
HIMA
SMART SAFETY.
Manual
HIQuad®X
F-CPU 01

Contact

HIMA Paul Hildebrandt GmbH

P.O. Box 1261

68777 Brühl

Phone: +49 6202 709-0

Fax: +49 6202 709-107

E-mail: info@hima.com

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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 the Document

The content of this manual is part of the hardware description of the HIQuad X 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.
HIQuad X system manual	Hardware description of the HIQuad X system	HI 803 211 E
HIQuad X safety manual	Safety functions of the HIQuad X system	HI 803 209 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. The documentation is available for registered HIMA customers in the download area 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 particularly marked. When the cursor hovers over a hyperlink, it changes its shape. Click the hyperlink to jump to the corresponding position.

Safety notices and operating tips are particularly 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 situations 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.

⚠ SIGNAL WORD

Type and source of risk!

Consequences arising from non-observance.

Risk prevention.

NOTICE

Type and source of damage!

Damage prevention.

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

i The text giving additional information is located here.

Useful tips and tricks appear as follows:

TIP The tip text is located here.

2 Safety

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

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

2.1 Intended Use

HIQuad X components are designed for assembling safety-related controller systems.

When using the components in the HIQuad X 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 HIQuad X 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 HIQuad X 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 a plant. 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 F-CPU 01 processor module is intended for use in the programmable electronic system (PES) HIQuad X.

The processor module is used for:

- Processing up to 32 user programs
- Performing all central functions including system bus communication.
- Handling redundancy with an additional processor module.
- Handling communication via safe**ethernet**.
- Creating and storing CPU and I/O events.
- Managing the system bus connections to the I/O processing modules (F-IOP 01).
- Managing the system ID.
- Providing the interface to the programming and debugging tool (PADT).

A maximum of two processor modules may be inserted in the base rack. The permitted slots are specified in Chapter 4.1.1.

If the base rack contains one processor module, the HIQuad X system only operates with one system bus (mono operation). If two processor modules are used, the HIQuad X system operates with redundant system bus A and system bus B (redundancy operation).

HIMA recommends using redundancy operation (default) to exploit the high availability of the HIQuad X 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).

Refer to the HIMA website and the HIQuad X safety manual (HI 803 209 E) for more information on the standards used to test and certify the module and the HIQuad X system.

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 (HIQuad X, 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.
- Safe communication between HIQuad X and HIQuad using the safety-related HIPRO-S V2 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 system bus subscribers.

3.1.1 Response in the Event of a Fault

If the processor module detects internal faults, it enters the ERROR STOP state and restarts. 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

The module is delivered with no additional accessories.

3.3 Type Label

The type label specifies the following important details:

- Product name
- Mark of conformity
- Part no.
- Serial number
- Hardware revision index (HW-Rev.)
- Operating system revision index (OS-Rev.)
- Ex specifications (if applicable)
- Production year (Prod-Year:)

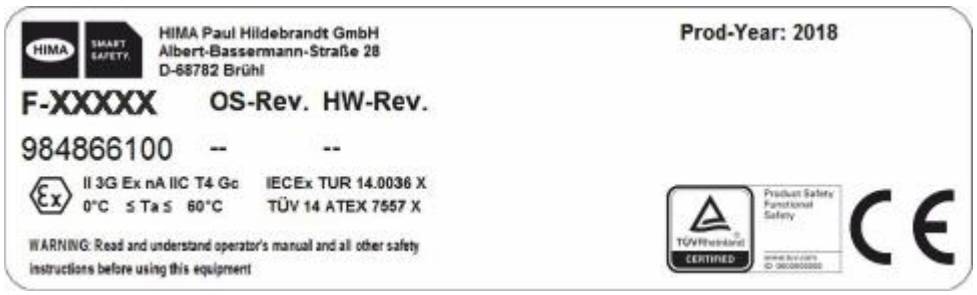


Figure 1: Sample Type Label

3.4 Structure

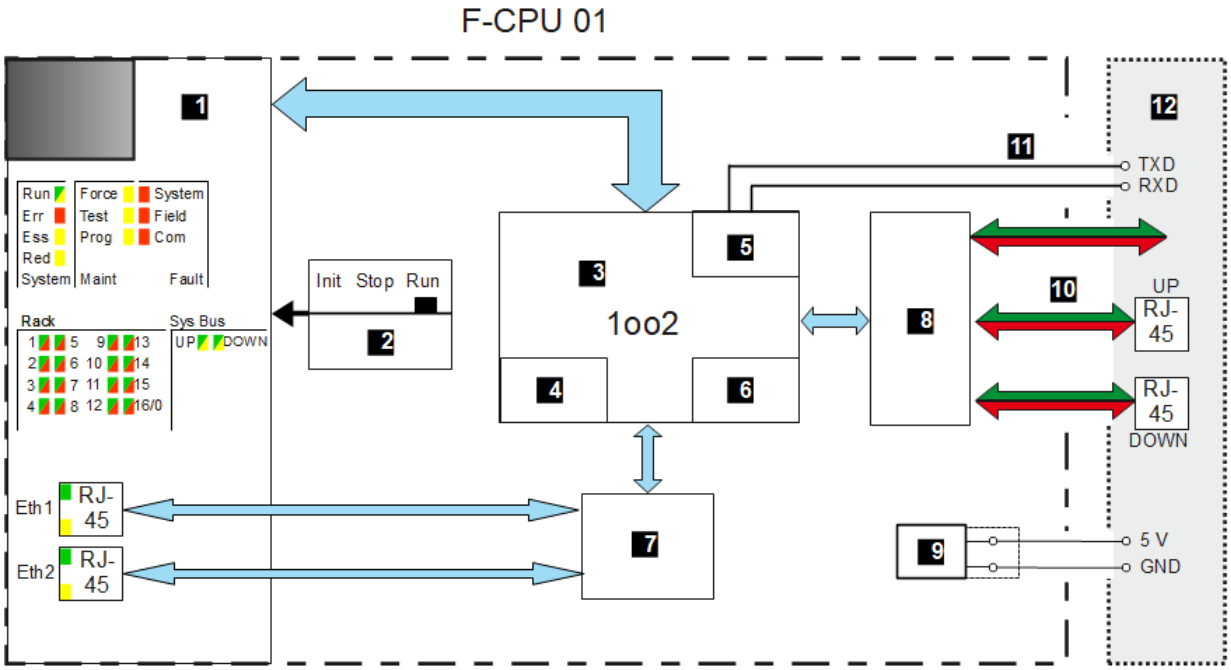
The processor module is a plug-in module that is inserted into a base rack and supplied with electric power.

Essential functional units of the module are:

- Safety-related 1oo2 processor system, see Chapter 3.4.2.
- Ethernet switch.
- Memory, see Chapter 3.4.3
- Ethernet interfaces, see Chapter 3.4.4.
- Mode switch, see Chapter 3.4.8.
- Indicators, see Chapter 3.4.7.

3.4.1 Block Diagram

The following block diagram illustrates the structure of the module.



1 Front plate
2 Mode switch on the front plate rear side.
3 1oo2 processor system
4 Memory
5 Comparator
6 Watchdog
7 Ethernet switch for external communication
8 Ethernet switch for system bus communication
9 Power supply
10 System bus A or system bus B
11 Infobus
12 Base rack

Figure 2: Block Diagram

3.4.2 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.

The 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 HIQuad X system. The processor module in the left base rack slot controls and monitors system bus A whereas the processor module in the right slot controls and monitors system bus B. During redundancy operation, the two processor modules communicate via system bus A and system bus B. The connection to the redundant system bus is established via the redundant processor module.

3.4.3 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 and trimming data.
- Fault status history.
- Events.
- SRS.

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

3.4.4 Ethernet Interfaces

The Ethernet interfaces serve to connect to the PADT 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 Service Interfaces

3.4.5 System Bus Interfaces

The system bus interfaces connect system buses A and B to the I/O level via the I/O processing module. Patch cables complying with Ethernet standard (at least Cat. 5e in accordance with IEEE 802.3) must be used to connect the system buses. The maximum length of the patch cable between two system bus subscribers is 50 m.

System bus interfaces	
Number	▪ H41X base rack: 2 ▪ H51X base rack: 4
Transfer Rate	100 Mbit/s, full duplex
Connection socket	RJ-45 (on the rear side of the base racks)
Labeling (base rack)	▪ Base rack H41X: Sys A UP, Sys B UP ▪ Base rack H51X: Sys A DOWN, Sys B DOWN, Sys A UP, Sys B UP

Table 3: Specifications for the System Bus Interfaces

3.4.6 Ports in Use for Ethernet Communication

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

Table 4: Ports in Use

3.4.7 Indicators

The following figure shows the front view of the module with the LEDs and both Ethernet connection sockets.

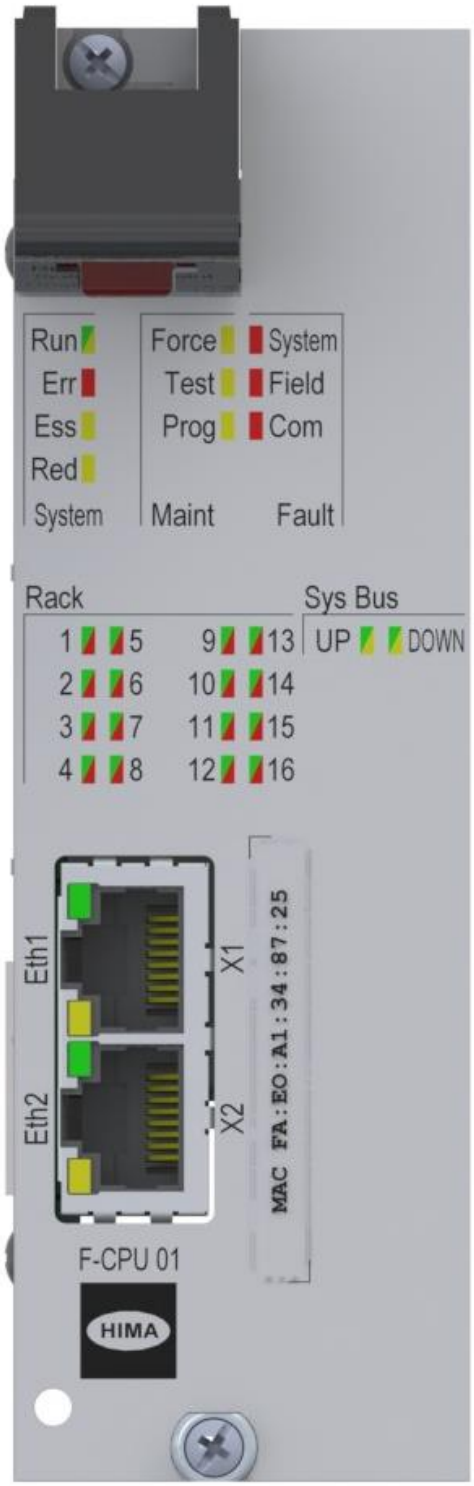


Figure 3: Front View

Additionally, a label specifying the MAC address is located on the front plate.

The mode switch is located on the front plate rear side.

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:

- System status indicators (Run, Err, Ess, Red)
- Maintenance indicators (Force, Test, Prog)
- Fault indicators (System, Field, Com)
- Rack connection indicators (rack 1…16)
- System bus indicators (UP, DOWN)
- Communication indicators (Eth1, Eth2)

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.

3.4.7.1 System status indicators

The system status indicator LEDs are labeled *System*.

LED	Color	Status	Description
RUN	Green	On	Module in the RUN state, normal operation. A loaded user program is being processed.
		Blinking1	Module state: OPERATE.
	Yellow	On	The module is in one of the following states: ▪ Module state: STOP / VALID CONFIGURATION ▪ The emergency loader is active.
		Blinking1	The module is in one of the following states: ▪ STOP / INVALID CONFIGURATION. ▪ STOP / LOADING OS. ▪ INIT / OutOfGroup. ▪ MODESWITCH_INIT.
Err	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. ▪ Error while loading the operating system. ▪ The emergency loader is active.
		Off	No faults detected.
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 module is in one of the following states: ▪ The processor module starts redundant operation. ▪ Less processor modules than configured are operating redundantly.
		Off	The processor module is not operating redundantly, no redundancy configured.

Table 6: System Status Indicators

3.4.7.2 Maintenance Indicators

The maintenance indicator 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 7: Maintenance Indicators

3.4.7.3 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 respond 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). ▪ Line monitoring (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 disturbed external data communication. Example: No connection to the communication partner.
		Off	Communication OK.

Table 8: Fault Indicators

3.4.7.4 Rack Connection Indicators

The rack connection indicator LEDs are labeled *Rack*.

LED	Color	Status	Description
1…16	Green	On	The rack is connected and returns no errors or warnings.
		Blinking2	The rack is connected and returns no errors or warnings. The service mode is activated.
	Red	On	▪ The rack is connected and returns warnings. ▪ The rack is connected, but not configured.
		Blinking1	▪ The rack is connected and returns errors. ▪ The rack is configured, but not connected.
		Blinking2	The rack is connected and returns an error or a warning. The service mode is activated.
	Off	Off	The rack is neither configured nor connected.

Table 9: Rack Connection Indicators

3.4.7.5 System Bus Indicators

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

LED	Color	Status	Description
UP, DOWN	Green	On	There is a logical and physical connection to at least one I/O processing module.
		Blinking1	There is a logical and physical connection to at least one I/O processing module. A transient error occurred on the system bus.
	Yellow	On	There is only a physical but no logical connection to a system bus subscriber.
		Blinking2	There is a physical connection to a system bus subscriber, but it is improperly configured.
	Off	Off	There is no connection to another system bus subscribers device.

Table 10: System Bus Indicators

3.4.7.6 Communication Indicators

All RJ-45 connectors are provided with a green and a yellow LEDs. The LEDs signal the following states:

Connector	LED	Status	Description
Eth1, Eth2	Green	On	Connection available, no communication.
		Blinking1	IP address conflict, all communication LEDs are blinking.
		Blinking-x	Interface activity.
		Off	No connection available.
	Yellow	On	Full duplex operation.
		Blinking1	IP address conflict, all communication LEDs are blinking.
		Blinking-x	Collision.
		Off	Half duplex operation, no collision.

Table 11: Ethernet Indicators

3.4.8 Mode Switch

The mode switch is located on the front plate rear side. The switch position can only be changed when the module is removed.

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*.

3.4.8.1 Switch Position: Init

If the switch is set to *Init*, the processor module enters the MODESWITCH_INIT 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 MODESWITCH_INIT 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.

3.4.8.2 Transition from MODESWITCH_INIT State to System Operation

Requirement:

- Processor module state: MODESWITCH_INIT.

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

- 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 MODESWITCH_INIT 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*!

3.4.8.3 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.
- Redundant 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*!

3.4.8.4 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.
- Redundant 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!

3.4.8.5 Overview of the Switch Positions

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

Switch position	Single processor module	Additional processor module (redundant operation)
Init	Enters the MODESWITCH_INIT state with the factory settings.	
Init: Command from PADT ▪ System operation ▪ Cold start	MODESWITCH_INIT → RUN (Mono operation)	Starts redundant operation.
STOP	Enters the STOP state.	
RUN	Executes the user programs.	

Table 12: Overview of the Mode Switch Positions

3.4.9 Monitoring the Supply Voltages

The power supplies (F-PWR 01) monitor the values of the 24 V supply voltage (L1+/L1-, L2+/L2-) and 5 V supply voltage of the HIQuad X system, refer to the F-PWR 01 manual (HI 803 225 E) for details. The voltage values and the monitoring results are provided to the processor module via the infobus.

System variables can be used to evaluate the state of the supply voltage in the user program. For details on the system variables, refer to the system manual (HI 803 211 E).

In interference is present on the Infobus, the values are not available.

Additionally, the processor module monitors and tests its internal voltages. If the internal voltages fail, the system enters the ERROR STOP state.

3.4.10 Temperature Monitoring

Sensors continuously measure 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 threshold	Temperature state	*Temperature State [X]* [BYTE]
≤ 40 °C	Normal	0x00
> 40 °C	Warning: Threshold 1 exceeded.	0x01
> 60 °C	Error: Threshold 2 exceeded.	0x03

Table 13: Temperature State

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

Table 13 applies when the HIQuad X 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. The system variables can be evaluated in the user program. For details on the system variables, refer to the system manual (HI 803 211 E).

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.

3.4.11 Operating System

The operating system of the processor module contains all basic functions of the HIQuad X programmable electronic system (PES), for example:

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

For a thorough description of the operating system functions, refer to the system manual (HI 803 211 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.

3.5 Product Data

General	
Current consumption	2 A at 5 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...5000
Size of the non-volatile event buffer	1000 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...+70 °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
Space requirement	8 HP
Weight	Approx. 470 g

Table 14: Product Data

4 Start-Up

The processor module is started up by inserting it into a permissible base rack slot, see Chapter 4.1.1.

If the base rack 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 rack 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 HIQuad X base rack. For more information on how to structure the base rack, refer to the system manual (HI 803 211 E).
- Only operate the processor module in the permissible slot, see Chapter 4.1.1.
- Only operate the module with forced cooling (fan rack).
- Modifications or extensions to the system wiring must be performed by personnel with knowledge of ESD protective measures.

NOTICE

Electrostatic discharge!

Failure to comply with these instructions can destroy 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 3.5.

4.1.1 Slots Permitted for the Processor Module

The following points must be observed when assigning the slots to the processor modules, including the Hardware Editor:

- A maximum of two processor modules may be used.
- A processor module occupies two slots. SILworX shows the left slot.
- Processor modules in the H41X basis rack (F-BASE RACK 02, K 1422) are only permitted in base rack slots 16 and 18.
- Processor modules in the H51X basis rack (F-BASE RACK 01, K 1421) are only permitted in base rack slots 08 and 10.
- No processor modules are permitted in the extension rack (F-BASE RACK 11, K 1406).

4.2 Mounting and Removing the Module

This chapter describes how to mount and remove a module.

The following points must be adhered to when mounting and removing modules:

- Quickly disconnect the modules from the backplane to avoid faulty signals in the system that could cause its shutdown.
- Only use the module in the designated slot.

i HIMA cannot be made liable for consequential loss caused by improperly removing and reinserting the modules.

NOTICE

Damage to bus and power sockets due to module jamming!

Failure to comply with these instructions can damage the controller.

Always insert the modules in the racks carefully.

Tools:

- Screwdriver, cross PH1.

Installation:

1. Check the mode switch and configure it in accordance with the application.
2. Pull back as far as possible the fastening screws on the module's front plate.
3. Carefully insert the module into the guiding rail of the intended slot and push it in the rack as far as it can go.
4. Push the red release button bottom up to unlock the extractor handle.
5. With your thumbs, press the module carefully, but quickly inwards as far as it can go to ensure that no faulty signals are triggered within the system.
6. Press the extractor handle down until it snaps into position.
7. Tighten the fastening screws of the module (max. 0.35 Nm).
8. If provided, insert the patch cables.

► The module is mounted.

Removal:

1. If present, remove the patch cables.
2. Completely release the fastening screws from the module.
3. Push the red release button bottom up to unlock the extractor handle.
4. Completely push the extractor handle upwards to rapidly separate the module from the backplane. This avoids faulty signals.
5. Press the extractor handle down once again until it snaps into position.
6. Remove the module from the rack holding it by the extractor handle.

► The module is removed.

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. This ensures that data packets cannot be intentionally or unintentionally forwarded to external network subscribers (ARP spoofing). ▪ 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 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 15: Module Parameters

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 16: 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 front plate; 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 setting of the HIQuad X ports. 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 17: Ethernet Switch Parameters

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

This tab is used to configure the use of port-based VLAN.

i If standard VLAN is to be supported, port-based VLAN must be switched 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 18: **VLAN** Tab

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

4.4.5 The **Mirroring** Tab

This tab 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:

- Insert the module into a base rack that is supplied with supply voltage.
- Switch on the supply voltage of the base rack 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 3.4.8).
- 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 more information on how to start up modules, refer to the HIQuad X system manual (HI 803 211 E).

The instructions specified in the safety manual (HI 803 209 E) must also be observed.

4.5.1 Starting up Multiple Processor Modules

If the supply voltage is connected for a HIQuad X 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 3.4.8.

The *Init* switch position does not influence the other processor module 3.4.8.

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 HIQuad X base rack. 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 more details, refer to the SILworX documentation.

5.2 Diagnostics

LEDs on the front side of the module indicate the module state, see Chapter 3.4.7.

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.

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.

6.1 Maintenance Measures

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 803 211 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 3.3.

6.1.2 Proof Test

The proof test interval for HIQuad X 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 rack. For more details, refer to the Chapter *Mounting and Removing the Module*.

8 Transport

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

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

9 Disposal

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

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

Appendix

Glossary

Term	Description
AI	Analog input
AO	Analog output
ARP	Address resolution protocol, network protocol for assigning the network addresses to hardware addresses
COM	Communication module
CRC	Cyclic redundancy check
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
HW	Hardware
ICMP	Internet control message protocol, network protocol for status or error messages
IEC	International electrotechnical commission
Interference-free	Inputs are designed for interference-free operation and can be used in circuits with safety functions
MAC	Media access control address, hardware address of one network connection
PADT	Programming and debugging tool (in accordance with IEC 61131-3), PC with SILworX
PELV	Protective extra low voltage
PES	Programmable electronic system
R	Read, the variable is read out
R/W	Read/Write, column title for system variable type
Rack ID	Rack identification (number)
r_P	Peak value of a total AC component
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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For further information, please contact:

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

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

Learn more about HIMA solutions online:

www.hima.com/en/

www.hima.com