

HIMax[®]

Digital Output Module
Manual

SAFETY
NONSTOP



X-DO 32 01

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All of the instructions and technical specifications in this manual have been written with great care and effective quality assurance measures have been implemented to ensure their validity. For questions, please contact HIMA directly. HIMA appreciates any suggestion on which information should be included in the manual.

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For further information, refer to the CD-ROM and our website <http://www.hima.de> and <http://www.hima.com>.

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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. |
| <i>Italics:</i> | 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.
- Notice 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 32 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 32 digital outputs that can be loaded with a nominal current of up to 0.5 A per channel. With high level, a voltage equivalent to the supply voltage is present on the corresponding output.

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 modules 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. The back-read branch is testable.

The safety function is performed in accordance with SIL 3.

3.1.1 Reaction in the Event of a Fault

If a channel fault occurs, the affected channel is set to the safe state. If a safety-relevant fault occurs (e.g., multiple faults in one channel), the module adopts the safe state.

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:)

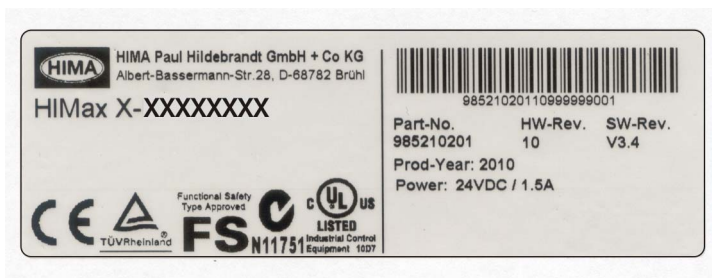


Figure 1: Sample Type Label

3.4 Structure

The module is equipped with 32 digital outputs. The outputs are not electrically isolated from one another and from the voltage supply.

The module automatically diagnosis short-circuits (SC). To do so, line monitoring must be configured in SILworX, see Chapter 4.3. The switching threshold for short-circuit monitoring is predefined and cannot be changed.

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.

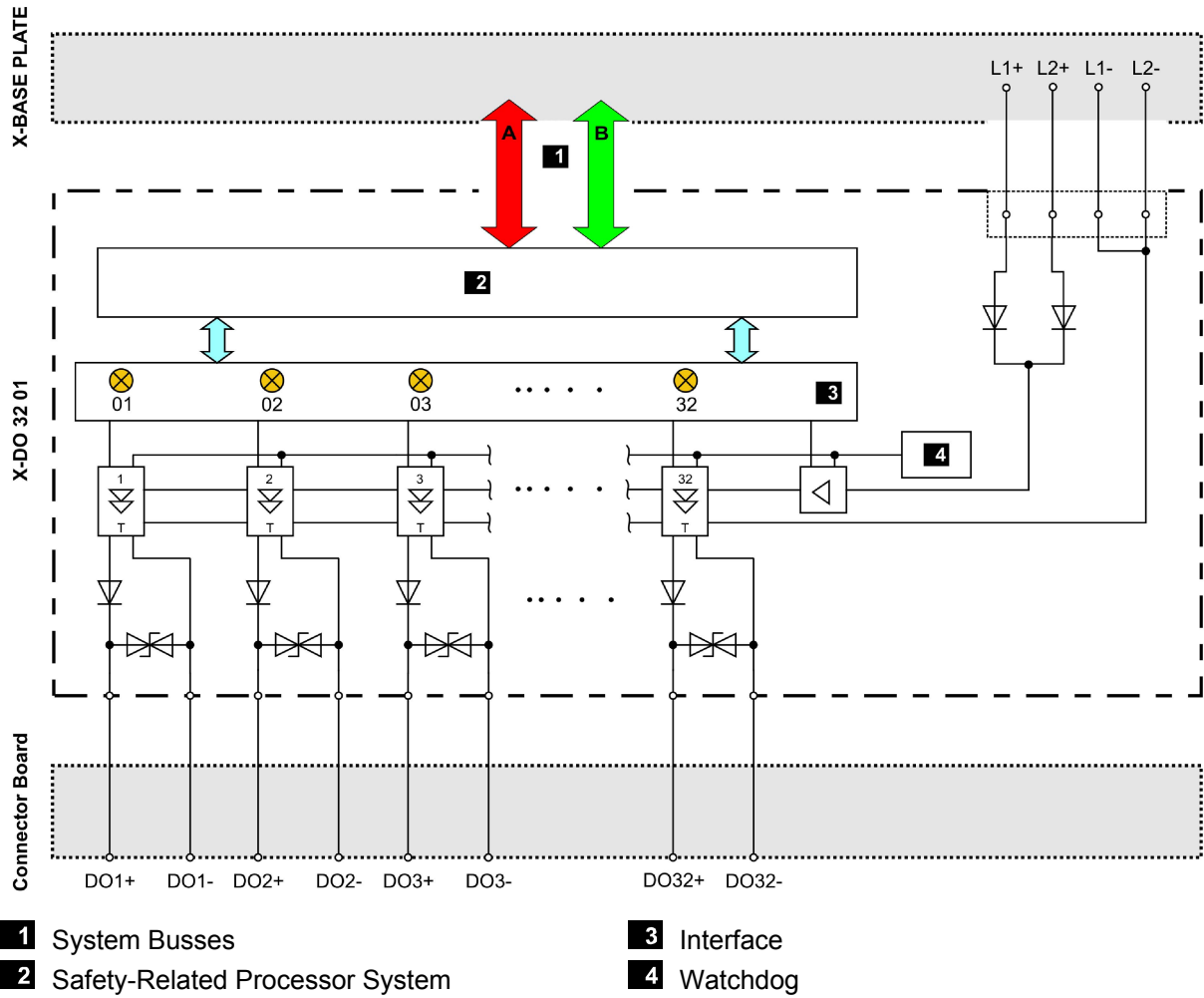


Figure 2: Block Diagram

3.4.2 Indicators

The following figure shows the LED indicators for the module.

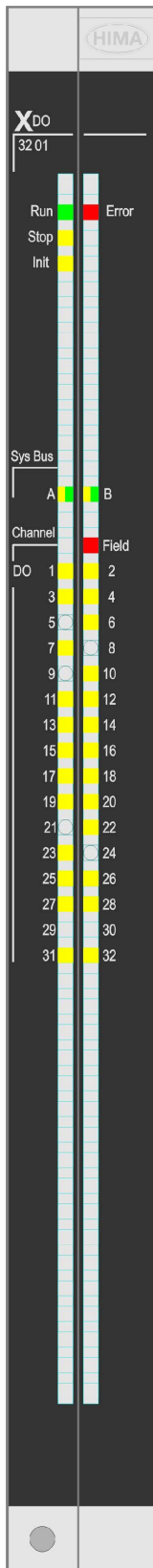


Figure 3: Indicators

The LEDs indicate the operating state of the 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...32)

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 indicators are labeled *Channel*.

| LED | Color | Status | Description |
|----------------|--------|-----------|--|
| Channel 1...32 | Yellow | On | The related channel is active (energized). |
| | | Blinking2 | Channel fault |
| | | Off | The related channel is inactive (de-energized). |
| Field | Red | Blinking2 | Field fault on at least one channel, e.g., short-circuit, etc. |
| | | Off | No field fault displayed! |

Table 6: I/O LEDs

3.5 Product Data

| | |
|------------------------------|--|
| General | |
| Supply voltage | 24 VDC, -15 %...+20 %, $r_p \leq 5\%$, SELV, PELV |
| Current input | min. 0.5 A (idle) |
| Continuous load | max. 12 A at 24 VDC |
| 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) in mm | 310 x 29.2 x 230 |
| Weight | approx. 1.1 kg |

Table 7: Product Data

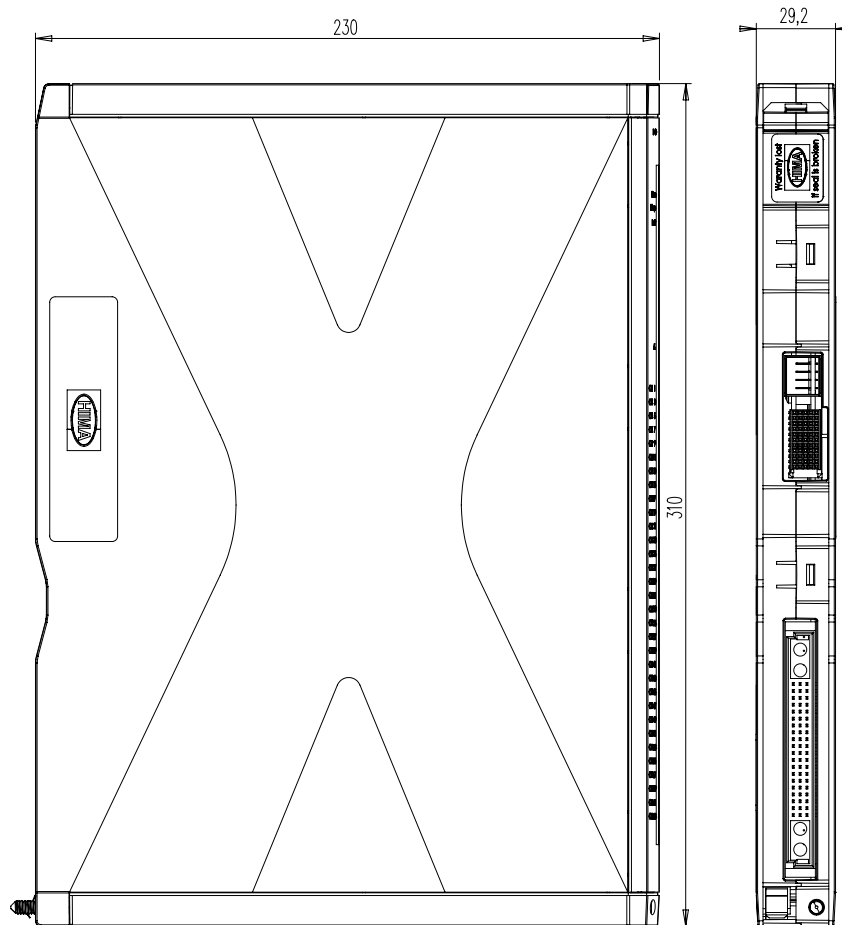


Figure 4: Views

| Digital Outputs | |
|--|--|
| Number of outputs (number of channels) | 32, non-galvanically isolated |
| Output voltage | $\geq L+$ minus internal voltage drop |
| Voltage drop (with high level) | 1.3 V at 0.75 A output current |
| Nominal rated current (with high level) | 0.5 A, range 0...0.6 A |
| Total current permitted for the module | 12 A |
| Leakage current (with low level) | 20 μ A |
| Current limiting in the event of short-circuit | 2 A, each channel |
| Overcurrent interruption | $I > 0.8$ A for $t > 50$ ms |
| Ohmic load | To nom. rated current 0.5 A |
| Inductive load | 10 H |
| Capacitive load | 100 μ F |
| Lamp load (24 V) | 4 W |
| SC Limit | 0.8 A, range 0.8...0.85 A |
| Overload protection of the outputs, transient | 33 V (max. 43 V) |
| Switching time of the channels (with ohmic load) | ≤ 100 μ s |
| Test impulse (with ohmic load) | 200 μ s |
| 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:

| Designation | 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 |

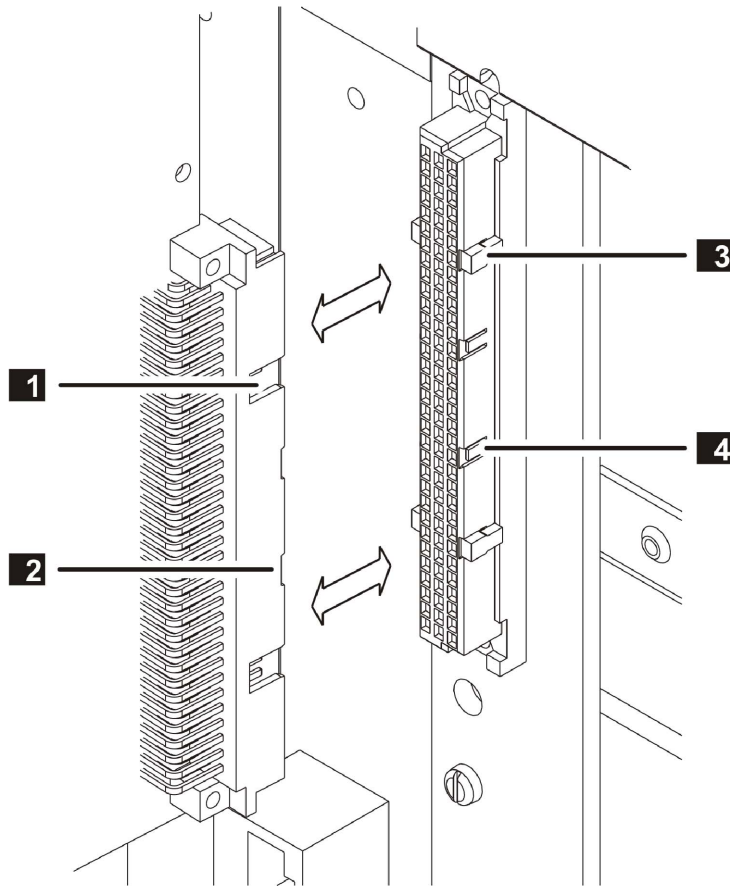
Table 9: Available Connector Boards

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** Available 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

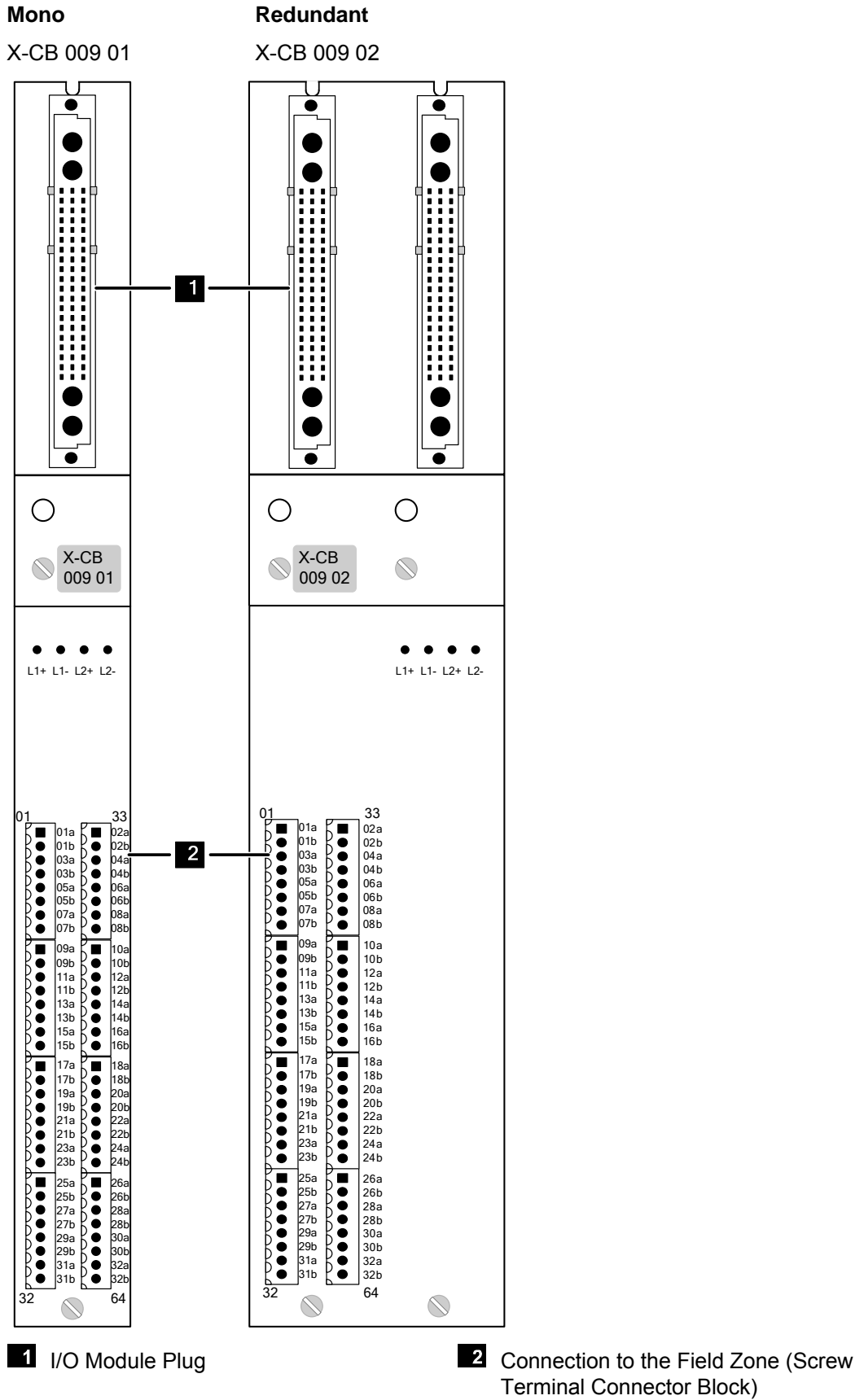


Figure 6: Connector Boards with Screw Terminals

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 | DO25+ | 1 | 26a | DO26+ |
| 2 | 25b | DO25- | 2 | 26b | DO26- |
| 3 | 27a | DO27+ | 3 | 28a | DO28+ |
| 4 | 27b | DO27- | 4 | 28b | DO28- |
| 5 | 29a | DO29+ | 5 | 30a | DO30+ |
| 6 | 29b | DO29- | 6 | 30b | DO30- |
| 7 | 31a | DO31+ | 7 | 32a | DO32+ |
| 8 | 31b | DO31- | 8 | 32b | DO32- |

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

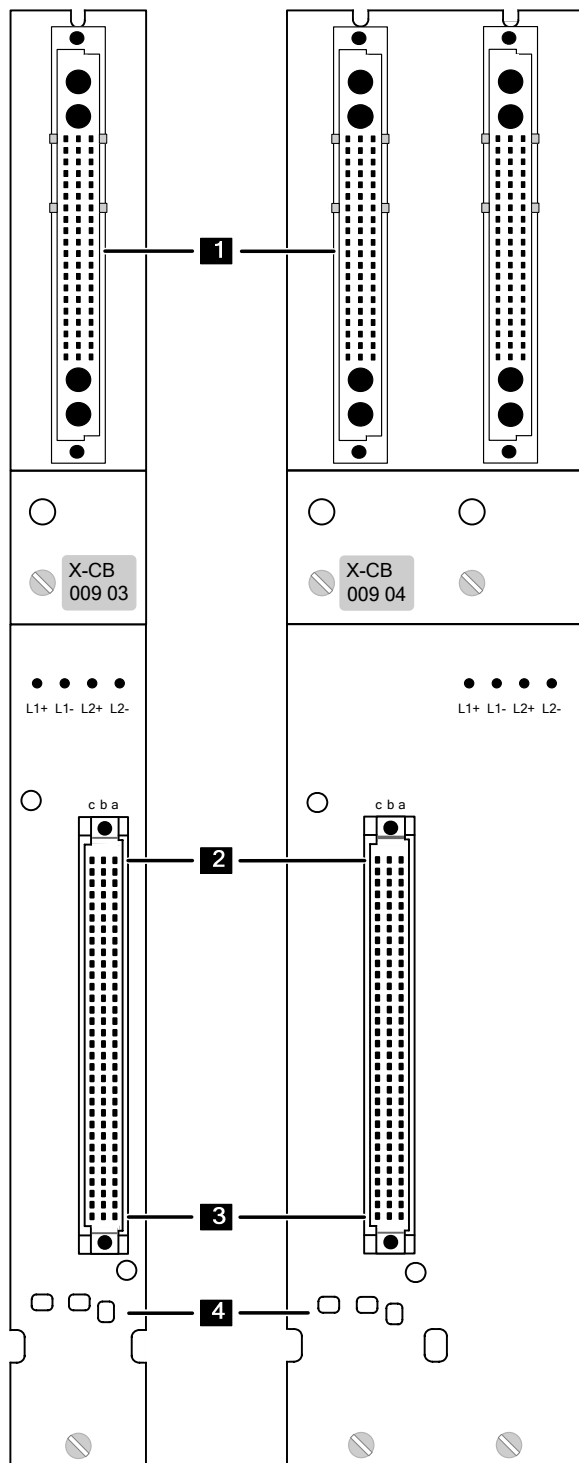
3.6.5 Connector Boards with Cable Plug

Mono

X-CB 009 03

Redundant

X-CB 009 04



- 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. The cable plug and the connector boards are coded.

i

Connector pin assignment!

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

Lead marking based on DIN 47100:

| Row | c | | b | | a | |
|-----|--------|---------------------|--------|---------------------|----------|------------------|
| | Signal | Color | Signal | Color | Signal | Color |
| 1 | DO32+ | PK-BN ¹⁾ | DO32- | WH-PK ¹⁾ | Reserved | YE ²⁾ |
| 2 | DO31+ | GY-BN ¹⁾ | DO31- | WH-GY ¹⁾ | Reserved | GN ²⁾ |
| 3 | DO30+ | YE-BN ¹⁾ | DO30- | WH-YE ¹⁾ | Reserved | BN ²⁾ |
| 4 | DO29+ | BN-GN ¹⁾ | DO29- | WH-GN ¹⁾ | Reserved | WH ²⁾ |
| 5 | DO28+ | RD-BU ¹⁾ | DO28- | GY-PK ¹⁾ | | |
| 6 | DO27+ | VT ¹⁾ | DO27- | BK ¹⁾ | | |
| 7 | DO26+ | RD ¹⁾ | DO26- | BU ¹⁾ | | |
| 8 | DO25+ | PK ¹⁾ | DO25- | GY ¹⁾ | | |
| 9 | DO24+ | YE ¹⁾ | DO24- | GN ¹⁾ | | |
| 10 | DO23+ | BN ¹⁾ | DO23- | WH ¹⁾ | | |
| 11 | DO22+ | RD-BK | DO22- | BU-BK | | |
| 12 | DO21+ | PK-BK | DO21- | GY-BK | | |
| 13 | DO20+ | PK-RD | DO20- | GY-RD | | |
| 14 | DO19+ | PK-BU | DO19- | GY-BU | | |
| 15 | DO18+ | YE-BK | DO18- | GN-BK | | |
| 16 | DO17+ | YE-RD | DO17- | GN-RD | | |
| 17 | DO16+ | YE-BU | DO16- | GN-BU | | |
| 18 | DO15+ | YE-PK | DO15- | PK-GN | | |
| 19 | DO14+ | YE-GY | DO14- | GY-GN | | |
| 20 | DO13+ | BN-BK | DO13- | WH-BK | | |
| 21 | DO12+ | BN-RD | DO12- | WH-RD | | |
| 22 | DO11+ | BN-BU | DO11- | WH-BU | | |
| 23 | DO10+ | PK-BN | DO10- | WH-PK | | |
| 24 | DO9+ | GY-BN | DO9- | WH-GY | | |
| 25 | DO8+ | YE-BN | DO8- | WH-YE | | |
| 26 | DO7+ | BN-GN | DO7- | WH-GN | | |
| 27 | DO6+ | RD-BU | DO6- | GY-PK | | |
| 28 | DO5+ | VT | DO5- | BK | | |
| 29 | DO4+ | RD | DO4- | BU | | |
| 30 | DO3+ | PK | DO3- | GY | | |
| 31 | DO2+ | YE | DO2- | GN | | |
| 32 | DO1+ | BN | DO1- | WH | | |

¹⁾ Additional orange ring if one lead marking color is repeated.

²⁾ Additional violet ring if one lead marking color is repeated for the second time.

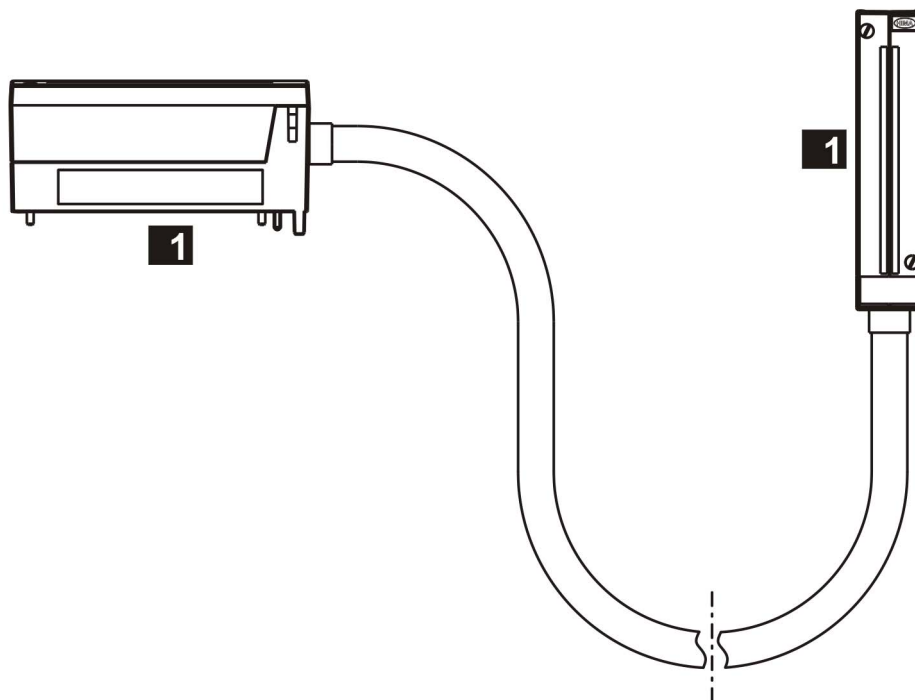
Table 13: Pin Assignment for the System Cable Plug

3.7 System Cable X-CA 006

The X-CA 006 system cable is used to wire the X-CB 009 03/04 connector board with the field zone via field termination assemblies.

| General | |
|----------------------------|---|
| Cable | LIYY 64 x 0.34 mm ² + 2 x 2 x 0.25 mm ² |
| Wire | Finely stranded |
| Average outer diameter (d) | approx. 17.2 mm |
| Minimum bending radius | |
| Fixed laying | 5 x d |
| Flexible application | 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: System Cable X-CA 006 01 n

The system cable is available in the following standard variants:

| System cable | Description | Length |
|----------------|---------------------------------|--------|
| X-CA 006 01 8 | Coded cable plugs on both sides | 8 m |
| X-CA 006 01 15 | | 15 m |
| X-CA 006 01 30 | | 30 m |

Table 15: Available System Cables

3.7.1 Cable Plug Coding

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

4 Start-up

This chapter describes how to install, configure and connect the module. For 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).
- Operation is only permitted with the suitable connector board, see Chapter 3.6.
- The module and its connected components must be mounted to provide protection of at least IP20 in accordance with EN 60529: 1991 + A1: 2000.

NOTE



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 zone.
 - Take the appropriate earthing measures when connecting the plugs and terminals to the field zone.
 - An unshielded, twisted pair cable may be used for connecting field current circuit to the digital outputs.
 - On the module side, the shielding must be connected to the cable shield rail (use SK 20 shield connection terminal block or similar).
 - When using stranded wires, HIMA recommends fastening ferrules to the wire ends. The terminals must be suitable for fastening the cross-sections of the cables in use.

The outputs can be interconnected redundantly using the corresponding connector boards, 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.

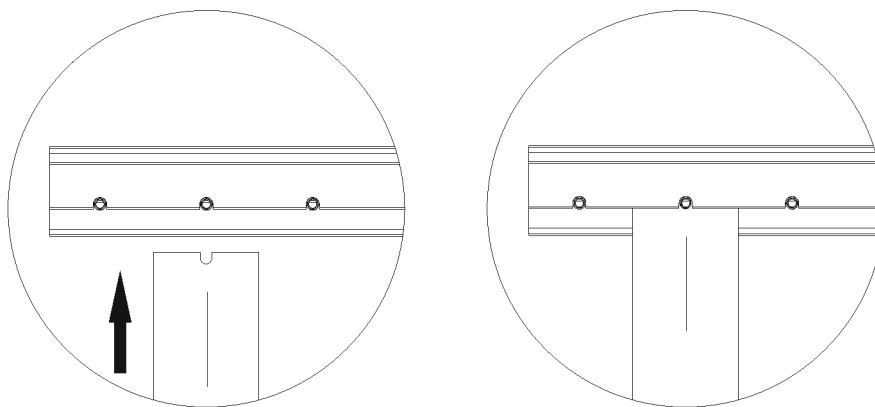


Figure 9: Inserting the Connector Board

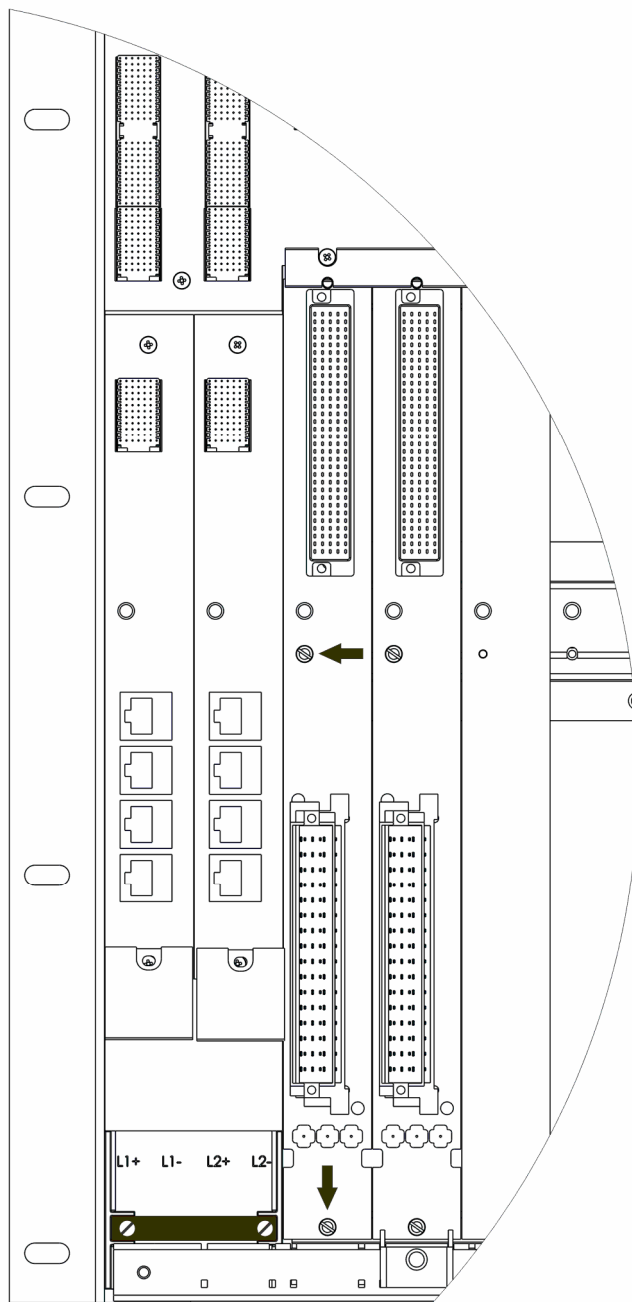


Figure 10: Securing the Connector Board with Captive Screws

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

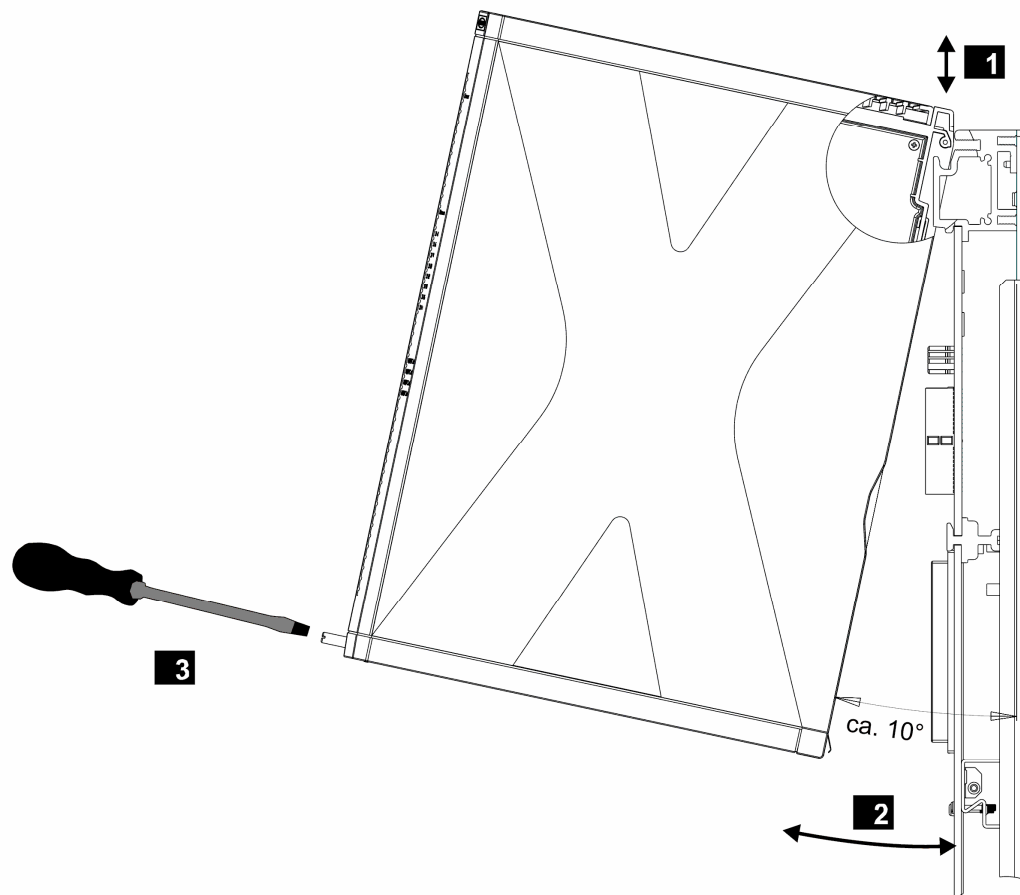
- Screwdriver, slotted 0.8 x 4.0 mm
- Screwdriver, slotted 1.2 x 8.0 mm

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 **3** Securing and Releasing a Module
2 Swiveling a Module in and out

Figure 11: Mounting and Removing a Module

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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 Short-Circuit Monitoring

The module is provided with short-circuit monitoring which can be individually configured for each channel. The switching thresholds for short-circuit monitoring are predefined (see Chapter Table 8)

The following points must be taken into account for short-circuit monitoring:

- 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 when currents exceed 1.6 mA.

Short-circuit monitoring can be configured for each channel as follows:

- In the **I/O Submodule DO32_01** tab, adopt the setting *SC Interval* [μ s] (≥ 40 ms) for all channels
- In the **I/O Submodule DO32_01: Channels**, activate *SC active*,
Default setting: Deactivated
- In the **I/O Submodule DO32_01: Channels**, *max. Test Pulse Duration* 0 μ s...50 ms,
if *SC active* (**activated**)

4.3.1 Recommended Values for Line Monitoring

| Test Impulse Duration | SC Interval | Relationship |
|-----------------------|-------------|--------------|
| 200 μ s | 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 Pulse Duration and SC Interval

For actuators, a pulse-duty factor of 0.5 % between the SC 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 interval.

Short-circuit monitoring does not affect the statuses *Channel OK*, *Submodule OK* and *Module OK*, 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 statuses and parameters 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 <i>Module Status</i> parameter! | | | | | | | | | | | | | | | | | | |
| Module Status | DWORD | R | Status of the module <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Coding</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x00000001</td> <td>Module fault ¹⁾</td> </tr> <tr> <td>0x00000002</td> <td>Temperature threshold 1 exceeded</td> </tr> <tr> <td>0x00000004</td> <td>Temperature threshold 2 exceeded</td> </tr> <tr> <td>0x00000008</td> <td>Incorrect temperature value</td> </tr> <tr> <td>0x00000010</td> <td>Voltage on L1+ is defective</td> </tr> <tr> <td>0x00000020</td> <td>Voltage on L2+ is defective</td> </tr> <tr> <td>0x00000040</td> <td>Internal voltage is defective</td> </tr> <tr> <td>0x80000000</td> <td>No connection to the module ¹⁾</td> </tr> </tbody> </table> <p>¹⁾ These faults affect the <i>Module OK</i> status and need not be separately evaluated in the user program.</p> | 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⁾ |
| 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⁾ | | | | | | | | | | | | | | | | | | | | |
| 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. | | | | | | | | | | | | | | | | | | |

Table 17: Module Tab in the Hardware Editor

4.4.2 Tab: I/O Submodule DO32_01

The **I/O Submodule DO32_01** tab contains the following systemparameters:

| Name | R/W | Description | |
|--|-----------|--|--|
| Enter these statuses and parameters directly in the Hardware Editor. | | | |
| Name | W | Module name, it cannot be modified. | |
| 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 Interval [μ s] | W | SC interval of test impulse (≥ 40 ms) Default setting: 40 000 = 40 ms See Chapter 4.3 | |
| Show Short-Circuit | W | Display via LED <i>Field</i> (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. | | | |
| Background Test Error | BOOL | R | TRUE: Background test is faulty FALSE: Background test is free of faults |
| Diagnostic Request | DINT | W | To request a diagnostic value, the appropriate ID must be sent to the module using the parameter <i>Diagnostic Request</i> (see Chapter 4.4.5 for coding details). |
| Diagnostic Response | DINT | R | As soon as <i>Diagnostic Response</i> returns the ID of <i>Diagnostic Request</i> (see 4.4.5 for coding details), <i>Diagnostic Status</i> contains the diagnostic value requested. |
| Diagnostic Status | DWORD | R | Requested diagnostic value in accordance with <i>Diagnostic Response</i> . The IDs of <i>Diagnostic Request</i> and <i>Diagnostic Response</i> can be evaluated in the user program. <i>Diagnostic Status</i> only contains the requested diagnostic value when both Diagnostic Request and Diagnostic Response have the same ID. |
| Restart on Error | BOOL | W | Using the parameter <i>Restart on Error</i> , 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 <i>Restart on Error</i> 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 (see 4.4.4 for coding details) |

Table 18: Tab: I/O Submodule DO32_01 in the Hardware Editor

4.4.3 Tab: I/O Submodule DO32_01: Channels

The **I/O Submodule DO32_01: Channels** tab contains the following systemparameters 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, defined by default |
| 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 Active | BOOL | R | Short-circuit monitoring (Activated/Deactivated) Default setting: Deactivated |
| Max. Test Pulse Duration [µs] | UDINT | W | Test impulse duration with short-circuit monitoring Range of values: 0...50 000 µs Default setting: 0 µs |
| -> SC | BOOL | R | TRUE: Short-circuit FALSE: No short-circuit |
| -> SC Monitoring Defective | BOOL | R | TRUE: Defective short-circuit monitoring FALSE: Short-circuit monitoring not defective |
| Redund. | BOOL | W | Requirement: The 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 DO32_01: Channels in the Hardware Editor

4.4.4 Submodule Status [DWORD]

Coding of the variable **Submodule Status**.

| 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 | Hardware fault in short-circuit monitoring |
| 0x00800000 | Voltage monitoring of WD1: voltage error |
| 0x01000000 | Voltage monitoring of WD2: voltage error |
| 0x02000000 | Voltage monitoring of L1+ HIGH voltage defective |
| 0x04000000 | Voltage monitoring of L1+ LOW voltage defective |
| 0x08000000 | Voltage monitoring of L2+ HIGH voltage defective |
| 0x10000000 | Voltage monitoring of L2+ LOW voltage defective |
| 0x20000000 | 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 Status [DWORD]

4.4.5 Diagnostic Status [DWORD]

Coding of **Diagnostic Status**

| ID | Description | | | | | | | | | | | | | | | | |
|-------------|--|--------|-------------|--------|--|--------|---------------------|--------|-------------------------------|--------|---|--------|------------------------|--------|---|--------|---|
| 0 | Diagnostic values (100...1032) are indicated consecutively. | | | | | | | | | | | | | | | | |
| 100 | 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 | | | | | | | | | | | | | | | | |
| 101 | Measured temperature (10 000 digits/ °C) | | | | | | | | | | | | | | | | |
| 200 | Bit-coded voltage status 0 = normal Bit0 = 1 : L1+ (24 V) is faulty Bit1 = 1 : L2+ (24 V) is faulty | | | | | | | | | | | | | | | | |
| 201 | Not used | | | | | | | | | | | | | | | | |
| 202 | | | | | | | | | | | | | | | | | |
| 203 | | | | | | | | | | | | | | | | | |
| 300 | Comparator 24 V low voltage (BOOL) | | | | | | | | | | | | | | | | |
| 1001...1032 | Status of the channels 1...32 <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Coding</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0001</td> <td>Fault occurred in hardware unit (submodule).</td> </tr> <tr> <td>0x0002</td> <td>Reset of an E/A 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>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> </tbody> </table> | Coding | Description | 0x0001 | Fault occurred in hardware unit (submodule). | 0x0002 | Reset of an E/A bus | 0x0004 | Overcurrent, channel shutdown | 0x0008 | Read-back value 0 on the output with reference value 1, due to hardware fault | 0x0010 | Short-circuit detected | 0x0040 | Fault Read back value = 1 at set point = 0 | 0x0080 | Read back value = 0 at set point = 1 due to a field fault |
| Coding | Description | | | | | | | | | | | | | | | | |
| 0x0001 | Fault occurred in hardware unit (submodule). | | | | | | | | | | | | | | | | |
| 0x0002 | Reset of an E/A bus | | | | | | | | | | | | | | | | |
| 0x0004 | Overcurrent, channel shutdown | | | | | | | | | | | | | | | | |
| 0x0008 | Read-back value 0 on the output with reference value 1, due to hardware fault | | | | | | | | | | | | | | | | |
| 0x0010 | Short-circuit detected | | | | | | | | | | | | | | | | |
| 0x0040 | Fault Read back value = 1 at set point = 0 | | | | | | | | | | | | | | | | |
| 0x0080 | Read back value = 0 at set point = 1 due to a field fault | | | | | | | | | | | | | | | | |

Table 21: Diagnostic Information [DWORD]

4.5 Connection Variants

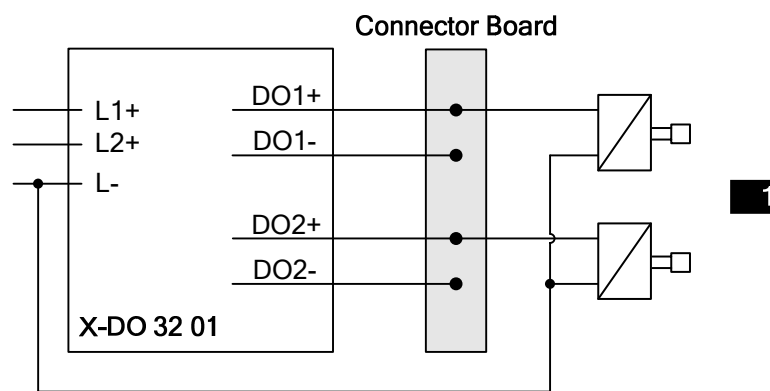
This chapter describes the correct wiring of the module in safety-related applications. The connection variants specified here are permitted.

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 (such as free-wheeling diode or varistor) is required when connecting inductive loads.
- Unshielded, twisted pairs of cables may be connected.
- The ground wires of the outputs may not be interconnected.

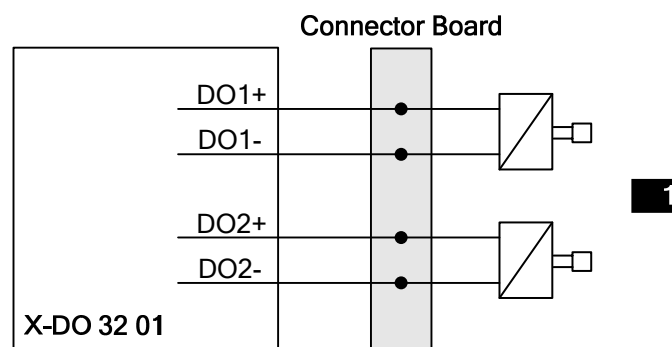
4.5.1 1-Pole Wiring of Actuators



1 Actuators

Figure 12: 1-Pole Wiring of Amplifiers and Actuators

4.5.2 2-Pole Wiring of Actuators

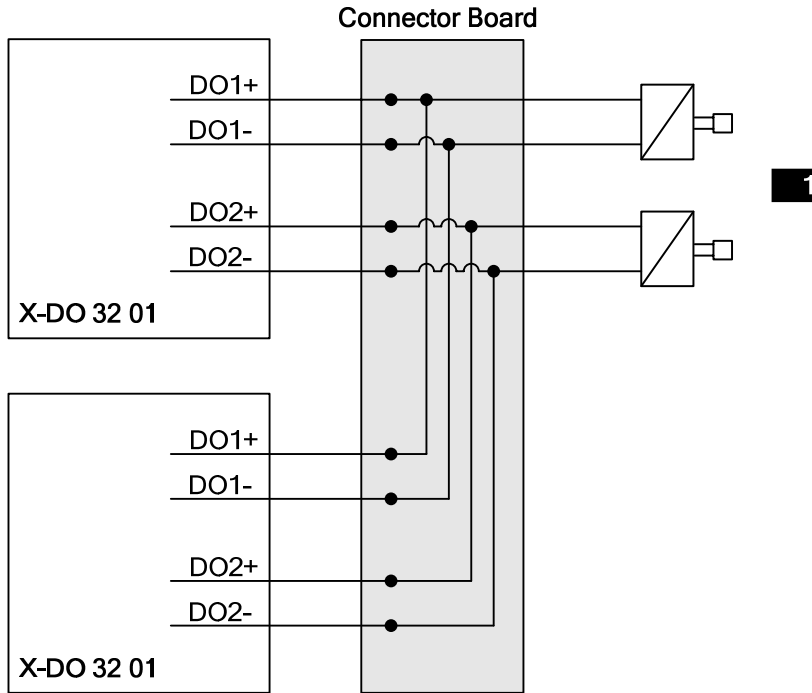


1 Actuators

Figure 13: 2-Pole Wiring of Actuators

4.5.3 Redundant Wiring of Actuators

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



1 Actuators

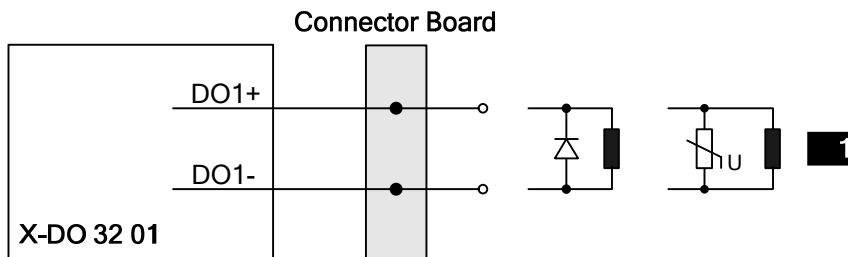
Figure 14: Redundant Wiring of Actuators

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

4.5.4 Wiring Inductive Loads

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



1 Inductive Load with Protective Circuits

Figure 15: Wiring Inductive Loads

4.5.5 Wiring Actuators via Field Termination Assembly

Actuators are connected via the X-FTA 002 01 as described in Figure 16. For further information, refer to the X-FTA 002 01 Manual (HI 801 117 E).

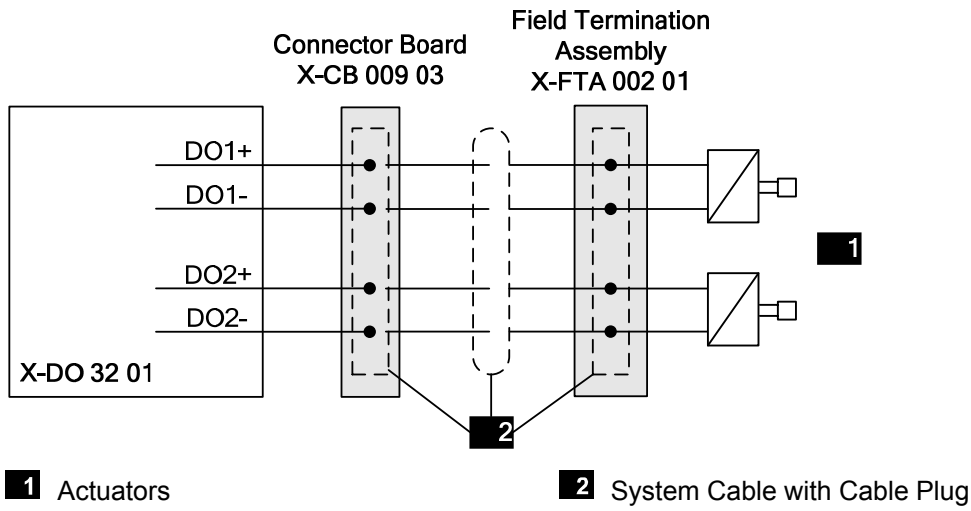


Figure 16: Wiring Actuators via Field Termination Assembly

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.

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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.

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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 |

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