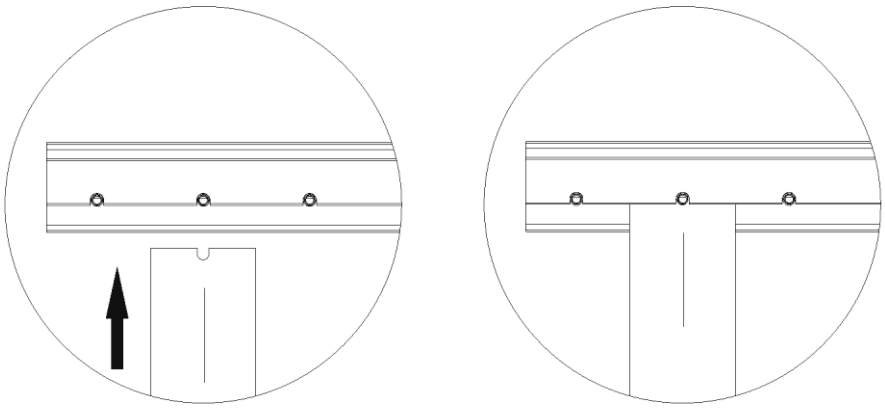


Figure 12: Example of how to Insert the Mono Connector Board

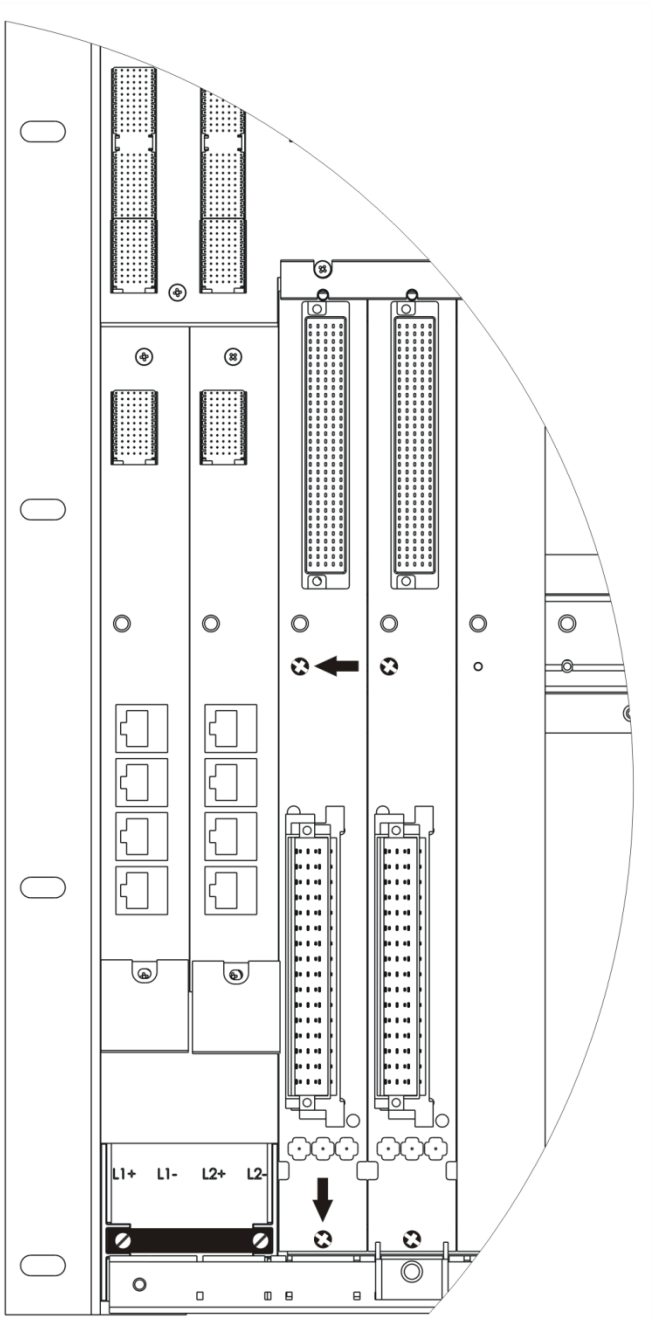


Figure 13: Example of how to Secure the Mono Connector Board with Captive Screws

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:

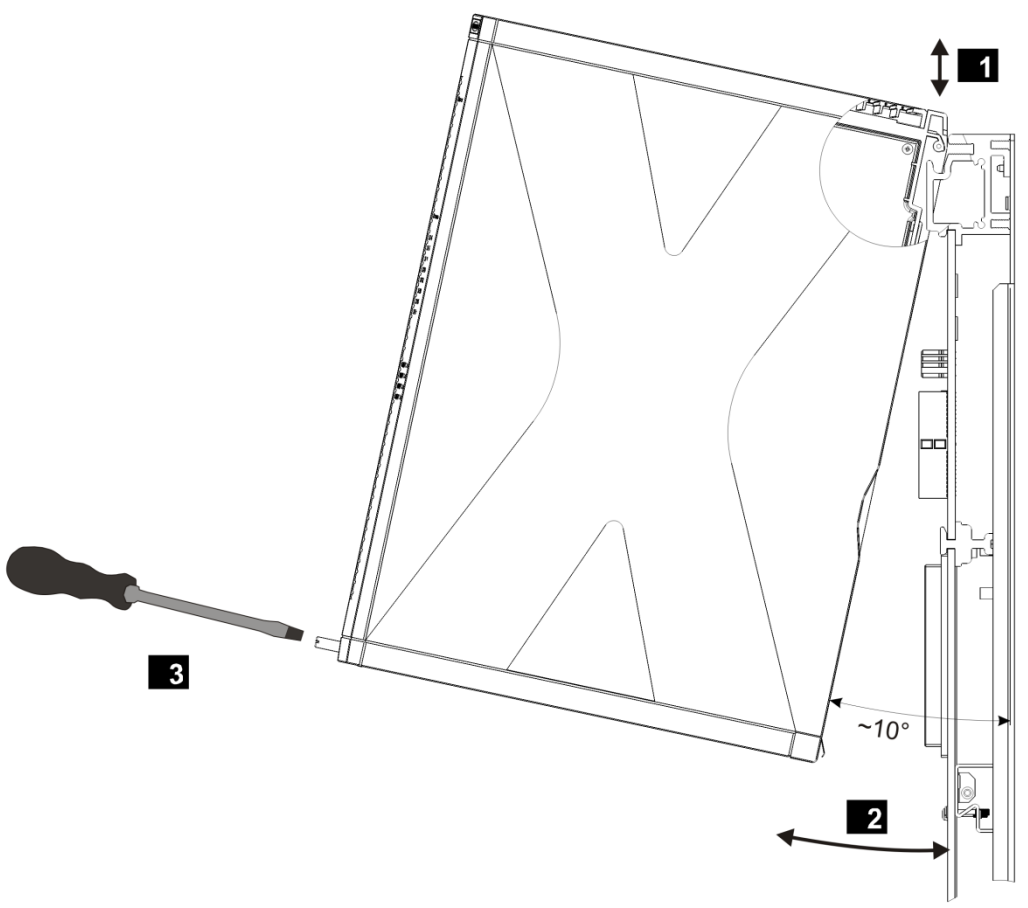
- Screwdriver, slotted 0.8 x 4.0 mm.
- Screwdriver, slotted 1.2 x 8.0 mm.

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 14: 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 Module and Channel Modes of Operation

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

4.3.1 The Mode of Operation Module Settings

The *Mode of Operation* parameter in the *I/O Submodule AI16_51* tab provides the following options:

- Voltage / Temperature

  The *Voltage / Temperature* mode of operation is used to select the connection of thermocouples, sensors and Pt100 for the individual channels, see Chapter 4.3.2.
- Current

  In the channel properties, all channels are set to the *Voltage / Current* mode, see Chapter 4.3.2.

i If the *Current* module operating mode is configured, the *Operating Mode* system parameter located in the channel settings is grayed out. All channels are set to *Voltage / Current* and the operating mode can no longer be changed.

4.3.2 Channel Settings for Mode of Operation

The *Mode of Operation* system parameter in the *I/O Submodule AI16_51: Channels* tab provides the following options:

- Voltage / Current

  If **Voltage / Current** is selected as mode of operation, this channel can be used for measuring the voltage or current.
- Thermocouple

  The Thermocouple mode of operation provides multiple types of thermocouples (Table 25), which take the cold junction temperature into account when determining the temperature.

  As soon as a thermocouple is used in a channel, the Cold Junction Temperature system parameter must be assigned the process value (global variable) of a temperature measuring channel (Pt100). This is used as thermo voltage reference point for all channels configured as thermocouples in the channel settings. The cold junction temperature (Pt100) must be within -40…+80 °C.
- Pt100

  The **Pt100** mode of operation serves for determining the cold junction temperature. For supplying current to the Pt100 and ensuring that the odd channels are DC supplied, the Current Source 1 ON system parameter must be activated. Activate the *Current Source 2 ON* system parameter to ensure that the even channels are DC supplied.

  If connector boards X-CB 024 53 with additional open-circuit detection is used, an even channel must be selected for the cold junction temperature. System parameter *Current Source 2 ON* must be activate to activate current source 2.

  The cold junction can also be used for additional modules (X-AI 16 51) within a HIMax system.

i The configuration is not accepted if odd channels are set to Pt100 measurement and *Current Source 1 ON* is deactivated or if even channels are set to Pt100 measurement and *Current Source 2 ON* is deactivated.

4.3.3 System Parameters OC LOW and SC HIGH

If the system parameters *OC Limit* and *SC Limit* are required, they are normalized as described in Chapter 4.3.5.

4.3.4 System Parameters SP LOW and SP HIGH

If the Boolean value -> Channel Value [BOOL] is required, the threshold values SP LOW and SP HIGH must be adjusted in accordance with the measured values, see Chapter 4.3.5.

4.3.5 Output of Measured Values

The measured values are displayed after normalization to the -> *Raw Value [DINT]* system parameter in accordance with the following rules:

- Voltages
  -2 000 000 digits corresponds to -200 mV
  +2 000 000 digits corresponds to +200 mV
  10 000 digits corresponds to 1 mV

- Temperatures
  10 000 digits corresponds to 1 °C
  0 digits corresponds to 0 °C

- Currents
  200 000 digits corresponds to 20 mA
  10 000 digits corresponds to 1 mA

4.4 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* status in addition to the -> *Raw Value.*

  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 further details on these system parameters, refer to Table 21 and Table 22.
- 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.

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.

4.4.1 The **Module** Tab

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

System parameter	Data type	S [1]	R/W	Description
Name	---	---	W	Module name.
Spare Module	---	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	---	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 parameter	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	N	R	TRUE: • Mono operation: No module faults. • Redundancy operation: At least one of the redundant modules has no module fault (OR logic). FALSE: • Module fault. • Channel fault (no external faults). • The module is not plugged in. Observe the *Module Status* parameter!
Module Status	DWORD	N	R	Status of the module.
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.

Coding	Description
0x00000001	Module fault.[1]
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. [1]

[1] These faults affect the *Module OK* status and need not be separately evaluated in the user program.

[1]) The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).

Table 20: The **Module** Tab in the Hardware Editor

4.4.2 The **I/O Submodule AI16_51** Tab

The **I/O Submodule AI16_51** tab contains the following system parameters:

System parameter	Data type	S [1)]	R/W	Description
Name	---	---	W	Tab name
Show Signal Overflow	---	N	W	Parameter without function! Default setting: Activated
Current Source 1 ON	---	N	W	Use current source 1 for the module. Activated: The current sources of odd channels (1, 3…15) are activated. Deactivated: The current sources of odd channels (1, 3…15) are deactivated. Default setting: Activated
Current Source 2 ON	---	N	W	Use current source 2 for the module. Activated: The current sources of even channels (2, 4…16) are activated. Deactivated: The current sources of even channels (2, 4…16) are deactivated. Default setting: Activated **X-CB 024 53: Current source S2 must have been activated for the cold joint temperature.**
Mode of Operation	---	Y	W	The following options are available: ▪ *Voltage / Temperature* ▪ *Current* Default setting: *Voltage / Temperature* For further information, refer to 4.3.1.
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.				
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 4.4.5).
Diagnostic Response	DINT	N	R	As soon as *Diagnostic Response* returns the ID of *Diagnostic Request* (for coding details, see Chapter 4.4.5), *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 not faulty.

System parameter	Data type	S [1)]	R/W	Description
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
Submodule OK	BOOL	Y	R	TRUE: No submodule fault, no channel faults. FALSE: Submodule fault, channel faults (external faults included).
Submodule Status	DWORD	N	R	Bit-coded submodule status. For coding details, see Chapter 4.4.4.
Cold Junction Temperature	REAL	Y	W	The *Cold Junction Temperature* system parameter must be assigned with the process value of a temperature measuring channel (Pt100). Range of values: -40…+80 °C For further information, refer to Chapter 4.3.1.
[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 21: The **I/O Submodule AI16_51** Tab in the Hardware Editor

4.4.3 The **I/O Submodule AI16_51: Channels** Tab

The **I/O Submodule AI16_51: 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 parameter	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 = (*Raw Value* x *Scal. Factor* / 10 000) + *Offset*
Scaling Factor	LREAL	Y	W	Scaling factor that is multiplied by the raw value. Default setting: 1.0
Scaling Offset	LREAL	Y	W	Offset added to the raw value. Default setting: 0.0
-> Raw Value [DINT]	DINT	N	R	Unprocessed measured value of the channel, see Chapter 4.3.5. If the raw value is evaluated instead of the process value, users 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 process value is valid. FALSE: Faulty channel. The process value is set to its initial value (default value = 0). The initial value must be configured by the users!
OC Limit	DINT	Y	W	Threshold in mA for detecting an open-circuit. If the process value falls under *OC Limit*, the module detects an open-circuit and switches off the *Channel* LED for this channel to Blinking2 and switches on the *Field* LED. Default setting: -20 000 000
-> 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 process value exceeds *SC Limit*, the module detects a short-circuit and sets the *Channel* LED for this channel to Blinking2 and switches on the *Field* LED. Default setting: 20 000 000
-> SC [BOOL]	BOOL	Y	R	TRUE: Short-circuit present. FALSE: No short-circuit present. Defined through *SC Limit.*
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: -10 000

System parameter	Data type	S [1)]	R/W	Description
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: 10 000
-> 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}. 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^{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}. 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^{32}-1) Granularity: 1000 µs, e.g., 0, 1000, 2000, … Default setting: 0
Mode of Operation	BYTE	Y	W	The following options are available: ▪ *Pt100* ▪ *Voltage / Current* ▪ *Thermocouple Type B* (not released!) ▪ *Thermocouple Type E* ▪ *Thermocouple Type J* ▪ *Thermocouple Type K* ▪ *Thermocouple Type R* (not released!) ▪ *Thermocouple Type S* (not released!) ▪ *Thermocouple Type T* Default setting: *Voltage / Current* For further information, refer to 4.3.2.
Filter parameter [ms]	---	Y	W	The *Filter Parameter [ms]* system parameter indicates the time used to average the measured value. Range of values: 2…1 000 [ms] with a granularity of 2 ms (2, 4, 6, …). Default setting: 2

System parameter	Data type	S [1)]	R/W	Description
Redund.	---	Y	W	TRUE: Redundancy group created. FALSE: Module in mono operation. The redundancy group can only be created and deleted using the corresponding context menu.
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 22: The **I/O Submodule AI16_51: Channels** Tab in the Hardware Editor

4.4.4 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.
0x00000080	Reset of the chip select monitoring.

Table 23: Coding of *Submodule Status [DWORD]*

4.4.5 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 rowspan="3">Not used!</td></tr>
<tr><td>202</td></tr>
<tr><td>203</td></tr>
<tr><td>300</td><td>Comparator 24 V undervoltage (BOOL).</td></tr>
<tr><td>1001…1016</td><td>Status of the channels 1…16
<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>0x1000</td><td>Cold junction temperature is out of the range of values.</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>
</table></td></tr>
</table>

Table 24: Coding of *Diagnostic Status [DWORD]*

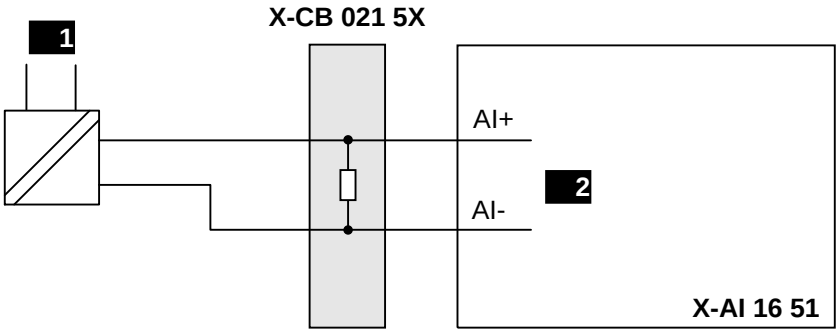
4.5 Connection Variants

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

The inputs are wired via connector boards. The universal FTAs, X-FTA 002 01 (mono) and X-FTA 002 02 (redundant) are available for connection via system cables.

4.5.1 Input Wiring Variants

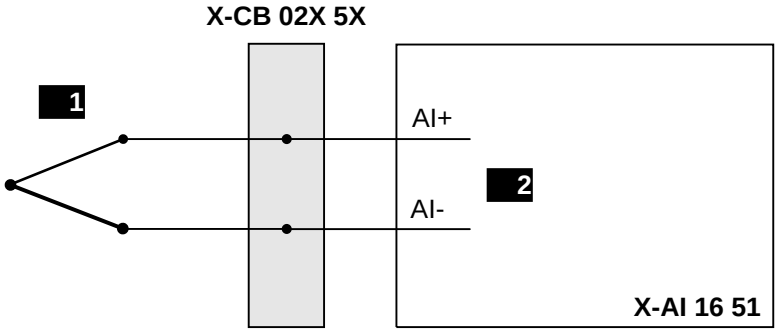
Connector boards with shunt (12.5 Ω), X-CB 021 51 (with screw terminals) or X-CB 021 53 (with cable plug) must be used to wire sensors as described in Figure 15.



1 Sensor 2 Analog input

Figure 15: 1-Channel Connection of a Sensor

Connector boards X-CB 024 53 (with cable plug), X-CB 020 51 (with screw terminals) or X-CB 020 53 (with cable plug) must be used to wire thermocouples as described in Figure 16.



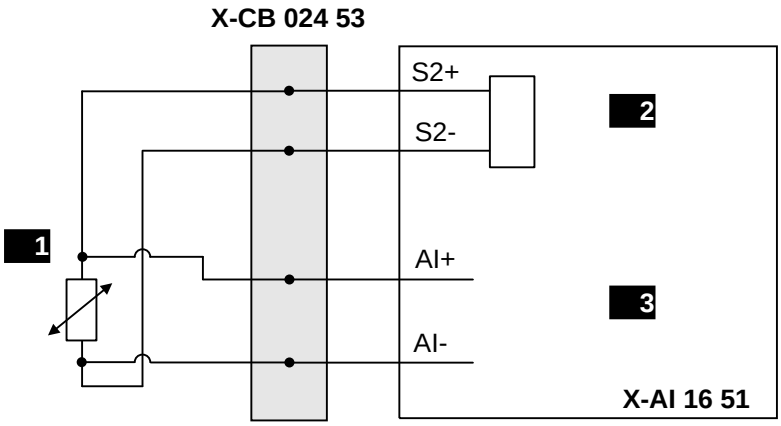
1 Thermocouple 2 Analog input

Figure 16: 1-Channel Connection of Thermocouples

4.5.2 Connecting the Pt100 for Measuring the Cold Junction Temperature

To determine the cold junction temperature, a Pt100 must be connected as described in Figure 17, Figure 18 or Figure 19.

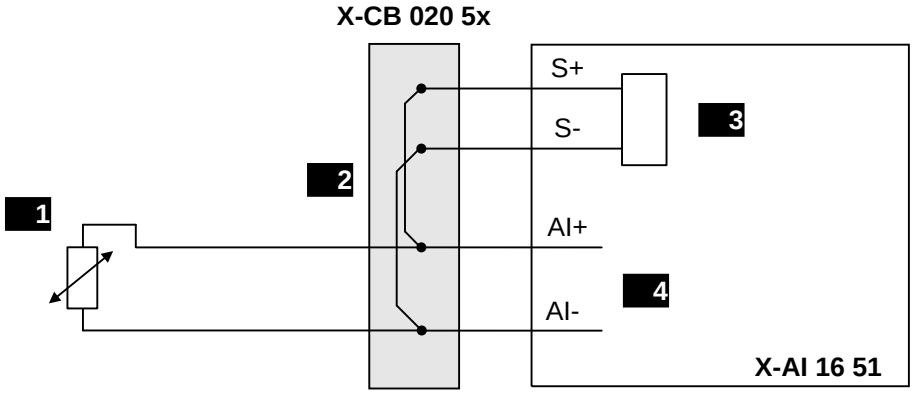
Current source 2 must be activated in SILworX and the even inputs must be used to ensure that the Pt100 is supplied via X-CB 024 53.



1 Pt100 (resistance thermometer)
2 Current source S2
3 Analog input

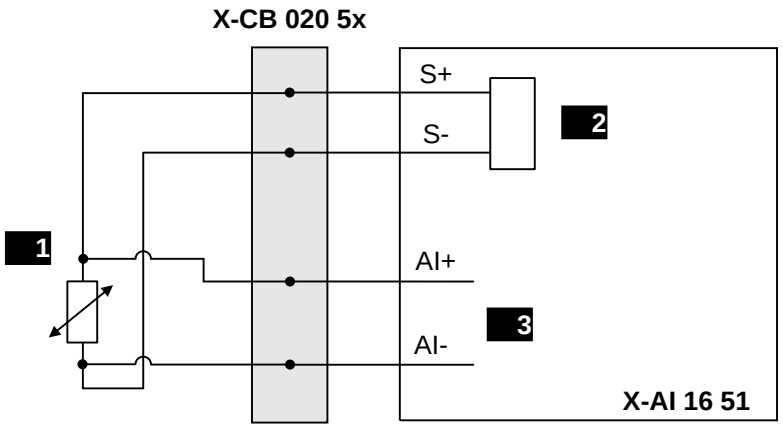
Figure 17: Connection of Pt100 (4-Wire Circuit) to X-CB 024 53

Current source 1 or current source 2 must be activated in SILworX to ensure that the Pt100 is supplied via X-CB 020 5x. Activate current source 1 (S1) to supply power to the Pt100 at one of the 8 odd inputs and activate current source 2 (S2) to supply power to the Pt100 at one of the 8 even inputs.



1 Pt100 (resistance thermometer)
2 Wire jumpers on the connector board
3 Current source
4 Analog input

Figure 18: Connection of Pt100 (2-Wire Circuit) to X-CB 020 5x



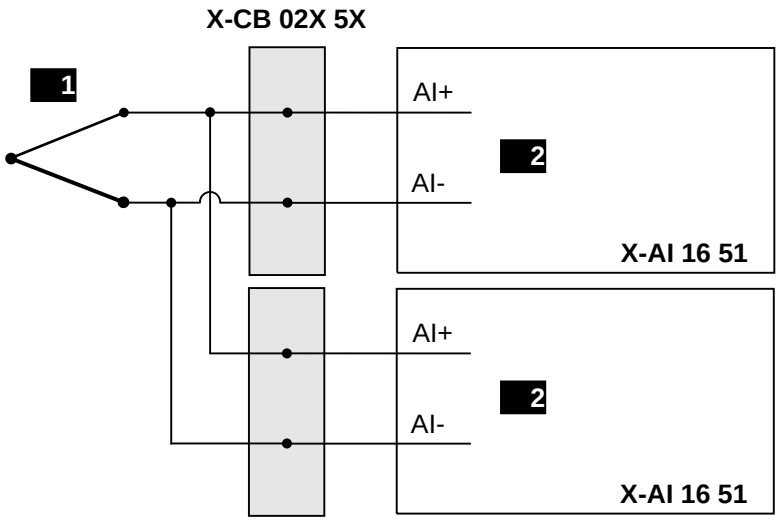
1 Pt100 (resistance thermometer)
2 Current source
3 Analog input

Figure 19: Connection of Pt100 (4-Wire Circuit) to X-CB 020 5x

4.5.3 Redundant Input Wiring Variants

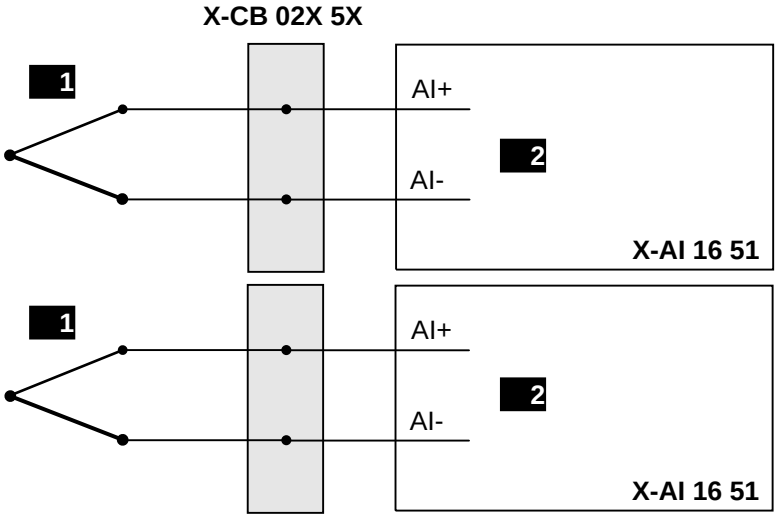
A safety function in accordance with SIL 2 can be achieved with a 1oo2 modules structure. The 1oo2 module structure must be evaluated in the user program.

Connector boards X-CB 024 53 (with cable plug), X-CB 020 51 (with screw terminals) or X-CB 020 53 (with cable plug) must be used to perform the wiring as described in Figure 20 through Figure 21.



1 Thermocouple 2 Analog input

Figure 20: Redundant Connection of one Thermocouple



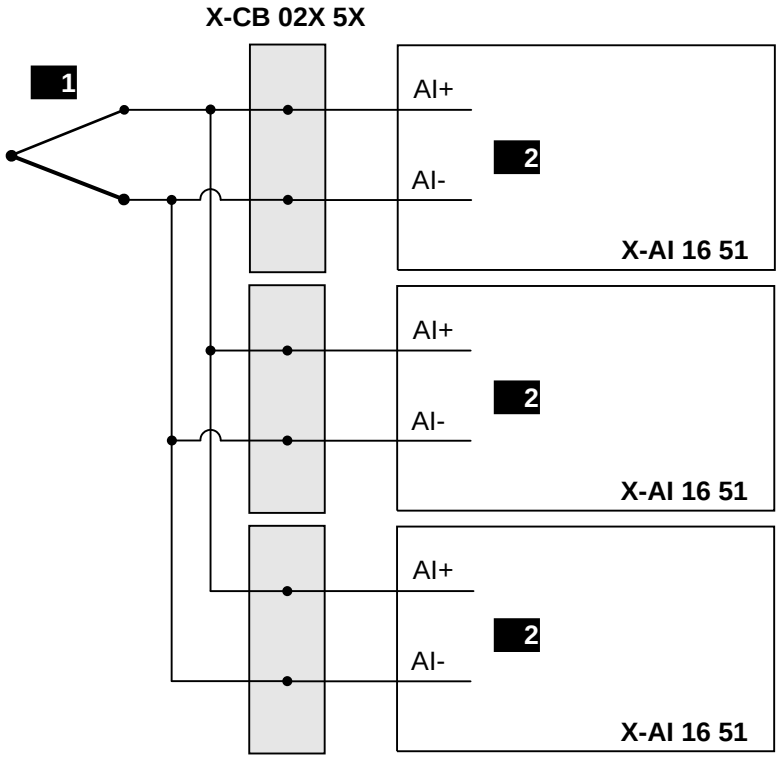
1 Thermocouple 2 Analog input

Figure 21: Redundant Connection of Redundant Thermocouples

4.5.4 Triple Redundant Input Wiring Variants

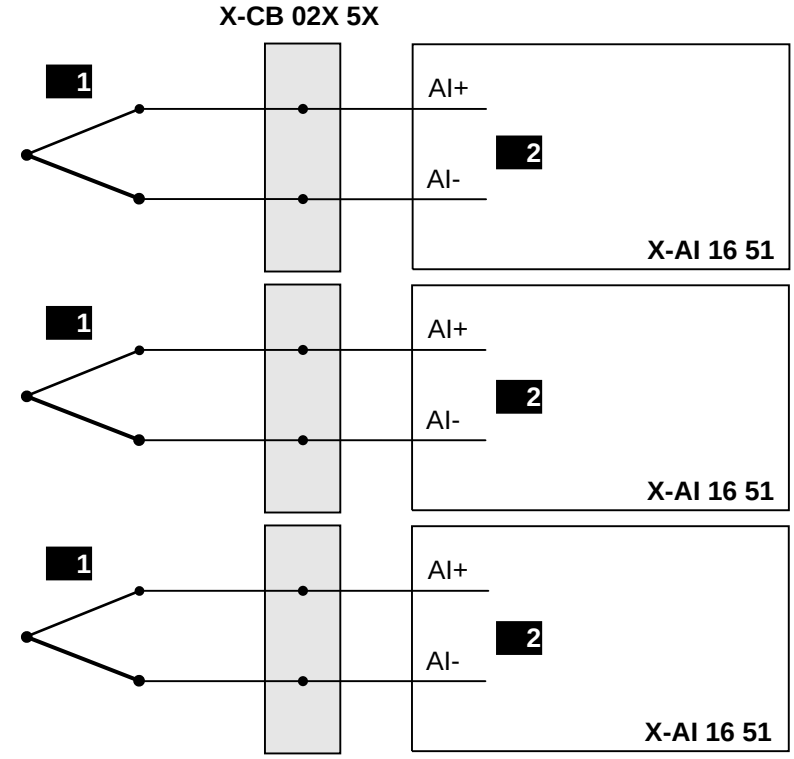
A safety function in accordance with SIL 3 can be achieved with a 1oo3 modules structure. The 1oo3 module structure must be evaluated in the user program.

Connector boards X-CB 024 53 (with cable plug), X-CB 020 51 (with screw terminals) or X-CB 020 53 (with cable plug) must be used to perform the wiring as described in Figure 22 through Figure 23.



1 Thermocouple 2 Analog input

Figure 22: Three-Fold Redundant Wiring of one Thermocouple



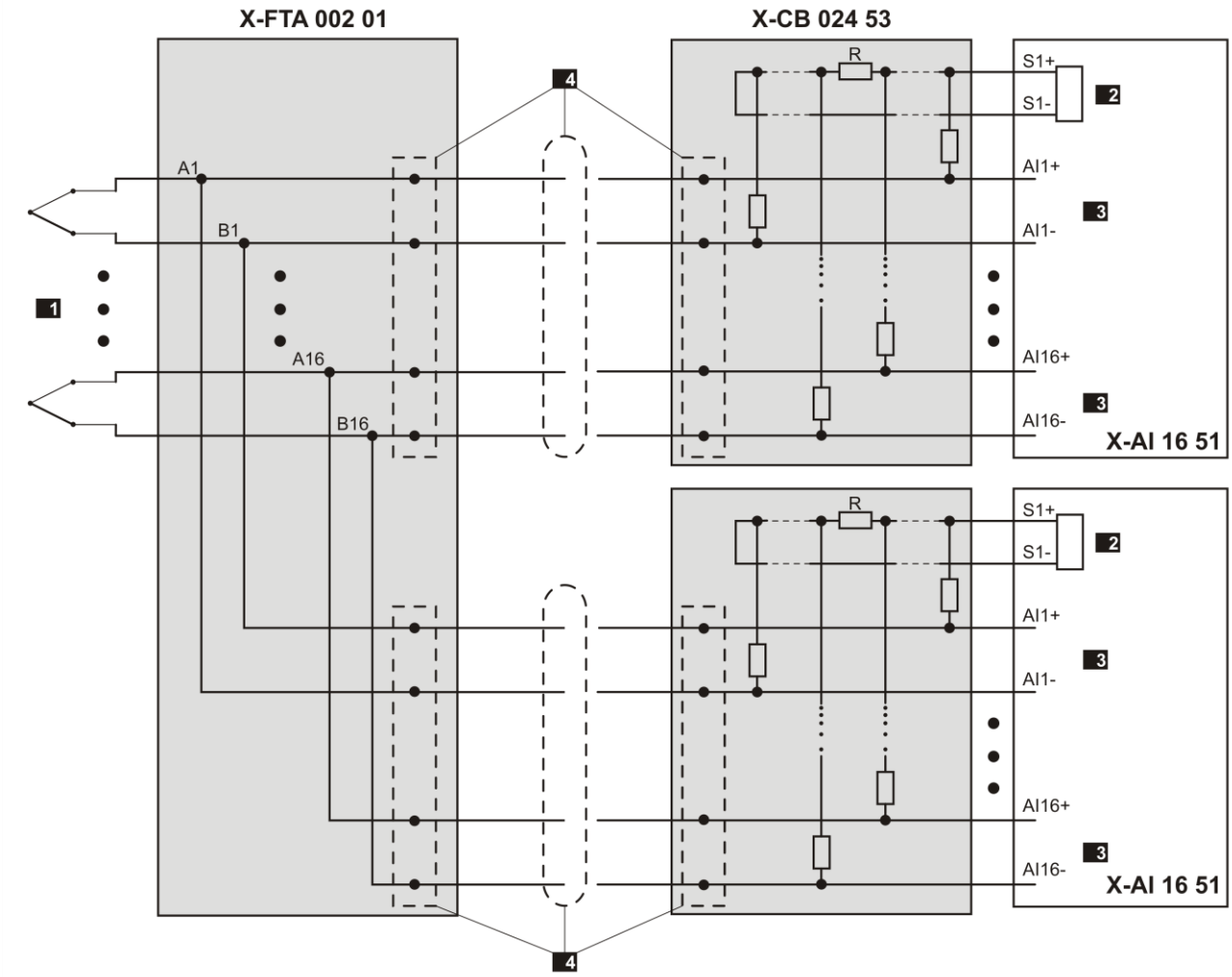
1 Thermocouple 2 Analog input

Figure 23: Three-Fold Redundant Wiring of Three-Fold Redundant Thermocouples

4.5.5 Connection of Thermocouples via X-FTA 002 02 and X-CB 024 53

The figure shows the connection of thermocouples via the universal X-FTA 002 02 and the X-CB 024 53 connector board with open-circuit detection function.

System parameter *Current Source 1 On* must be active in SILworX to ensure open-circuit detection via connector board X-CB 024 53.

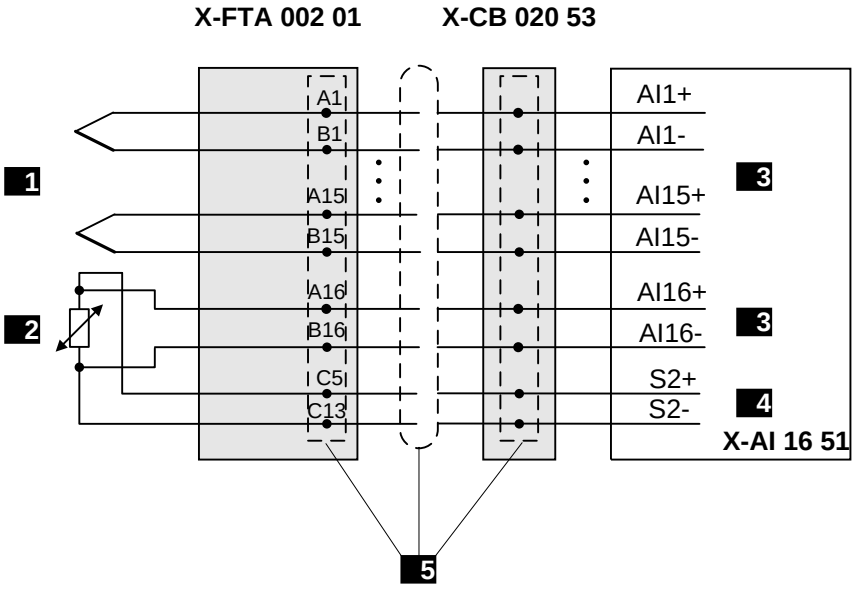


1 Thermocouples (TC)
2 Current source S1
3 Analog inputs
4 System cable with cable plug

Figure 24: Connection of Thermocouples via X-FTA 002 02 and X-CB 024 53

4.5.6 Connection of Thermocouples via X-FTA 002 02 and X-CB 020 53

The figure shows the connection of thermocouples (TC) via the universal X-FTA 002 01 and the X-CB 020 53 connector board, if the open-circuit detection function of thermocouples need not be used. A Pt100 connected to channel 16 is used to compensate the cold junction temperature. It is fed with the current source 2 for the even channels. For further information, refer to the X-FTA manuals.

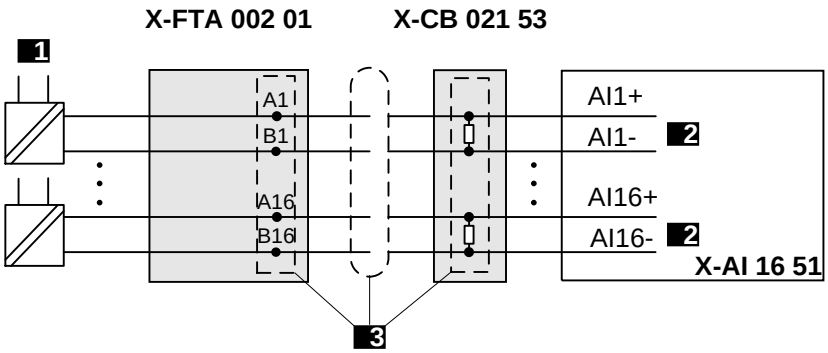


1 Thermocouples (TC)
2 Pt100, cold junction temperature
3 Analog input
4 Current source S2
5 System cable with cable plug

Figure 25: Connection of Thermocouples via X-FTA 002 01

4.5.7 Connection of Sensors via Field Termination Assembly

The figure shows the connection of sensors via the universal X-FTA 002 01:

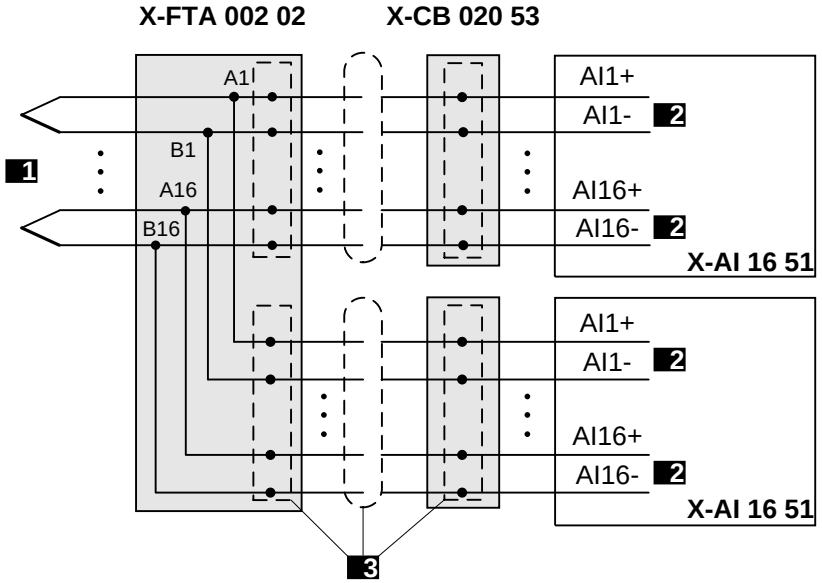


1 Sensors
2 Analog inputs
3 System cable with cable plug

Figure 26: Connection of Sensors via X-FTA 002 01

4.5.8 Redundant Connection of Thermocouples via X-FTA 002 02

The following figure shows the redundant connection of thermocouples (TC) via the universal X-FTA 002 02 and the X CB 020 53 connector board, if the open-circuit detection function of thermocouples need not be used.



1 Thermocouples
2 Analog inputs
3 System cable with cable plug

Figure 27: Redundant Connection of Thermocouples via X-FTA 002 02

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 3.4.4.

The diagnostic history of the module can also be read out using SILworX. Chapter 4.4.4 and Chapter 4.4.5 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

Applicable Thermocouples

TC type	Matching	Input voltage	Temperature range	Tolerance 25 °C	Tolerance (0…60 °C)
E	CrNi/CuNi	-9.063…+76.373 mV	-210…-150 °C -150…0 °C 0…1000 °C	± 3.1 °C ± 2 °C ± 1.3 °C	± 4.5 °C ± 2.8 °C ± 2.3 °C
Y	Fe/CuNi	-8.095…+69.553 mV	-210…0 °C 0…1200 °C	± 2 °C ± 1.7 °C	± 4.7 °C ± 2.7 °C
K	CrNi/NiAl	-6.035…+54.819 mV	-210…-150 °C -150…+1370 °C	± 3 °C ± 2 °C	± 4.1 °C ± 3.6 °C
T	Cu/CuNi	-5.753…1.003 mV	-210…-160 °C -160…+400 °C	± 2.6 °C ± 1.3 °C	± 4.7 °C ± 2.5 °C
B [1)]	Pt30%Rh/Pt6%Rh	0.092…13.820 mV	150…1820 °C		
R [1)]	Pt13%Rh/Pt	-0.226…+21.003 mV	-50…0 °C 0…1760 °C		
S [1)]	Pt10%Rh/Pt	0.236…18.609 mV	-50…0 °C 0…1760 °C		

1) Not released for use with X-AI 16 51! The results provided by the measured values are not sufficiently accurate.

Table 25: Thermocouple Tolerances

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

Index of Figures

Index of Tables

Index

MANUAL
X-AI 16 51

HI 801 179 E

For further information, please contact:

HIMA Paul Hildebrandt GmbH
Albert-Bassermann-Str. 28
68782 Brühl, Germany

Phone: +49 6202 709-0
Fax +49 6202 709-107
E-mail: info@hima.com

Learn more about HIMax online:

https://www.hima.com/en/products-services/himax/

www.hima.com