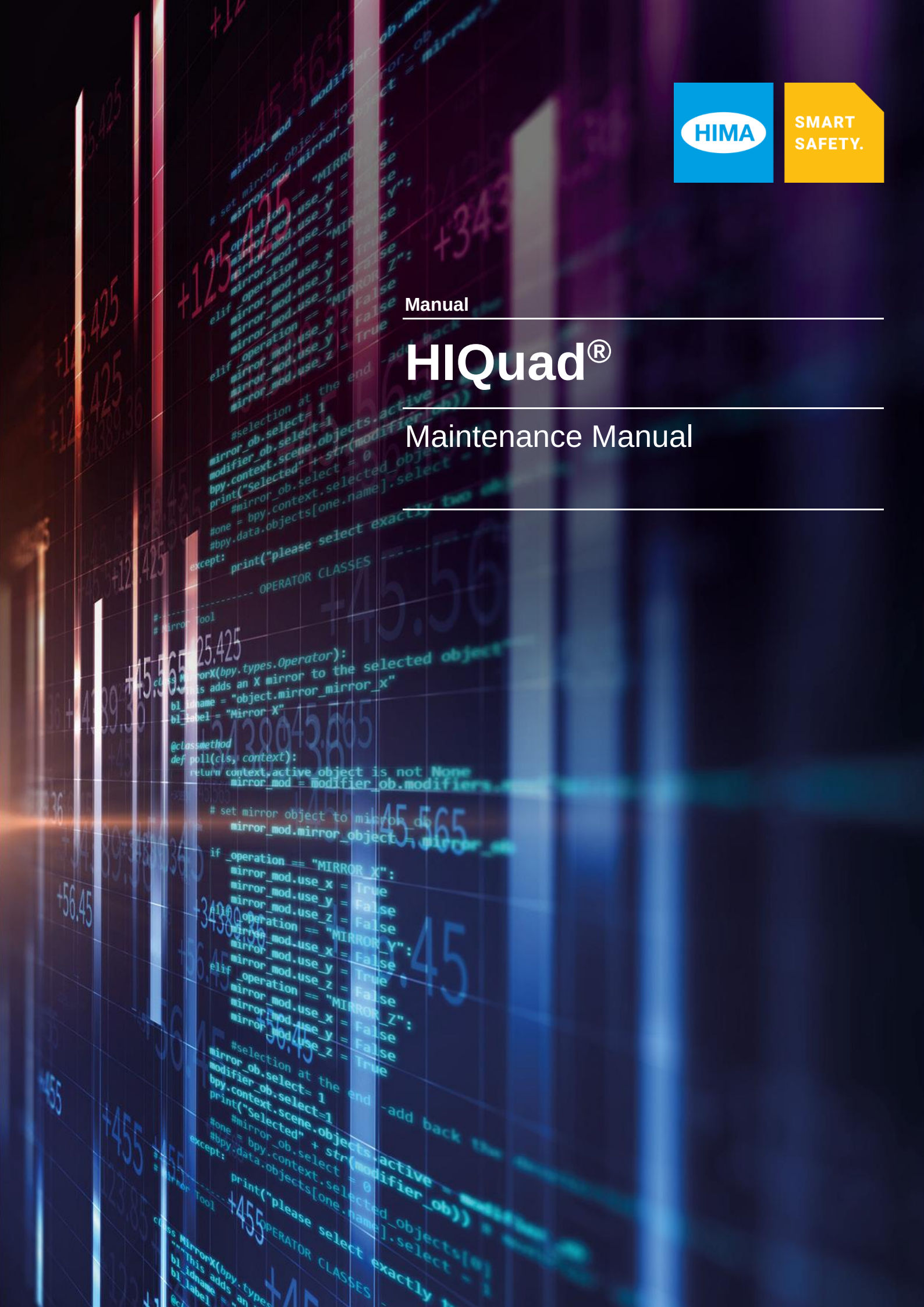

HIMA

SMART SAFETY.

Manual

HIQuad®

Maintenance Manual

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Document designation	Description
HI 800 438 D, Rev. 1.05 (1947)	German original document
HI 800 439 E, Rev. 1.05.00 (1948)	English translation of the German original document

Table of Contents

1 Introduction

This document describes all relevant activities for servicing and operating safety-related HIQuad controllers.

- Chapter 2 lists the activities in a table.
- Chapter 3 describes the proof test.
- Chapter 4 lists the manuals to be observed and other applicable documents.
- Chapter 5 includes maintenance action details.

1.1 Target Audience and Required Know-How

This manual is aimed at the planners, design engineers, programmers and maintenance personnel of automation systems. Specialized knowledge of safety-related automation systems is required.

Additional knowledge is necessary for maintenance activities on the HIQuad system hardware and software, e.g., for reading and evaluating diagnostics.

For work on safety-related automation systems, the safety standards demand proof of the qualifications required for maintenance personnel.

Qualified HIMA service personnel can be requested to perform maintenance tasks in accordance with the manufacturer's instructions. HIMA also offers specific training seminars to qualify the maintenance personnel.

HIMA recommends the following seminars for performing maintenance tasks:

- **FS 101** Functional safety for maintenance and operation
- **PT 320** ELOP II Maintenance with HIQuad

1.2 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.

1.2.1 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.

1.2.2 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.

1.3 Safety Lifecycle Services

HIMA provides support throughout all the phases of a 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 Operating and Maintenance Activities

The operating and maintenance activities of the individual system components are listed in the following table.

2.1 Activities Recurring in the Short Term

The HIQuad system must be tested by the operator at short recurring intervals in line with the Automation Security policy. The operator must specify the test details in a security risk analysis; refer to the automation security manual (HI 801 373 E).

2.2 Activities Recurring on an Annual Basis

The chapter specifies the activities recurring on an annual basis.

2.2.1 Mechanical Test (Visual Inspection)

The table specifies the maintenance activities for the mechanics:

Activity	Who	Reference
Check the module screws for firm connection, tighten if necessary.	Operating company, assembler, maintenance personnel	
Check the cable plug screws for firm connection, tighten if necessary.	Operating company, assembler, maintenance personnel	
Check the data cables for firm connection, including to the communication modules.	Operating company, assembler, maintenance personnel	
Check the fans for proper function.	Operating company, assembler, maintenance personnel	

Table 1: Annual Activities for the Mechanics

2.2.2 Power Supply Test

The table specifies the maintenance activities for the power supply:

Activity	Who	Reference
Check the 230 VAC/24 VDC power supply for compliance with tolerances, 24 VDC, -15…+20 %, $r_p \leq 5$ %.	Operating company, assembler, maintenance personnel	
Visually check the 24 VDC distribution. Check any existing decoupling diodes for proper function.	Operating company, assembler, maintenance personnel	
Check the 24 VDC/5 VDC power supply of the F 7126, F 7130A power supply units for compliance with the voltage range 5…5.4 V.	Operating company, assembler, maintenance personnel	D6
Check the 5 VDC power supply of the I/O subrack for compliance with the voltage ≥ 4.85 V.	Operating company, assembler, maintenance personnel	
Check the redundant supply for proper function.	Operating company, assembler, maintenance personnel	

Table 2: Annual Activities for the Power Supply

2.3 Activities Recurring in the Long Term

The chapter specifies activities recurring in the long term.

2.3.1 Hardware

The table specifies the maintenance activities for the hardware:

Activity	Who	Reference
At an operating temperature of > 40 °C: Replace the fans K 9203A, K 9202B and K 9212 every **2.5** years.	Operating company, assembler, maintenance personnel	Chapter 5.1
At an operating temperature of ≤ 40 °C: Replace the fans K 9203A, K 9202B and K 9212 every **5** years.	Operating company, assembler, maintenance personnel	Chapter 5.1
In the case of a safety-related application in accordance with SIL 3, check the F 3430 relay module for proper function every **5** years.	Operating company, assembler, maintenance personnel	D6
In the case of a safety-related application in accordance with SIL 2, replace the F 3430 relay module every **20** years.	Operating company, assembler, maintenance personnel	D6, Chapter 5.3
In the case of a safety-related application in accordance with SIL 2, check the H 4116 relay in terminal housing for proper functioning every **5** years.	Operating company, assembler, maintenance personnel	D7
In the case of a safety-related application in accordance with SIL 2, check the H 4134 relay in terminal housing for proper functioning every **5** years.	Operating company, assembler, maintenance personnel	D7
In the case of a safety-related application in accordance with SIL 3, check the H 4135 or H 4135A relay in terminal housing for proper functioning every **5** years.	Operating company, assembler, maintenance personnel	D7
In the case of a safety-related application in accordance with SIL 2, check the H 4135 or H 4135A relay in terminal housing for proper functioning every **20** years.	Operating company, assembler, maintenance personnel	D7
In the case of a safety-related application in accordance with SIL 3, check the H 4136 relay in terminal housing for proper functioning every **5** years.	Operating company, assembler, maintenance personnel	D7
In the case of a safety-related application in accordance with SIL 2, check the H 4136 relay in terminal housing for proper functioning every **20** years.	Operating company, assembler, maintenance personnel	D7
Replace the back-up battery in F 7131 after **6** years at the latest.	Operating company, assembler, maintenance personnel, HIMA	Chapter 5.2
Replace the back-up battery in F 865X after **6** years at the latest.	Operating company, assembler, maintenance personnel, HIMA	Chapter 5.2
Replace the back-up battery in the backplane PCB of H41q after **6** years at the latest, if F 8621A is used.	Operating company, assembler, maintenance personnel, HIMA	Chapter 5.2
Due to the short lifetime of the built-in electrolytic capacitors[1)], replace the PS 1000 power supply unit every **10** years.	Operating company, assembler, maintenance personnel, HIMA	D6, Chapter 5.3
Due to the short lifetime of the built-in electrolytic capacitors[1)], replace the F 7130A (H41q) and F 7126 (H51q) power supply units every **10** years.	Operating company, assembler, maintenance personnel, HIMA	D6, Chapter 5.3

Activity	Who	Reference
Replace the electrolytic capacitors[1)] on the F 3237 I/O module every **10** years. For maintenance, send modules to HIMA.	Operating company, assembler, maintenance personnel, HIMA	D6 Chapter 5.3
Replace the electrolytic capacitors[1)] on the following I/O modules every **10** years: F 6213 and F 6214. For maintenance, send modules to HIMA.	Operating company, assembler, maintenance personnel, HIMA	D6 Chapter 5.3
Replace the electrolytic capacitors[1)] on the following I/O modules every **20** years: F 3238, F 3240, F 3248, F 3325, F 3335, F 3348, F 3349, F 3430, F 5220, F 6217, F 6705, F 6706 and F 7553. For maintenance, send modules to HIMA.	Operating company, assembler, maintenance personnel, HIMA	D6 Chapter 5.3
1) The lifetime of electrolytic capacitors depends on the temperature Typical manufacturer specifications: > 10 years at an operating temperature of ≤ 40 °C.		

Table 3: Activities for the Hardware Recurring in the Long Term

2.3.2 Proof Test

The table specifies the activities for the proof test:

Activity	Who	Reference
The proof test interval must be in accordance with the interval required by the application-specific safety integrity level (SIL). The complete safety functions within the HIMA safety-related system must be checked during the proof test.	Operating company, assembler, maintenance personnel	N2, D2 Chapter 3.1

Table 4: Proof Test

2.4 Activities as Required

The chapter specifies activities to be carried out as required.

2.4.1 Hardware

The table specifies the activities for the hardware:

Activity	Who	Reference
Replace the modules.	Operating company, assembler, maintenance personnel	D6 Chapter 5.3

Table 5: Activities for the Hardware to be Carried out as Required

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

NOTICE

Damage 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 component is protected from electrostatic discharge, e.g., by storing it in its packaging.**

Use a grounding strap and connect it to the ESD connection point on the control cabinet before touching the module to preclude any potential residual charge during module replacement. This also applies when inserting the plugs of cables and data lines.

If the control cabinet is not provided with an ESD connection point, get in contact with a grounded part of the control cabinet before touching the module.

Avoid any direct contact with electronic module components and their PCBs. Only touch the modules by their handles.

2.4.2 Software

The table specifies the maintenance activities for the software:

Activity	Who	Reference
Loading the user program.	Operating company, assembler, maintenance personnel	
Load new operating systems.	Operating company, assembler, maintenance personnel	D1
Change the system parameters.	Operating company, assembler, maintenance personnel	D2, D5, D6

Table 6: Activities for the Software to be Carried out as Required

3 Proof Test (in Accordance with IEC 61508)

HIMA safety systems must be subject to a proof test in regular intervals. The proof test interval for HIMA controllers must be in accordance with the interval required by the application-specific safety integrity level (SIL). The proof test must comply with the applicable safety standards.

Refer to the functional safety data manual (HI 803 001 E) for the safety-related characteristic values of HIMA's HIQuad system.

3.1 Proof Testing

The proof test is performed by powering off and on again the controller. When the controller is restarted, all electronic components (e.g., memory and processors) are initialized and all diagnostic tests are performed simultaneously.

To perform the proof test

1. Power off the controller (Power OFF).
2. Power on the controller (Power ON).
   ☑ Restart completed.
3. After the restart, read out the following diagnostic information and check for error entries:
   - LEDs on the modules.
   - Warning and error counter in the Control Panel.
   - Diagnostic files of the processor modules.

Proof test as a part of the functional test (loop test)

Proof testing can be dispensed with if the complete safety functions between field level and controller are tested with sufficient testing depth within the specified intervals. The test of the complete safety functions includes all field devices connected to the controller, such as sensors and actuators.

The input and output modules of the safety controller can be tested independently of one another. The safety controller's application logic test is completed through a CRC check with the version comparator.

When testing analog signals in HIQuad modules, a sufficient testing depth is achieved by:

- Running through the nominal range, e.g., 0/4…20 mA, and simultaneously checking the switching thresholds.
- Underrunning the open-circuit limit, e.g., ≤ 3.6 mA.
- Overrunning the short-circuit limit, e.g., ≥ 21.0 mA.

When testing binary signals in HIQuad modules, a sufficient testing depth is achieved by:

- Checking the switching thresholds for high and low levels.
- Checking for open-circuits, if possible.
- Checking for short-circuits, if possible.

When testing counter signals in HIQuad modules, a sufficient testing depth is achieved by:

- Checking the switching thresholds for high and low levels.
- Checking the signal nominal range at 1 %, 10 %, 50 % and 100 %.
- Checking for open-circuits (line breaks), if possible.
- Checking for short-circuits, if possible.

The frequency values, in particular the error bits and value changes, must be checked and documented for 30 s each.

While testing the complete safety functions, the controller's response must be monitored using the SILworX programming tool. Significant channel information such as error states, channel values, open-circuits or short-circuits, must be monitored and documented.

If errors occur, they must be promptly removed (< MTTR for high demand mode) and the corresponding tests must be repeated.

4 Other Applicable Documents

The following table specifies other applicable documents.

Reference	Standard/Document ID	Description
N1	IEC 61511-1, Section 12	Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements
N2	IEC 61508-4, Section 3.8.5	Proof Test
D1	HI 800 105 E	HIQuad operating System Manual
D2	HI 800 013 E	HIQuad safety manual
D3	HI 803 001 E	HIQuad functional safety data manual
D4	HI 801 373 E	Automation security manual
D5	---	ELOP II online help
D6	**Data Sheets for the HIQuad Modules**	
Reference	Standard/Document ID	Description
D7	**Additional manuals or data sheets**	
	HI 803 229 E	H 7034
	HI 803 231 E	H 7035
	HI 803 007 E	H 4116
	HI 803 025 E	H 4134
	HI 803 003 E	H 4135A
	HI 803 009 E	H 4136

Table 7: Other Applicable Documentation

5 Maintenance Actions in Details

This chapter describes the maintenance actions for each module and other components of the H41q/H51q system.

i Only qualified personnel may perform maintenance actions to supply, signal and data lines, taking all ESD protection measures into account. Personnel must be electrostatically discharged prior to any direct contact with these supply or signal lines!

5.1 Replacing the Fans

The frequency with which the fans are replaced depends on the operating temperature.

HIMA recommends observing the instructions for replacing the system fans:

- every 5 years, at normal operating temperature (< 40 °C)
- every 2.5 years, at higher operating temperature (> 40 °C)

Refer to the specific data sheets (K 9212, K 9203 and K 9202) for further details.

To replace older fan types, please contact the HIMA Service.

5.2 Replacing Back-Up Batteries

Lithium batteries are used as back-up batteries.

Lifetime of back-up batteries (CPU not in operation, module without power supply):

1000 Days at t_A = 25 °C
200 Days at t_A = 60 °C

HIMA recommends replacing the back-up batteries (CPU in operation, modules with power supply) within 6 years.

HIMA recommends replacing the battery within three months if *BATI* appears on the display.

5.2.1 Replacing the External Batteries of the H41q/H51q Systems

To replace a battery with no soldering tag (CR-1/2 AA-CD, HIMA Part No. 440000019)

1. Remove the battery cap.
2. Release the battery from its fixture.
3. Insert the new battery, ensure proper polarity.

► The battery is now replaced.

To replace a battery with soldering tag (CR-1/2 AA-CD, HIMA Part No. 440000016)

1. Unsolder the battery, first the positive, then the negative pole.
2. First solder the negative pole onto the battery, then the positive pole. In the process, ensure proper polarity!

► The battery is now replaced.

5.2.2 External Batteries for H41q Systems: Rear Side of the Bus PCB

Replace the battery as described above, depending on the type of battery.

5.2.3 External Batteries for H51q Systems: F 7131 Power Supply Monitoring

The module can be removed under voltage. Then, continue the replacement as described above.

5.2.4 Central Modules F 8650E/F 8650X/F 8651E/F 8651X/F 8652E/F 8652X/F 8653E/F 8653X

Battery: CR 2477N, HIMA Part No. 440000018

To replace the battery, the central module must be removed from the subrack!

Make sure to observe the instructions provided in Chapter 5.3. Removing the central module from the subrack of mono systems causes the systems to fail whereas the response of redundant systems depends on their configuration.

5.2.5 F 8621A Co-Processor Module

The co-processor module can be optionally mounted in the central subrack of the H41q/H51q system family. In the H41q system, batteries installed on the backplane PCB buffer the module whereas in the H51q system, this task is carried out by the F 7131 power supply monitoring module.

5.3 Replacing Modules

Defective modules must be replaced with modules of the same type or with an approved replacement model. For the approved hardware revision indexes and firmware versions, refer to the TÜV version list of the HIQuad system.

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

- Strictly observe the following instructions when removing and reinserting the modules of HIMA H41q and H51q systems.
- Quickly disconnect the modules from the backplane to avoid faulty signals in the system that could cause its shutdown.
- Do not jam the modules by using a screwdriver or shaking them.

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

5.3.1 I/O Modules

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

To remove the I/O module

1. Release the fastening screws from the module.
2. Remove the module with inserted cable plug.
3. Unscrew and pull out the cable plug.

► The I/O module is now removed from the subrack.

To insert the I/O module

1. Insert the module without cable plug and screw it in place.
2. Plug in the cable plug and screw it in place.
3. Applying to safety-related modules and modules with slot detection:
   Press the **ACK** push-button on the central module to delete the message on the display.

► The I/O module is now inserted in the subrack.

5.3.2 Connection Modules

To remove the connection module

1. Switch off the module (**WD** switch set to *OFF*).
2. Release the fastening screws from the module.
3. Remove the module.
   ☑ The associated I/O subrack is switched off.

► The connection module is now removed.

i Removing the connection module without previously switching it off causes the watchdog signal to be switched off for all the I/O subracks. This causes MS and HS systems to enter the error stop state.

To insert the connection module

1. Set up the coding switch in accordance with the F 7553 data sheet.
2. Insert the module and screw it in place.
3. Switch on the module (**WD** switch set to *ON*).
4. Press the **ACK** push-button on the central module. *RUN* appears on the display.

► The connection module is now inserted.

5.3.3 Central Modules (CU)

HIQuad controllers use a technology allowing faulty central modules in the *STOP* state to be replaced during operation.
However, avoid removing a redundant central module that is in the *RUN* state since the redundant central modules continuously communicate with one another for synchronization. Removing a redundant central module from operation causes signal interference on the backplane. In seldom cases, this can trigger an error stop on the remaining central module and cause the PES to enter the safe state.
To prevent a faulty response, always bring the central module in the *STOP* state before removing it (e.g., by deleting the user program). Afterwards, communication between the two central modules is interrupted. Removing the stopped central module no longer generates signal interference on the backplane potentially disturbing the remaining central module.

i Prior to removing a redundant central module in the *RUN* state, HIMA recommends deleting the user program. Refer to the operating system manual (HI 800 105 E) for details on how to delete the user program.

To remove the central module

1. Release the screws of the data cable plug.
2. Pull out the data cable.
3. If required, read out the diagnostics and then delete the user program.
4. Completely release the fastening screws from the module: they must be entirely loose.
5. Firmly push the ejection lever (type label) down to quickly separate the module from the backplane. This avoids faulty signals in the system that could cause its shutdown.
6. Completely remove the module.

► The central module is now removed from the subrack.

Do not touch the module components! Observe the ESD rules for CMOS components.

To insert the central module

1. Check that the switch and jumper settings comply with the data sheet.
2. Completely pull back the fastening screws on the front plate.
3. Place the module on the terminal block and press it quickly inwards as far as it can go to ensure that no faulty signals are triggered within the system.

4. Tighten the fastening screws.
5. Plug in the data cable connectors and tighten the screws.

► The central module is now inserted in the subrack.

i In redundant systems, the operating system version of the central module newly inserted must be the same as that loaded in the running central module. Otherwise, an error message appears on the display of the newly inserted central module and the module enters the STOP state. The corresponding operating system version must then be loaded. Refer to the operating system manual (HI 800 105 E) for details.

5.3.4 Power Supply Units

To remove the power supply unit

1. Check the indicator LEDs on the F 7126, F 7130A power supply units and on the F 7127, F 7131 power supply monitoring modules.
   If the LED is lit, the module is functioning, if it is off, the module is faulty. Only replace faulty modules since the PES will otherwise fail!
2. If the green LEDs (**L+, 1, 2, 3**) on the front plate are off, check the 24 V supply.
3. Prior to removing the faulty power supply unit (F 7126 or F 7130A), check the output voltage on all the power supply units (see the corresponding data sheets).
4. Unscrew the faulty power supply unit and pull it out.

► The power supply unit is now removed.

To insert the power supply unit

1. Insert the power supply unit and screw it tightly.
2. Check the output voltage (see data sheet).

► The power supply unit is now inserted.

5.3.5 Communication and Co-Processor Modules

To remove the communication or co-processor module

1. Pull off the communication cable.
2. Important: After releasing the fastening screws, first remove the associated central module, see Chapter 5.3.3. Prior to removing the central module, the user program must be deleted.
3. Pull out the communication module (i.e., the Ethernet module with inserted HSR cable), after removing the fastening screws.
4. Release the HSR cable from the Ethernet module.

► The communication or co-processor module is now removed from the subrack.

To insert he communication or co-processor module

1. Check that the switch settings comply with the data sheet.
2. Insert the communication module without cable and screw it in place.
3. Applying to Ethernet modules:
   Insert the HSR cable (for HIPRO-S, but not for HIPRO-S DIRECT).
4. Plug in the communication cable.
5. Insert the associated central module and screw it tightly, see Chapter 5.3.3.

► The communication or co-processor module is now inserted.

5.3.6 Replacing the Subracks

If the subrack is faulty, it must be replaced. The subrack may only be replaced if the power supply is off.

Prior to shutting down the PES, check the impact that this may have on the safe function of the entire plant!

Appendix

Glossary

Term	Description
AI	Analog input
AO	Analog output
ARP	Address resolution protocol, network protocol for assigning the network addresses to hardware addresses
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
HW	Hardware
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
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)
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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HIQuad Maintenance Manual

HI 800 439 E

For further information, please contact:

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