HIMatrix M45

Safety-Related Controller

Manual M-CI 8 01

HIMA Paul Hildebrandt GmbH

Industrial Automation

Rev. 1.01

HI 800 667 E

For further information, refer to the HIMA DVD and our website at `http://www.hima.de` and `http://www.hima.com`.

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Revision index	Revisions	Type of change	
		technical	editorial
1.00	First edition of the HIMatrix M45 manual		
1.01	Revised: Chapter 3.1 and 4.5	X	X

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 M45 programmable electronic system.

This manual is organized in the following main chapters:

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

Additionally, the following documents must be taken into account:

Name	Content	Document no.
HIMatrix M45 Safety Manual	Safety functions of the HIMatrix system	HI 800 653 E
HIMatrix M45 System Manual	Hardware description of the HIMatrix M45	HI 800 651 E
SILworX 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 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. 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 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 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: warning, caution, notice
- Type and source of risk
- Consequences arising from non-observance
- Risk prevention

SIGNAL WORD

Type and source of risk!

Consequences arising from non-observance

Risk prevention

The signal words have the following meanings:

- Warning indicates hazardous situation which, if not avoided, could result in death or serious injury.
- Caution 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

1.3.2 Operating Tips

Additional information is structured as presented in the following example:

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

Useful tips and tricks appear as follows:

TIP	The tip text is located here.

2 Safety

All safety information, notes and instructions specified in this 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. 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 HIMatrix 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 risk results from a HIMatrix M45 system itself.

Residual risk may result from:

- Faults related to engineering
- Faults related to 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 HIMatrix M45 system is a part of the safety equipment of a plant. If a device or a module fails, the system enters the safe state.

In case of emergency, no action that may prevent the HIMatrix M45 systems from operating safely is permitted.

3 Product Description

The **M-CI 8 01** counter module is intended for use in the HIMatrix M45 system.

Up to 62 I/O modules can be used in a HIMatrix M45 system, if the structuring conditions as of the safety manual (HI 800 651 E) are met.

The counter module is equipped as follows:

- 8 safety-related counter inputs (SIL 1)
- 2 current limited supplies

The counter module can be used for measuring frequency and rotation speed. The pulses of the input signal can be count upwards and downwards depending on the rotation direction. For this, the counter inputs can be configured as up counter or quadrature counter. Two counter inputs are required for the quadrature counter, see Chapter 4.3.1.

The module has been certified by the TÜV for safety-related applications up to SIL 1 (IEC 61508, IEC 61511, IEC 62061 and EN 50156) as well as PL e (EN ISO 13849-1). With redundant sensor and channel structures and the corresponding evaluation in the user program, a safety function in accordance with SIL 3 is possible, see Chapter 4.5.2.

Further safety standards, application standards and test standards are specified in the certificates available on the HIMA website.

3.1 Safety Function

The safety function meets the integrity requirements described in the corresponding test standards.

3.1.1 Reaction in the Event of a Fault

If the safety-related processor system of the module detects a module fault during operation, the module adopts the safe state. All the outputs are in accordance with the de-energize to trip principle. The communication with the processor module (M-CPU) is being aborted. The user program processes the initial values of the counter readings. The initial values must be set to 0 to ensure that the counter readings transmit the value 0 to the user program. In this case, the *Err* LED is blinking.

3.2 Scope of Delivery

To be able to operate, the module must be installed on a suitable socket. The socket is not included within the scope of delivery of the module.

The socket is described in Chapter 3.6.

3.3 Type Label

The type plate contains the following details:

- Product name
- Mark of conformity
- Bar code (2D code)
- Part number (Part-No.)
- Hardware revision index (HW-Rev.)
- Operating system revision index (OS-Rev.)
- Operating data (Power:)
- Production year (Prod-Year:)

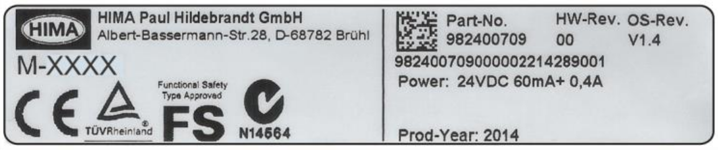


Figure 1: Sample Type Label

3.4 Structure

The chapter contains the following sections:

- Safety-Related Counter Inputs
- Current Limited Supply Outputs
- Block Diagram
- LED Indicators

The module is equipped with a safety-related 1oo2D processor system and performs the following functions:

- Evaluation of counter inputs
- Control and monitoring of the I/O level

The process data and states of the module are provided to the processor module (M-CPU) via the system bus.

3.4.1 Safety-Related Counter Inputs

The module has 8 safety-related counter inputs that can measure frequencies in the range of 0...10 kHz for electromechanical control circuit devices (type 1, type 3) and 24 V proximity switches.

Each counter input suppresses electromagnetic interference signals and test signals, using an internal MMH filter (Mean and Median Hybrid filter). The MMH filter can be configured in the range of 0...600 µs. The filter is configured in the SILworX programming tool, see Table 12.

The counter inputs can be configured in pairs for two different modes of operation:

- *Up Counter*
- *Quadrature Counter*

A channel pair (CI1 + CI2, CI3 + CI4, CI5 + CI6, CI7 + CI8) is required for the quadrature counter (counter up and down) mode of operation.

i Simultaneous configuration of a channel pair as up counter and quadrature counter is not possible.

3.4.1.1 *Up Counter* Mode of Operation

The *Up Counter* mode of operation is used to increment the number of rising edges. A 32-bit timestamp with a resolution of 1 µs is set for each rising edge.

3.4.1.2 *Quadrature Counter* Mode of Operation

The *Quadrature Counter* mode of operation is used to increment or decrement the rising and falling edges, depending on the two counter inputs phasing, see Chapter 4.3.2.2. An up and down counter can be thus implemented. The count direction is automatically determined from the phasing of a channel pairs input signals. To this end, a input signals phase-delayed by 90 ° is required. The timestamp is reset with each rising and falling edge.

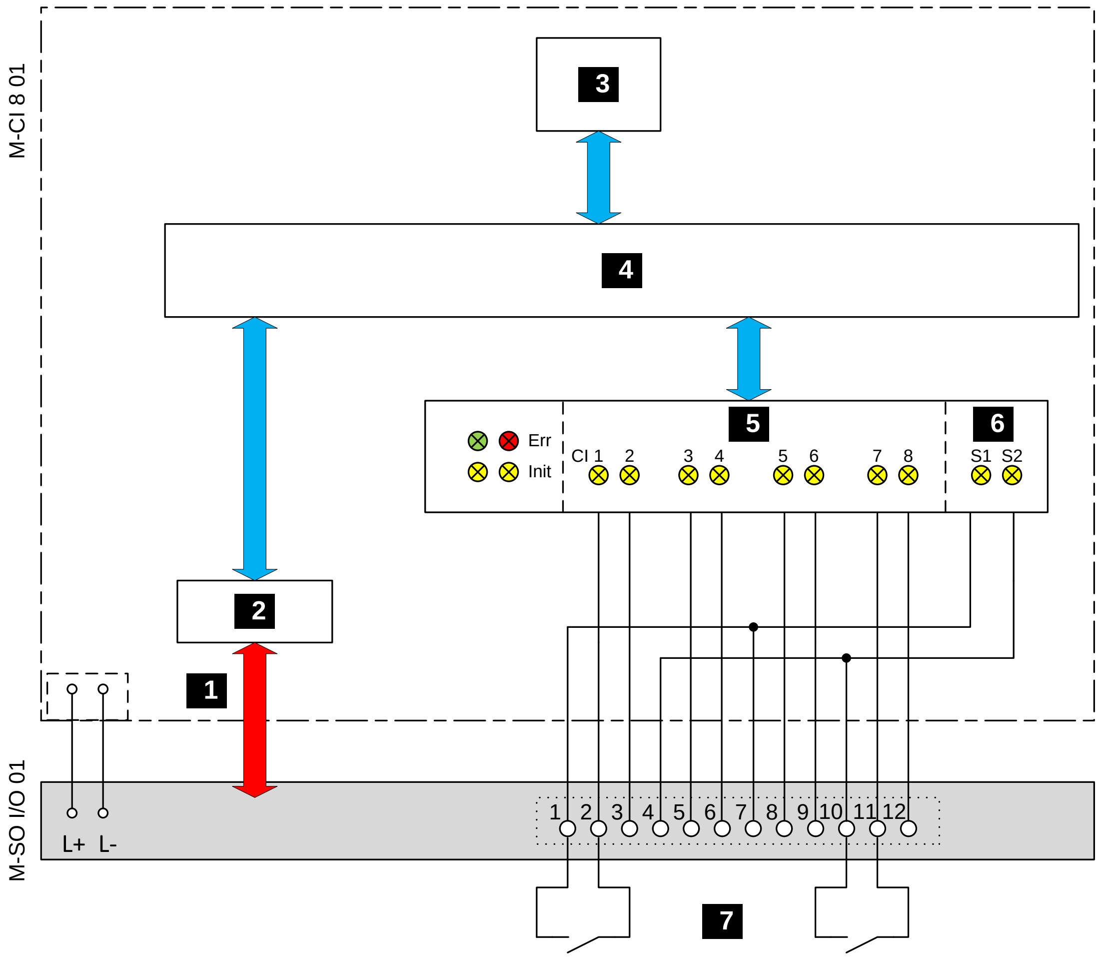
3.4.2 Current Limited Supply Outputs

The module is equipped with 2 current limiting supply outputs, each of them is attached on two clamps, see Figure 2. The state (HIGH, LOW) of each supply output is signaled by an individual LED.

A monitoring of the supply outputs are to realize in the user program or through external measurements.

3.4.3 Block Diagram

The following block diagram illustrates the structure of the module.



1 System Bus	**5** Interface
2 Switch	**6** Supplies S1, S2
3 Watchdog	**7** Field Zone: Proximity Switches, Control Circuit Devices
4 Safety-Related Processor System	

Figure 2: Block Diagram

3.4.4 Front View

The following figure shows the front view of the module:

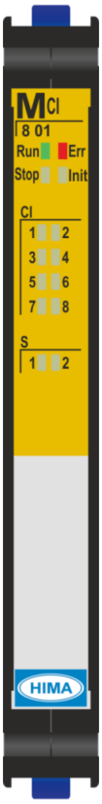


Figure 3: Front View

3.4.5 LED Indicators

The LEDs indicate the operating state of the module. The LEDs are classified as follows:

- Module status indicators
- I/O indicators

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

Definition of Blinking Frequencies

The following table defines the blinking frequencies of the LEDs:

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

Table 3: Blinking Frequencies of LEDs

3.4.5.1 Module Status Indicators

The LEDs signal the following states:

LED	Color	Status	Description
Run	Green	On	Module in RUN, normal operation
		Blinking1	Module state: STOP/OS_DOWNLOAD or OPERATE (only with processor modules)
		Off	Module not in RUN, observe the other status LEDs.
Err	Red	On	Warning, e.g.: No license for additional functions (e.g., communication protocols), test mode.
		Blinking1	Fault, e.g.: ▪ Internal module fault detected by self-tests, e.g., hardware or voltage supply. ▪ Error while loading the operating system.
		Blinking2	Field fault, but no internal fault
		Off	Normal operation
Stop	Yellow	On	Module state: STOP / VALID CONFIGURATION
		Blinking1	Module state: STOP / INVALID CONFIGURATION or STOP / LOADING OS
		Off	Module not in STOP, observe the other status LEDs.
Init	Yellow	On	Module state: INIT
		Blinking1	Module state: LOCKED or STOP / LOADING OS
		Off	Module state: neither INIT nor LOCKED, observe the other status LEDs.

Table 4: Module Status Indicators

3.4.5.2 I/O Indicators

The LEDs of the I/O indicators are labeled *Channel*.

LED	Color	Status	Description
CI 1…8	Yellow	On	Frequency < 25 Hz at high level Frequency > 25 Hz at high and low level, no distinction between high and low is made for the LED.
		Blinking2	The related channel is faulty.
		Off	Frequency < 25 Hz at low level or Channel not configured
S 1…2	Yellow	On	The related channel is active (energized).
		Blinking2	The related channel is faulty.
		Off	The related channel is inactive (de-energized).

Table 5: I/O LEDs

3.5 Product Data

General	
Supply voltage	24 VDC, -15...+20 %, $r_p \leq 5$ %, PELV, SELV
Max. supply voltage	30 VDC
Current input	60 mA at 24 VDC Max. 65 mA
Current input per channel High level	Max. 2.5 mA
Max. reaction time of the module [1)]	8.6 ms
Electrical isolation of the channels	No
Ambient temperature	0…+60 °C
Storage temperature	-40…+85 °C
Humidity	Max. 95 % relative humidity, non-condensing
Type of protection	IP20
Dimensions without socket (H x W x D) in mm	105 x 12.5 x 72
Dimensions with socket up to DIN rail (H x W x D) in mm	105 x 12.7 x 90
Weight Module Socket	 approx. 65 g approx. 55 g
[1)] In case of an internal fault	

Table 6: Product Data

Counter inputs	
Number of inputs (number of channels)	8 with common ground L-
Number of channel pairs (quadrature counter)	4, Channel pair 1 = CI1 and CI2 Channel pair 2 = CI3 and CI4 Channel pair 3 = CI5 and CI6 Channel pair 4 = CI7 and CI8
Type of input	Current sinking logic, 24 V, type 1 and type 3 in accordance with IEC 61131-2
Count frequency	0…10 kHz
Accuracy of pulse count	± 1 pulse
Rated input voltage	24 VDC
Low level	-3…+5 VDC
High level	+15…+30 VDC at min. 2 mA
Switching point	Typ. 10 VDC

Table 7: Specifications for Digital Inputs

Supplies	
Number of supplies (number of channels)	2, non-galvanically separated, common ground L-
Output voltage	L+ minus 2 V
Output current	Max. 200 mA
Leakage current per channel (with low level)	Max. 1 mA at 2 V

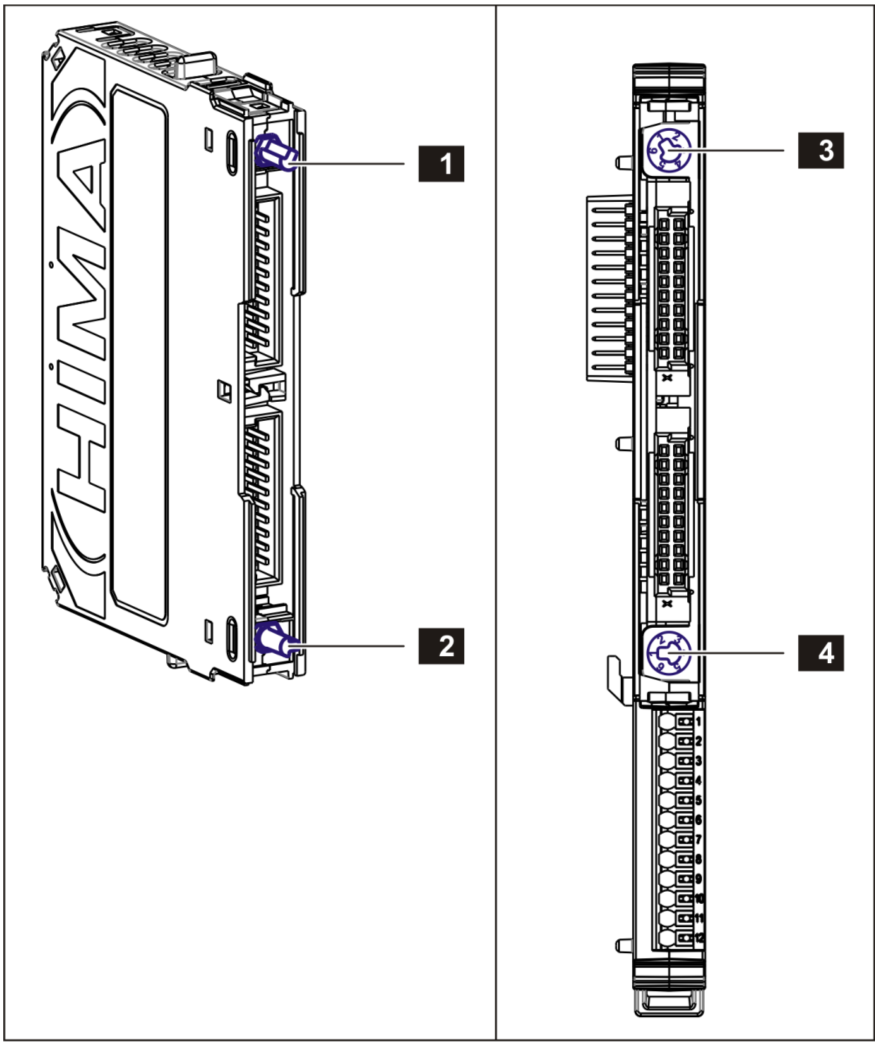
Table 8: Product Data for Supplies

3.6 Socket

Socket and module form together a functional unit. The module is connected to the system bus, the power supply and the field zone via a socket. The field lines are connected to the socket's tension clamp terminals, see Figure 5.

3.6.1 Mechanical Coding

Module and socket are mechanically coded, see Figure 4. The position of the coding pins determines the module's coding and is defined by the manufacturer. Two coding sockets accept the coding pins and must be configured in the selected module, see Chapter 3.6.2. Coding prevents the socket from improper assembling.



1 Upper Coding Pin
2 Lower Coding Pin
3 Upper Coding Socket
4 Lower Coding Socket

Figure 4: Example of Module and Socket Coding

3.6.2 Coding the M-CI 8 01 and Socket

To attach the module, the coding of the M-SO I/O 01 socket must be set as follows:

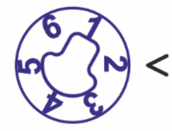
Order	Module coding (rear view)	Position	Coding socket
Upper		2	
Lower		5	

Table 9: Module and Socket Coding

3.6.2.1 Configuring the Socket Coding

Tools and utilities:

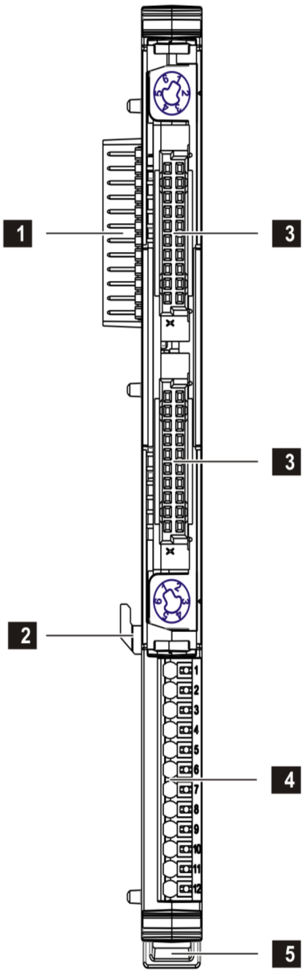
- Screwdriver, slotted 0.8 x 4.0 mm

Configuring the upper and lower coding socket

1. Insert the screwdriver into the opening of the upper coding socket.
2. Turn the screwdriver until the required coding is set.
3. Repeat these steps for the lower coding socket.
4. Insert the module into the socket to check the coding.
5. Remove the module

3.6.3 Socket M-SO I/O 01

Universal socket for being equipped with different modules, see system manual HI 800 651 E.



1 System Bus with Power Supply
2 Latch (Connection to the Left Socket)
3 I/O Plug
4 Field Terminals (Tension Clamp Terminals)
5 Latch (Securing to DIN Rail)

Figure 5: M-SO I/O 01 Socket

The latches are used to secure the socket (2, 5) to the DIN rail and simultaneously to ensure connection to the socket on the left hand-side. Socket and module are connected to the processor module and the power supply via the system bus. The I/O plugs provide the connection between module and socket. The sensors are connected to the field terminals, see Chapter 3.6.3.1 and Chapter 4.5.

3.6.3.1 Terminal Assignment for the Field Terminals

Terminal	Signal	Function
1	S1	Supply 1
2	CI1	Counter input 1
3	CI2	Counter input 2
4	S2	Supply 2
5	CI3	Counter input 3
6	CI4	Counter input 4
7	S1	Supply 1
8	CI5	Counter input 5
9	CI6	Counter input 6
10	S2	Supply 2
11	CI7	Counter input 7
12	CI8	Counter input 8

Table 10: Terminal Assignment for Field Terminals

3.6.3.2 Field Terminal Properties

The field terminals are implemented as tension clamp terminals with the following properties:

Connection to the field zone	
Tension clamp terminal	12-pole
Wire cross-section	0.2…1.5 mm^2 (single-wire) 0.2…1.5 mm^2 (finely stranded) 0.2…1.5 mm^2 (with wire end ferrule) 0.2…0.75 mm^2 (with wire end ferrule with collar)
Stripping length	8 mm
Screwdriver	Slotted, 0.6 x 3.5

Table 11: Tension Clamp Terminal Properties

4 Start-up

This chapter describes how to install, configure and connect the module. For more information, refer to HIMatrix M45 system manual (HI 800 651 E).

4.1 Mounting

The module is plugged in to the corresponding socket, which is mounted on a 35 mm DIN rail.

Observe the following points when mounting the module and the socket:

Sockets or modules may only be removed or replaced in the de-energized state.

4.1.1 Wiring Inputs Not in Use

Inputs that are not being used may stay open and need not be terminated. To prevent short-circuits and sparks in the field zone, never connect a wire to a socket if it is open on the field side.

4.2 Mounting Module and Socket

This chapter describes how to mount and remove the modules and sockets. When replacing modules, the sockets remain on the DIN rail. This saves additional wiring effort since all field lines are connected to the socket.

4.2.1 Mounting and Removing the Sockets

Tools and utilities:

- Screwdriver, slotted 1.0 x 5.5 mm

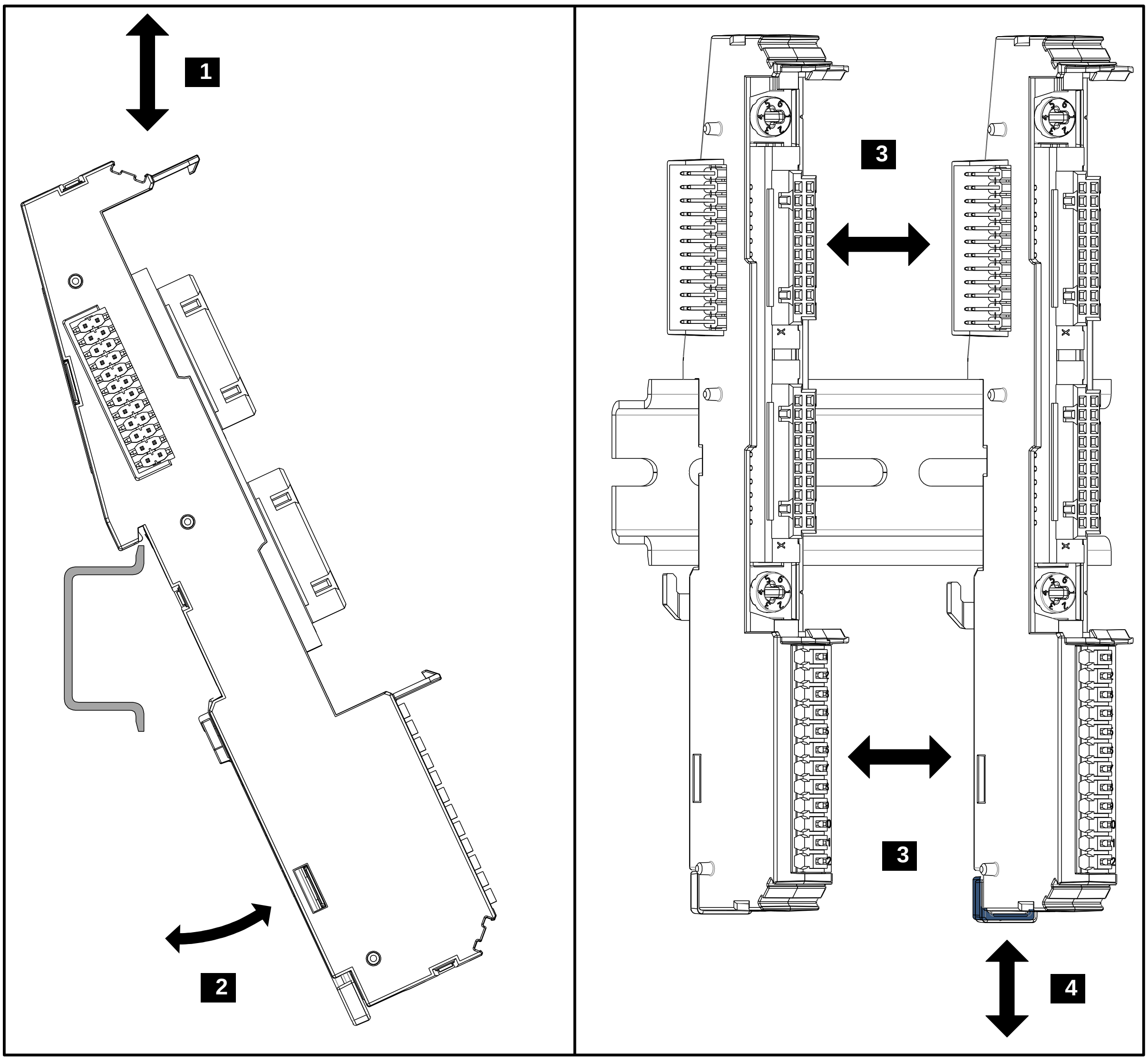
To insert the socket

1. Set the socket onto the DIN rail 1.
2. Swivel the socket in 2.
3. Move the socket on the DIN rail and connect it to another socket 3.
4. Press the socket's latch upwards 4.
   ☑ The latch is used to attach the socket to the DIN rail, and is secured to the socket located on its left-hand side.
5. The socket mounting is completed, the field lines can be connected.

To remove the socket

Prior to removing the socket, the module must be removed and the field lines must be released from the terminals.

1. Use a screwdriver to push the blue latch downwards 4.
2. Remove the sockets from the adjacent sockets 3.
3. Swivel the socket out 2.
4. Lift the socket and remove it 1.



1	Setting and Lifting the Socket	3	Connecting and Disconnecting Sockets
2	Swiveling the Socket In and Out	4	Closing and Opening the Latch

Figure 6: Example of Socket Mounting

4.2.2 Inserting and Removing the Module

This chapter describes how to mount and remove a module in the M45 system.

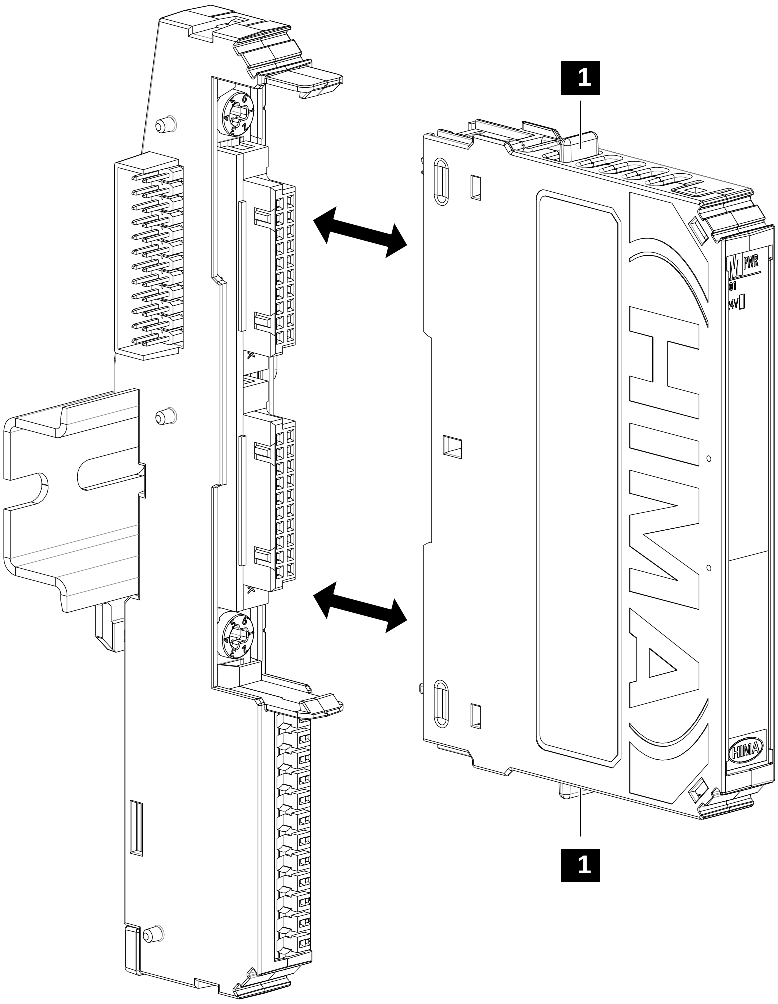
Coding prevents the module from improper assembling.

To insert the module

1. Plug the module onto the socket, until the locking mechanism is engaged.

To remove the module

1. Press the latch 1 backwards as far as it can go. The locking mechanism is released.
2. Remove the module from the socket.



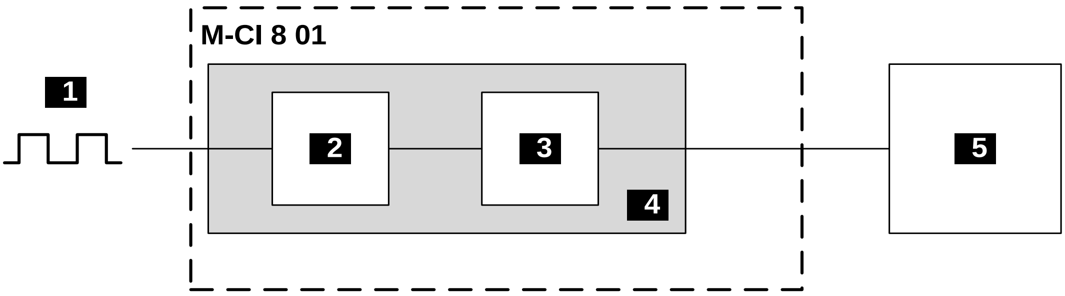
1 Latch for Releasing the Module

Figure 7: Example of Mounting and Removing the Module

4.3 Counter Module Sampling

The following chapter describes how the input signal is sampled for the *Up Counter* and *Quadrature Counter* modes of operation.

Up Counter Mode of Operation

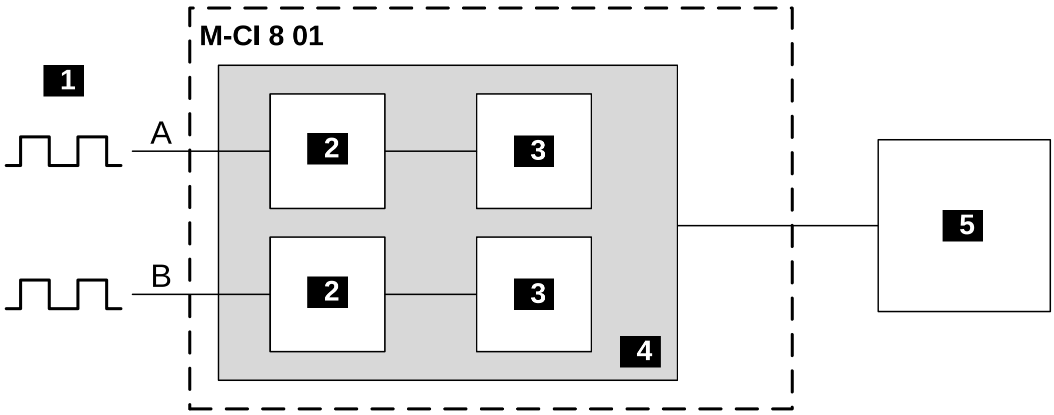


1 Input Signal
2 Filter
3 Counter
4 Safety-Related Processor System
5 Processor Module M-CPU 01

Figure 8: Up Counter Input Signal Evaluation

The filter 2 blanks interference pulses from the input signal 1. After that, the input signal is sampled by the counter. The counter increments the parameter *-> Counter Reading [UDINT]* value with each rising edge. The safety-related processor system 4 provides the *-> Counter Reading [UDINT]* parameter and the *-> Timestamp [UDINT]* parameter to the processor module 5.

Quadrature Counter Mode of Operation



1 Input Signal A, B Channel Pair
2 MMH Filter
3 Counter
4 Safety-Related Processor System
5 Processor Module M-CPU 01

Figure 9: Quadrature Counter Input Signal Evaluation

The filters 2 blank interference pulses of the input signals 1. After that, the input signals are sampled by the counter. Depending on the count direction, the counter increments or decrements *-> Counter Reading [UDINT]* value with each rising or falling edge, see Chapter 4.3.1. The safety-related processor system 4 provides the *-> Counter Reading [UDINT]* parameter and *-> Timestamp [UDINT]* parameter to the processor module 5.

4.3.1 MMH-Filter

The MMH filter blanks interference pulses from the input signal. To this end, the system parameter *Blanking Time MMH Filter [µs]* must be set in SILworX as follows:

Blanking Time MMH Filter [µs] = $t_{min\ High}$ / 2 or $t_{min\ Low}$ / 2

Either the input signal's shorter low level pulse duration or the shorter high level pulse duration must be divided by two and set in SILworX.

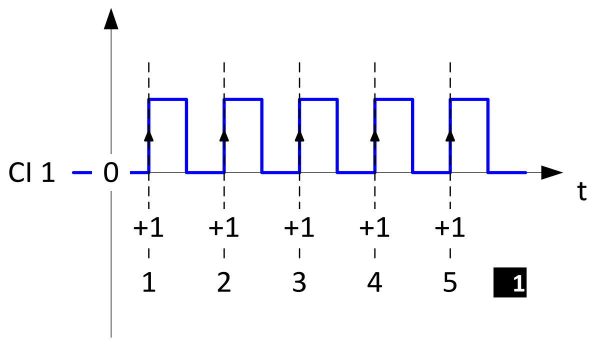
4.3.2 Counting Pulse Evaluation

In the **M-CI 8 01_1: Channels** tab the input mode of operation can be selected in the *Mode Counter* column:

- Up Counter
- Quadrature Counter

4.3.2.1 Up Counter Mode of Operation

This mode of operation is used to count the rising edges of the input signal. The value of the *-> Counter Reading [UDINT]* parameter is incremented with each rising edge.



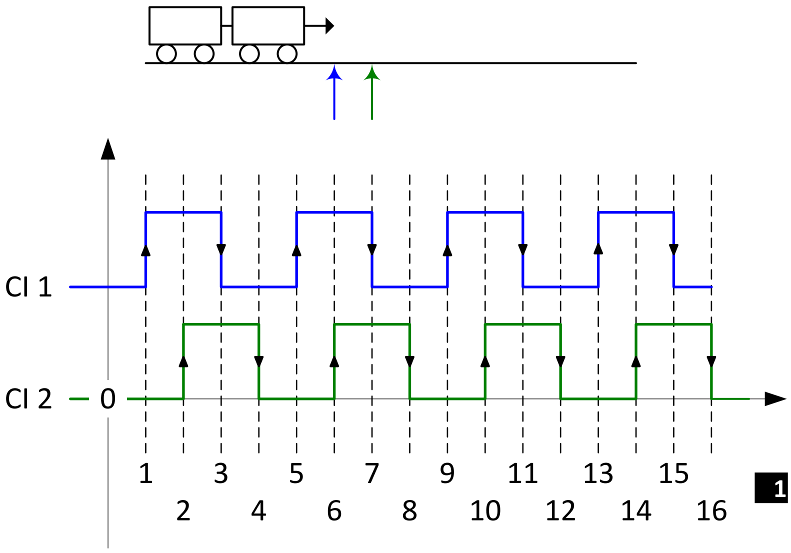
1 *-> Counter Reading [UDINT]* Parameter

Figure 10: Up Counter Mode Evaluation

4.3.2.2 Quadrature Counter Mode of Operation

This mode of operation is used to count the rising and falling edges of the input signal. The evaluation of rising and falling edges avoids counting errors due to contact bounce.

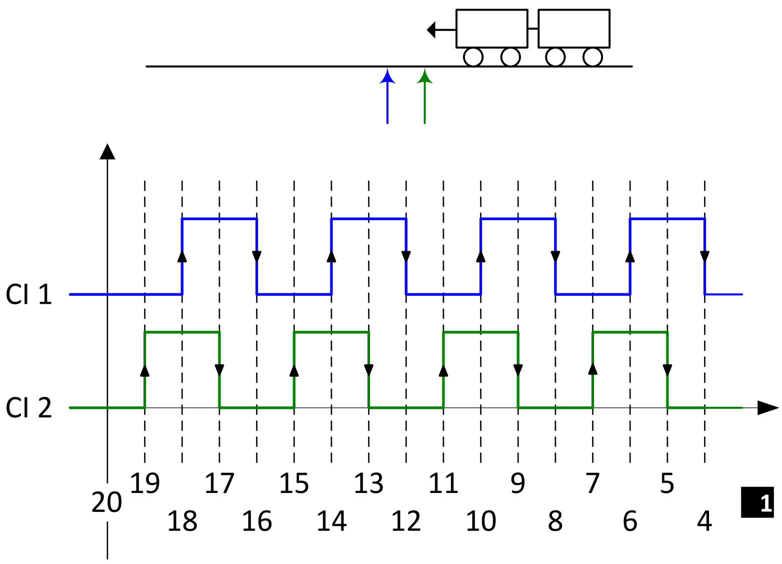
If the input signal of the odd channel (CI1, CI3, CI5, CI7) advances the even channel (CI2, CI4, CI6, CI8), the quadrature counter operates as up counter.



1 -> *Counter Reading [UDINT]* Parameter

Figure 11: Example: Axle Counting Up Counter

If the input signal of the odd channel lags the even channel, the quadrature counter operates as down counter.



1 -> *Counter Reading [UDINT]* Parameter

Figure 12: Example: Axle Counting Down Counter

4.4 Configuration with SILworX

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

Observe the following points when configuring the module:

- To diagnose the module and channels, both the statuses and the measured value can be evaluated within the user program. For more information on the statuses and parameters, refer to the tables starting with Chapter 4.4.1.
- The parameter *Blanking Time MMH Filter [µs]* is used to blank electromagnetic interference signals and test signals in the range of 0...600 µs. The setting is applied for all channels or channel pairs. Set the parameter as follows, see Chapter 4.3.1.
- The parameter *-> Timestamp [UDINT]* depends on the mode of operation. Therefore, the timestamp is reset to 0 with each new configuration.
- In the *Quadrature Counter* mode of operation the value of the *-> Timestamp [UDINT]* parameter must not be used for calculations, if the time interval between two timestamps is greater than one hour. Due to the overflow, the timestamp is not detected. This must be taken into account for the user program.
- The *Quadrature Counter* mode of operation is always set for a channel pair (CI1 + CI2, CI3 + CI4, CI5 + CI6, CI7 + CI8). The process values of a channel pair are provided at the odd channel.
- The overflow of the parameters *-> Counter Reading [UDINT]* and *-> Timestamp [UDINT]* is not detected. The overflow detection must be implemented in the user program.
- In the user program the *-> Channel Reset Done [BOOL]* parameter must be taken into account to reset the counter reading to 0.
  The process is started when the *Reset Channel [BOOL] ->* parameter is set to TRUE. Only when the *-> Channel Reset Done [BOOL]* parameter switches from FALSE to TRUE, the counter reading is reset to 0. After that the *Reset Channel [BOOL] ->* parameter must be set to FALSE to avoid a permanently reset. As soon as the *-> Channel Reset Done [BOOL]* parameter switches from TRUE to FALSE, the module restarts counting the pulses.

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

The following tables present the statuses and parameters for the module in the same order given in the SILworX Hardware Editor.

4.4.1 Tab Module

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

<table>
<tr><th colspan="2">Name</th><th>R/W</th><th>Description</th></tr>
<tr><td colspan="4">Enter these statuses and parameters directly in the Hardware Editor.</td></tr>
<tr><td colspan="2">Name</td><td>W</td><td>Module name</td></tr>
<tr><td colspan="2">Blanking Time MMH Filter [µs]</td><td>W</td><td>Configuring noise blanking of the input signal.
Range of values: 0...600 µs
Default setting: 35 µs
Minimum blanking time 2 µs even if 0 or 1 µs is selected, settings see Chapter 4.3.1.</td></tr>
<tr><th>Name</th><th>Data type</th><th>R/W</th><th>Description</th></tr>
<tr><td colspan="4">The following statuses and parameters can be assigned global variables and used in the user program.</td></tr>
<tr><td>Data valid</td><td>BOOL</td><td>R</td><td>TRUE: Current values are processed.
FALSE: Initial values are processed.</td></tr>
<tr><td>Module OK</td><td>BOOL</td><td>R</td><td>Module State
TRUE: No faults detected
FALSE: Module fault or channel fault</td></tr>
<tr><td>Power supply state</td><td>BYTE</td><td>R</td><td>Bit-coded state of the power supply units
0 = normal
Bit0 = 1: Supply voltage (24 V) faulty</td></tr>
<tr><td>Temperature state</td><td>BYTE</td><td>R</td><td>Bit-coded temperature state of the module
0 = normal
Bit0 = 1: Temperature threshold 1 has been exceeded
Bit1 = 1: Temperature threshold 2 has been exceeded
Bit2 = 1: Fault in temperature measurement

For further details, refer to chapter Monitoring the Temperature State integrated in the system manual.</td></tr>
</table>

Table 12: System Parameters for Counter Inputs, Module Tab

4.4.2 Tab M-CI 8 01_1: Channels

The **M-CI 8 01_1: Channels** tab contains the following parameters and statuses for each digital input.

Global variables can be assigned to the statuses and parameters with **->** and used in the user program. The value without **->** must be directly entered.

Name	Data type	R/W	Description
Channel no.	---	R	Channel number, preset and not changeable
-> Counter Reading [UDINT]	UDINT	R	**Up counter mode of operation:** It adds the values sampled by the counter up to a maximum value of 2^{32}-1 (Overflow). **Quadrature counter mode of operation:** It adds and subtracts the values sampled by the counter up to the overflow. **Behavior upon overflow:** If the maximum value is exceeded, the counter reading restarts at 0 and adds the excess counter pulses. If the minimum value is exceeded, the counter reading restarts with 2^{32}-1 and subtracts the overflowed counting pulses.
Mode Counter	BYTE	W	Counter input mode of operation: ▪ Up Counter ▪ Quadrature Counter Default setting: Up Counter Quadrature counter applies for a channel pair.
-> Timestamp [UDINT]	UDINT	R	**Up counter mode of operation:** Detects the timestamp of the last edge in µs, values of 0...2^{32}-1 **Quadrature counter mode of operation:** Detects the timestamp of the last edge of both input signals in µs, values of 0...2^{32}-1 **Behavior upon overflow:** If the maximum value is exceeded, the time restarts at 0.
Reset Channel [BOOL] ->	BOOL	W	Resets -> *Counter Reading [UDINT]* parameter to 0 TRUE: Counter reading reset to 0 FALSE: Counter reading not reset
-> Channel Reset Done [BOOL]	BOOL	R	Only when switching from FALSE to TRUE, the counter reading is reset. TRUE: Channel reset successful, counter reading is reset. FALSE: Pulses are counted.

Table 13: Tab M-CI 8 01_1: Channels in the Hardware Editor

4.5 Connection Variants

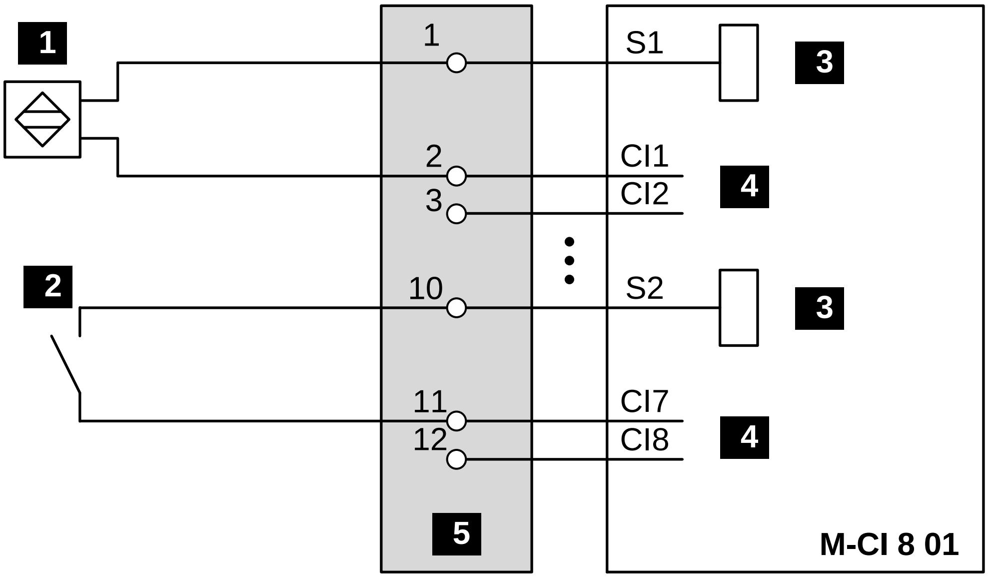
This chapter describes the correct wiring of the counter module in safety-related applications. The connection variants specified here are permitted.

The following points must be taken into account when connecting the sensors to the outputs:

- Using the DI extension module M-LS 4 01, circuits with 3-wire proximity switches can be implemented, see Figure 16.
- Cables to the sensors must be shielded.

4.5.1 Connecting Sensors, SIL 1

The following figure shows the single channel connection of sensors.



1 Sensor (Proximity Switch)
2 Sensor (Control Circuit Device)
3 Supplies S1, S2
4 Counter Inputs
5 Socket M-SO I/O 01

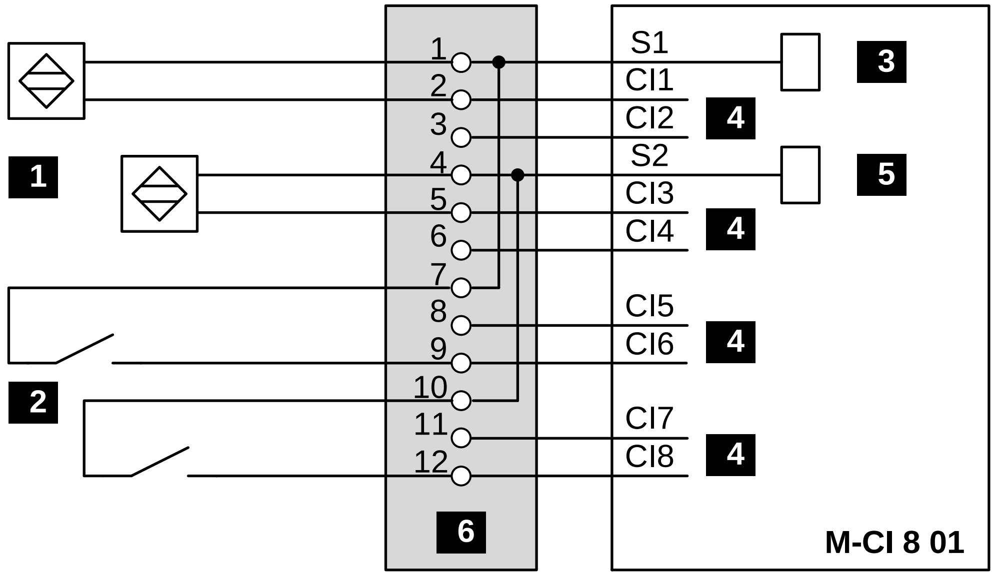
Figure 13: Single Channel Wiring of Sensors

4.5.2 Connection of Redundant Sensors, SIL 3 Applications

The following figure shows the structure of a SIL 3 application of sensors.

The following points must be taken into account for the SIL 3 application:

- Redundant sensors required.
- Deviating from the *Quadrature Counter* mode of operation, redundant sensors must be connected to the channel pairs as follows: CI1 + CI3, CI2 + CI4, CI5 + CI7, CI6 + CI8.
- The redundant sensors must be connected to the independent supplies S1 and S2. Connect one sensor to S1 and the other to S2.
- Due to the different signal propagation time of the sensors, the counter readings may differ. Therefore, the counter readings must be compared in the user program. The difference between the counter readings should not exceed the tolerance, given by the application. This must also be verified in the user program.
- If no pulses are counted for a period of more than one year, an additional condition is necessary in the user program to achieve SIL 3, e.g., movement command.



1 Redundant Sensors (Proximity Switches)

2 Redundant Sensors (Control Circuit Devices)

3 Supply S1

4 Counter Inputs

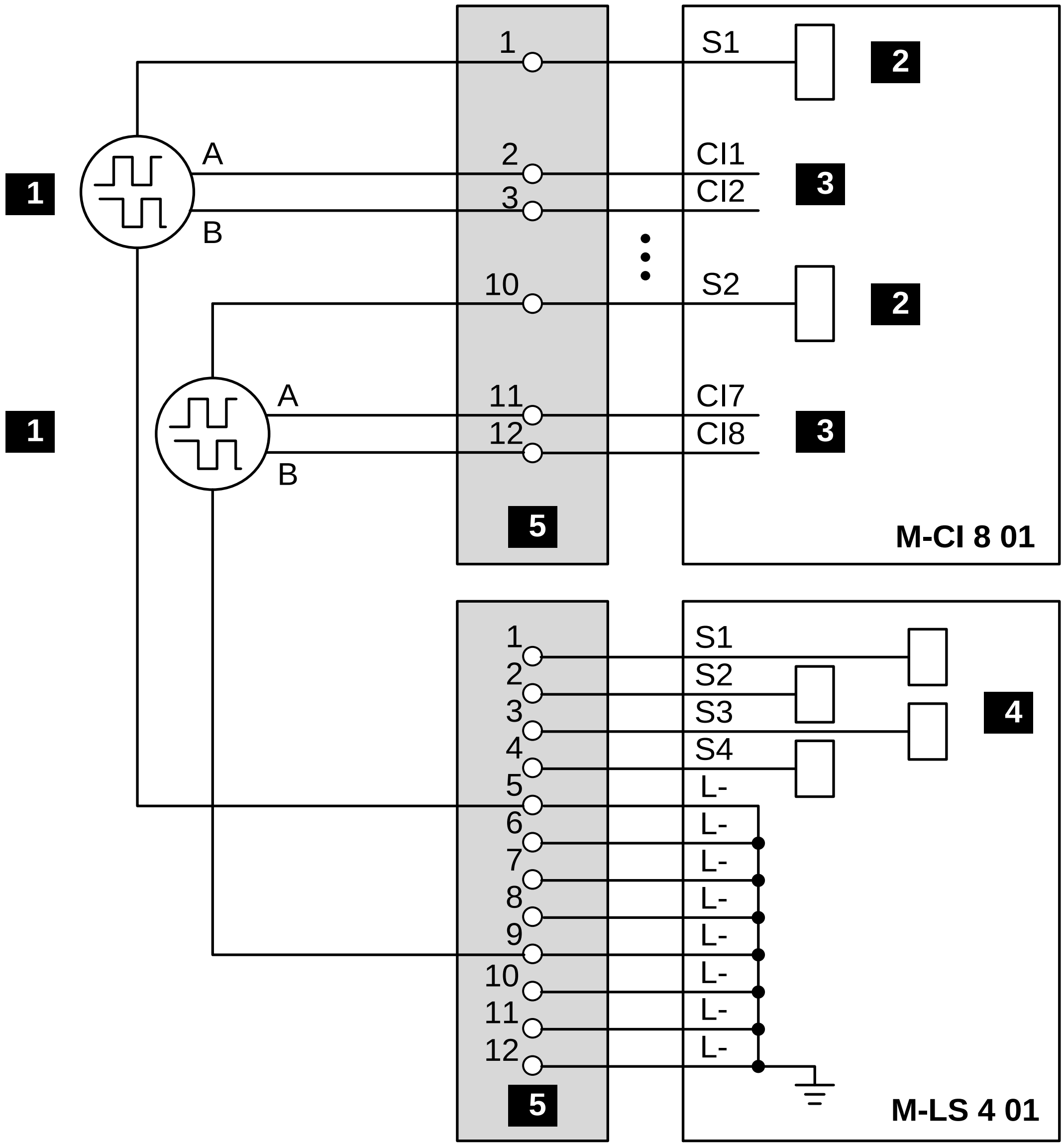
5 Supply S2

6 Socket M-SO I/O 01

Figure 14: SIL 3 Applications with Redundant Sensors

4.5.3 Connection of Incremental Encoders in the *Quadrature Counter* Mode of Operation, SIL 1

A channel pair (CI1 + CI2, CI3 + CI4, CI5 + CI6, CI7 + CI8) is required to connect incremental encoders. In SILworX the *Mode Counter* parameter must be set to *Quadrature Counter*. Always use one of the two supplies S1, S2 for feeding the incremental encoder. Use the DI extension module M-LS 4 01 to connect the incremental encoders ground, see Figure 15.

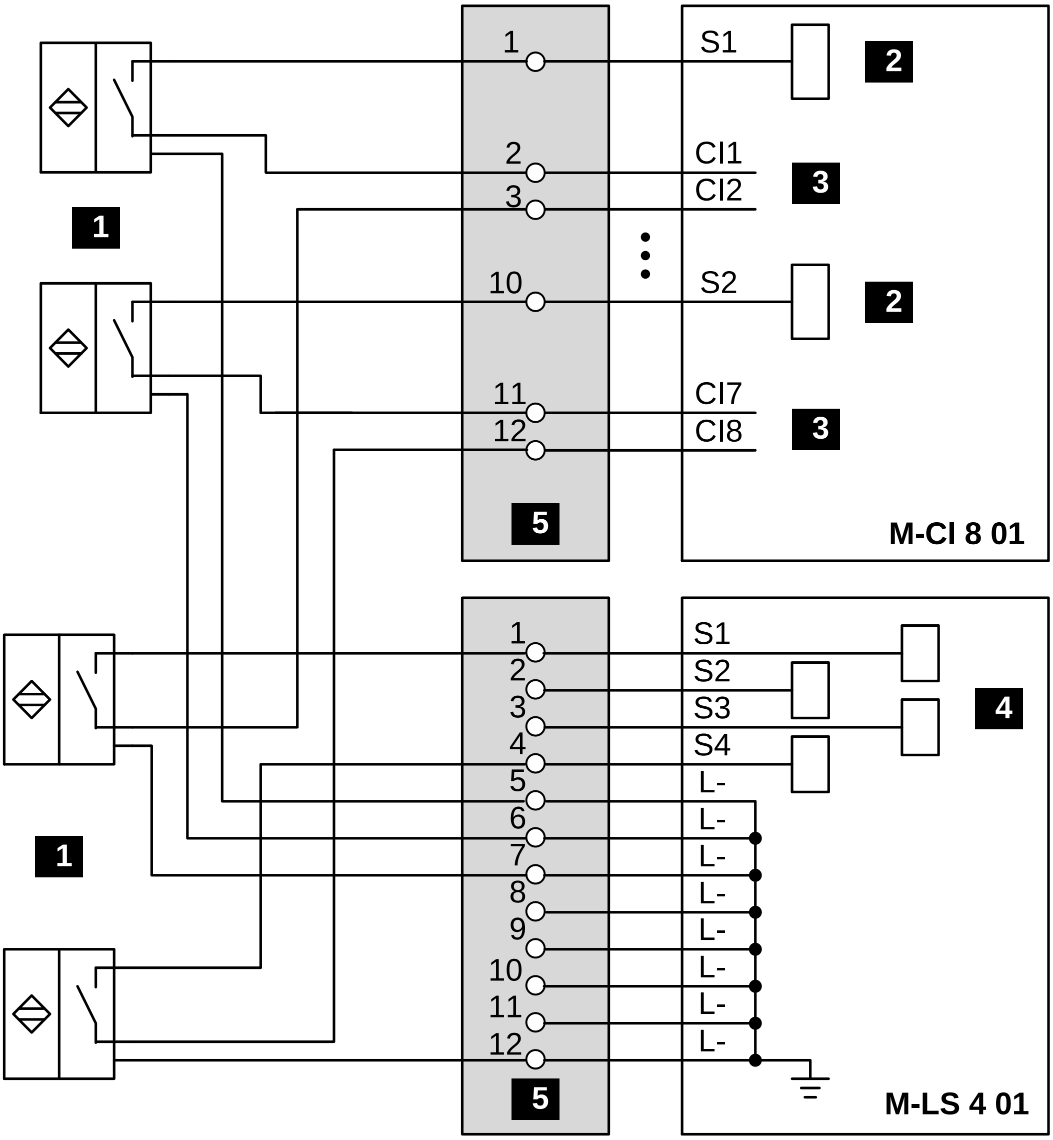


1 Incremental Encoder
2 Supplies S1, S2 of M-CI 8 01
3 Counter Inputs
4 Supplies S1...S4 of M-LS 4 01
5 Socket M-SO I/O 01

Figure 15: Wiring of Incremental Encoders in the *Quadrature Counter* Mode of Operation

4.5.4 Connection 3-Wire Proximity Switches, SIL 1

Interconnect the module and the DI extension module M-LS 4 01 to connect 3-wire proximity switches. The DI extension module provides four additionally supplies and eight L- ports, see module M-LS 4 01 manual.



1 3-Wire Proximity Switch
2 Supplies S1, S2 of M-CI 8 01
3 Counter Inputs
4 Supplies S1...S4 of M-LS 4 01
5 Socket M-SO I/O 01

Figure 16: Connecting 3-Wire Proximity Switch

5 Operation

The module runs within the HIMatrix M45 system and does not require any specific monitoring.

When operating the system, ensure that the air circulation is not obstructed.

5.1 Handling

Handling of the module and the HIMatrix M45 system during operation is not required.

Do not pull or plug the modules during operation!

5.2 Diagnosis

The LEDs are used to give an overview of the operating state, see Chapter 3.4.5.

The diagnostic history of the M45 system can also be read using SILworX.

6 Maintenance

No maintenance measures are required during normal operation.

If a failure occurs, the defective module must be replaced with a module of the same type or with a replacement model approved by HIMA.

Modules may only be replaced in the de-energized state.

Only the manufacturer is authorized to repair the module.

6.1 Errors

Refer to Chapter 3.1.1, for more information on the fault reaction of inputs.

If the test harnesses of the module detect safety-critical faults (module faults), the module is rebooted. If the fault is still present, the module is rebooted again. This process is repeated as long as the fault is present. If no fault is detected, the module is restarted (RUN state).

If the restart after a module fault must be prevented, the user program must be configured accordingly. To this end, use the system parameters *Emergency Stop 1*…*Emergency Stop 4*. If the system parameters *Emergency Stop 1*…*Emergency Stop 4* are used, the entire M45 system enters the STOP state.

If the test harnesses detect module faults, the module is rebooted. If a further module fault occurs within the first minute after restart, the module enters the STOP_INVALID state and will remain in this state. This means that the input signals are no longer processed by the module and the outputs switch to the de-energized, safe state. The evaluation of diagnostics provides information about the fault cause.

6.2 Maintenance Measures

The following measures are required for the module:

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

6.2.1 Loading the Operating System

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

Refer to the release notes to check the impact of the operation system version on the system!

The operating system can be loaded into the module using SILworX. To this end, the HIMatrix M45 system must be in STOP. Otherwise, stop the system.

For more information, refer to the system manual (HI 800 651 E).

i The current version of the module in use is displayed in the SILworX Control Panel. The type label specifies the version when the module is delivered, see Chapter 3.3.

6.2.2 Proof Test

HIMatrix M45 modules must be subjected to a proof test in intervals of 10 years. For more information, refer to the safety manual (HI 800 653 E).

7 Decommissioning

The decommissioning of the module is carried out after de-energization. Following steps are necessary:

1. Stop the HIMatrix M45 system.
2. Disconnect the system from the power supply.
3. Remove the module from the socket.

8 Transport

To avoid mechanical damage, HIMatrix M45 components must be transported in packaging.

Always store HIMatrix components in their original product packaging. This packaging also provides protection against electrostatic discharge.

9 Disposal

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

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

Appendix

Glossary

Term	Description
ARP	Address resolution protocol: Network protocol for assigning the network addresses to hardware addresses
AI	Analog input
AO	Analog output
COM	Communication module
CRC	Cyclic redundancy check
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European norm
ESD	Electrostatic discharge
FB	Fieldbus
FBD	Function block diagrams
FTT	Fault tolerance time
ICMP	Internet control message protocol: Network protocol for status or error messages
IEC	International electrotechnical commission
MAC Address	Media access control address: Hardware address of one network connection
PADT	Programming and debugging tool (in accordance with IEC 61131-3), PC with SILworX
PE	Protective earth
PELV	Protective extra low voltage
PES	Programmable electronic system
R	Read: The system variable or signal provides value, e.g., to the user program
Rack ID	Base plate identification (number)
Interference-free	Supposing that two input circuits are connected to the same source (e.g., a transmitter). An input circuit is termed *interference-free* if it does not distort the signals of the other input circuit.
R/W	Read/Write (column title for system variable/signal type)
SB	System bus
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 for HIMatrix systems
SNTP	Simple network time protocol (RFC 1769)
SRS	System.Rack.Slot addressing of a module
SW	Software
TMO	Timeout
W	Write: System variable is provided with value, e.g., from the user program
r_P	Peak value of a total AC component
Watchdog (WD)	Time monitoring for modules or programs. If the watchdog time is exceeded, the module or program enters the STOP_ERROR state.
WDT	Watchdog time

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SAFETY
NONSTOP

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