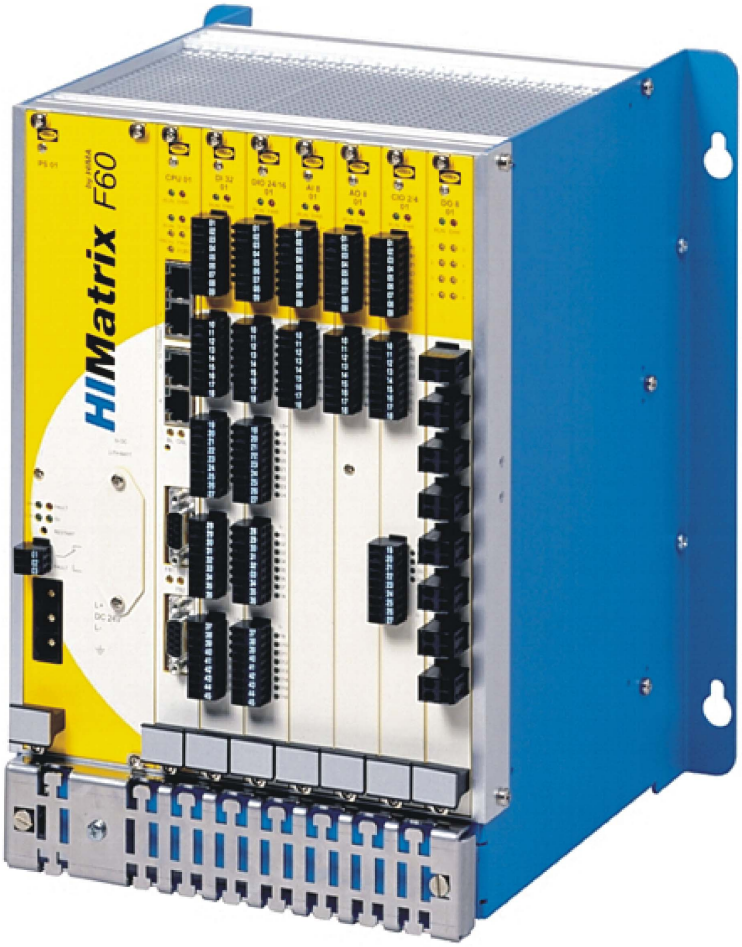
# HIMatrix

## Safety-Related Controller

# CPU 03 Manual




HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

Rev. 1.00

HI 800 479 E

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

Equipment subject to change without notice. HIMA also reserves the right to modify the written material without prior notice.

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



## Contact

HIMA contact details:

HIMA Paul Hildebrandt GmbH + Co KG

P.O. Box 1261

68777 Brühl, Germany

Phone: +49 6202 709-0

Fax: +49 6202 709-107

E-mail: info@hima.com

| Revision index | Revisions | Type of Change | |
|---|---|---|---|
| | | technical | editorial |
| 1.00 | First edition of the manual | | |
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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 HIMatrix programmable electronic system.

This manual is organized in the following main chapters:

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

Additionally, the following documents must be taken into account:

| Name | Content | Document number |
|---|---|---|
| HIMatrix System Manual Modular System F60 | Hardware description of the HIMatrix modular system | HI 800 191 E |
| HIMatrix Safety Manual | Safety functions of the HIMatrix system | HI 800 023 E |
| HIMatrix Engineering Manual | Project planning description for HIMatrix systems | HI 800 101 E |
| SILworX Communication Manual | Description of the communication protocols, ComUserTask and their configuration in SILworX | HI 801 101 E |
| SILworX Online Help | Instructions on how to use SILworX | - |
| SILworX First Steps | Introduction to SILworX using the HIMax system as an example | HI 801 103 E |

Table 1: Additional Relevant Documents

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

## 1.2 Target Audience

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

## 1.3 Formatting Conventions

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

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

Safety notes and operating tips are particularly marked.

### 1.3.1 Safety Notes

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

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

**⚠ SIGNAL WORD**

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

---

The signal words have the following meanings:

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

**NOTE**

**Type and source of damage!**
**Damage prevention**

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### 1.3.2 Operating Tips

Additional information is structured as presented in the following example:

| | |
|---|---|
| i | The text corresponding to the additional information is located here. |

Useful tips and tricks appear as follows:

| | |
|---|---|
| **TIP** | The tip text is located here. |

# 2 Safety

The following safety information, notes and instructions must be strictly observed. The product may only be used if all guidelines and safety instructions are adhered to.

This product is operated with SELV or PELV. No imminent danger results from the product itself. The use in Ex-Zone is permitted if additional measures are taken.

## 2.1 Intended Use

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

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

### 2.1.1 Environmental Requirements

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

Table 2: Environmental Requirements

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

### 2.1.2 ESD Protective Measures

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

**NOTE**

**Device damage due to electrostatic discharge!**

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

## 2.2 Residual Risk

No imminent danger results from a HIMatrix system itself.

Residual risk may result from:

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

## 2.3 Safety Precautions

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

## 2.4 Emergency Information

A HIMatrix system is a part of the safety equipment of a site. If a device or a module fails, the site adopts the safe state.

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

# 3 Product Description

The **CPU 03** module is the central component of the HIMatrix F60 controller.

The module can only be inserted in the slot located on the right, next to the power supply module of the HIMatrix F60 subrack. It is used to store the operating system and the user program, and executes all central functions, including communication with the PADT and other systems. It monitors the operating voltage and operating temperature.

The configuration is carried out with the programming tool SILworX, see Chapter 4.4.

The module is suitable for sequence of events recording (SOE), see Chapter 4.3. The device supports multitasking and reload. For more details, refer to the System Manual for Modular Systems (HI 800 191 E).

i A licence is required to use the events recording, the multitasking and the reload features.

The module has been certified by the TÜV for safety-related applications up to SIL 3 (IEC 61508, IEC 61511 and IEC 62061) and PL e (EN ISO 13849-1). Further safety standards, application standards and test standards are specified in the certificate available on the HIMA website.

Module's faults are signaled by the *ERR* LED located on the front plate, see Chapter 3.4.3.

## 3.1 Safety Function

The CPU monitors the sequence and the proper, logical execution of the operating system and user program. The following functions are time monitored:

- CPU hardware and software self-tests
- CPU RUN cycle (including the user program)
- I/O tests and processing of I/O signals

For further information on the fault reaction of the processor module, refer to Chapter 6.1.

## 3.2 Equipment and Scope of Delivery

The following list specifies the available components and the corresponding part numbers:

| Designation | Description | Part no. |
|---|---|---|
| CPU 03 SILworX | Central module,<br>for SILworX programming tool | 98 2200139 |

Table 3: Part Numbers

### 3.2.1 IP Address and System ID (SRS)

A transparent label is delivered with the device to allow one to note the IP addresses of the CPU and COM and the system ID (SRS for system rack slot) after a change.

Default value for IP address of the CPU: 192.168.0.99

Default value for IP address of the COM: 192.168.0.100

Default value for SRS: 60000.0.0

The label must be affixed such that the ventilation slots in the housing are not obstructed.

Refer to the *SILworX* First Steps manual for more information on how to modify the IP address and the system ID.

## 3.3 Type Label

The type plate contains the following details:

- Product name
- Bar code (1D or 2D code)
- Part no.
- Production year
- Hardware revision index (HW Rev.)
- Firmware revision index (FW Rev.)
- Operating voltage
- Mark of conformity

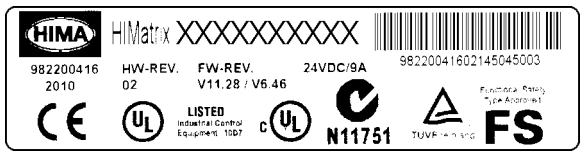
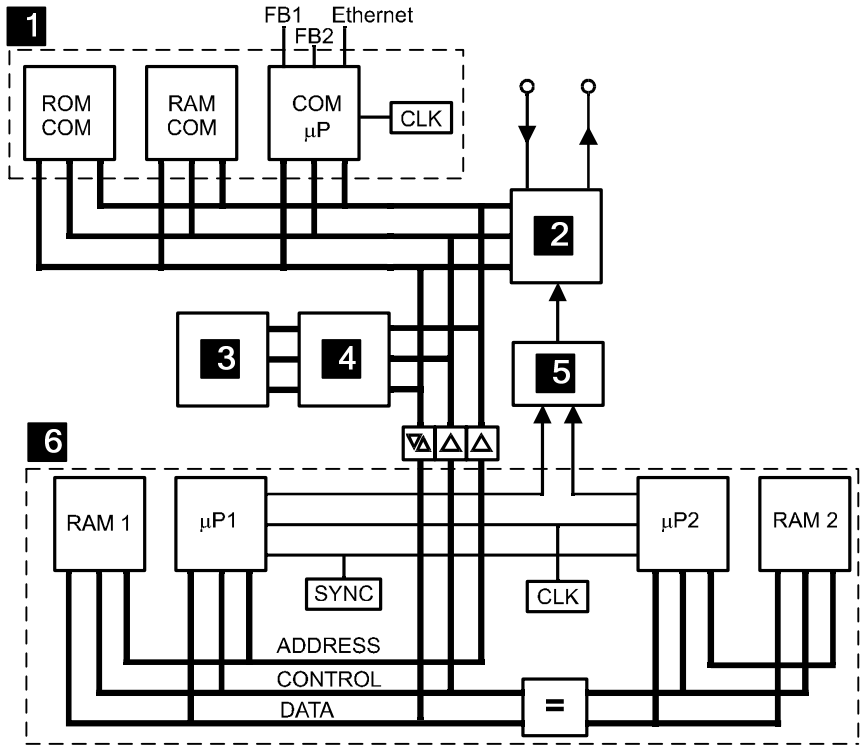



Figure 1: Sample Type Label

## 3.4 Structure

This chapter describes the layout and function of the plug-in module, and its communication via safe**ethernet**.

### 3.4.1 Block Diagram




1 Communication System (COM)
2 I/O Bus Module
3 Program Memory
4 Data Memory in NVRAM
5 Watchdog
6 Safety-Related Processor System (CPU)

Figure 2: Block Diagram

### 3.4.2 Front View

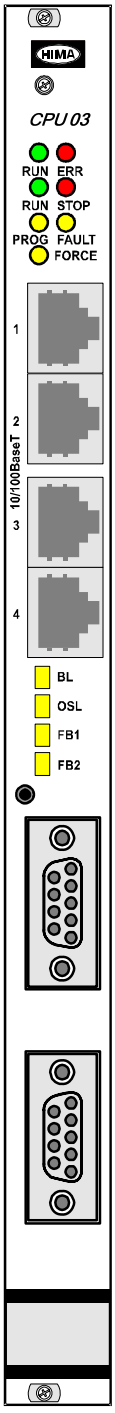



Figure 3: Front View of CPU 03

### 3.4.3 LED Indicators

The light-emitting diodes (LEDs) indicate the operating state of the device. The LEDs are classified as follows:

- System LEDs
- Program LEDs
- Communication LEDs
- Fieldbus LEDs

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

**Definition of Blinking Frequencies**

The following table defines the blinking frequencies of the LEDs:

| Name | Blinking frequencies |
|---|---|
| Blinking1 | Long (approx. 600 ms) on, long (approx. 600 ms) off |
| Blinking-x | Ethernet communication: Blinking in sync with data transfer |

Table 4: Blinking Frequencies of LEDs

#### 3.4.3.1 System Light Emitting Diodes

While the controller is being booted, all LEDs are lit simultaneously.

| LED | Color | Status | Description |
|---|---|---|---|
| RUN | Green | On | Module in STOP or RUN, normal operation |
| | | Blinking1 | A new operating system is being loaded. |
| | | Off | The controller is not in the RUN state. |
| ERR | Red | On | The controller is in the ERROR STOP state<br>Internal module faults detected by self-tests, e.g., hardware, software or voltage supply.<br>The processor system can only be restarted with a command from the PADT (reboot). |
| | | Off | No faults detected. |

Table 5: System Light Emitting Diodes

### 3.4.3.2 Program Light Emitting Diodes

While the controller is being booted, all LEDs are lit simultaneously.

| LED | Color | Status | Description |
|---|---|---|---|
| RUN | Green | On | The controller is in the RUN state. The user program is in the RUN or FREEZE state. |
| | | Blinking1 | ▪ The controller is in the OPERATE state.<br>▪ A new operating system is being loaded. |
| | | Off | Controller is in none of the states described. |
| STOP | Red | On | Controller in the STOP / VALID CONFIGURATION state |
| | | Blinking1 | ▪ Controller in the STOP / INVALID CONFIGURATION state<br>▪ A new operating system is being loaded. |
| | | Off | Controller is in none of the states described. |
| PROG | Yellow | On | ▪ The controller is being loaded with a new configuration.<br>▪ WDT or FTT change<br>▪ Check for duplicate IP address<br>▪ SRS change |
| | | Blinking1 | ▪ Reload is being performed<br>▪ A duplicate IP address was detected. [1)]<br>▪ Profinet has received an identify request. [1)] |
| | | Off | None of the described events occurred. |
| FORCE | Yellow | On | Forcing prepared: Force switch of a variable is set, the force mais switch is still deactivated. The controller is in the RUN or STOP state. |
| | | Blinking1 | ▪ Forcing is active: At least one local or global variable has adopted the corresponding force value.<br>▪ A duplicate IP address was detected. [1)]<br>▪ Profinet has received an identify request. [1)] |
| | | Off | None of the described events occurred. |
| FAULT | Yellow | Blinking1 | ▪ The new operating system is corrupted (after OS download).<br>▪ Fault while loading a new operating system<br>▪ The loaded configuration is defective.<br>▪ One or multiple I/O faults occurred.<br>▪ A duplicate IP address was detected. [1)]<br>▪ Profinet has received an identify request. [1)] |
| | | Off | None of the described faults occurred. |
| OSL | Yellow | Blinking1 | ▪ Operating system emergency loader active.<br>▪ A duplicate IP address was detected. [1)]<br>▪ Profinet has received an identify request. [1)] |
| | | Off | None of the described events occurred. |
| BL | Yellow | Blinking1 | ▪ OS and OLS binary defective or INIT_FAIL hardware fault.<br>▪ Fault in the external process data communication<br>▪ A duplicate IP address was detected.<br>▪ Profinet has received an identify request. [1)] |
| | | Off | None of the described events occurred. |
| [1)] If all the LEDs PROG, FORCE, FAULT, OSL and BL are blinking simultaneously. | | | |

Table 6: Program Light Emitting Diodes

#### 3.4.3.3 Communication LEDs

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

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

Table 7: Ethernet Indicators

#### 3.4.3.4 Fieldbus LEDs

LEDs FB1…FB2 are used to display the state of communication occurring via the serial interfaces. The function of the LED depends on the used protocol.

Refer to the SILworX Communication Manual (HI 801 101 E) for more details on the function of the LEDs.

### 3.4.4 Operating System

The operating system loaded into the CPU contains all basic functions of the HIMatrix programmable electronic system (PES), for example:

- Reading the inputs and writing to the outputs
- Processing the user program
- Performing all test routines for hardware and software
- Cycle time monitoring (watchdog)
- Communication with other systems

For a description of the operating system functions and the variables used to configure the systems and all modules, refer to the HIMatrix System Manual for the Modular F60 System.

### 3.4.5 User Program

The user program is created using the programming tool SILworX. It is then translated into a machine code using the code generator and transferred to the flash EPROM of CPU module.

### 3.4.6 Communication

The Ethernet interfaces and fieldbus interfaces of the CPU 03 module are used to communicate with external systems.

The controller communicates with remote I/Os via safe**ethernet**. Up to 128 redundant safe**ethernet** connections can be configured.

i When configuring safety-related communication, observe the instructions specified in the SILworX Communication Manual.

#### 3.4.6.1 Connections for Ethernet Communication

| Property | Description |
|---|---|
| Ports | 4 |
| Transfer standard | 10/100/Base-T, half and full duplex |
| Auto negotiation | Yes |
| Auto crossover | Yes |
| IP address | Freely configurable[1)] |
| Subnet Mask | Freely configurable[1)] |
| Supported protocols | ▪ Safety-related: safe**ethernet**, PROFIsafe<br>▪ Standard protocols: Programming and debugging tool (PADT), OPC, Modbus TCP, TCP SR, SNTP, ComUserTask, PROFINET |
| [1)] The general rules valid for assigning IP address and subnet masks must be adhered to. | |

Table 8: Connections for Ethernet Communication

The 4 RJ-45 connectors with integrated LEDs are located on the front plate of the module. Refer to Chapter 3.4.3.3 for a description of the LEDs' function.

The connection parameters are read based on the MAC address (media access control address) defined during manufacturing.

The MAC address of the module is specified on the label on the rear side of the printed circuit board. The first MAC address applies for the COM module on the CPU module, the second for the switch.

Examples of label: MAC-ADR1: 00.E0.A1.00.0E.04 (COM)

MAC ADR2: 00.E0.A1.00.0E.05 (switch)

### 3.4.6.2 Network Ports Used for Ethernet Communication

| UDP ports | Use |
|---|---|
| 123 | SNTP (time synchronization between PES and remote I/O, PES and external devices) |
| 502 | Modbus (can be modified by the user) |
| 6010 | safe**ethernet** and OPC |
| 6005/ 6012 | If TCS_DIRECT was not selected in the HH network |
| 8000 | Programming and operation with SILworX |
| 8004 | Configuration of the remote I/O using the PES (SILworX) |
| 34964 | PROFINET endpoint mapper (required for establishing the connection) |
| 49152 | PROFINET RPC server |
| 49153 | PROFINET RPC client |

Table 9: Network Ports (UDP Ports) in Use

| TCP ports | Use |
|---|---|
| 502 | Modbus (can be modified by the user) |
| xxx | TCP SR assigned by the user |

Table 10: Network Ports (TCP Ports) in Use

i The ComUserTask can use any port if it is not already used by another protocol.

### 3.4.6.3 Connections for Fieldbus Communication

The 2 9-pole D-sub connectors can be accessed through the front plate of the module.

The fieldbus interfaces FB1 and FB2 can be equipped with fieldbus submodules. The fieldbus submodules are optional and must be mounted by the manufacturer. The available fieldbus submodules are described in the SILworX Communication Manual (HI 801 101 E).

The fieldbus interfaces are not operational without fieldbus submodule.

### 3.4.7 Reset Key

The device is equipped with a reset key. The key is only required if the user name or password for administrator access is not known. If only the IP address set for the device does not match the PADT (PC), the connection can be established with a `Route add` entry on the PC.

The key can be accessed through a small round hole located on the front plate. The key is engaged using a suitable pin made of insulating material to avoid short-circuits within the device.

The reset is only effective if the device is rebooted (switched off and on) while the key is simultaneously engaged for at least 20 seconds. Engaging the key during operation has no effect.

**⚠ WARNING**

**Caution! Fieldbus communication may be disturbed!**

**Prior to switching on the device with the reset key engaged, all device fieldbus connectors must be unplugged to ensure that the fieldbus communication among other stations is not disturbed.**

**The fieldbus plugs may only be plugged in again when the device is in the RUN or STOP state.**

Properties and behavior of the device after a reboot with engaged reset key:

- Connection parameters (IP address and system ID) are set to the default values.
- All accounts are deactivated except for the administrator default account with empty password.
- With COM operating system version 10.42 and beyond, loading a user program or operating system with default connection parameters is inhibited!
  The loading procedure is only allowed after the connection parameters and the account have been configured on the device and the device has been rebooted.

After a new reboot without the reset key engaged, the connection parameters (IP address and system ID) and accounts become effective.

- Those configured by the user.
- Those valid prior to rebooting with the reset key engaged, if no changes were performed.

### 3.4.8 Monitoring the Operating Voltage

The CPU 03 central module monitors the 24 VDC operating voltage of the HIMatrix F60; reactions occur in accordance with the listed levels:

| Voltage level | Reaction of the CPU |
|---|---|
| 18...28.8 V | No reaction |
| < 18.0 V | Alarm state (the internal variables are written to) |
| < 13.0 V | Shutdown |

Table 11: Operating Voltage Monitoring

The alarm can be evaluated with a PADT loaded with a programming tool, using the *Power Supply State* system parameter.

## 3.5 Product Data

| General | |
|---|---|
| Total program and data memory for all application programs | 5 MB less 64 kBytes for CRCs |
| Response time | ≥ 6 ms |
| Ethernet interfaces | 4 x RJ-45, 10/100BaseT (at 100 Mbit/s)<br>with integrated switch |
| Fieldbus Interfaces | 2 x 9-pole D-sub<br>FB1 and FB2 with fieldbus submodule pluggable |
| Operating Voltage | 24 VDC, -15 %...+20 %, $r_{PP}$ ≤ 15 %,<br>provided by a power supply unit with safe isolation in accordance with IEC 61131-2 requirements. |
| Operating data | 3.3 VDC / 1.5 A<br>5 VDC / 0.1 A |
| Buffer for date/time | Gold capacitor |
| Ambient temperature | 0 °C...+60 °C |
| Storage temperature | -40 °C...+85 °C |
| Space requirement | 6 RU, 4 HP |
| Weight | 280 g |

Table 12: Product Data

## 3.6 Certified HIMatrix F60 CPU 03

| HIMatrix F60 CPU 03 | |
|---|---|
| CE | EMC |
| TÜV | IEC 61508 1-7:2010 up to SIL 3<br>IEC 61511:2004<br>EN ISO 13849-1:2008<br>IEC 62061:2005<br>EN 50156-1:2004<br>EN 298:2003<br>EN 230:2005 |
| PROFIBUS Nutzerorganisation (PNO) | Test Specification for PROFIBUS DP Slave,<br>Version 3.0 November 2005 |

Table 13: Certificates

Further safety standards and application standards are specified in the certificate. The certificate and the EC Type-Examination Certificate are available on the HIMA website at www.hima.com.