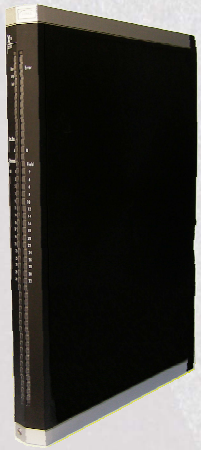


HIMax®

Digital Output Module Manual

SAFETY NONSTOP

HIMA

X-DO 24 01

8

Contact

HIMA Address

HIMA Paul Hildebrandt GmbH + Co KG

P.O. Box 1261

68777 Brühl, Germany

Phone: +49 6202 709-0

Fax: +49 6202 709-107

E-mail: info@hima.com

Revision index	Revisions	Type of Change	
		technical	editorial
4.00	New edition for SILworX V4	X	X

Table of Contents

1 Introduction

The present 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 is organized in the following main chapters:

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

Additionally, the following documents must be taken into account:

Name	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 Communication manual	Description of communication and protocols	HI 801 101 E
SILworX Online Help (OLH)	Instructions on how to use SILworX	-
First Steps	Introduction to SILworX	HI 801 103 E

Table 1: Additional Relevant Manuals

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

1.2 Target Audience

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

1.3 Formatting Conventions

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

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

Safety notes and operating tips are particularly marked.

1.3.1 Safety Notes

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

- Signal word: danger, warning, caution, notice
- Type and source of danger
- Consequences arising from the danger
- Danger prevention

⚠ SIGNAL WORD

Type and source of danger!
Consequences arising from the danger
Danger prevention

The signal words have the following meanings:

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

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 corresponding to the additional information is located here.

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

2 Safety

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

This product is operated in accordance with SELV or PELV. No imminent danger results from the module itself. The use in Ex-Zone is 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

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

Table 2: Environmental Requirements

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

2.1.2 ESD Protective Measures

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

NOTE

Device damage due to electrostatic discharge!

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

2.2 Residual Risk

No imminent danger results from a HIMax module itself.

Residual risk may result from:

- Faults in the engineering
- Faults in the user program
- Faults in the wiring

2.3 Safety Precautions

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

2.4 Emergency Information

A HIMax controller is a part of the safety equipment of a system. If the controller fails, the system adopts the safe state.

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

3 Product Description

The X-DO 24 01 digital output module is intended for use in the programmable electronic system (PES) HIMax.

The module can be inserted in any of the base plate slots with the exception of the slots reserved for system bus modules. For more information, refer to the System Manual (HI 801 001 E).

The module is equipped with 24 digital outputs that can be loaded with a nominal current of up to 0.5 A per channel. The supply voltage minus internal voltage drop is present on the outputs.

The outputs are suitable for connecting ohmic, inductive and capacitive loads and lamps.

The module has been certified by the TÜV for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061), Cat. 4 (EN 954-1) and PL e (EN ISO 13849-1).

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.

3.1 Safety Function

The module ensures its safety function using three safety switches connected in series for each channel. This ensures that each output is two-fault-tolerant with respect to the safety switch. Each safety switch of a channel can be individually switched off either via the system bus (I/O bus) or via the second independent shutdown function (watchdog).

The safe output state is the de-energized state. Redundant processor systems monitor the values expected for the outputs. Outputs that do not correspond to the expected values are reset. One of the two read-back branches that were monitored for their expected values can be tested.

The safety function is performed in accordance with SIL 3.

3.1.1 Reaction in the Event of a Fault

If a fault is detected, the module adopts the safe state and all the outputs are de-energized in accordance with the 'de-energize to trip principle'. If a channel fault occurs, only the corresponding output is switched off; if a module fault occurs, all module outputs are switched off.

If the system bus fails, the outputs are de-energized.

The module activates the *Error* LED on the front plate.

3.2 Scope of Delivery

The module must be installed on a suitable connector board to be able to operate. If a FTA is used, a system cable is required to connect the connector board to the FTA. Connector boards, system cables and FTAs are not included within the scope of delivery.

The connector boards are described in Chapter 3.6, the system cables are described in Chapter 3.7. The FTAs are described in own 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.)
- Software revision index (SW Rev.)
- Operating voltage (Power)
- Ex specifications (if applicable)
- Production year (Prod-Year:)

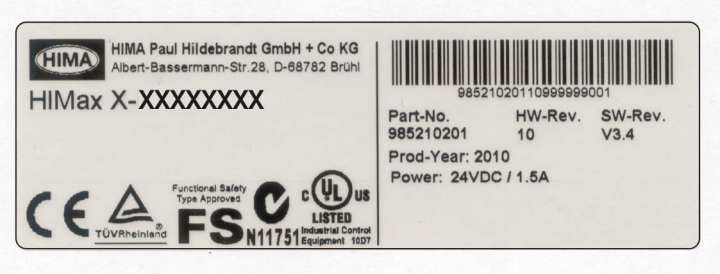


Figure 1: Sample Type Label

3.4 Structure

The module is equipped with 24 digital outputs. The outputs are not electrically isolated from one another and from the voltage supply.

The module comes with line monitoring (SC/OC). If the open-circuit monitoring is configured in SILworX, see Chapter 4.3, the channels are automatically checked for open-circuits (OC) and short-circuits (SC).

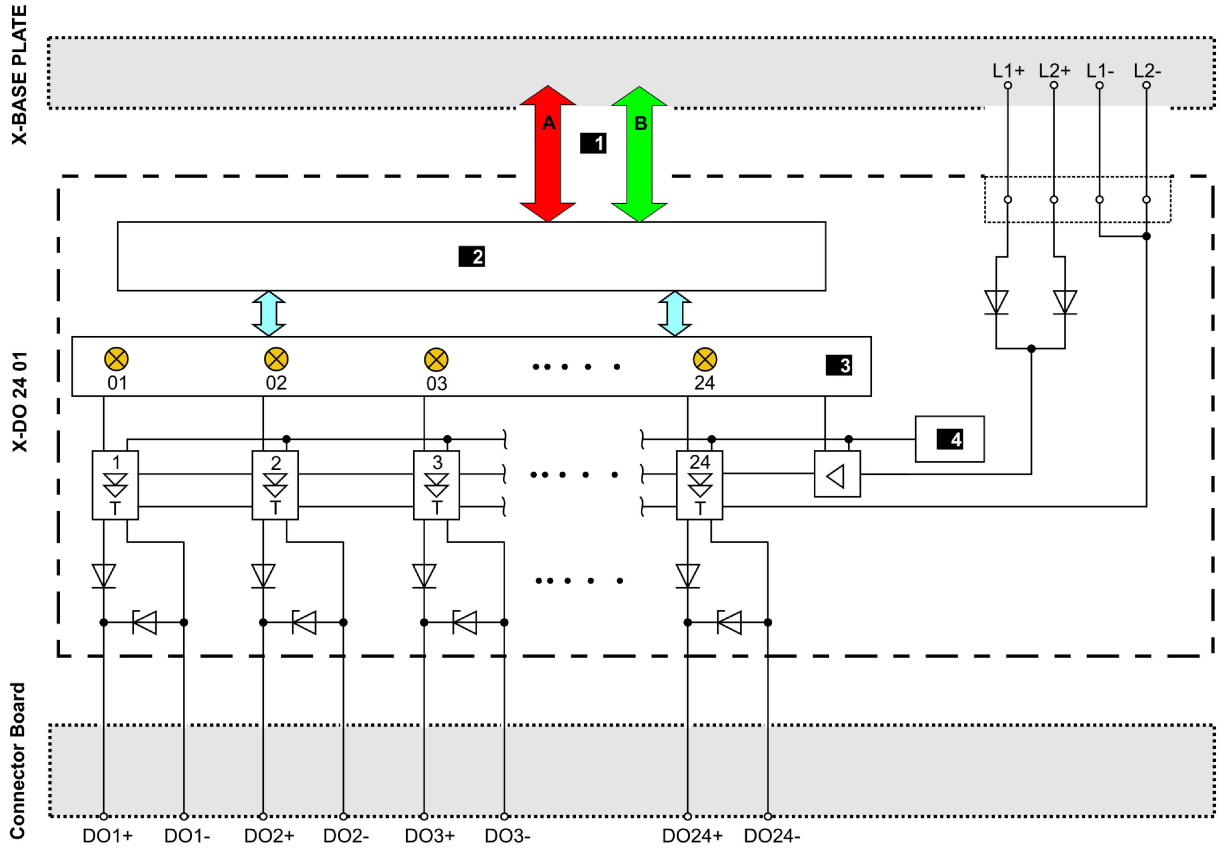
The outputs are protected against overload. If an overload is detected, the corresponding output is switched off and switched on again after five seconds. If the overload is still present, the output is switched off again for five seconds. This process is repeated as long as the overload is present.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

The safety-related 1oo2 processor system for the I/O module controls and monitors the I/O level. The data and states of the I/O module are made available 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 digital outputs, see Chapter 3.4.2.

3.4.1 Block Diagram

The following block diagram illustrates the structure of the module.



1 System Busses
2 Safety-Related Processor System
3 Interface
4 Watchdog

Figure 2: Block Diagram

3.4.2 Indicators

The following figure shows the LED indicators for the module.

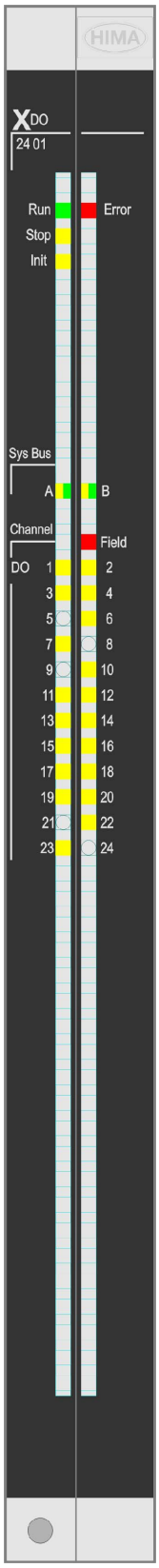


Figure 3: Indicators

The LEDs indicate the operating state of the output module.

The LEDs on the module are divided into three groups:

- Module status indicators (Run, Error, Stop, Init)
- System bus indicators (A, B)
- I/O indicators (DO 1...24, Field)

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

Definition of Blinking Frequencies

The following table defines the blinking frequencies of the LEDs:

Name	Blinking Frequencies
Blinking1	Long (approx. 600 ms) on, long (approx. 600 ms) off
Blinking2	Short (approx. 200 ms) on, short (approx. 200 ms) off, short (approx. 200 ms) on, long (approx. 600 ms) off
Blinking-x	Ethernet communication: Flashing in sync with data transfer

Table 3: Blinking Frequencies of LEDs

3.4.3 Module Status Indicators

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

LED	Color	Status	Description
Run	Green	On	Module in RUN, normal operation
		Blinking1	Module state: STOP/OS_DOWNLOAD or OPERATE (only with processor modules)
		Off	Module not in RUN, observe the other status LEDs
Error	Red	On/Blinking1	Internal module faults detected by self-tests, e.g., hardware, software or voltage supply. Fault while loading the operating system
		Off	Normal operation
Stop	Yellow	On	Module state: STOP / VALID CONFIGURATION
		Blinking1	Module state: STOP / INVALID CONFIGURATION or STOP / OS_DOWNLOAD
		Off	Module not in STOP, observe the other status LEDs
Init	Yellow	On	Module state: INIT, observe the other status LEDs
		Blinking1	Module state: LOCKED, observe to the other status LEDs
		Off	Module state: neither INIT nor LOCKED, observe the other status LEDs

Table 4: Module Status Indicators

3.4.4 System Bus Indicators

The system bus 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 5: System Bus Indicators

3.4.5 I/O Indicators

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

LED	Color	Status	Description
Channel 1…24	Yellow	On	The related channel is active (energized).
		Blinking2	The related channel is faulty.
		Off	The related channel is inactive (de-energized).
Field	Red	Blinking2	Field fault on at least one channel, e.g., open-circuit, short-circuit, over-current, etc.
		Off	No field fault displayed!

Table 6: I/O Indicators

3.5 Product Data

General	
Supply voltage	24 VDC, -15 %...+20 %, $r_P \leq 5$ % PELV, SELV
Current input	min. 0.5 A (idle)
Continuous load	max. 12 A at 24 VDC
Electrical isolation	No
Operating temperature	0…+60 °C
Storage temperature	-40…+85 °C
Humidity	max. 95 % relative humidity, non-condensing
Type of protection	IP20
Dimensions (H x W x D)	310 x 29.2 x 230 mm
Weight	approx. 1.0 kg

Table 7: Product Data

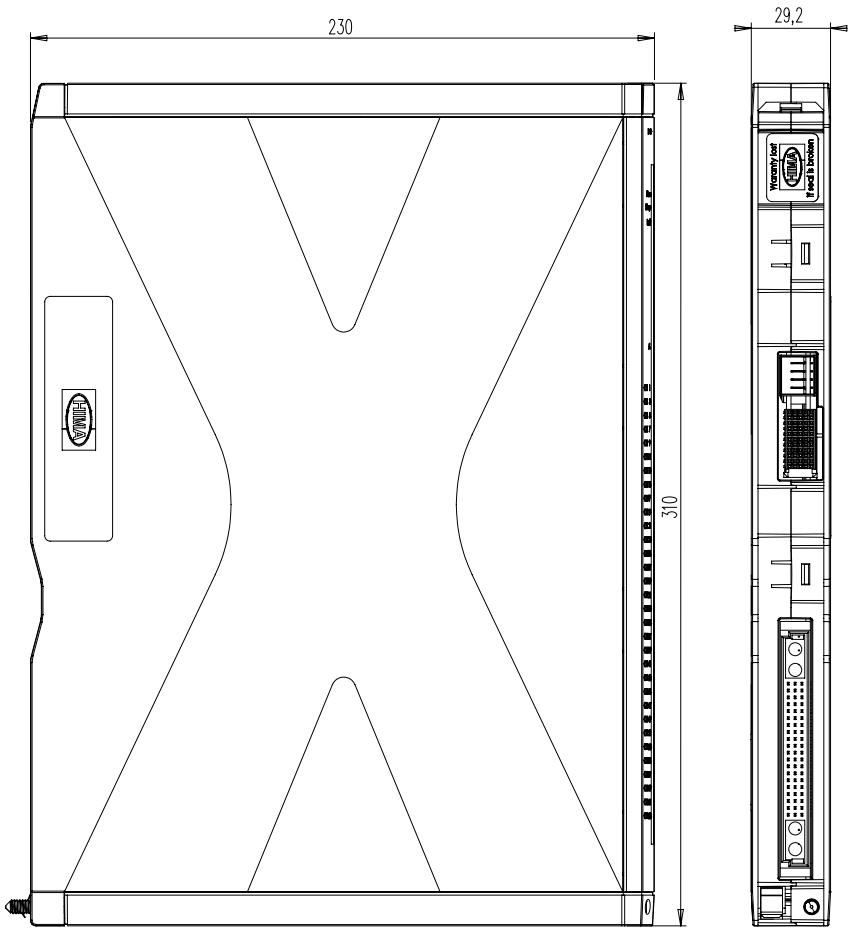


Figure 4: Views

Digital Outputs	
Number of outputs (number of channels)	24, non-electrically isolated
Output voltage	≥ L+ minus internal voltage drop
Voltage drop (with high level)	0.8 V at 0.75 A output current
Nominal rated current (with high level)	0.5 A, range 0.01...0.6 A
Total current permitted for the module	12 A
Leakage current (with low level)	max. 500 µA
Current limiting in the event of short-circuit	approx. 2 A, each channel
Overcurrent interruption	I > 0.75 A for t > 50 ms
Ohmic load	To nom. rated current 0.5 A
Inductive load	max. 50 H
Lamp load (24 V lamps)	max. 4 W
Capacitive load	max. 100 µF
Line monitoring	
OC Limit	≤ 4 mA
SC Limit	> 0.75 A (range 0.75...0.8 A)
Overload protection of the outputs, transient	33 V (max. 43 V)
Switching time of the channels (with ohmic load)	100 µs
Test impulse (with ohmic load)	typ. 200 µs
Behavior upon overload	The affected output is switched off and re-started cyclically.

Table 8: Specifications for the Digital Outputs

3.6 Connector Boards

A connector board connects the module to the field zone. Module and connector board form together 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 009 01	Connector board with screw terminals
X-CB 009 02	Redundant connector board with screw terminals
X-CB 009 03	Connector board with cable plug
X-CB 009 04	Redundant connector board with cable plug
X-CB 009 06	Three-fold redundant connector board with screw terminals
X-CB 009 07	Three-fold redundant connector board with cable plug

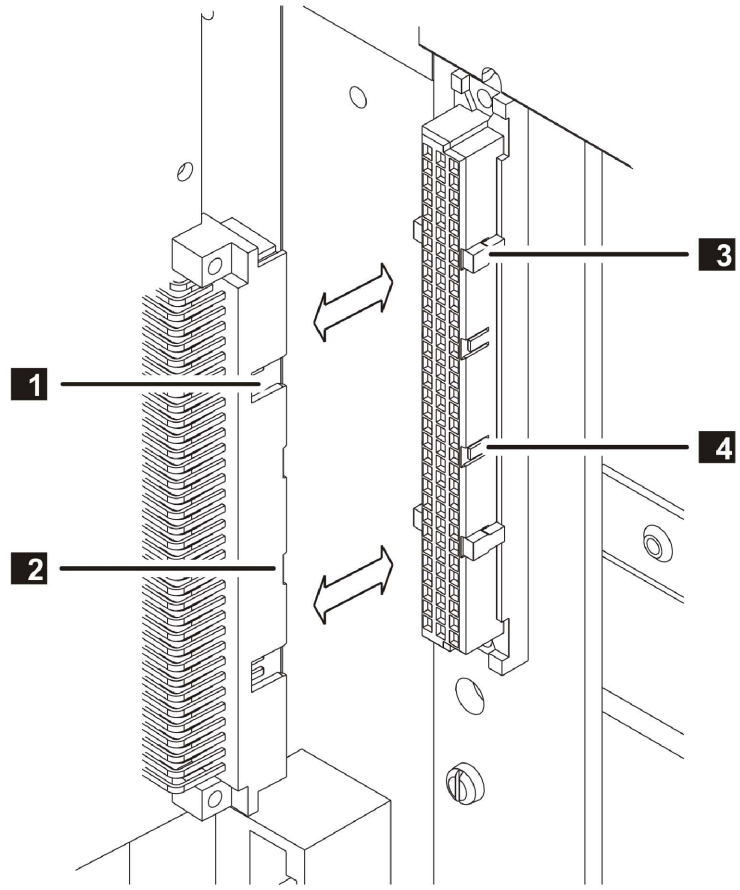
Table 9: Available Connector Boards

3.6.1 Mechanical Coding of Connector Boards

I/O modules and connector boards are mechanically coded starting from hardware revision AS10 to prevent them from being equipped with improper I/O modules. Coding avoids incorrect installation of improper I/O modules thus preventing negative effects on redundant modules and field zone. A part from that, improper equipment has no effect on the HIMax system since only I/O modules that are correctly configured in SILworX enter the RUN state.

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

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



1 Male Connector Recess
2 Prepared Male Connector Recess
3 Coding Wedge
4 Guideway for Coding Wedge

Figure 5: Coding Example

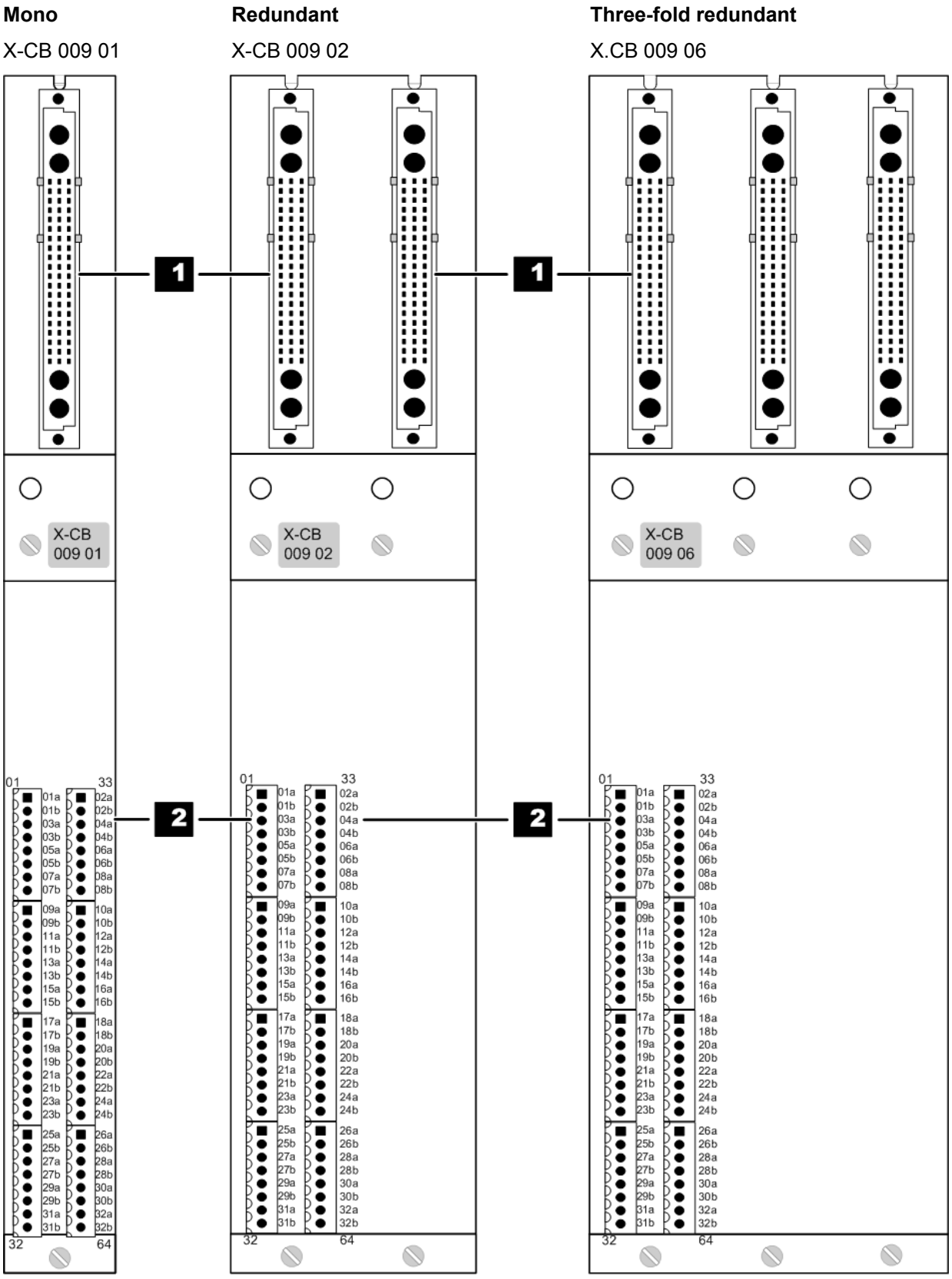
Coded I/O modules can be plugged in to uncoded connector boards. Uncoded I/O modules cannot be plugged in to coded connector boards.

3.6.2 Coding of X-CB 009 Connector Boards

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

Table 10: Position of Coding Wedges

3.6.3 Connector Boards with Screw Terminals



1 I/O Module Plug

2 Connection to the Field Zone (Screw Terminal Connector Block)

Figure 6: Connector Boards with Screw Terminals

3.6.4 Terminal Assignment for Connector Boards with Screw Terminals

Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	01a	DO1+	1	02a	DO2+
2	01b	DO1-	2	02b	DO2-
3	03a	DO3+	3	04a	DO4+
4	03b	DO3-	4	04b	DO4-
5	05a	DO5+	5	06a	DO6+
6	05b	DO5-	6	06b	DO6-
7	07a	DO7+	7	08a	DO8+
8	07b	DO7-	8	08b	DO8-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	09a	DO9+	1	10a	DO10+
2	09b	DO9-	2	10b	DO10-
3	11a	DO11+	3	12a	DO12+
4	11b	DO11-	4	12b	DO12-
5	13a	DO13+	5	14a	DO14+
6	13b	DO13-	6	14b	DO14-
7	15a	DO15+	7	16a	DO16+
8	15b	DO15-	8	16b	DO16-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	17a	DO17+	1	18a	DO18+
2	17b	DO17-	2	18b	DO18-
3	19a	DO19+	3	20a	DO20+
4	19b	DO19-	4	20b	DO20-
5	21a	DO21+	5	22a	DO22+
6	21b	DO21-	6	22b	DO22-
7	23a	DO23+	7	24a	DO24+
8	23b	DO23-	8	24b	DO24-
Pin no.	Designation	Signal	Pin no.	Designation	Signal
1	25a	Not used!	1	26a	Not used!
2	25b	Not used!	2	26b	Not used!
3	27a	Not used!	3	28a	Not used!
4	27b	Not used!	4	28b	Not used!
5	29a	Not used!	5	30a	Not used!
6	29b	Not used!	6	30b	Not used!
7	31a	Not used!	7	32a	Not used!
8	31b	Not used!	8	32b	Not used!

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 zone.

The cable plugs feature the following properties:

Connection to the field zone	
Cable plugs	8 pieces, with 8 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 Properties

3.6.5 Connector Boards with Cable Plug

Mono

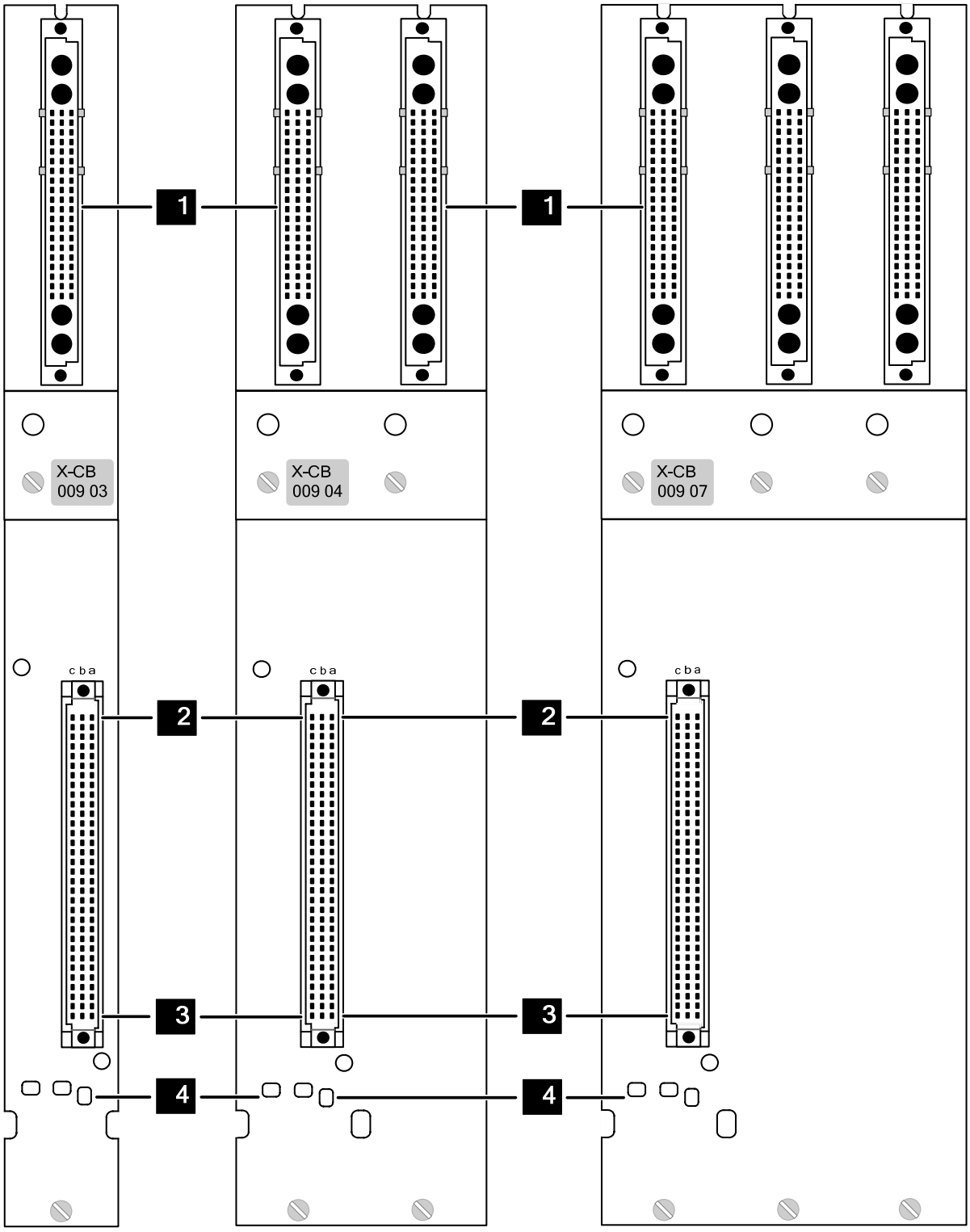
X-CB 009 03

Redundant

X-CB 009 04

Three-fold redundant

X-CB 009 07



1 I/O Module Plug

2 Connection to the Field Zone (Cable Plug in Row 1)

3 Connection to the Field Zone (Cable Plug in Row 32)

4 Coding for Cable Plugs

Figure 7: Connector Boards with Cable Plug

3.6.6 Pin Assignment for Connector Boards with Cable Plug

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

Connector pin assignment!

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

Lead marking based on DIN 47100:

Pin Assignment						
Row	c		b		a	
	Signal	Color	Signal	Color	Signal	Color
1	DO32+	Not used	DO32-	Not used	Reserved	RD **
2	DO31+	Not used	DO31-	Not used	Reserved	BU **
3	DO30+	Not used	DO30-	Not used	Reserved	PK **
4	DO29+	Not used	DO29-	Not used	Reserved	GY **
5	DO28+	Not used	DO28-	Not used	Not used	
6	DO27+	Not used	DO27-	Not used	Not used	
7	DO26+	Not used	DO26-	Not used	Not used	
8	DO25+	Not used	DO25-	Not used	Not used	
9	DO24+	YE *	DO24-	GN *	Not used	
10	DO23+	BN *	DO23-	WH *	Not used	
11	DO22+	RD-BK	DO22-	BU-BK	Not used	
12	DO21+	PK-BK	DO21-	GY-BK	Not used	
13	DO20+	PK-RD	DO20-	GY-RD	Not used	
14	DO19+	PK-BU	DO19-	GY-BU	Not used	
15	DO18+	YE-BK	DO18-	GN-BK	Not used	
16	DO17+	YE-RD	DO17-	GN-RD	Not used	
17	DO16+	YE-BU	DO16-	GN-BU	Not used	
18	DO15+	YE-PK	DO15-	PK-GN	Not used	
19	DO14+	YE-GY	DO14-	GY-GN	Not used	
20	DO13+	BN-BK	DO13-	WH-BK	Not used	
21	DO12+	BN-RD	DO12-	WH-RD	Not used	
22	DO11+	BN-BU	DO11-	WH-BU	Not used	
23	DO10+	PK-BN	DO10-	WH-PK	Not used	
24	DO9+	GY-BN	DO9-	WH-GY	Not used	
25	DO8+	YE-BN	DO8-	WH-YE	Not used	
26	DO7+	BN-GN	DO7-	WH-GN	Not used	
27	DO6+	RD-BU	DO6-	GY-PK	Not used	
28	DO5+	VT	DO5-	BK	Not used	
29	DO4+	RD	DO4-	BU	Not used	
30	DO3+	PK	DO3-	GY	Not used	
31	DO2+	YE	DO2-	GN	Not used	
32	DO1+	BN	DO1-	WH	Not used	

*) Additional orange ring if one lead marking color is repeated.

**) Lead marking 2 x 2 x 0.14 mm² (system cable: X-CA 010).

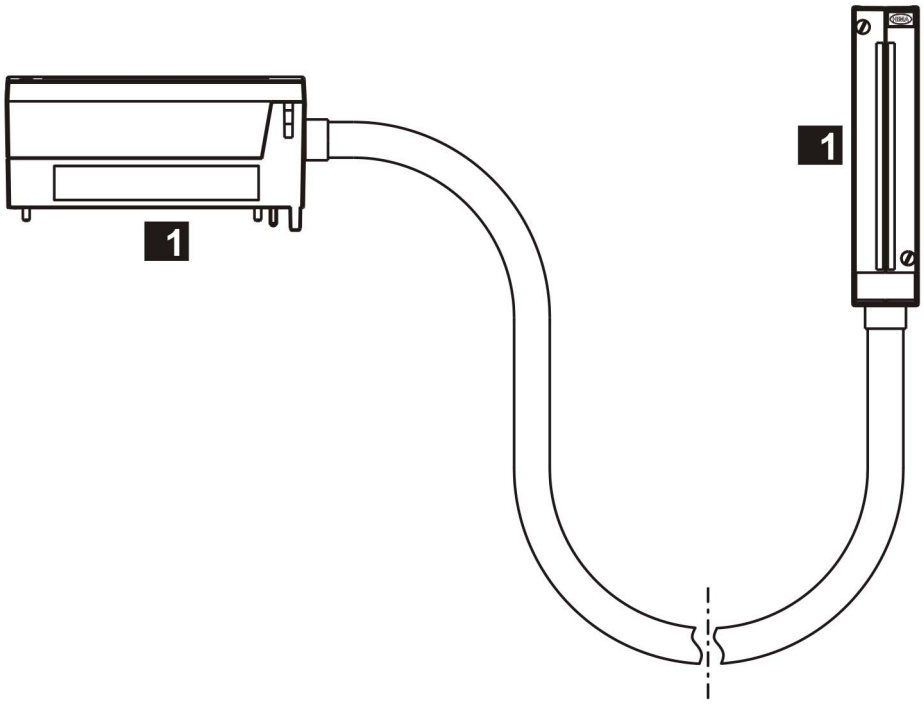
Table 13: Pin Assignment for the System Cable Plug

3.7 System Cable X-CA 010

The X-CA 010 system cable is used to wire the X-CB 009 03/04/07 connector board with the field zone via field termination assemblies. To connect the module to the FTA, the X-CA 006 system cable can also be used, see the X-DO 32 01 Manual.

General	
Cable	LIYY 48 x 0.5 mm² + 2 x 2 x 0.14 mm²
Wire	Finely stranded
Average outer diameter (d)	approx. 15.7 mm
Minimum bending radius Fixed laying Flexible application	 5 x d 10 x d
Combustion behavior	flame resistant and self-extinguishing in accordance with IEC 60332-1-2, -2-2
Length	8…30 m
Color coding	Based on DIN 47100, see Table 13.

Table 14: Cable Data



1 Identical Cable Plugs

Figure 8: X-CA 010 01 n

The system cable is available in the following standard variants:

System Cable	Description	Length
X-CA 010 01 8	Coded cable plugs on both sides	8 m
X-CA 010 01 15		15 m
X-CA 010 01 30		30 m

Table 15: Available System Cables

3.7.1 Cable Plug Coding

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

4 Start-up

This chapter describes how to install, configure and connect the module. For more information, refer to the Safety Manual (HI 801 003 E).

i The safety-related application (SIL 3 in accordance with IEC 61508) of the outputs and the actuators connected must comply with the safety requirements. For more information, refer to the HIMax Safety Manual.

4.1 Mounting

Observe the following points when mounting the module:

- Only operate the module with the appropriate fan components. For more information, see the System Manual (HI 801 001 E).
- Only operate the module with the suitable connector board. For more information, see Chapter 3.6.
- Connection to the field zone with twisted pair wire
- The module and its connected components must be mounted to provide protection of at least IP20 in accordance with EN 60529: 1991 + A1: 2000.
- The outputs may be wired redundantly using the corresponding connector boards. For more information, see Chapters 3.6 and 4.5.

4.1.1 Wiring Outputs not in Use

Outputs that are not being used may stay open and need not be terminated. To prevent short-circuits and sparks in the field zone, never connect a wire to a connector board if it is open on the field side.

4.2 Mounting and Removing the Module

When replacing an existing module or mounting a new one, follow the instructions given in this chapter.

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

4.2.1 Mounting a Connector Board

Tools and utilities

- Screwdriver, 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 figure). Fit the groove into the guiding rail pin.
2. Place the connector board on the cable shield rail.
3. Secure the two captive screws to the base plate. First screw in the lower than the upper screw.

To remove the connector board

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

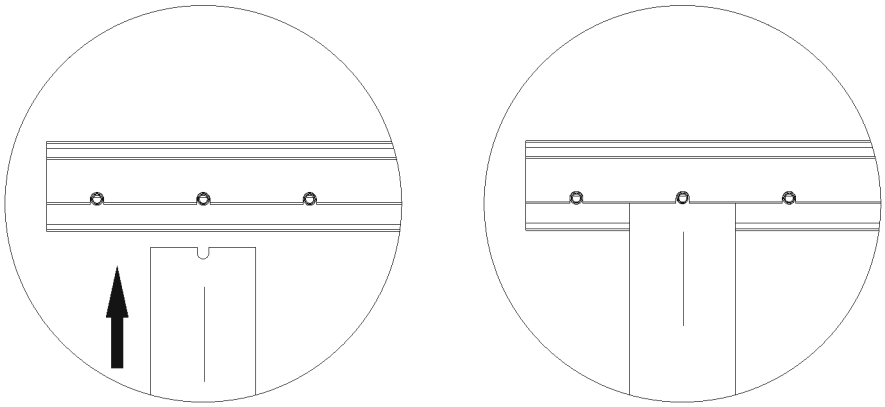


Figure 9: Inserting the Connector Board

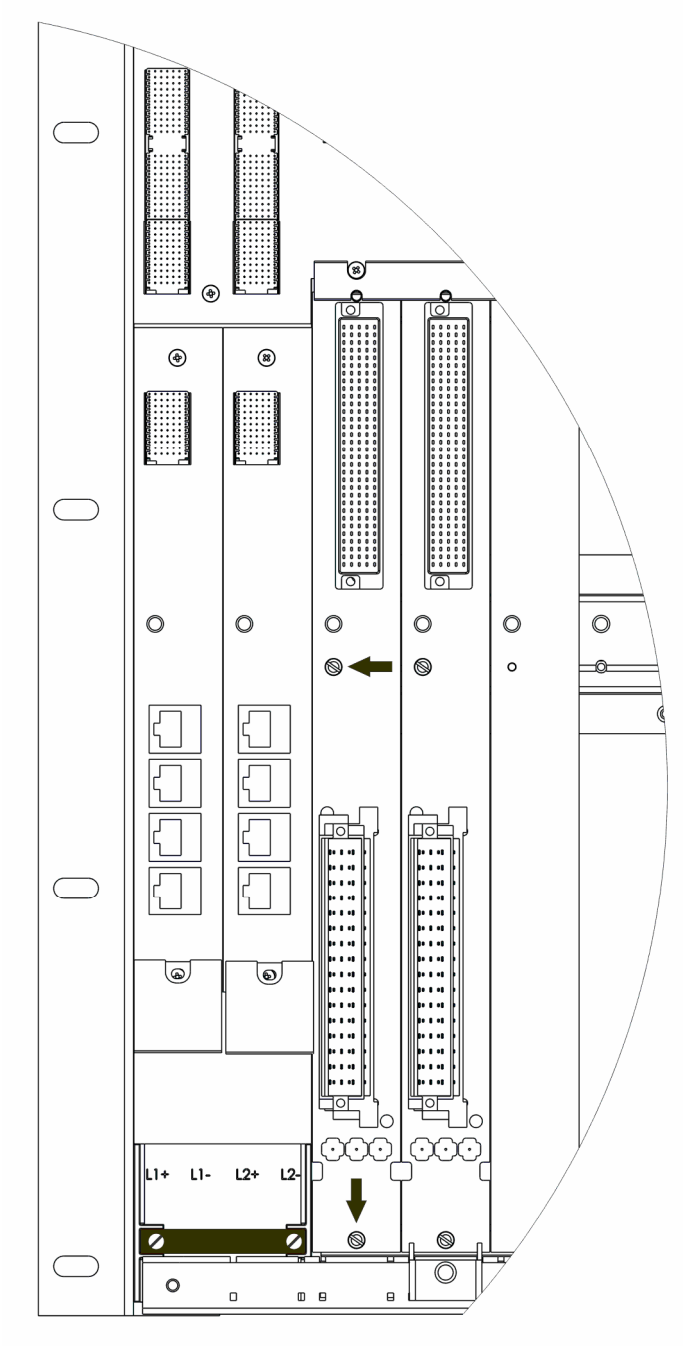


Figure 10: Securing the Connector Board with Captive Screws

4.2.2 Mounting and Removing the 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 observe this can damage the controller.

Always take care when inserting the module in the base plate.

Tools and utilities

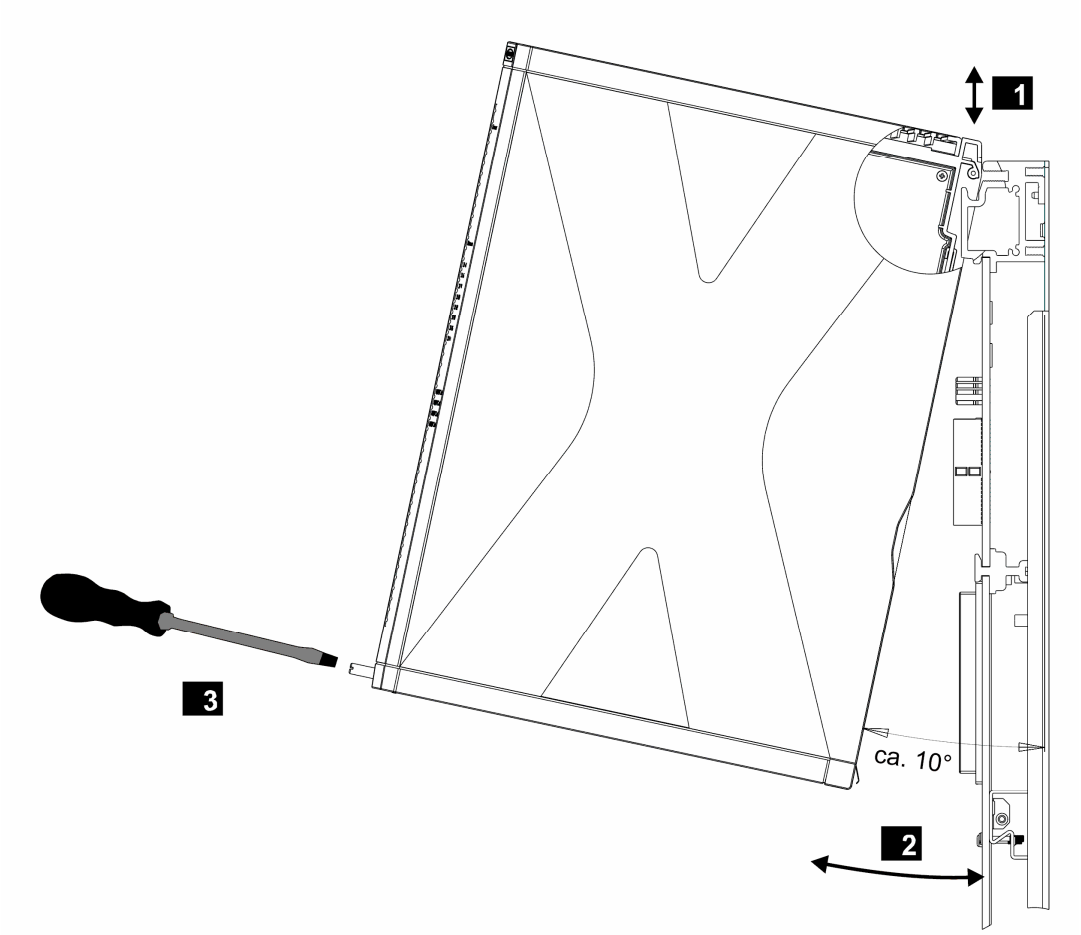
- Screwdriver, slotted 0.8 x 4.0 mm
- Screwdriver, slotted 1.2 x 8.0 mm

Installation

1. Open the cover plate on the fan rack:
   ☑ Move the locks to the *open* position.
   ☑ Lift the cover plate and insert 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.

Removal

1. Open the cover plate on the fan rack:
   ☑ Move the locks to the *open* position.
   ☑ Lift the cover plate and insert into the fan rack
2. Release the screw **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 a Module in and out
3 Securing and Releasing a Module

Figure 11: Mounting and Removing a Module

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

4.3 Line monitoring (SC/OC)

Line monitoring consists of monitoring for both short-circuits and open-circuits (SC/OC monitoring) and can be configured for each channel. The switching thresholds for line monitoring are predefined (see Table 8)

The following points must be taken into account for line monitoring (SC/OC):

- Line monitoring reliably detects an open-circuit (OC) if a load with current input of at least 10 mA is connected.
- If an actuator is redundantly connected to two modules, line monitoring reliably detects an open-circuit (OC) if a load with current input of at least 20 mA is connected.
- Line monitoring reliably detects a short-circuit (SC) when currents exceed 0.8 A.
- If an actuator is redundantly connected to two modules, line monitoring reliably detects a short-circuit (SC) when currents exceed 1.6 A.

Line monitoring (OC/SC) can be configured for each channel as follows:

- In the **I/O Submodule DO24_01** tab, adopt the setting *SC/OC Interval* (**≥ 40 ms**) for all channels
- In the **I/O Submodule DO24_01: Channels**, activate *SC/OC active*,
  Default setting: Activated
- In the **I/O Submodule DO24_01: Channels**, *max. Test Pulse Duration* 0 µs...50 ms, if *SC/OC active* (**activated**)

4.3.1 Recommended Values for Line Monitoring

Test Impulse Duration	SC/OC Interval	Relationship
200 µs	40 ms	0.5 %
1 ms	200 ms	0.5 %
10 ms	2 s	0.5 %
20 ms	4 s	0.5 %
50 ms	10 s	0.5 %

Table 16: Relationship between Test Impulse Duration and SC/OC Interval

For actuators, a pulse-duty factor of 0.5 % between the SC/OC interval and the test impulse duration has provided good results in practice. The value for the test impulse duration must always be lower than the value for the SC/OC interval.

If line monitoring is not functioning properly, a short-circuit or an open-circuit is indicated. Line monitoring does not affect the *Channel OK*, *Submodule OK* and *Module OK* statuses, see Chapter 4.4.

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 more information on the statuses and parameters, refer to the tables starting with Chapter 4.4.1.
- 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 statuses from within the user program, connect the module statuses to global variables. Perform this step in the Hardware Editor using the module's detail view.

The following tables present the statuses and parameters for the module in the same order given in the SILworX Hardware Editor.

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

4.4.1 Tab: Module

The **Module** tab contains the systemparameters for the module:

Name		R/W	Description
Enter these statuses and parameters directly in the Hardware Editor.			
Name		W	Module name
Spare Module		W	Activated: The module missing in the redundancy group is not considered as a fault. Deactivated: The module missing in the redundancy group is considered as a fault. Default setting: Deactivated **It is only displayed in the redundancy group tab!**
Noise Blanking		W	Noise blanking performed by processor module allowed (activated/deactivated). Default setting: Activated Status acknowledgments are suppressed until the safety time. The user program retains its last valid process value.
Name	Data type	R/W	Description
The following statuses and parameters can be assigned global variables and used in the user program.			
Module OK	BOOL	R	TRUE: Mono operation: No module faults. Redundant operation: At least one of the redundant modules is faultless (OR logic). FALSE: Module fault Channel fault (no external faults) The module is not plugged in. Observe the *Module Status* parameter!
Module Status	DWORD	R	Bit-coded module status
Timestamp [µs]	DWORD	R	Microsecond fraction of the timestamp. Point in time at which the digital outputs were measured.
Timestamp [s]	DWORD	R	Second fraction of the timestamp. Point in time at which the digital outputs were measured.

Coding	Description
0x00000001	Module fault [1]
0x00000002	Temperature threshold 1 exceeded
0x00000004	Temperature threshold 2 exceeded
0x00000008	Incorrect temperature value
0x00000010	Voltage L1+ is defective
0x00000020	Voltage 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.

Table 17: Module Tab in the Hardware Editor

4.4.2 Tab: I/O Submodule DO24_01

The **I/O Submodule DO24 01** tab contains the following systemparameters:

Name		R/W	Description
Enter these statuses and parameters directly in the Hardware Editor.			
Name		W	Module name
Output Noise Blanking		W	Allow output noise blanking performed by the output module (activated/deactivated). Default setting: Deactivated (**recommended!**) If a discrepancy exists between the channel's default and read-back values, the channel switch-off is suppressed.
SC/OC Interval [µs]		W	SC/OC interval of test impulse (≥ 40 ms) Default setting: 40 000 = 40 ms See Chapter 4.3
Show Open-Circuit		W	Display via LED *Field* (activated/deactivated) Default setting: Activated
Show Short-Circuit		W	Display via LED *Field* (activated/deactivated) Default setting: Activated
Name	Data type	R/W	Description
The following statuses and parameters can be assigned global variables and used in the user program.			
Diagnostic Request	DINT	W	To request a diagnostic value, the appropriate ID must be sent to the module using the parameter *Diagnostic Request* (see Chapter 4.4.5 for coding details).
Diagnostic Response	DINT	R	As soon as *Diagnostic Response* returns the ID of *Diagnostic Request* (see 4.4.5 for coding details), *Diagnostic Status* contains the diagnostic value requested.
Diagnostic Status	DWORD	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	R	TRUE: Background test is faulty FALSE: Background test is free of faults
Restart on Error	BOOL	W	Using the parameter *Restart on Error*, each I/O module that has switched off permanently due to faults can be forced to re-adopt the RUN state. To do this, set the *Restart on Error* parameter 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	R	TRUE: No submodule fault, no channel faults FALSE: Submodule fault. Channel fault (external faults included)
Submodule Status	DWORD	R	Bit-coded submodule status (For coding details, see Chapter 4.4.4)

Table 18: Tab: I/O Submodule DO24_01 in the Hardware Editor

4.4.3 Tab: I/O Submodule DO24_01: Channels

The **I/O Submodule DO24_01: Channels** tab contains the following system parameters for each digital output.
Global variables can be assigned to the systemparameters with **->** and used in the user program. The value without **->** must be directly entered.

Name	Data type	R/W	Description
Channel no.	---	R	Channel number
Channel value [BOOL] ->	BOOL	R	Binary value in accordance with the switching level LOW (dig) and HIGH (dig). TRUE: Channel energized FALSE: Channel de-energized
-> Channel OK	BOOL	R	TRUE: Faultless channel The channel value is valid FALSE: Faulty channel The channel is de-energized
SC/OC Active	BOOL	R	Short-circuit and open-circuit monitoring (activated/deactivated) Default setting: Activated
Max. Test Pulse duration [µs]	UDINT	W	Test impulse duration with line monitoring (OC/SC) Range of values: 0…50 000 µs Default setting: 0 µs
-> OC	BOOL	R	TRUE: Open-circuit FALSE: No open-circuit
-> SC	BOOL	R	TRUE: Short-circuit FALSE: No short-circuit
Redund.	BOOL	W	Requirement: One redundant module must be configured. Activated: Activate the channel redundancy for this channel Deactivated: Deactivate the channel redundancy for this channel Default setting: Deactivated

Table 19: Tab: I/O Submodule DO24_01: Channels in the Hardware Editor

4.4.4 Submodule State [DWORD]

Coding of **Submodule State**

Coding	Description
0x00000001	Fault in hardware unit (submodule).
0x00000002	Reset of an I/O bus
0x00000004	Fault detected while configuring the hardware
0x00000008	Fault detected while verifying the coefficients
0x00000010	First temperature threshold exceeded (warning temperature)
0x00000020	Second temperature threshold exceeded (limit temperature)
0x00000040	Overcurrent, module shutdown
0x00000080	Reset of CS monitoring (Chip Select monitoring)
0x00000100	Line monitoring hardware fault
0x00800000	Voltage monitoring of WD1: voltage error
0x01000000	Voltage monitoring of WD2: voltage error
0x02000000	Voltage monitoring of L1+ HIGH voltage defective
0x04000000	Voltage monitoring of L1+ LOW voltage defective
0x08000000	Voltage monitoring of L2+ HIGH voltage defective
0x10000000	Voltage monitoring of L2+ LOW voltage defective
0x20000000	Voltage monitoring of AGND voltage defective
0x40000000	Voltage monitoring of VMOS HIGH voltage defective
0x80000000	Voltage monitoring of VMOS LOW voltage defective

Table 20: Submodule State [DWORD]

4.4.5 Diagnostic Status [DWORD]

Coding of **Diagnostic Status**

<table>
<tr><th>ID</th><th>Description</th></tr>
<tr><td>0</td><td>Diagnostic values (100...1024) 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 Digit/ °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 low voltage (BOOL)</td></tr>
<tr><td>1001…1024</td><td>Status of channels 1...24
<table>
<tr><th>Coding</th><th>Description</th></tr>
<tr><td>0x0001</td><td>Fault in hardware unit (submodule).</td></tr>
<tr><td>0x0002</td><td>Reset of an I/O bus</td></tr>
<tr><td>0x0004</td><td>Overcurrent, channel shutdown</td></tr>
<tr><td>0x0008</td><td>Read-back value 0 on the output with reference value 1, due to hardware fault</td></tr>
<tr><td>0x0010</td><td>Short-circuit detected</td></tr>
<tr><td>0x0020</td><td>Open-circuit detected</td></tr>
<tr><td>0x0040</td><td>Fault
Read back value = 1 at set point = 0</td></tr>
<tr><td>0x0080</td><td>Read back value = 0 at set point = 1
due to a field fault</td></tr>
</table></td></tr>
</table>

Table 21: Diagnostic Information [DWORD]

4.5 Connection Variants

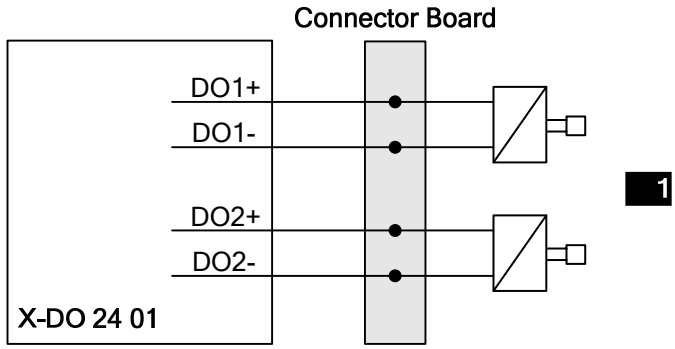
This chapter describes the correct wiring of the module in safety-related applications. The connection variants specified here are permitted.

The outputs are wired via connector boards. Special connector boards are available for redundantly wiring the modules, see Chapter 3.6.

The following points must be taken into account when connecting the loads to the outputs:

- A protective circuit (free-wheeling diode) is required when connecting inductive loads.
- Unshielded, twisted pair cables may be connected.
- The ground wires of the outputs may not be interconnected.

4.5.1 Wiring Actuators



1 Actuators

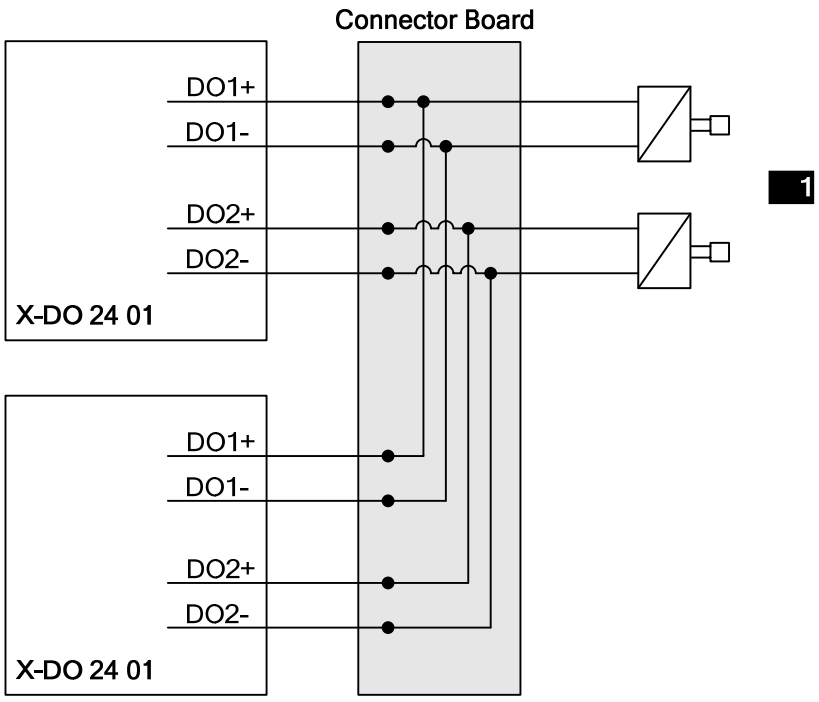
Figure 12: Wiring of the Module with Actuators

NOTICE

The module outputs must be connected with two poles.
The ground wires of actuators may not be interconnected.
The use of common lines can result in interfering coupling loops that may cause the module or the safety shutdown to fail.

4.5.2 Redundant Wiring of Actuators via Two Modules

When actuators are redundantly wired, the general requirements for line monitoring must be observed, see Chapter 4.3.



1 Actuators

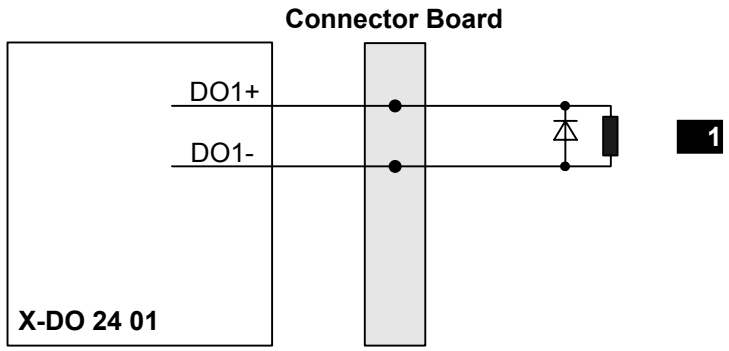
Figure 13: Redundant Wiring of Actuators

NOTICE

The wiring described above is only allowed if both channels have identical channel numbers.

4.5.3 Wiring Inductive Loads

When connecting inductive loads, a protective circuit (such as a suitable free-wheeling diode) must be connected in parallel to the load.

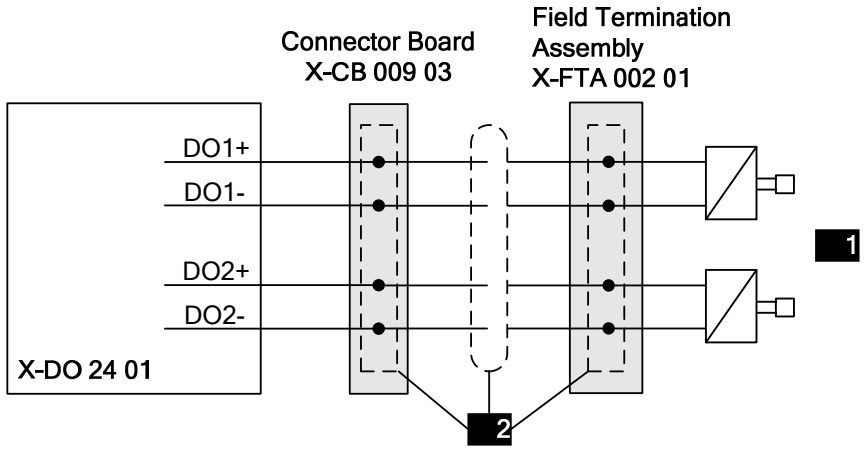


1 Inductive Load

Figure 14: Wiring Inductive Loads

4.5.4 Wiring Actuators via Field Termination Assembly

Actuators are connected via the X-FTA 002 01 as described in Figure 15. For further information, refer to the X-FTA 002 01 Manual (HI 801 117 E).



1 Actuators

2 System Cable with Cable Plug

Figure 15: Wiring Actuators via Field Termination Assembly

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 outputs. For more details, refer to the SILworX documentation.

5.2 Diagnosis

LEDs on the front side of the module indicate the module state, see Chapter 3.4.2.

The module diagnostic history can also be read using the programming tool SILworX. Chapter 4.4.4 and Chapter 4.4.5 describe the most important module-specific diagnostic messages.

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

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

6 Maintenance

Defective modules must be replaced with a faultless module of the same type or with an approved replacement model.

Only the manufacturer is authorized to repair the module.

When replacing modules, observe the instructions specified in the System Manual (HI 801 001 E) and Safety Manual (HI 801 003 E).

6.1 Maintenance Measures

6.1.1 Loading the Operating System

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

For detailed instructions on how to load the operating system, see the system manual and the online help. The module must be in STOP to be able to load an operating system.

i The current version of the module in use is displayed in the SILworX Control Panel! The type label specifies the version when the module is delivered, see Chapter 3.3.

6.1.2 Proof Test

HIMax modules must be subjected to a proof test in intervals of 10 years. For more information, refer to the Safety Manual HI 801 003 E.

7 Decommissioning

To decommission the module, remove it from the base plate. For more information, see *Mounting and Removing the Module*.

8 Transport

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

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

9 Disposal

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

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

Appendix

Glossary

Term	Description
ARP	Address Resolution Protocol: Network protocol for assigning the network addresses to hardware addresses
AI	Analog Input
Connector Board	Connector board for the HIMax module
COM	Communication module
CRC	Cyclic Redundancy Check
DI	Digital Input
DO	Digital Output
EMC	Electromagnetic Compatibility
EN	European Norm
ESD	ElectroStatic Discharge
FB	Fieldbus
FBD	Function Block Diagram
FTT	Fault Tolerance Time
ICMP	Internet Control Message Protocol: Network protocol for status or error messages
IEC	International Electrotechnical Commission
MAC address	Hardware address of one network connection (Media Access Control)
PADT	Programming And Debugging Tool (in accordance with IEC 61131-3), PC with SILworX
PE	Protective Earth
PELV	Protective Extra Low Voltage
PES	Programmable Electronic System
PFD	Probability of Failure on Demand, probability of failure on demand of a safety function
PFH	Probability of Failure per Hour, probability of a dangerous failure per hour
R	Read
Rack ID	Base plate identification (number)
Non-reactive	Supposing that two input circuits are connected to the same source (e.g., a transmitter). An input circuit is termed "non-reactive" if it does not distort the signals of the other input circuit.
R/W	Read/Write
SB	System Bus (Module)
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction, portion of safely manageable faults
SIL	Safety Integrity Level (in accordance with IEC 61508)
SILworX	Programming tool for HIMax
SNTP	Simple Network Time Protocol (RFC 1769)
SRS	System.Rack.Slot addressing of a module
SW	Software
TMO	TiMeOut
TMR	Triple Module Redundancy
W	Write
r_P	Peak value of a total AC component
Watchdog (WD)	Time monitoring for modules or programs. If the watchdog time is exceeded, the module or program enters the ERROR STOP state.
WDT	WatchDog Time

Index of Figures

Index of Tables

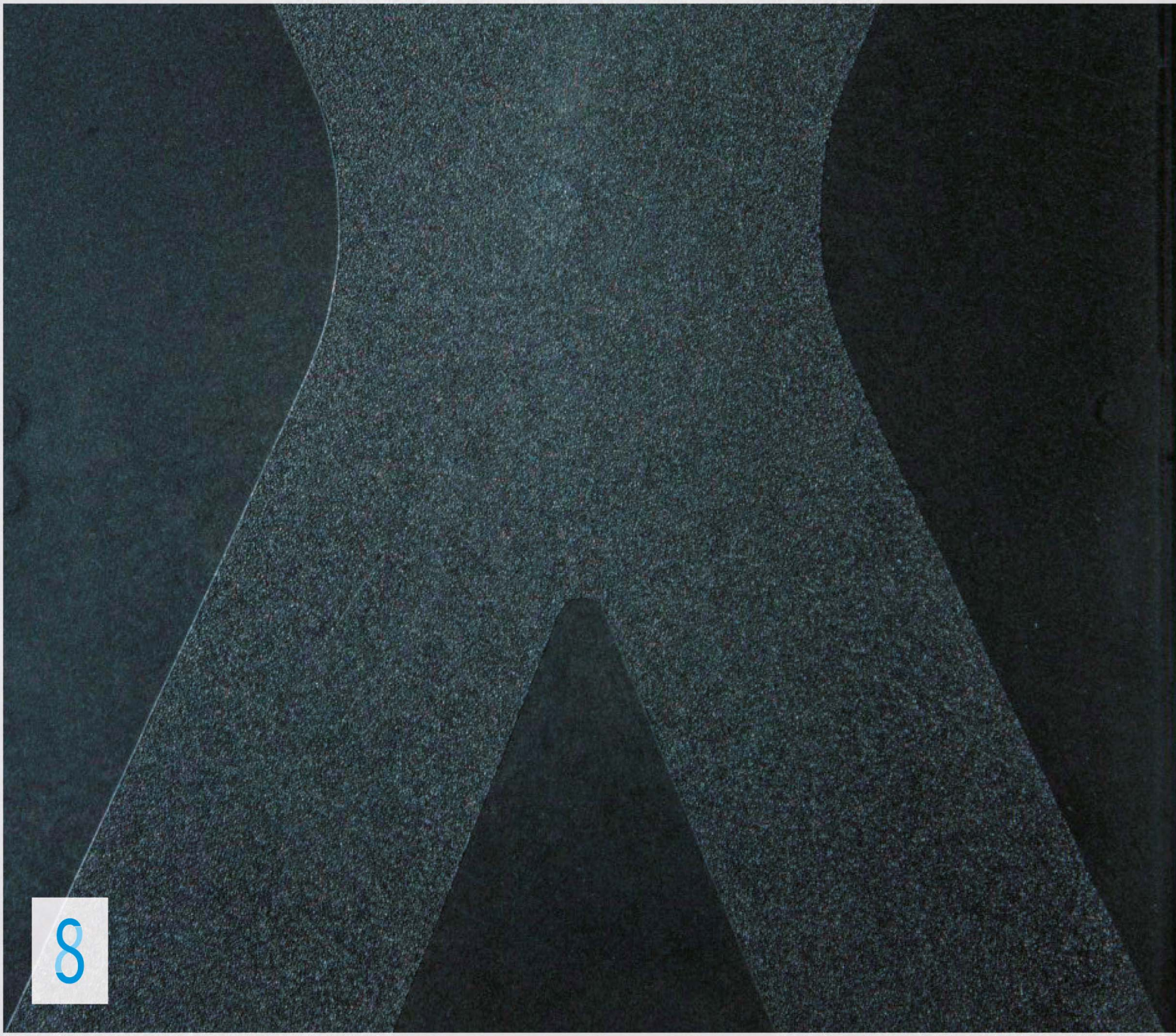
Index

HI 801 019 E

Albert-Bassermann-Str. 28
68782 Brühl, Germany
Phone +49 6202 709-0
Fax +49 6202 709-107
HIMax-info@hima.com
www.hima.com

HIMA

SAFETY
NONSTOP



8