Manual

HIMax®

X-CPU 31

Processor Module

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HI 801 354 D, Rev. 10.00 (1907)	German original document
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Table of Contents

1 Introduction

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

1.1 Structure and Use of This Manual

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

This manual contains the following main chapters:

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

Additionally, the following documents must be taken into account:

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

Table 1: Additional Applicable Manuals

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

1.2 Target Audience

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

1.3 Writing Conventions

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

Bold	To highlight important parts. Names of buttons, menu functions and tabs that can be clicked and used in the programming tool.
Italics	Parameters and system variables, references.
`Courier`	Literal user inputs.
RUN	Operating states are designated by capitals.
Chapter 1.2.3	Cross-references are hyperlinks even if they are not specially marked. In the electronic document (PDF): When the mouse pointer hovers over a hyperlink, it changes its shape. Click the hyperlink to jump to the corresponding position.

Safety notices and operating tips are specially marked.

1.3.1 Safety Notices

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

The safety notices are represented as described below.

- Signal word: warning, caution, notice.
- Type and source of risk.
- Consequences arising from non-observance.
- Risk prevention.

The signal words have the following meanings:

- Warning indicates hazardous situations which, if not avoided, could result in death or serious injury.
- Caution indicates hazardous situation which, if not avoided, could result in minor or moderate injury.
- Notice indicates a hazardous situation which, if not avoided, could result in property damage.

⚠ SIGNAL WORD

Type and source of risk!

Consequences arising from non-observance.

Risk prevention.

NOTICE

Type and source of damage!

Damage prevention.

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

i	The text giving additional information is located here.

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

1.4 Safety Lifecycle Services

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

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

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

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

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

2 Safety

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

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

2.1 Intended Use

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

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

2.1.1 Environmental Requirements

All the environmental conditions specified in this manual must be observed when operating the HIMax system. The environmental requirements are listed in the product data.

2.1.2 ESD Protective Measures

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

NOTICE

Damage to the HIMax system due to electrostatic discharge!

- **When performing the work, make sure that the workspace is free of static, and wear a grounding strap.**
- **If not used, ensure that the components are protected from electrostatic discharge, e.g., by storing them in their packaging.**

2.2 Residual Risk

No imminent risk results from a HIMA system itself.

Residual risk may result from:

- Faults related to engineering.
- Faults in the user program.
- Faults related to the wiring.

2.3 Safety Precautions

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

2.4 Emergency Information

A HIMA system is a part of the safety equipment of an overall system. If the controller fails, the system enters the safe state.

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

3 Product Description

The X-CPU 31 processor module is intended for use in the programmable electronic system (PES) HIMax.

The processor module is used for:

- Processing up to 32 user programs
- Performing all central functions including communication.
- Handling redundancy with an additional processor module.
- Handling communication via safe**ethernet**.
- Creating and storing CPU events.
- Storing events created by I/O modules.
- Establishing the connections between modules.
- Establishing the connections to other base plates.
- Managing the rack IDs and SRS of the modules.
- Providing the interface to the programming and debugging tool (PADT).

The module can only be inserted into slots 1 and 2 of the base plates X-BASE PLATE 10 31, X-BASE PLATE 15 31 or X-BASE PLATE 18 31. A maximum of 64 I/O modules can be installed in a HIMax system with X-CPU 31 module.

If the base plate only contains one X-CPU 31 module, the HIMax system operates with only one system bus (mono operation). If the base plate contains two modules, the HIMax system operates with two redundant system buses (redundancy operation).

HIMA recommends using redundancy operation (default) to exploit the high availability of the HIMax system.

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

3.1 Safety Function

The safety function of the processor module includes the following points:

- Processing the user programs

  If faults occur:
  - Stop the user program and reset the variables to the initial values.
  - Reset the processor module to the safe state and report the CPU status.
- Safe communication between HIMA controllers (HIMax, HIMatrix) and remote I/Os using the safety-related safe**ethernet** protocol. Data is transferred either using the Ethernet interfaces of the processor module itself or using the Ethernet interfaces of a communication module.

The safety function is performed in accordance with SIL 3.

The safety function also includes:

- Hardware self-tests.
- Safe communication with the I/O modules.

3.1.1 Response in the Event of a Fault

If the test harness detects faults, the processor module enters the ERROR STOP state and restarts itself. The fault cause can be investigated using the diagnostic information.

If a failure occurs on a system bus, the bus connection is ensured via the redundant system bus, provided that both system buses have been previously configured.

3.1.1.1 Start after an Error Stop

If the cause of the fault is still present, the processor module avoids restarting and repeating the error stop:

- After a first error stop, the processor module restarts normally and switches to its system operation.
- After the second error stop, the user must restart the system using the PADT after eliminating the problem.
- Once the processor module has run in system operation for approximately one minute, the next error stop to occur is considered the *first* error stop.

3.2 Scope of Delivery

To operate, the module must be installed on a matching connector board. The connector board is described in Chapter 3.7. An Ethernet cable is required to connect to the PADT.

Connector boards and Ethernet cables are not included within the scope of delivery of the module.

3.3 X-CPU 31 Certification

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

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

3.4 Type Label

The type label specifies the following important details:

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

Figure 1: Sample Type Label

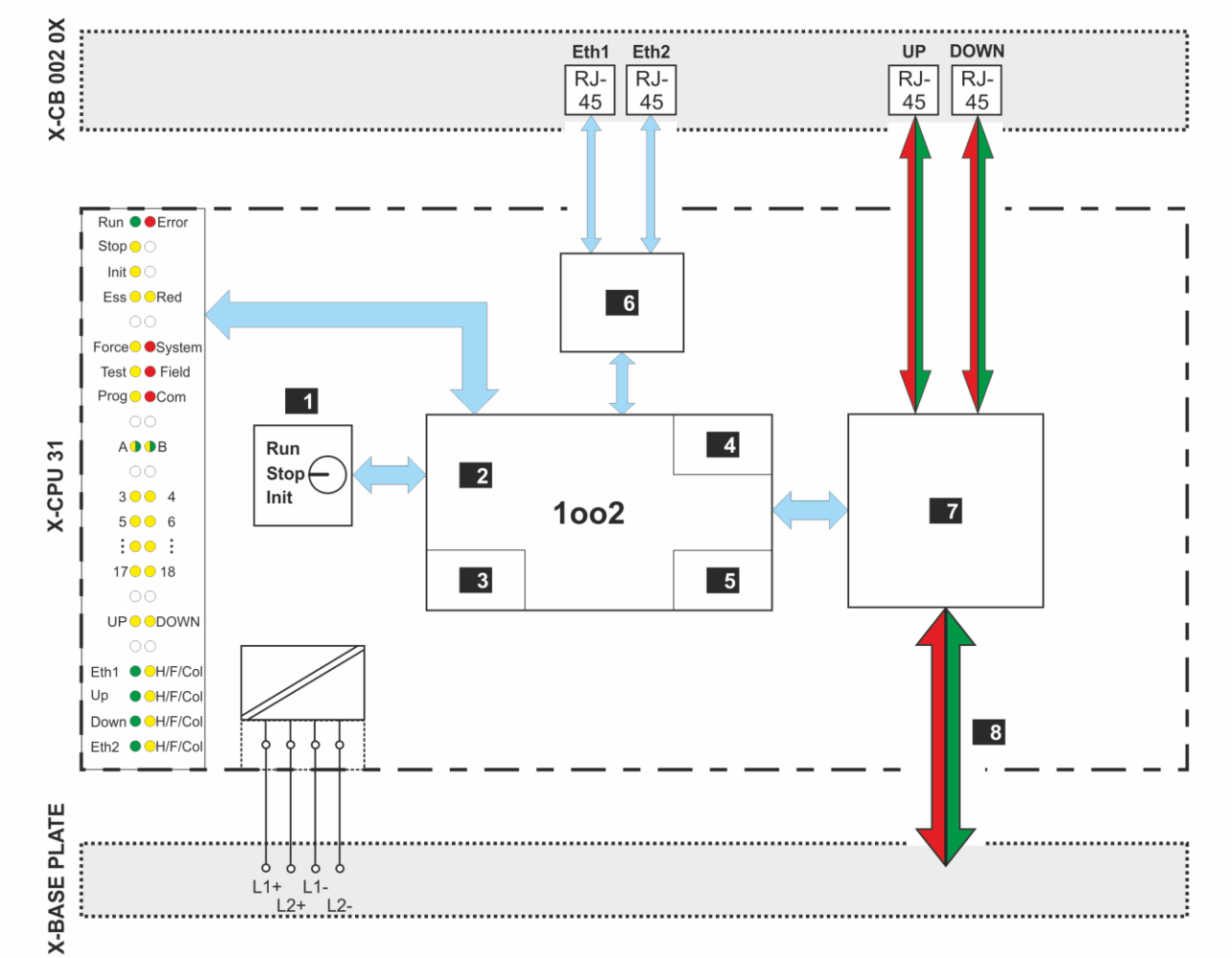
3.5 Structure

Essential functional units of the module are:

- Safety-related 1oo2 processor system, see Chapter 3.5.2.
- Ethernet switch.
- Memory, see Chapter 3.5.3.
- Ethernet and system bus interfaces, see Chapter 3.5.5.
- Mode switch, see Chapter 3.5.16.
- Indicators, see Chapter 3.5.7.

3.5.1 Block Diagram

The following block diagram illustrates the structure of the module.



1 Mode switch
2 1oo2 processor system
3 Memory
4 Comparator
5 Watchdog
6 Switch 1 (external communication)
7 Switch 2 (system bus communication)
8 System bus A or system bus B

Figure 2: Block Diagram

3.5.2 Safety-Related Processor System

The safety-related processor module is a 1oo2 processor system. Continuous self-tests ensure safety-related operation.

Characteristics:

- Two synchronous microprocessors.
- Specific SDRAM memory with 128 MB for each microprocessor.
- NVRAM for configuration data and retain variables.
- Testable hardware comparator for data buses.
- Watchdog (WD).
- Gold capacitor for buffering date/time.
- LEDs for indicating the system states.
- Mode switch for configuring the module behavior when voltage is switched on.

The processor module compares the data on both processors and triggers an interrupt if faults occur.

A watchdog monitors both processors. Self-tests of the module also check the watchdog.

The safety-related 1oo2 processor system controls and monitors one system bus of the HIMax system. The module in base plate slot 1 controls and monitors system bus A and the module in slot 2 controls and monitors system bus B.

3.5.3 Memory

The module has a RAM and a non-volatile memory. The non-volatile memory is secured by a CRC.

The non-volatile memory contains the following programs and information:

- Operating system.
- Number of user programs.
- Enable switch, watchdog time, safety time.
- Online changes.
- Variable with the RETAIN attribute.
- Production data and, if necessary, trimming data.
- Fault status history.
- Events.

While booting, the system transfers the program code from the non-volatile memory to the program and data memory.

3.5.4 Alarms and Events

The processor module records alarms and other events in its non-volatile memory.

For further details on alarms and events, their creation and recording, refer to the system manual (HI 801 001 E).

3.5.5 Interfaces

Communication with external systems occurs via Ethernet interfaces. The interfaces are part of a switch.

The RJ-45 connectors are located on the connector board. Each LED on the front plate of the module indicates the corresponding connection status. For further details, refer to Chapter 3.5.7.

The connector board provides the following interfaces for the processor module:

- Two Ethernet interfaces (Eth1, Eth2).
- Two system bus interfaces (UP, DOWN).

Ethernet Interfaces

The Ethernet interfaces serve to connect to the programming tool and external devices. The Ethernet interfaces can be used to load the user program into the processor module as well as the operating system into the individual modules.

Ethernet interfaces	
Number	2
Transmission standard	10BASE-T/100BASE-Tx, half and full duplex.
Autonegotiation	Yes
Autocrossover	Yes
Connection socket	RJ-45
Labeling	Eth1, Eth2
IP address	Freely configurable [1)]
Subnet mask	Freely configurable [1)]
Supported protocols	safe**ethernet**, PADT, OPC, SNTP
[1)] The general rules for assigning IP addresses and subnet masks must be adhered to.	

Table 2: Specifications for the Ethernet Interfaces

System Bus Interfaces

The system bus interfaces are used to connect to additional base plates in the HIMax system and are configured with the SILworX programming tool. Cables complying with Ethernet megabit standard (at least CAT 5e cable) must be used to connect the interfaces.

System bus interfaces	
Number	2
Transmission standard	1000BASE-T, half and full duplex
Autonegotiation	Yes
Autocrossover	Yes
Connection socket	RJ-45
Labeling	UP, DOWN

Table 3: Specifications for the System Bus Interfaces

3.5.6 Ports in Use for Ethernet Communication

UDP ports	Use
8000	Programming and operation with SILworX
8001	Configuring the remote I/O using the PES
6010	safe**ethernet** and OPC
123	SNTP (time synchronization between PES and remote I/O, PES and external devices)

Table 4: Ports in Use

3.5.7 Indicators

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

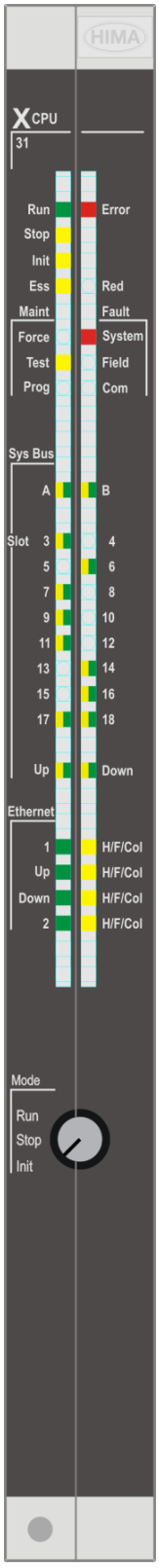


Figure 3: Front View with LEDs and Mode Switch

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

- Module status indicators (Run, Error, Stop, Init)
- Redundancy indicators (Ess, Red)
- Maintenance indicators (Force, Test, Prog)
- Fault indicators (System, Field, Com)
- System bus indicators (A, B)
- Slot indicators (Slot 3…18)
- Rack connection indicators (Up, Down)
- Ethernet indicators (Eth1, Up, Down, Eth2, H/F/Col1…4)

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

Definition of blinking frequencies

The following table defines the blinking frequencies:

Definition	Blinking frequencies
Blinking1	Long (600 ms) on, long (600 ms) off.
Blinking2	Short (200 ms) on, short (200 ms) off, short (200 ms) on, long (600 ms) off.
Blinking-x	Ethernet communication: Blinking synchronously with data transmission.

Table 5: Blinking Frequencies of the LEDs

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

3.5.8 Module Status Indicators

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

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

Table 6: Module Status Indicators

3.5.9 Redundancy Indicators

The LEDs are located below the module status indicators.

LED	Color	Status	Description
Ess	Yellow	On	**Do not remove the module!** Only one processor module is configured and only one processor module is running in system operation. (Complying with the configuration or in case of repair).
		Blinking1	**Do not remove the module!** ▪ Only one processor module is running in system operation, although the redundant processor module is configured. ▪ The processor module is essential for system operation. Both processor modules are running in system operation.
		Off	The processor module is not *essential*. Prior to removing the module, check for proper configuration!
Red	Yellow	On	The processor module is operating redundantly to a second module.
		Blinking1	▪ The processor module starts redundancy operation. ▪ Less modules than configured are operating redundantly.
		Off	The processor module is not operating redundantly, no redundancy configured.

Table 7: Redundancy Indicators

3.5.10 Maintenance Indicators

The maintenance LEDs are labeled *Maint*.

LED	Color	Status	Description
Force	Yellow	On	Forcing prepared, processor module in the STOP, RUN or RUN / UP STOP state.
		Blinking1	Forcing is active, at least one local or global variable has adopted the corresponding force value.
		Off	Forcing not active.
Test	Yellow	On	Connection to the PADT with write permission.
		Blinking1	At least one user program is in the RUN_FREEZE state (single-step mode).
		Off	No connection to the PADT with write permission and no user program in the RUN_FREEZE state.
Prog	Yellow	On	Download (processor module in STOP), the configuration is being loaded. A PADT write command is being processed.
		Blinking1	Reload procedure active or exchange of configuration data between processor modules.
		Off	No loading procedure active and no configuration data exchange between processor modules.

Table 8: Maintenance Indicators

3.5.11 Fault Indicators

The fault indicator LEDs are labeled *Fault*.

LED	Color	Status	Description
System	Red	On	Warning: At least one module or the system reports a warning related to the system. Examples: ▪ No license for additional functions (e.g., communication protocols), test mode. ▪ Temperature warning.
		Blinking1	Error message: At least one module or the system reports a system error. Examples: ▪ Hardware fault. ▪ At least one module does not react to a system request because it is not available or not properly configured.
		Off	System OK.
Field	Red	On	Warning: At least one I/O module reports a warning related to the field level. Reserved for future warnings.
		Blinking1	Error message: At least one I/O module reports a field error. Examples: ▪ At least one I/O module reports a channel error (OC/SC). ▪ OC/SC configured with no actuator connected.
		Off	Field level OK.
Com	Red	On	Warning: At least one communication or processor module reports a warning related to data communication. Example: The Modbus slave received corrupted telegrams (invalid telegram address or telegram length).
		Blinking1	Error message: At least one communication or processor module reports faulty external data communication. Example: No connection to the communication partner.
		Off	Communication OK.

Table 9: Fault Indicators

3.5.12 System Bus Indicators

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

LED	Color	Status	Description
A	Green	On	The processor module is running in system operation. Error-free communication with the redundant processor module.
		Blinking1	The processor module is running in system operation. No or faulty communication with the redundant processor module. In a redundant system, the processor module is the only module running in system operation.
	Yellow	On	The processor module is not running in system operation. Error-free communication with the redundant processor module.
		Blinking1	The processor module is not running in system operation. Faulty communication with the redundant processor module.
B	Green	On	The processor module is running in system operation. Error-free communication with the redundant processor module.
		Blinking1	The processor module is running in system operation. No or faulty communication with the redundant processor module. In a redundant system, the processor module is the only module running in system operation.
	Yellow	On	The processor module is not running in system operation. Error-free communication with the redundant processor module.
		Blinking1	The processor module is not running in system operation. Faulty communication with the redundant processor module.
A+B	Off	Off	The processor module is not running in system operation and there is no communication with the redundant processor module. In a mono system, the processor module is running in system operation.

Table 10: System Bus Indicators

3.5.13 Slot Indicators

The slot indicator LEDs are located after the *Slot* label.

LED	Color	Status	Description
3…18	Green	On	Module inserted in slot X, logical connection established.
	Yellow	Blinking1	Module inserted in slot X, logical connection not established.
	Off	Off	Slot X not used.

Table 11: Slot Indicators

3.5.14 Rack Connection Indicators

The LEDs are labeled with Up and Down. The behavior of the LEDs depends on the system bus mode.

System bus mode: Line

LED	Color	Status	Description
UP	Green	On	Physical and logical connection to a system bus module in another base plate.
	Yellow	Blinking1	Only a physical connection to a system bus module in another base plate.
	Off	Off	No connection to another system bus module.
Down	Green	On	Physical and logical connection to a system bus module in another base plate.
	Yellow	Blinking1	Only a physical connection to a system bus module in another base plate.
	Off	Off	No connection to another system bus module.

Table 12: Rack Connection Indicators in *Line* Mode

System bus mode: Network

LED	Color	Status	Description
UP	Green	Blinking1	Transient interference on the system bus.
	Yellow	On	Only a logical connection to a system bus module in another base plate.
		Blinking1	Only a physical connection to a system bus module in another base plate.
	Off	Off	No connection to another system bus module.
Down	Green	Blinking1	Transient interference on the system bus.
	Yellow	On	Only a logical connection to a system bus module in another base plate.
		Blinking1	Only a physical connection to a system bus module in another base plate.
	Off	Off	No connection to another system bus module.

Table 13: Rack Connection Indicators in *Network* Mode

3.5.15 Ethernet Indicators

The LEDs of the Ethernet indicators are labeled *Ethernet*.

LED	Color	Status	Description
1 UP Down 2	Green	On	Communication partner connected. No communication detected on interface.
		Blinking-x	Communication detected on interface.
		Blinking1	IP address conflict detected. All Ethernet indicator LEDs are blinking.
		Off	No communication partner connected.
H/F/Col 1 … 4	Yellow	On	Full duplex operation on Ethernet line.
		Blinking-x	Collisions detected on Ethernet line.
		Blinking1	IP address conflict detected. All Ethernet indicator LEDs are blinking.
		Off	Half duplex operation on Ethernet line.

Table 14: Ethernet Indicators

3.5.16 Mode Switch

The mode switch defines how the processor module behaves when booted.

The processor module is booted in the following cases:

- Automatically:
  - When applying the supply voltage.
  - After a severe failure.
  - After loading the operating system.
- During operation, using the corresponding command on the PADT.

The mode switch has three different switch positions:

- Init
- STOP
- RUN

The switch position during normal operation is *Run*.

i When setting the mode switch, make sure that the switch position engages!

3.5.16.1 Switch Position: Init

If the switch is set to *Init*, the processor module enters the LOCKED state when booted. In this state, the configured settings no longer apply for the module. This can be required if, for instance, the administrator password is unknown.

In the LOCKED state, the module is reset to the factory settings:

- Default SRS, the slot number depends on the slot used.
- Default IP address and IP settings.
- Only accessible for *Administrator* user account with empty password.
- Enabling switches set to default values.

Setting values that are modified in this state overwrite the factory settings and all the settings previously used!

If the settings remain unchanged, the previously saved settings are used after the switch position changes from *Run* to *Stop* and the module is rebooted.

3.5.16.2 Transition from LOCKED to system operation

Requirement:

- Processor module state: LOCKED.

System operation is started if one of the following events occurs:

- The mode switch is turned from *Init* to *Run* or *Stop*.
- The user sends a command from within the PADT.

i The controller does not restart automatically after interrupting the supply voltage!

If the mode switch of one processor module is in the *Init* position and this processor module is accidentally the first to be started when the supply voltage is reconnected, it remains in the LOCKED state and does not adopt system operation.

If an *Autostart* is required after interrupting the operating voltage, the mode switches on all the processor modules must be set to *Run*!

i Turn the mode switch quickly from *Init* to *Run* to prevent the processor module from entering the STOP state.

3.5.16.3 Switch Position: Stop

Only operative if the processor module is not operating redundantly.

If the switch is set to *Stop*, the processor module behave as follows when booted:

- Non-redundant operation:
  The processor module disables any pre-configured *Autostart* and remains in the STOP state.
- Redundancy operation:
  The processor module adopts the same operating state as the other processor module.

i The controller does not restart automatically after interrupting the supply voltage!

If the mode switch of one processor module is in the *Stop* position and this processor module is accidentally the first to be started when the supply voltage is reconnected, it remains in the STOP state. Consequentially, also the other processor module cannot start.

If an *Autostart* is required after interrupting the operating voltage, the mode switches on all the processor modules must be set to *Run*!

3.5.16.4 Switch Position: Run

To set for safety-related operation!

If the switch is set to *Run*, the processor module behaves as follows when rebooted:

- Non-redundant operation:
  The processor module starts the user programs if *Autostart* is activated.
- Redundancy operation:
  The processor module adopts the same operating state as the other processor module.

i If a module login stops the processor modules, an added processor module with mode switch set to *Run* enters the RUN state if *Autostart* is activated!

3.5.16.5 Overview of Switch Positions

Module behavior if the module boots after switching on the supply voltage or after a fault:

Switch position	Only individual processor module	Additional processor module (redundant operation)
Init	Enters the LOCKED state with the factory settings.	
Switching *Init* → *Stop*	LOCKED → STOPP	Starts redundancy operation.
Switching *Init* → *Run*	LOCKED → System operation, if *Autostart* is set to TRUE.	
Init: Command from PADT ▪ System operation ▪ Cold start	LOCKED → RUN (Mono operation)	
STOP	Enters the STOP state.	
RUN	Executes the user programs.	

Table 15: Overview of the Mode Switch Positions

3.5.17 Monitoring the Supply Voltage

The HIMax processor module monitors its supply voltages L1+/L1-, L2+/L2-. The following applies to each supply voltage:

Voltage level	Voltage status
< 19 V	Undervoltage
Otherwise	Supply voltage OK.
> 29 V	Overvoltage

Table 16: Supply Voltage Status

3.5.18 Temperature Monitoring

Sensors continuously monitor the temperature of the modules.

The temperature state of a processor module indicates whether the temperature thresholds have been exceeded with respect to the following ambient temperature ranges:

Temperature range	Temperature state	System variable value *Temperature State[X]* [BYTE]
< 55 °C	Normal	0x00
≥55 °C	Threshold 1 exceeded	0x01
> 65 °C	Threshold 2 exceeded	0x03
Back to 65…55 °C	Threshold 1 exceeded	0x01
Back to < 55 °C	Normal	0x00

Table 17: Temperature States

If the temperature exceeds or falls below a specific threshold, the temperature state changes.

Table 17 applies when the HIMax module with the X-FAN system fan is running in normal operation. Depending on the module slot in the rack and its power dissipation, the system variable *Temperature State [X]* may be activated below the specified temperature thresholds.

In case of abnormal operation, e.g., without fans, the temperature state can indicate that the temperature thresholds have been exceeded even at a lower ambient temperature.

The temperature state is a status of the processor module. After logging in to the processor module, the module status is displayed in the SILworX Control Panel.

3.5.19 Operating System

The operating system loaded into the CPU contains all basic functions of the HIMax programmable electronic system (PES), including:

- Processing of the user programs.
- Performing all test routines for hardware and software.
- Cycle time monitoring (watchdog).
- Safe communication with the I/O modules.
- Safe communication with other systems, such as:
  - HIMax
  - HIMatrix
  - HIQuad X
- Creating and storing events.

For a description of the operating system functions, refer to the system manual (HI 801 001 E).

Cycle Processing

A CPU cycle runs through the following phases:

- Reading of the input data.
- Processing of the user programs.
- Writing to the output data.
- Other activities, e.g., reload processing.

3.6 Product Data

General	
Supply voltage	24 VDC, -15…+20 %, $r_p \leq 5$ % SELV, PELV
Current consumption	0.72 A at 24 VDC
Microprocessor	PowerPC
Total program and data memory for all user programs	5 MB less 64 kB for CRCs
Data memory for retain variables	32 kB
Number of user programs	1…32
Number of event definitions	0…20 000
Size of the non-volatile event buffer	5000 Events
Buffer for date/time	Min. 5 days, gold capacitor
Protection class	Protection class III in accordance with IEC/EN 61131-2.
Ambient temperature	0…+60 C
Transport and storage temperature	-40…+85 °C
Humidity	Max. 95 % relative humidity, non-condensing
Pollution	Pollution degree II in accordance with IEC/EN 60664-1
Altitude	< 2000 m
Degree of protection	IP20
Dimensions (H x W x D) in mm	310 x 29.2 x 236
Weight	Approx. 1 kg

Table 18: Product Data

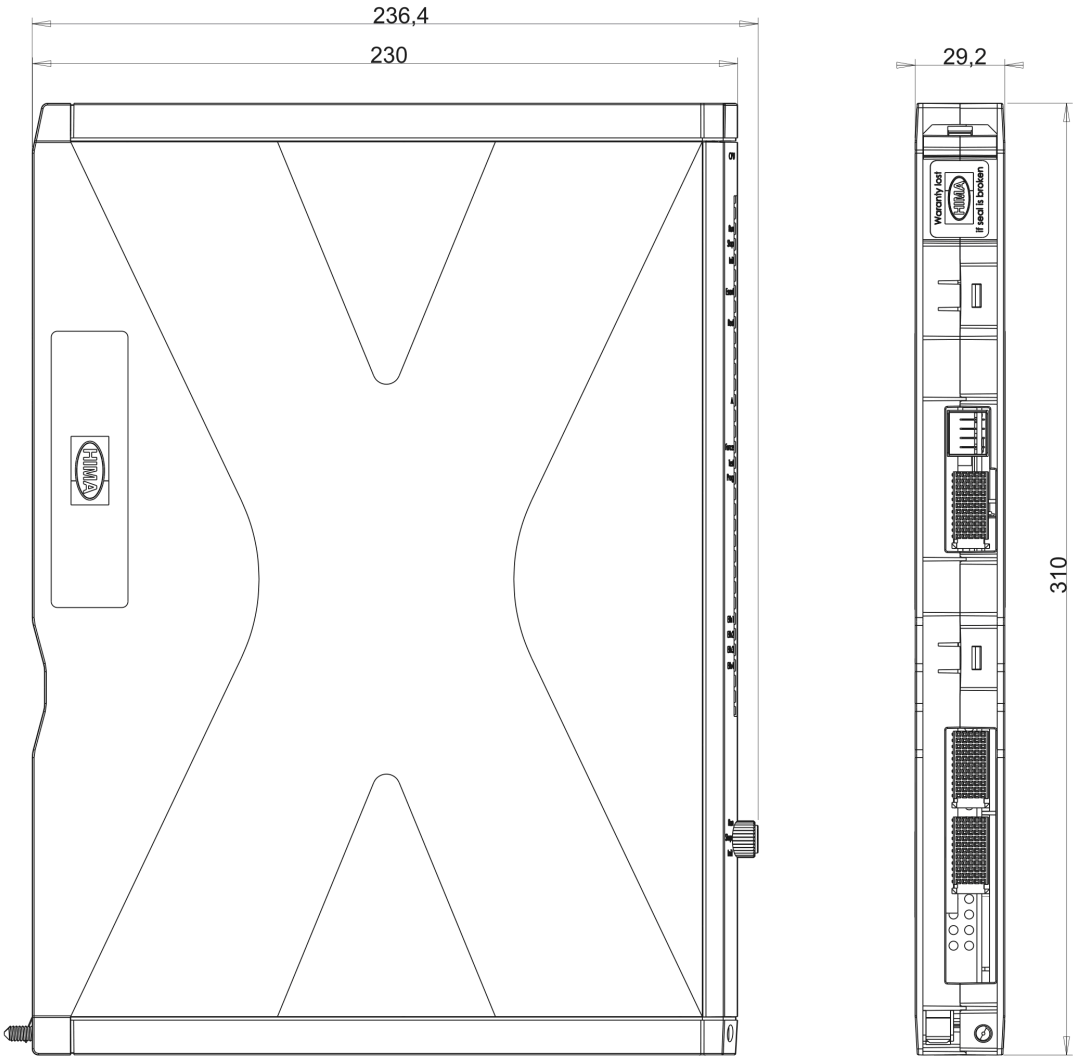


Figure 4: Views

3.7 Connector Board

The connector board connects the processor modules to the Ethernet interfaces. The connector board is secured to the base plate. It is designed to integrate two processor modules. The connector board contains information on the number of modules (10, 15 or 18) that can be inserted into the base plate and the corresponding slot ID.

3.7.1 Pin Assignment

The module in slot 1 of the base plate controls and monitors system bus A and the module in slot 2 controls and monitors system bus B. Connectors X1…X4 are related to slot 1 and connectors X5…X8 are related to slot 2. The connector designations are printed on the connector board.

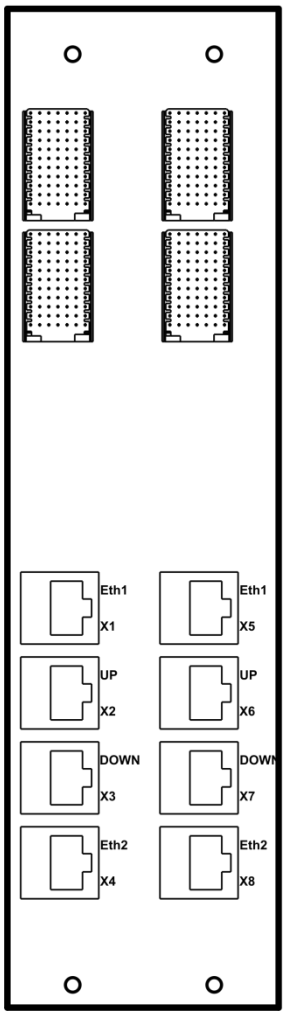


Figure 5: Connector Board

Designation	Description
Slot 1	
Eth1 (X1)	Connection of external systems (e.g., PADT) to the processor module
UP (X2)	Connection of additional HIMax base plates to system bus A
DOWN (X3)	Connection of additional HIMax base plates to system bus A
Eth2 (X4)	Connection of external systems (e.g., PADT) to the processor module
Slot 2	
Eth1 (X5)	Connection of external systems (e.g., PADT) to the processor module
UP (X6)	Connection of additional HIMax base plates to system bus B
DOWN (X7)	Connection of additional HIMax base plates to system bus B
Eth2 (X8)	Connection of external systems (e.g., PADT) to the processor module

Table 19: Description of the Connector Board

4 Start-Up

To start up the processor module, insert the processor module into a permissible base plate slot, see Chapter 4.1.1.

If the base plate is already operating, the processor module starts up and adopts the operating state defined through its configuration and the mode switch position.

If the base plate is not operating, connect the supply voltage.

4.1 Mounting

Observe the following points when mounting the module:

- The module is intended for use within a HIMax base plate. For further information on how to structure the base plates, refer to the corresponding system documentation.
- Only operate the processor module in the permissible slot, see Chapter 4.1.1.
- Only operate the module with forced cooling (X-FAN).
- Operation is only allowed with connector boards secured to the base plate, see Chapter 3.7.
- Effects of removing and inserting the module:

  When removing the module, the connector board remains in the HIMax base plate. This saves additional wiring effort at the external interfaces since these are connected via the connector board of the module.
- The SRS of the module is stored to the connector board and becomes available after the module is inserted.
- Effects of pulling and plugging the plugs:

  Pulling the plugs interrupts the external communication.

  Take appropriate grounding measures.

NOTICE

Electrostatic discharge!

Failure to comply with these instructions can destroy the connector board and/or the module.

- **Make sure that the workspace is free of static and wear a grounding strap.**
- **If not used, ensure that the device is protected from electrostatic discharge, e.g., by storing it in its packaging.**

- Effects due to EMC influences:

  Exposing the module to environmental influences other than those specified in the manual may lead to malfunctions or even the destruction of the module.

NOTICE

Damage to the controller or system malfunction possible!

Only expose the modules to permissible environmental influences, see Chapter 3.6.

4.1.1 Slots Permitted for the Processor Module

The following rules apply when assigning the slots to the processor modules, including in the Hardware Editor:

1. A maximum of two processor modules may be used.
2. Processor modules may only be inserted in slot 1 and slot 2 of rack 0.

4.2 Mounting and Removing the Module

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

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

4.2.1 Mounting a Connector Board

The connector board is part of the X-BASE PLATE and does not have to be mounted.

4.2.2 Mounting and Removing a Module

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

NOTICE

Damage to bus and power sockets due to module jamming!

Failure to comply with these instructions can damage the controller.

Always insert the module in the base plate carefully.

Tools and utilities:

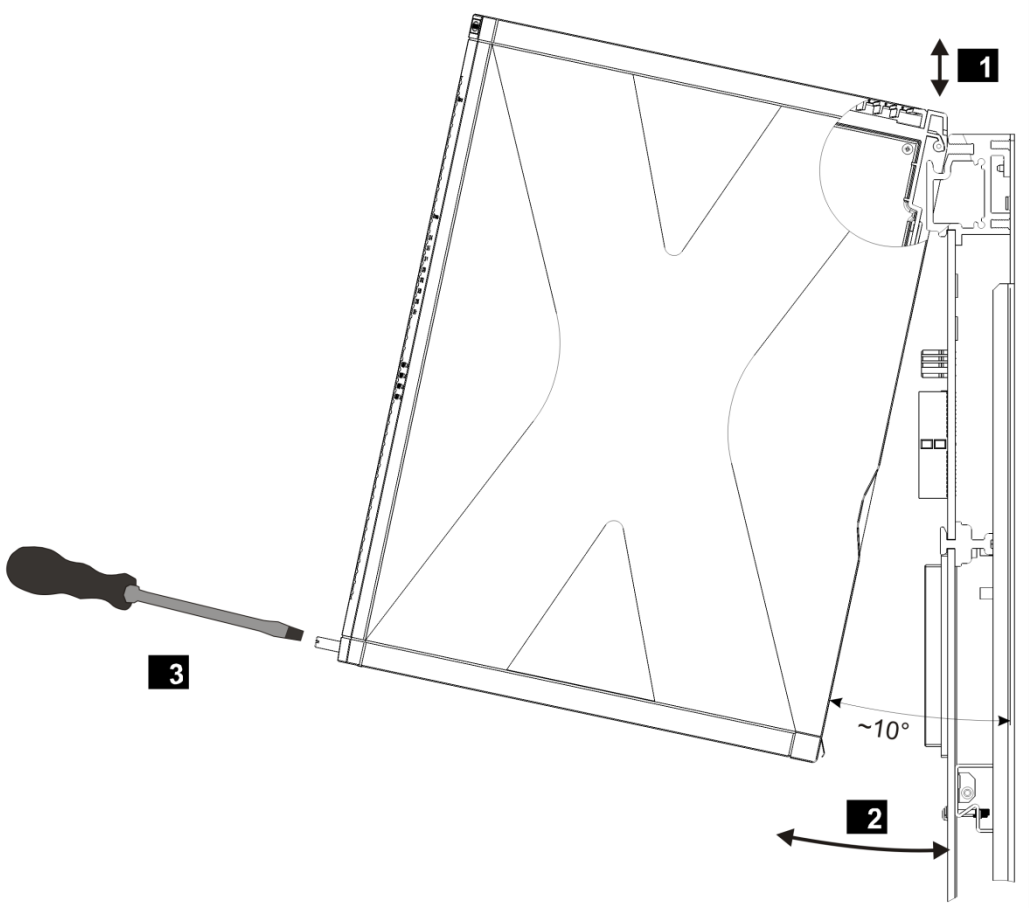
- Screwdriver, slotted 0.8 x 4.0 mm.
- Screwdriver, slotted 1.2 x 8.0 mm.

To insert the modules

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

To remove the modules

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



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

Figure 6: Mounting and Removing a Module

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

4.3 Configuring the User Program in SILworX

Which user function the PES should perform is specified in the user program. The PADT is used to create and compile the resource configuration with the user program, and to load it into the processor module. Refer to the SILworX online help (OLH) for further information on how to configure and program the modules in SILworX.

4.4 Configuring the Module in SILworX

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

The Ethernet interface of the processor module must be configured.

Ensure proper setting of the IP address!

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

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

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

4.4.1 The **Module** Tab

The **Module** tab contains the following parameters:

Designation	Description
Name	Module name
Activating Max. µP Budget for HH Protocol	▪ Activated: Use CPU load limit from the *Max. µP Budget for HH Protocol [%]* field. ▪ Deactivated: Do not use the CPU load limit for IP data transmission. Default setting: Deactivated
Max. µP Budget for HH Protocol [%]	Module's maximum CPU load that can be used for processing the IP data transmission. i The maximum load must be distributed among all the implemented protocols that use this communication submodule.
IP address	IP address of the Ethernet interface. Default value: 192.168.0.99
Subnet mask	32-bit address mask to split up the IP address into network and host address. Default value: 255.255.252.0
Standard Interface	Activated: The interface is used as standard interface for system login. Default setting: Deactivated

Designation	Description
Default Gateway	IP address of the default gateway. Default value: 0.0.0.0
ARP Aging Time [s]	A processor module stores the MAC addresses of the communication partners in a MAC/IP address assignment table (ARP cache). The MAC address remains stored in the ARP cache if messages from the communication partner are received within 1x…2x *ARP Aging Time*. The MAC address is erased from the ARP cache if no messages from the communication partner are received within 1x…2x *ARP Aging Time*. The typical value for the *ARP Aging Time* in a local network ranges from 5…300 s. The contents of the ARP cache cannot be read out. Range of values: 1…3600 s Default value: 60 s **Note:** If routers or gateways are used, the *ARP Aging Time* must be adjusted (increased) due to the additional time required for two-way transmission. If the *ARP Aging Time* is too low, the MAC address of the communication partner is erased from the ARP cache and communication is delayed or interrupted. For an efficient performance, the *ARP Aging Time* value must be greater than the receive timeout set for the protocols in use.
MAC Learning	*MAC Learning* and *ARP Aging Time* are used to set how quick the Ethernet switch should learn the MAC address. The following settings are possible: ▪ Conservative (recommended): If the ARP cache already contains MAC addresses of communication partners, these are locked and cannot be replaced by other MAC addresses for at least 1 *ARP Aging Time* and a maximum of 2 *ARP Aging Time* periods. ▪ Tolerant: When a message is received, the IP address contained in the message is compared to the data in the ARP cache and the MAC address stored in the ARP cache is immediately overwritten with the MAC address from the message. The *Tolerant* setting must be used if the availability of communication is more important than the authorized access to the controller. Default setting: Conservative

Designation	Description
ICMP Mode	The Internet Control Message Protocol (ICMP) allows the higher protocol layers to detect error states on the network layer and optimize the transmission of data packets. Message types of Internet Control Message Protocol (ICMP) supported by the CPU module: ▪ No ICMP Responses All the ICMP commands are deactivated. This ensures a high degree of safety against potential sabotage that might occur over the network. ▪ Echo Response If Echo Response is activated, the node responds to a ping command. It is thus possible to determine if a node can be reached. Safety is still high. ▪ Host Unreachable Not important for the user. Only used for testing at the manufacturer's facility. ▪ All Implemented ICMP Responses All ICMP commands are activated. This allows a more detailed diagnosis of network malfunctions. Default setting: Echo Response

Table 20: Configuration Parameters, **Module** Tab

4.4.2 The **Routings** Tab

The **Routings** tab contains the routing table. This table is empty if the module is new. A maximum of 8 routing entries are possible.

Designation	Description
Name	Designation of the routing settings.
IP Address	Target IP address of the communication partner (with direct host routing) or network address (with subnet routing). Range of values: 0.0.0.0…255.255.255.255 Default value: 0.0.0.0
Subnet mask	Define the target address range for a routing entry. 255.255.255.255 (in connection with direct host routing) or subnet mask of the addressed subnet. Range of values: 0.0.0.0…255.255.255.255 Default value: 255.255.252.0
Gateway	IP address of the gateway to the addressed network. Range of values: 0.0.0.0…255.255.255.255 Default value: 0.0.0.1

Table 21: Routing Parameters

4.4.3 The **Ethernet Switch** Tab

The **Ethernet Switch** tab contains the following parameters:

Designation	Description
Name	Name of the port (Eth1, Eth2) as printed on the connector board; per port, only one configuration may exist.
Speed [MBit/s]	10: Data rate 10 Mbit/s 100: Data rate 100 Mbit/s Autoneg: Automatic baud rate setting. Default value: Autoneg
Flow Control	Full duplex: Simultaneous communication in both directions. Half duplex: Communication in one direction. Autoneg: Automatic communication control. Default value: Autoneg
Autoneg also with fixed values	The *Advertising* function (forwarding the speed and flow control properties) is also performed if the parameters *Speed* and *Flow Control* have fixed values. This allows other devices whose ports are set to *Autoneg* to detect the settings of the HIMax port settings. Default setting: Activated.
Limit	Limit the inbound multicast and/or broadcast packets. Off: No limitation. Broadcast: Limit broadcast packets (128 kbit/s) Multicast and Broadcast: Limit multicast and broadcast packets (1024 kbit/s) Default value: Broadcast

Table 22: Ethernet Switch Parameters

4.4.4 The **VLAN** Tab (Port-Based VLAN)

For configuring the use of port-based VLAN.

i Should VLAN be supported, port-based VLAN should be off to enable each port to communicate with the other switch ports.

For each port of a switch, the user can define to which other ports of the switch received Ethernet frames may be sent to.

The table in the VLAN tab contains entries through which the connection between two ports can be set to *active* or *inactive*.

Name	Eth1	Eth2
Eth1		
Eth2	Active	
CPU	Active	Active

Table 23: **VLAN** Tab

Default setting: All connections between ports are set to *Active*

4.4.5 The **LLDP** Tab

LLDP (Link Layer Discovery Protocol) periodically sends information on the own device via multicast (e.g., MAC address, device name, port number) and receives the same information from the neighboring devices.

The processor module supports LLDP on ports Eth1 and Eth2.

The following parameters define how a given port should work:

Off	LLDP is disabled on this port.
Send	LLDP sends LLDP Ethernet frames, received LLDP Ethernet frames are deleted without being processed.
Receive	LLDP sends no LLDP Ethernet frames, but received LLDP Ethernet frames are processed.
Send/Receive	LLDP sends and processes received LLDP Ethernet frames.

Default setting: Off.

4.4.6 The **Mirroring** Tab

Mirroring is used to configure whether the module should duplicate Ethernet packets on a given port such that they can be read from a device connected to that port, e.g., for test purposes.

The following parameters define how a given port should work:

Off	This port does not participate in the mirroring process.
Egress	Outgoing data of this port are duplicated.
Ingress	Incoming data of this port are duplicated.
Egress/Ingress	Incoming and outgoing data of this port are duplicated.
Dest Port	Duplicated data are sent to this port.

Default setting: Off.

If Mirroring is configured, exactly one port must be selected as the target.

4.5 Starting the Processor Module

The processor module can be started as described below:

- By inserting it into a base plate that is supplied with supply voltage.
- By switching on the supply voltage for the base plate in which the module is inserted.

The behavior of the module during start-up depends on the following factors:

- Position of the mode switch (see Chapter 3.5.16).
- Existence of a redundant processor module.
- Existence of a valid resource configuration including user programs in the non-volatile memory.

If the switch is set to Stop or Run, the processor module searches for additional processor modules.

- If no other processor modules exist, the module starts operation alone.
- If an additional processor module exists, the module attempts to automatically start operation based on the configuration of the existing processor module. Safety-related operation is maintained.

For further details on how to start up modules, refer to the HIMax system manual (HI 801 001 E).

The instructions specified in the safety manual (HI 801 003 E) must also be observed.

4.5.1 Starting Up Multiple Processor Modules

If the supply voltage is connected for a HIMax system containing multiple processor modules, the processor modules determine which processor module will start first. The system automatically controls the start order.

If the mode switch on the first processor module starting operation is in the *Run* position and Autostart is activated, the module automatically starts system operation. Afterwards, the other processor module starts system operation unless its switch position is *Init*.

If the mode switch of the first processor module starting operation is in the *Stop* position, this processor module enters the STOP state and the user program does not start. Afterwards, the other processor module enters the STOP state unless its switch position is *Init*, see Chapter 3.5.16.

The *Init* switch position does not influence the other processor module, see Chapter 3.5.16.

i Before switching on the supply voltage, set the mode switch on all processor modules to *Run* to ensure the automatic start.

5 Operation

The module is operated within a HIMax base plate. No specific monitoring is required.

5.1 Handling

Direct handling of the module is not foreseen.

The module's user program is operated, e.g., started or stopped, from within the PADT. For further details, refer to the SILworX documentation.

5.2 Diagnostics

LEDs on the front side of the module indicate the module state, see Chapter 3.5.7.

The processor module has a diagnostic memory that can be read using the PADT. The diagnostic memory can store up to 1500 diagnostic messages for short-term diagnosis and 2500 diagnostic messages for long-term diagnosis.

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 HIMax system manual (HI 801 001 E) and HIMax safety manual (HI 801 003 E).

6.1 Maintenance Measures

In rare cases, the following measures are required for the processor module:

- Load the operating system, if a new version is required.
- Perform the proof test.

6.1.1 Loading the Operating System

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

For detailed instructions on how to load the operating system, refer to the system manual (HI 801 001 E) and the online help. For loading the operating system, the processor module must be in the **OutOfRed** state (displayed in SILworX). Otherwise, stop the processor module's system operation.

i The module's operating system version can be read out via the SILworX Control Panel. The type label specifies the version when the module is delivered, see Chapter 3.4.

6.1.2 Proof Test

The proof test interval for HIMax modules must be in accordance with the interval required by the application-specific safety integrity level (SIL).

7 Decommissioning

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

8 Transport

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

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

9 Disposal

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

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

Appendix

Application Examples

The following chapters explain the proper use of the module. The module can be used in slots 1 and 2 of rack 0. The required I/O modules or COM modules can be inserted as from slot 3.

Connecting to the PADT

The connection to the PADT is made at the Ethernet interface Eth1 or Eth2 of the processor module inserted in rack 0.

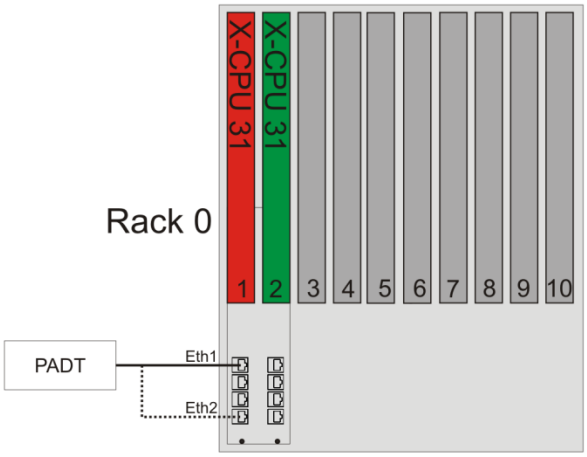


Figure 7: Rack 0 with PADT

Mono System

The processor module is inserted in slot 1 of rack 0, a spare module is inserted in slot 2. Only system bus A is therefore available.

A mono system with a processor module in slot 2 is not permitted. If the processor module is defective, slot 2 can be used for the duration of the repair. To do so, system bus B must be configured!

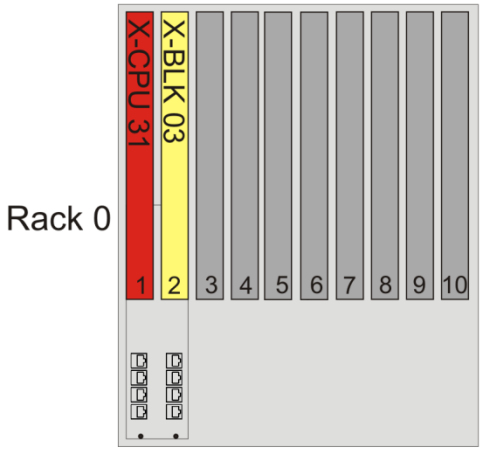


Figure 8: Mono System

Redundant System

If the system is configured redundantly, the processor modules are inserted in slots 1 and 2.

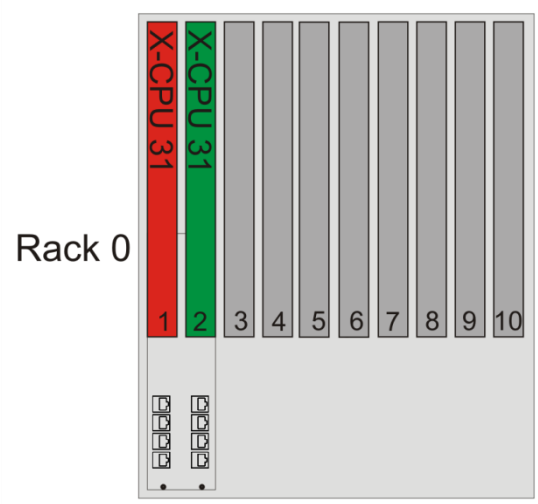


Figure 9: Redundant System

Redundant System with Extension Rack

The following figure shows the wiring of multiple racks. The processor modules must be located in the base plate (rack 0). The connection to the extension rack (rack 1, rack 2, …) is performed via the X-SB 01 system bus modules.

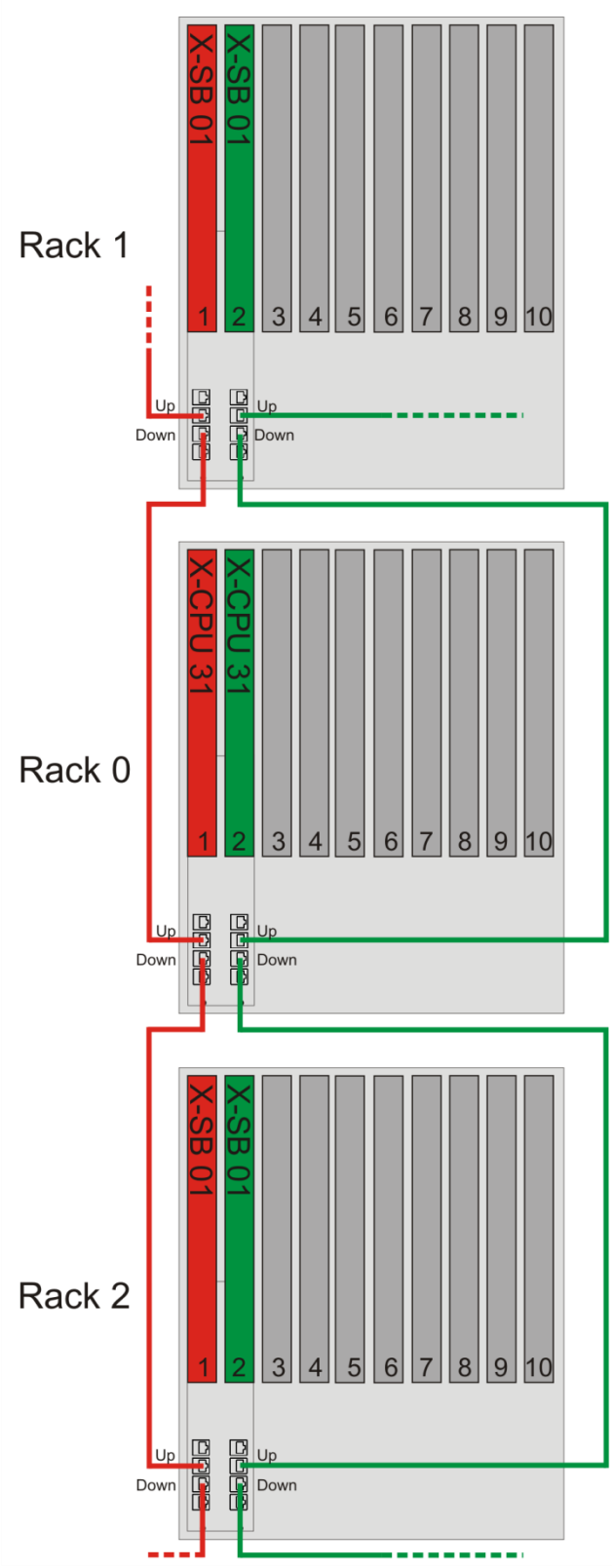


Figure 10: Rack 0 with Extension Racks

Glossary

Term	Description
AI	Analog input
AO	Analog output
ARP	Address resolution protocol, network protocol for assigning the network addresses to hardware addresses
COM	Communication module
CRC	Cyclic redundancy check
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
HW	Hardware
ICMP	Internet control message protocol, network protocol for status or error messages
IEC	International electrotechnical commission
Interference-free	Inputs are designed for interference-free operation and can be used in circuits with safety functions
MAC	Media access control address, hardware address of one network connection
PADT	Programming and debugging tool (in accordance with IEC 61131-3), PC with SILworX
PELV	Protective extra low voltage
PES	Programmable electronic system
R	Read, the variable is read out
R/W	Read/Write, column title for system variable type
Rack ID	Base plate identification (number)
r_P	Peak value of a total AC component
SB	System bus (module)
SC/OC	Short-circuit/open-circuit
SELV	Safety extra low voltage
SFF	Safe failure fraction, portion of faults that can be safely controlled
SIL	Safety integrity level (in accordance with IEC 61508)
SILworX	Programming tool
SNTP	Simple network time protocol (RFC 1769)
SRS	System.Rack.Slot, addressing of a module
SW	Software
TMO	Timeout
W	Write, the variable receives a value, e.g., from the user program
WD	Watchdog, device for monitoring the system's correct operation Signal for fault-free process
WDT	Watchdog time

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