# NUMSafe CTMP1960-2600 Compact Controller

## Operating manual

M00060EN-01

Edition 06.2025

www.num.com

CNC Solutions

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The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

# Summary

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# 1 Foreword

## 1.1 EC declaration of Conformity

CTMP1960-2600 Compact controller is a safety component according to EC directive 2006/42/EC, annex IV.
It complies with the relevant requirements of the machinery directive 2006/42/EC.

**Applied standards:**

| | |
|---|---|
| **EN 62061:2005+A1:2013** | Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems. |
| **EN 61131-2:2007** | Industrial-process control systems - Instruments with analogue inputs and two- or multi-state outputs - Part 2: Guidance for inspection and routine testing. |
| **EN 50581:2012** | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances. |
| **EN ISO 13849-1:2008** | Safety of machinery - Safety- related parts of control systems. |
| **EN 61000-6-2:2011** | Electromagnetic compatibility (EMC) - Immunity for industrial environments. |
| **EN 61000-6-4:2011** | Electromagnetic compatibility (EMC) - Emission standard for industrial environments. |

## 1.2 Notes on the manual

This description is only intended for the use of trained specialists in control and automation technology who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

This documentation was originally written in English. All other languages are derived from the English original.

### 1.2.1 Currentness

Please check whether you are using the current and valid version of this document. In case of doubt, please contact NUM Technical Support.

### 1.2.2 Product features

Only the product features specified in the current user documentation are valid. Further information given on catalogue, brochures, web-site etc. Is not authoritative.

### 1.2.3 Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics.

In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

### 1.2.4 Trademarks

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### 1.2.5 Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, DE102004044764, DE102007017835 with corresponding applications or registrations in various other countries.


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### 1.2.7 Delivery conditions

In addition, the general delivery conditions of the company NUM apply.

## 1.3 Safety instructions

### 1.3.1 Delivery state

All the components are supplied in particular hardware and software configurations appropriate for the application.

Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of NUM.

### 1.3.2 Operator's obligation to exercise diligence

The operator must ensure that:

- the NUMSafe products are only used as intended (see chapter Product description);
- the NUMSafe products are only operated in sound condition and in working order;
- the NUMSafe products are operated only by suitably qualified and authorized personnel;
- the personnel is instructed regularly about relevant occupational safety and environmental protection aspects, and is familiar with the operating manual and in particular the safety notes contained herein;
- the instruction manual is in good condition and complete, and always available for reference at the location where the NUMSafe products are used;
- none of the safety and warning notes attached to the NUMSafe products are removed, and all notes remain legible.

### 1.3.3 Description of safety symbols

The following safety symbols are used in this operating manual. They are intended to alert the reader to the associated safety instructions.

| Symbol | Meaning of the symbol |
|---|---|
|  | **Tip or pointer**<br><br>This symbol indicates information that contributes to better understanding. |
|  | **Damage to the environment or devices**<br><br>**Failure** to follow the instructions associated with this symbol can lead to damage to the environment or equipment. |
|  | **Serious risk of injury!**<br><br>**Failure** to follow the safety instructions associated with this symbol directly endangers the life and health of persons. |
|  | **Risk of injury!**<br><br>**Failure** to follow the safety instructions associated with this symbol endangers the life and health of persons. |
|  | **Personal injuries!**<br><br>**Failure** to follow the safety instructions associated with this symbol can lead to injuries to persons. |

## 1.4 Document revisions

| Code | Edition | Evolution Index | Meaning of the major documentation evolution points | See chapter |
|---|---|---|---|---|
| **M00060** | 05.2019 | 00 | First version of the manual. | - |
| | 06.2025 | 01 | New Certificates 2025 | 5.2 |

## 1.5 Version history of the NUMSafe product

This version history lists the releases of the software and hardware versions. A description of the respective changes to the previous version is also listed.

**Updated hardware and software**
The NUMSafe products are subject to a cyclical revision. We reserve the right to revise and change the NUMSafe products at any time and without notice.
These hardware and/or software changes do not give rise to any claims for changes to products that have already been delivered.

| Date | SW-Version | HW-Version | Changes |
|---|---|---|---|
| 2017-05-02 | 01 | 00 | • First Release |
| 2017-07-14 | 02 | 01 | • Optimized safety mat function<br>• Added support for backup/restore mode<br>• Protective circuit of the outputs changed |
| 2018-09-19 | 03 | 01 | • Local logic projects can now also be created without a linked RUN signal.<br>• Time stamp for diagnostic messages corrected.<br>• FB Muting: After an FB error in the backwards operating mode, the FB error can be acknowledged without restarting the NUMSafe group.<br>• An error acknowledgement is now required after a user has logged in to the Logic without deleting the project.<br>• Support of Module Fault Link active parameter added.<br>• Firmware and vendor data CRCs can be read out in CoE objects. |

## 1.6 NUM Agencies

The list of NUM agencies is given on http://www.num.com

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# Summary

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# 2 System description

## 2.1 Extension NUM EtherCAT I/O system with safety functions

The NUMSafe products enable convenient expansion of the I/O system with safety components, and integration of all the cabling for the safety circuit within the existing fieldbus cable.

Safe signals can be mixed with standard signals as required. The transfer of safety-related NUMSafe telegrams is handled by the standard controller. Maintenance is simplified significantly thanks to faster diagnosis and simple replacement of components.

The following basic functionalities are included in the NUMSafe components:
Digital inputs (e.g. CTMS1904), digital outputs (e.g. CTMS2904), drive component (e.g. NUM-SAMX) and logic units (e.g. CTMP1960-2600, CTMP6900).

For a large number of applications, the complete safety sensor and actuator technology can be wired on these components. The required logical link of the inputs and the outputs is handled by the CTMP1960-2600. In addition to Boolean operations, the CTMP1960-2600 now also enables analog operations.

## 2.2 Safety concept

### 2.2.1 NUMSafe: Safety and I/O technology in one system

- Extension of the familiar NUMEtherCAT I/O system with NUMSafe components
- Safe and non-safe components can be combined as required
- Logical link of the I/Os in the CTMP1960-2600 NUMSafe logic terminal
- Suitable for applications up to SIL 3 according to EN 61508:2010 and Cat 4, PL e according to EN ISO 13849-1:2015
- Safety-relevant networking of machines via bus systems
- In the event of an error, all NUMSafe components always switch to the watt less and therefore safe state.
- No safety requirements for the higher-level standard NUMSafe system.

### 2.2.2 Safety over EtherCAT protocol (FSoE)

- Transfer of safety-relevant data via any media (“genuine black channel”)
- NUMSafe communication via fieldbus systems such as EtherCAT.
- IEC 61508:2010 SIL 3 compliant
- FSoE is IEC standard (IEC 61784-3-12) and ETG standard (ETG.5100).

### 2.2.3 Fail-safe principle (fail stop)

The basic rule for a safety system such as NUMSafe is that failure of a part, a system component or the overall system must never lead to a dangerous condition. The safe state is always the switched off and wattless state.


**Safe state**

For all NUMSafe components the safe state is always the switched-off, wattless state.

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# Summary

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# 3 Product description

## 3.1 CTMP1960-2600 NUMSafe Compact Controller

The CTMP1960-2600 is a NUMSafe controller with 20 fail-safe inputs, 24 fail-safe outputs and four relays, each with one make contact.

The CTMP1960-2600 is a NUMSafe is suitable for safety applications up to SIL 3 according to IEC 62061 and IEC 61508 and up to Cat. 4, PL e according to EN ISO 13849-1:2015.
(See following list for restrictions):

- The single-channel relay output is suitable up to Cat. 2, PL d
- The two-channel relay output (use of two relay contacts in series) is suitable up to Cat. 3, PL d or Cat.
- 4, PL e, depending on the number of actuations. Cat. 4, PL e requires an actuation at least once per month, Cat. 3, PL d at least once per year.
- The safe input for the safety mat operation mode is limited to Cat. 2, PL d.

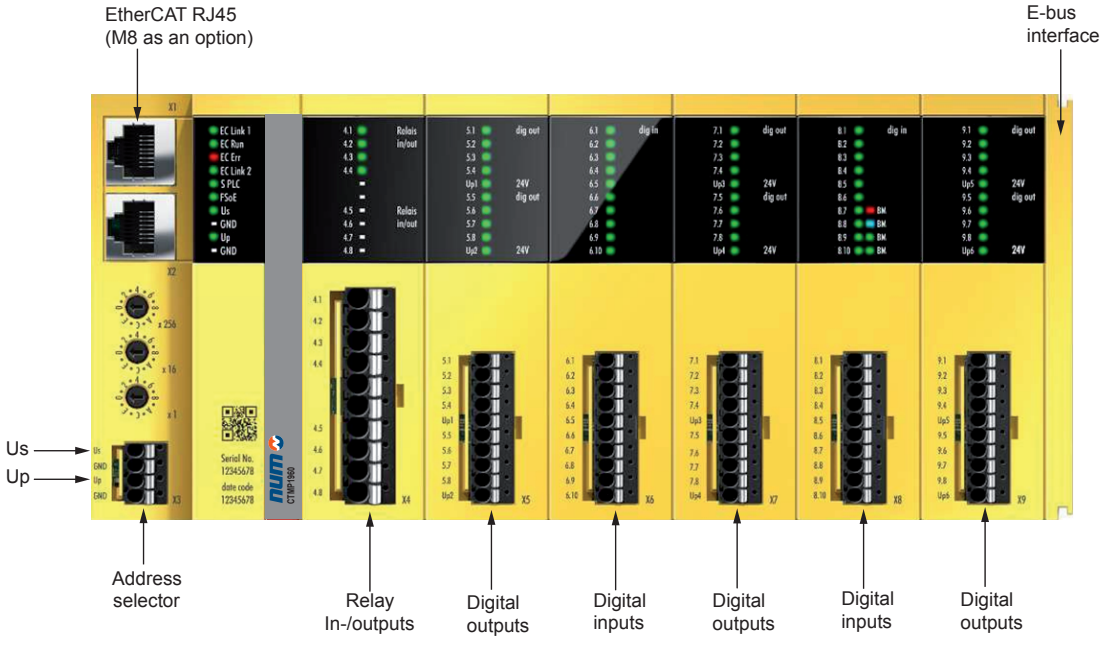
Special proof tests are not necessary during the entire lifetime of the CTMP1960-2600 on account of the high level of diagnostic coverage.

The CTMP1960-2600 can be used as NUMSafe compact controller integrated into an EtherCAT network. The CTMP1960-2600 can be extended with standard and safety terminals on the E-bus connection and via the EtherCAT network.

The inputs of the CTMP1960-2600 can be used as digital 24V inputs.
They can be fed to the safe input either with static 24 VDC or with a clock from one of the NUMSafe outputs of the CTMP1960-2600 or via an external clock source via, for example, a switch contact.
Inputs 17 to 20 can additionally be switched to a safety mat operation mode (Bumper Mode On).

Only safety mats operating according to the resistance-change principle are supported. The safety mats can also be cascaded in accordance with the manufacturer's specifications.
The inputs can be parameterized in groups of two.

The outputs can be parameterized in groups of four. It is possible to set the mark-to-space-ratio and the activation as a clock source for the safe inputs.




*CTMP1960-2600 Compact Controller*

## 3.2 Product designations

| Product designation | Description |
|---|---|
| CTMP1960-2600 | CTMP1960-2600 with EtherCAT RJ45 connections with four potential-free contacts (NO) |

## 3.3 Inputs and outputs of the CTMP1960-2600

### Fuses for the CTMP1960-2600

Fuses must be provided for the power supplies of the CTMP1960-2600 2 A each for $U_S$ and $U_P$ (X3) and 5 A each for $U_{P1}$ to $U_{P6}$ (X5, X7, X9).

| Plug | Contact | Name | Description |
|---|---|---|---|
| **EtherCAT (X1)** | | EtherCAT 1 | EtherCAT connection 1 (RJ45) |
| **EtherCAT (X2)** | | EtherCAT 2 | EtherCAT connection 2 (RJ45) |
| **Power (X3)** | 1 | $U_s$ | Control voltage 24 $V_{DC}$ (SELV/PELV).<br>Supply of power for internal logic and E-bus connection. |
| | 2 | 0 V | GND |
| | 3 | $U_p$ | Peripheral voltage 24 $V_{DC}$ (SELV/PELV).<br>Supply of power for relays and inputs in the safety mat operation mode. |
| | 4 | 0 V | GND |
| **Relais (X4)** | 1 | 4.1 | Input to Relay 1 make contact.<br>(FSOUT Relais Module.Channel1.Output) |
| | 2 | 4.2 | Input to Relay 2 make contact.<br>(FSOUT Relais Module.Channel2.Output) |
| | 3 | 4.3 | Input to Relay 3 make contact.<br>(FSOUT Relais Module.Channel3.Output) |
| | 4 | 4.4 | Input to Relay 4 make contact.<br>(FSOUT Relais Module.Channel4.Output) |
| | 5 | n.c. | not used |
| | 6 | n.c. | not used |
| | 7 | 4.5 | Output to Relay 1 make contact.<br>(FSOUT Relais Module.Channel1.Output) |
| | 8 | 4.6 | Output to Relay 2 make contact.<br>(FSOUT Relais Module.Channel2.Output) |
| | 9 | 4.7 | Output to Relay 3 make contact.<br>(FSOUT Relais Module.Channel3.Output) |
| | 10 | 4.8 | Output to Relay 4 make contact.<br>(FSOUT Relais Module.Channel4.Output) |
| **Output (X5)** | 1 | 5.1 | Output 1 from $U_{P1}$<br>(FSOUTmodule1.Channel1.Output) |
| | 2 | 5.2 | Output 2 from $U_{P1}$<br>(FSOUTModule1.Channel2.Output) |
| | 3 | 5.3 | Output 3 from $U_{P1}$<br>(FSOUTModule1.Channel3.Output) |
| | 4 | 5.4 | Output 4 from $U_{P1}$<br>(FSOUTModule1.Channel4.Output) |
| | 5 | $U_{P1}$ | Peripheral voltage $U_{P1}$ 24 $V_{DC}$ (SELV/PELV) |
| | 6 | 5.5 | Output 5 from $U_{P2}$<br>(FSOUTModule2.Channel1.Output) |
| | 7 | 5.6 | Output 6 from $U_{P2}$<br>(FSOUT Module2.Channel2.Output) |
| | 8 | 5.7 | Output 7 from $U^{P2}$<br>(FSOUTModule2.Channel3.Output) |
| | 9 | 5.8 | Output 8 from $U_{P2}$<br>(FSOUTModule2.Channel4.Output) |
| | 10 | $U_{P2}$ | Peripheral voltage $U_{P2}$ 24 $V_{DC}$ (SELV/PELV) |

| Plug | Contact | Name | Description |
|---|---|---|---|
| **Input (X6)** | 1 | 6.1 | Input 1<br>(FSIN Module 1.Channel 1.Input) |
| | 2 | 6.2 | Input 2<br>(FSIN Module 1.Channel 2.Input) |
| | 3 | 6.3 | Input 3<br>(FSIN Module 2.Channel 1.Input) |
| | 4 | 6.4 | Input 4<br>(FSIN Module 2.Channel 2.Input) |
| | 5 | 6.5 | Input 5<br>(FSIN Module 3.Channel 1.Input) |
| | 6 | 6.6 | Input 6<br>(FSIN Module 3.Channel 2.Input) |
| | 7 | 6.7 | Input 7<br>(FSIN Module 4.Channel 1.Input) |
| | 8 | 6.8 | Input 8<br>(FSIN Module 4.Channel 2.Input) |
| | 9 | 6.9 | Input 9<br>(FSIN Module 5.Channel 1.Input) |
| | 10 | 6.10 | Input 10<br>(FSIN Module 5.Channel 2.Input) |
| **Output (X7)** | 1 | 7.1 | Output 9 from $U_{P3}$<br>(FSOUT Module 3.Channel 1.Output) |
| | 2 | 7.2 | Output 10 from $U_{P3}$<br>(FSOUT Module 3.Channel 2.Output) |
| | 3 | 7.3 | Output 11 from $U_{P3}$<br>(FSOUT Module 3.Channel 3.Output) |
| | 4 | 7.4 | Output 12 from $U_{P3}$<br>(FSOUT Module 3.Channel 4.Output) |
| | 5 | $U_{P3}$ | Peripheral voltage $U_{P3}$ 24 $V_{DC}$ (SELV/PELV) |
| | 6 | 7.5 | Output 13 from $U_{P4}$<br>(FSOUT Module 4.Channel 1.Output) |
| | 7 | 7.6 | Output 14 from $U_{P4}$<br>(FSOUT Module 4.Channel 2.Output) |
| | 8 | 7.7 | Output 15 from $U_{P4}$<br>(FSOUT Module 4.Channel 3.Output) |
| | 9 | 7.8 | Output 16 from $U_{P4}$<br>(FSOUT Module 4.Channel 4.Output) |
| | 10 | $U_{P4}$ | Peripheral voltage $U_{P4}$ 24 $V_{DC}$ (SELV/PELV) |
| **Input (X8)** | 1 | 8.1 | Input 11<br>(FSIN Module 6.Channel 1.Input) |
| | 2 | 8.2 | Input 12<br>(FSIN Module 6.Channel 2.Input) |
| | 3 | 8.3 | Input 13<br>(FSIN Module 7.Channel 1.Input) |
| | 4 | 8.4 | Input 14<br>(FSIN Module 7.Channel 2.Input) |
| | 5 | 8.5 | Input 15<br>(FSIN Module 8.Channel 1.Input) |
| | 6 | 8.6 | Input 16<br>(FSIN Module 8.Channel 2.Input) |
| | 7 | 8.7 | Input 17 (digital - *Digital Mode On*, safety mat operation mode (resistance change) - *Bumper Mode On*)<br>(FSIN Module 9.Channel 1.Input) |
| | 8 | 8.8 | Input 18 (digital - *Digital Mode On*, safety mat operation mode (resistance change) - *Bumper Mode On*)<br>(FSIN Module 9.Channel 2.Input) |
| | 9 | 8.9 | Input 19 (digital - *Digital Mode On*, safety mat operation mode (resistance change) - *Bumper Mode On*)<br>(FSIN Module 10.Channel 1.Input) |
| | 10 | 8.10 | Input 20 (digital - *Digital Mode On*, safety mat operation mode (resistance change) - *Bumper Mode On*)<br>(FSIN Module 10.Channel 2.Input) |

| Plug | Contact | Name | Description |
|---|---|---|---|
| **Input (X9)** | 1 | 9.1 | Output 17 from $U_{P5}$ (FSOUT Module 5.Channel 1.Output) |
| | 2 | 9.2 | Output 18 from $U_{P5}$ (FSOUT Module 5.Channel 2.Output) |
| | 3 | 9.3 | Output 19 from $U_{P5}$ (FSOUT Module 5.Channel 3.Output) |
| | 4 | 9.4 | Output 20 from $U_{P5}$ (FSOUT Module 5.Channel 4.Output) |
| | 5 | $U_{P5}$ | Peripheral voltage $U_{P5}$ 24 $V_{DC}$ (SELV/PELV) |
| | 6 | 9.5 | Output 21 from $U_{P6}$ (FSOUT Module 6.Channel 1.Output) |
| | 7 | 9.6 | Output 22 from $U_{P6}$ (FSOUT Module 6.Channel 2.Output) |
| | 8 | 9.7 | Output 23 from $U_{P6}$ (FSOUT Module 6.Channel 3.Output) |
| | 9 | 9.8 | Output 24 from $U_{P6}$ (FSOUT Module 6.Channel 4.Output) |
| | 10 | $U_{P6}$ | Peripheral voltage $U_{P6}$ 24 $V_{DC}$ (SELV/PELV) |

### Protected wiring

If the wiring of the outputs or the connected actuators leaves the control cabinet, the user must ensure that the wiring is protected.


### Active loads

The use of active loads (with their own power supply) is not permissible unless the manufacturer of the load ensures the non-reactivity of the power supply to the control signal.


### Clocked signals within a sheathed cable

Are clocked signals of different output modules used within a sheathed cable, a failure of a module, such as cross-circuit or external power supply must lead to a switch off of all these modules. This switch off must be performed by the user program.
From firmware version 03 and revision -0021 the parameter Module Fault Link active is available. If the parameter is set to TRUE for all modules involved, all these modules are set to the error state in the event of a module error.
This parameter is set to TRUE by default.

## 3.4 Connection technology

### 3.4.1 Power supply spring contact strip

The power supply spring contact strip is required for the X3 connection.

| | |
|---|---|
| Number of contacts | 4 |
| Contact spacing | 3.5 mm |
| Connection methods | Spring-loaded terminal technology |
| Wire cross-section (solid-wire) | 0.2 - 1.5 mm² |
| Wire cross-section (fine-wire) | 0.2 - 1.5 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules with plastic collars) | 0.25 - 0.75 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules without plastic collars) | 0.25 - 1.5 mm² |
| Strip length | 8 - 9 mm |

### 3.4.2 Input and output spring contact strip

The input and output spring contact strip is required for the connection X5 to X9.

| | |
|---|---|
| Number of contacts | 10 |
| Contact spacing | 3.5 mm |
| Connection methods | Spring-loaded terminal technology |
| Wire cross-section (solid-wire) | 0.2 - 1.5 mm² |
| Wire cross-section (fine-wire) | 0.2 - 1.5 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules with plastic collars) | 0.25 - 0.75 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules without plastic collars) | 0.25 - 1.5 mm² |
| Strip length | 8 - 9 mm |

### 3.4.3 Relay contact spring contact strip

The relay contact spring contact strip is required for the connection X4.

| | |
|---|---|
| Number of contacts | 10 |
| Contact spacing | 5 mm |
| Connection methods | Spring-loaded terminal technology |
| Wire cross-section (solid-wire) | 0.2 - 2.5 mm² |
| Wire cross-section (fine-wire) | 0.2 - 2.5 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules with plastic collars) | 0.25 - 1.5 mm² |
| Conductor cross-sectional area - fine wire (with wire- end ferrules without plastic collars) | 0.25 - 2.5 mm² |
| Strip length | 8 - 9 mm |

## 3.5 Intended use


**Caution - Risk of injury!**

The NUMSafe compact controller may only be used for the purposes described below!

The NUMSafe compact controller expands the application range of the NUM EtherCAT system by functions that enable it to be used in the field of machine safety as well.

The NUMSafe compact controller is designed for machine safety functions and the directly associated industrial automation tasks.
It is therefore approved only for applications with a defined fail-safe state. This safe state is the wattless state.

The CTMP1960-2600 NUMSafe compact controller is suitable for operation as a safety controller within an EtherCAT network.


**System limits**

The TÜV-Süd certificate applies to the CTMP1960-2600, the function blocks available in it, the documentation and the engineering tool.
Approved engineering tools is *CODESYS Safety for EtherCAT Safety Module*.
Any deviations from the procedures or tools, particularly externally generated xml files for NUMSafe import or externally generated automatic project creation procedures, are not covered by the certificate.

**Power supply**

The NUMSafe compact controller must be supplied with 24 $V_{DC}$ by an SELV/PELV power supply unit with an output voltage limit Umax of 36 $V_{DC}$.
Failure to observe this can result in a loss of security.

**Commissioning test**

Before the CTMP1960-2600 can be used for the safety task, the user must carry out a commissioning test so that sensor and actuator wiring errors can be ruled out.


**Note the Machinery Directive**

The NUMSafe compact controller may only be used in machines within the meaning of the Machinery Directive.

**Ensure traceability**

The buyer has to ensure the traceability of the device via the serial number.

## 3.6 Technical data

| Product designation | CTMP1960-2600 |
|---|---|
| Number of inputs | 20 |
| Number of outputs | 24 (+ 4 optional relay outputs) |
| Cable length between sensor and input | 30 m (if cables with a cross-sectional area of 0.75 mm² are used) |
| Cable length between output and actuator | 30 m (if cables with a cross-sectional area of 0.75 mm² are used) |
| Minimum/maximum logic cycle time | approx. 1 ms / according the project size |
| Fault response time | ≤ watchdog times |
| Watchdog time | min. 2 ms, max. 60.000 ms |
| Input process image | Dynamic, according to the NUMSafe configuration in FlexiumTools Safe configuration. |
| Output process image | Dynamic, according to the NUMSafe configuration in FlexiumTools Safe configuration. |
| Supply voltage (SELV/PELV) | 24 $V_{DC}$ (-15% / +20%)<br>Provide a 2 A fuse for $U_S$ and $U_P$ |
| E-bus power supply (5 V) | max. 500 mA<br>(In the case of higher current consumption, please use the CTMT9410 power feed terminals in addition!) |
| Signal voltage inputs | see Characteristic curve of the inputs on chapter 3.9. |
| Output module (4 channels) | 24 $V_{DC}$ (-15% / +20%) SELV/PELV for $U_{P1}$ to $U_{P6}$<br>Max. 2 A per channel.<br>Min. 30 mA with a test pulse length of 400 µs and resistive load.<br>Simultaneity factor 50% per module.<br>Provide 5 A fuse for each $U_{Px}$<br><br>Diagnostic thresholds:<br>> 4 V -> high signal is detected.<br>< 2.4 V -> low signal is detected. |
| Permissible actuators | • Inductive loads (see also Load characteristic curve - inductive load)<br>(A free-wheeling diode must be provided on the load)<br>• Resistive loads<br>• Capacitive loads. |
| Current consumption of the modular electronics at 24 $V_{DC}$ (without current consumption of sensors/actuators) | $U_S$ typ. 80 mA<br>$U_P$ typ. 2 mA<br>$U_{P1}$ to UP6 each typ. 2 mA |
| Dimensions (W x H x D) | 230.5 mm x 100 mm x 58.6 mm |
| Weight | approx. 560 g |
| Permissible ambient temperature (operation) | -25 °C to +55 °C |
| Permissible ambient temperature (transport/storage) | -40 °C to +70 °C |
| Permissible humidity | 5% to 95%, non-condensing |
| Permissible air pressure (operation/storage/transport) | 750 hPa to 1100 hPa<br>(this corresponds to an altitude of approx. -690 m to 2450 m above sea level, assuming an international standard atmosphere) |
| Climate category according to EN 60721-3-3 | 3K3<br>(the deviation from 3K3 is possible only with optimal environmental conditions and also applies only to the technical data which are specified differently in this documentation) |
| Permissible level of contamination according to EN 60664-1 | level of contamination 2<br>(comply with the chapter 4.22.1 Cleaning) |

| **Product designation** | **CTMP1960-2600** |
|---|---|
| Inadmissible operating conditions | NUMSafe controllers must not be used under the following operating conditions:<br>under the influence of ionizing radiation (exceeding the natural background radiation)<br>in corrosive environments<br>in an environment that leads to impermissible soiling of the controller. |
| Vibration / shock resistance | conforms to EN 60068-2-6 / EN 60068-2-27 |
| EMC immunity/emission | conforms to EN 61000-6-2 / EN 61000-6-4 |
| Shocks | 15 g with pulse duration 11 ms in all three axes |
| Protection class as per IEC 60529 | IP20 |
| Permitted operating environment | In the control cabinet or terminal box, with minimum protection class IP54 according to IEC 60529 |
| Correct installation position | see chapter 4.2.3.3 Installation position and minimum distances. |
| Technical approvals | CE, TÜV SÜD |

**Protective circuit**

No protective circuit is integrated in the output circuit of the CTMP1960-2600, so it is necessary to provide a freewheeling diode on the actuator for inductive loads. However, it must be borne in mind that the freewheeling diode may prolong the switch-off times of the actuator.
The protective circuit must limit the induced voltage at the output to an amount of less than 29V. Thus, R/C circuits and varistors are typically unsuitable.

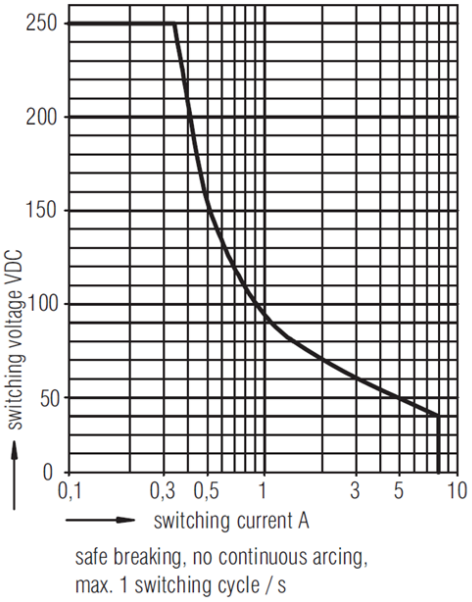
### 3.6.1 Technical data - relay

| Product designation | CTMP1960-2600 |
|---|---|
| Contacts | 1 NO |
| Make contact material (NO) | AgNi + 0.2 µm Au |
| Feedback contact material (NC) | AgNi + 5 µm Au |
| Coil voltage | $24V_{DC}$ |
| Maximum continuous current, NO contact<br>(when used in safety applications) | DC13 (24 $V_{DC}$) I = 2 A<br>AC15 (230 $V_{AC}$ ) I = 3 A |
| Maximum switching current (NO contact) | 8 A |
| Minimum switching current (NO contact) | 10 mA (AgNi) |
| Switching capacity according to IEC/EN60947-5-1<br>AC15<br>DC13 | <br>250 $V_{AC}$ / 3 A<br>24 $V_{DC}$ / 2 A |
| Switching frequency (maximum) | 20 switching cycles / s |
| Response time | ≤ 15 ms (typically 10 ms) |
| Release time | ≤ 5 ms (typically 2 ms) |

**Allowed loads of the relay**

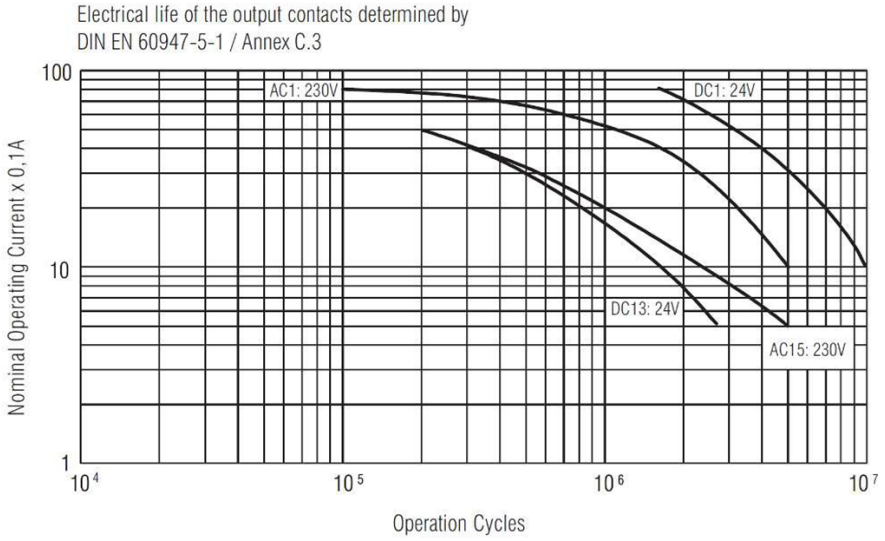
The potential-free contacts of the relay (X4) may only be connected to resistive and inductive loads. Capacitive loads are not permissible.

**Load limit curve**



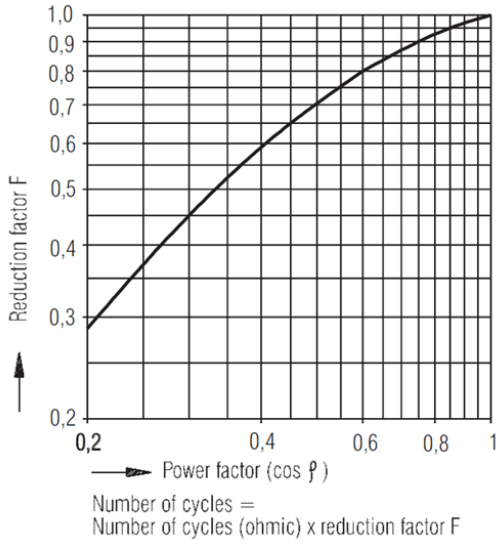

*Load limit curve, make contact*

### Operating lifetime for contact material AgNi




*Operating lifetime of the AgNi NO contact for DC1, DC13, AC1 and AC15*

### Reduction factor for inductive loads




*Reduction factor for inductive loads*

## 3.7 Safety parameters

In the following tables the safety parameters are shown separately for inputs, logic and outputs. The PFH values for the inputs, logic and outputs used must be added together for the complete safety loop. The Safety-over-EtherCAT communication is included in the logic part.

| General parameters | CTMP1960-2600 |
|---|---|
| Lifetime [a] | 20 |
| Prooftest Intervall [a] | - [1)] |
| HFT | 1 |
| Classification element [2)] | Type B |

1. Special proof tests are not necessary during the entire lifetime of the CTMP1960-2600 NUMSafe compact controller on account of the high level of diagnostic coverage.
2. Classification according to IEC 61508-2:2010 (see chapters 7.4.4.1.2 and 7.4.4.1.3)

The CTMP1960-2600 NUMSafe compact controller can be used for safety-related applications within the meaning of IEC 62061:2005/A2:2015 up to SILCL3 and IEC 61508:2010 up to SIL 3 and EN ISO 13849-1:2015 up to Cat. 4, PL e. (See following note for restrictions):


**CTMP1960-2600 category and performance level restrictions**

- The single-channel relay output is suitable up to **Cat. 2, PL d**.
- The two-channel relay output (use of two relay contacts in series) is suitable up to **Cat. 3, PL d or Cat. 4, PL e**, depending on the number of actuations. Cat. 4, PL e requires an actuation at least **once per month**, Cat. 3, PL d at least **once per year**.
- The safe input for the safety mat operation mode is limited to **Cat. 2, PL d**.

Further information on calculating or estimating the MTTFD value from the PFHD value can be found in the NUMSafe application manual or in EN ISO 13849-1:2015, Table K.1.

### Relay output safety parameters (Cat. 4 – two-channel)

The following table contains the safety parameters for the two-channel relay output. This must be added to the logic and input value to determine the total PFH value.
One actuation of the relay per hour is assumed for the calculation.

| Relay output parameters (Cat. 4 – two-channel) | Value |
|---|---|
| $PFH_D$ | 1.46 E-09 |
| $PFD_G$ | 1.48 E-06 |
| $MTTF_D$ | high |
| $DC_{avg}$ | high |
| Performance Level | PL e |
| Category | 4 |
| SIL | 3 |

### Relay output safety parameters (Cat. 2 – single-channel)

The following table contains the safety parameters for the single-channel relay output. This must be added to the logic and input value to determine the total PFH value.

One actuation of the relay per hour is assumed for the calculation.

| Relay output parameters (Cat. 2 – single-channel) | Value |
|---|---|
| $PFH_D$ | 7.25 E-10 |
| $PFD_G$ | 6.42 E-05 |
| $MTTF_D$ | high |
| $DC_{avg}$ | high |
| Performance Level | PL d |
| Category | 2 |
| SIL | 2 |

### $B_{10D}$ relay values

| Characteristic numbers | CTMP1960-2600 |
|---|---|
| $B_{10D}$ value (DC13 24 $V_{DC}$ and Imax ≤ 2 A) | 1.500.000 [switching cycles] |
| $B_{10D}$ value (AD15 230 $V_{AC}$ and Imax ≤ 1 A) | 750.000 [switching cycles] |
| $B_{10D}$ value (AD15 230 $V_{AC}$ and Imax ≤ 3 A) | 300.000 [switching cycles] |

### Digital input safety parameters

The following table contains the safety parameters for the digital input of the CTMP1960-2600. This must be added to the logic and input value to determine the total PFH value.

| Digital input parameters | Value |
|---|---|
| $PFH_D$ | 6.4 E-11 |
| $PFD_G$ | 6.1 E-06 |
| $MTTF_D$ | high |
| $DC_{avg}$ | high |
| Performance Level | PL e |
| Category | 4 |
| SIL | 3 |

### Safety mat input safety parameters

The following table contains the safety parameters for the analog input in the safety mat operation mode of the CTMP1960-2600. This must be added to the logic and input value to determine the total PFH value.

| Safety mat input parameters | Value |
|---|---|
| $PFH_D$ | 8.84 E-10 |
| $PFD_G$ | 7.5 E-05 |
| $MTTF_D$ | high |
| $DC_{avg}$ | medium |
| Performance Level | PL d |
| Category | 2 |
| SIL | 2 |

### Logic safety parameters

The following table contains the safety parameters for the logic module of the CTMP1960-2600. This must be added to the input and output value to determine the total PFH value. The Safety-over-EtherCAT communication is included in the logic part.

| Safety mat input parameters | Value |
|---|---|
| $PFH_D$ | 5.18 E-09 |
| $PFD_G$ | 4.32 E-05 |
| $MTTF_D$ | high |
| $DC_{avg}$ | high |
| Performance Level | PL e |
| Category | 4 |
| SIL | 3 |

### Output safety parameters

The following table contains the safety parameters for the digital output of the CTMP1960-2600. This must be added to the input and logic value to determine the total PFH value.

| Safety mat input parameters | Value |
|---|---|
| $PFH_D$ | 1.5 E-10 |
| $PFD_G$ | 2.62 E-07 |
| $MTTF_D$ | high |
| $DC_{avg}$ | high |
| Performance Level | PL e |
| Category | 4 |
| SIL | 3 |

### Examples of safety loops

| **Characteristic numbers** | | | **Sample 1** | **Sample 2** | **Sample 3** | **Sample 4** |
|---|---|---|---|---|---|---|
| Safety mat input | PLd, Cat. 2 | 8.48 E-10 | 8.48 E-10 | | 8.48 E-10 | 8.48 E-10 |
| Digital input | PLe, Cat. 4 | 6.4 E-11 | | 6.4 E-11 | | |
| Logic | PLe, Cat. 4 | 5.18 E-09 | 5.18 E-09 | 5.18 E-09 | 5.18 E-09 | 5.18 E-09 |
| Digital output | PLe, Cat. 4 | 1.5 E-10 | 1.5 E-10 | 1.5 E-10 | | |
| Relay output (Cat. 4) | PLe, Cat. 4 | 1.46 E-09 | | | 1.46 E-09 | |
| Relay output (Cat. 2) | PLd, Cat. 2 | 7.25 E-10 | | | | 7.25 E-10 |
| | | | | | | |
| **Overall result PFHD/ Performance Level / Category** | | | **6.18 E-09 PLd, Cat. 2** | **5.39 E-09 PLe, Cat. 4** | **7.49 E-09 PLd, Cat. 2** | **6.75 E-09 PLd, Cat. 2** |

## 3.8 Error response times

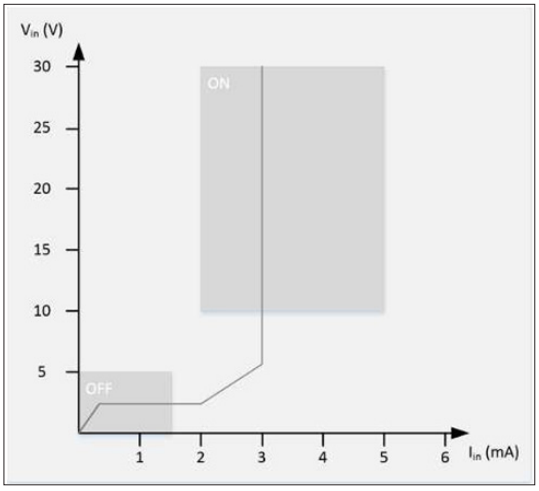
The error response times depend, among other things, on the logic program used and the settings of the *MultiplierDiagTestPulse* and *ModuloDiagTestPulse* parameters.

An error reaction for the tests of the I/O signals is realized by a weighted counter, therefore the switch-off does not occur immediately at the first error of the diagnostic tests.

The maximum error reaction time results from the duration of the longest lasting test, this is the RAM test and this is several hours.

## 3.9 Characteristic curve of the inputs

The characteristic curve of the inputs of the CTMP1960-2600 is similar to type 3 according to EN 61131-2.




*CTMP1960-2600 input characteristic curve*

## 3.10 Test pulses for the outputs

The output signals of each module of the CTMP1960-2600 can be determined via the parameter *Diag TestPulse Active*.
The test pulses generated have a length of 400 µs, which is multiplied by the factor *MultiplierDiagTestPulse*.

This factor should be set to at least 2 for outputs with no load or only a small load, so that a test pulse length of 800 µs results. The frequency of the test pulses results from the processing of the input and output modules and the cycle time of the internal logic.
For example, if the logic has a cycle time of 2 ms and a *ModuloDiagTestpulse* of 0, a typical time b results in accordance with the following calculation.

For each output module the resulting time is:
Module time = (4 cycles feedback test + (4 cycles diagnostic test * (ModuloDiagTestPulse + 1))) * internal cycle time * 1.25 * 4 outputs = (4 + (4 * 1)) * 2 ms * 1.25 * 4 = 80 ms

For the relay module the resulting time is:
Relay module time = 100 * internal cycle time * 1.25

The input modules each require one cycle. This results in a total time b of:
b = 6 x module time + 1x relay module time + 10 x internal cycle time x 1.25 (for the input modules)

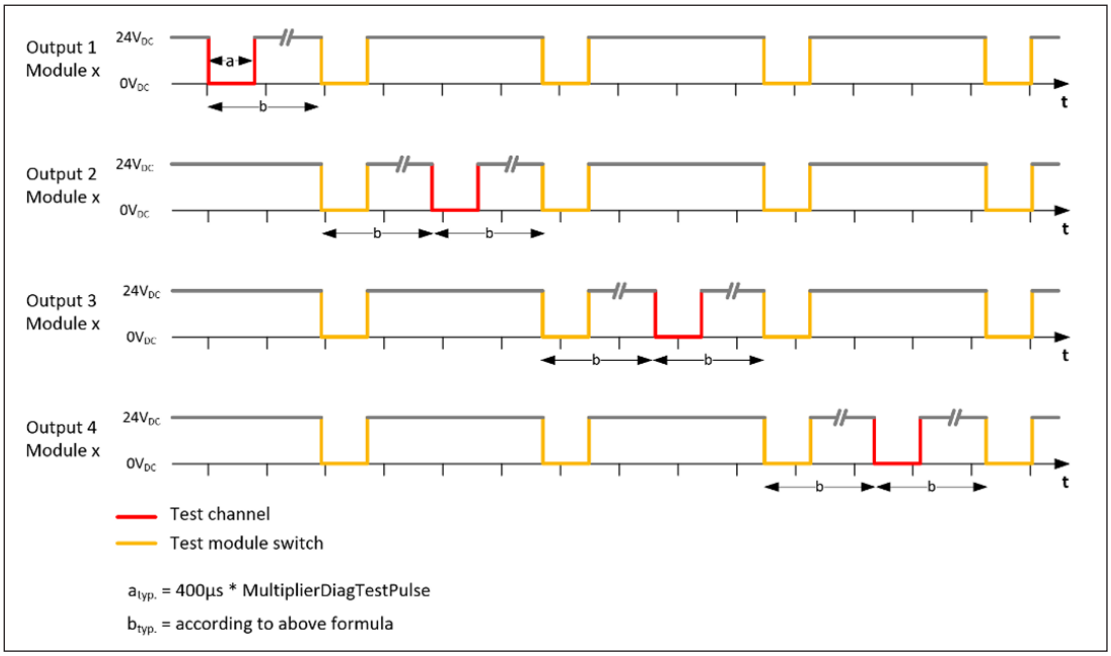
Inserting the values, this produces:
b= (6 * 80 ms) + (100 * 2 ms * 1.25) + (10 * 2 ms * 1.25) = 480 ms + 250 ms + 25 ms = 755 ms

The test pulse sequence is shown in the following table, where the time b typically elapses between a channel test and a module switch test. The tests start over once they have been performed for all four channels.

If the parameter *Diag TestPulse for Inputs active* is set in addition, all outputs of the module are switched on and the test pulses shown here are similarly applied to the individual output channels.

These signals can then be used as clocked signals for the safe inputs. The module switch test is not performed in this operation mode; instead, the four channels are tested directly in succession, leading to the time interval b between the tests of the individual channels.

| Test | Time until next test |
|---|---|
| Channel 1 (only channel 1 is tested) | b |
| Module switch (all four channels are tested) | b |
| Channel 2 (only channel 2 is tested) | b |
| Module switch (all four channels are tested) | b |
| Channel 3 (only channel 3 is tested) | b |
| Module switch (all four channels are tested) | b |
| Channel 4 (only channel 4 is tested) | b |
| Module switch (all four channels are tested) | b (next test channel 1) |




### Length of the test pulses

When setting the test pulses, make sure that the connected actuator is not switched due to the test pulse length.
The output signal must be 0 V for at least 200 µs within a test pulse.
This is independent of the setting of the parameter *MultiplierDiagTestPulse*.

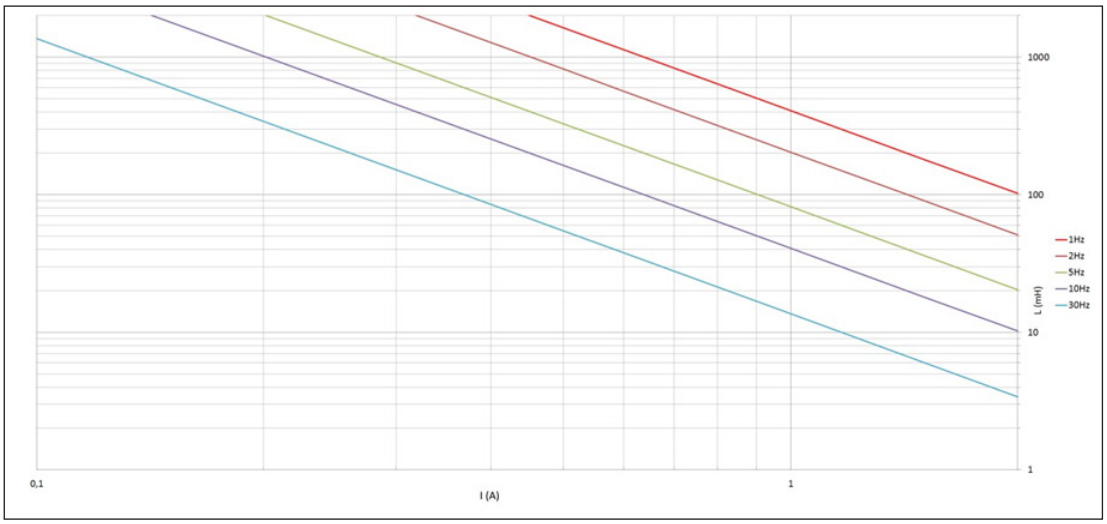
### Minimum load

The test pulse length of the outputs is set by default to 2 x 400 µs. This setting is suitable for typical actuators with and without a protective circuit. The test pulse length can typically be reduced to 400µs with a resistive load and a current of at least 30 mA. Please observe the violation counter in the diagnostic history.

If messages are displayed for the corresponding output module, this means that the setting of the test pulse length is borderline and may need to be increased.
For electronic contactors that tend towards a capacitive behavior, it may be necessary to set the parameter *MultiplierDiagTestPulse* to 3 or higher.

## 3.11 Load characteristic curve - inductive load

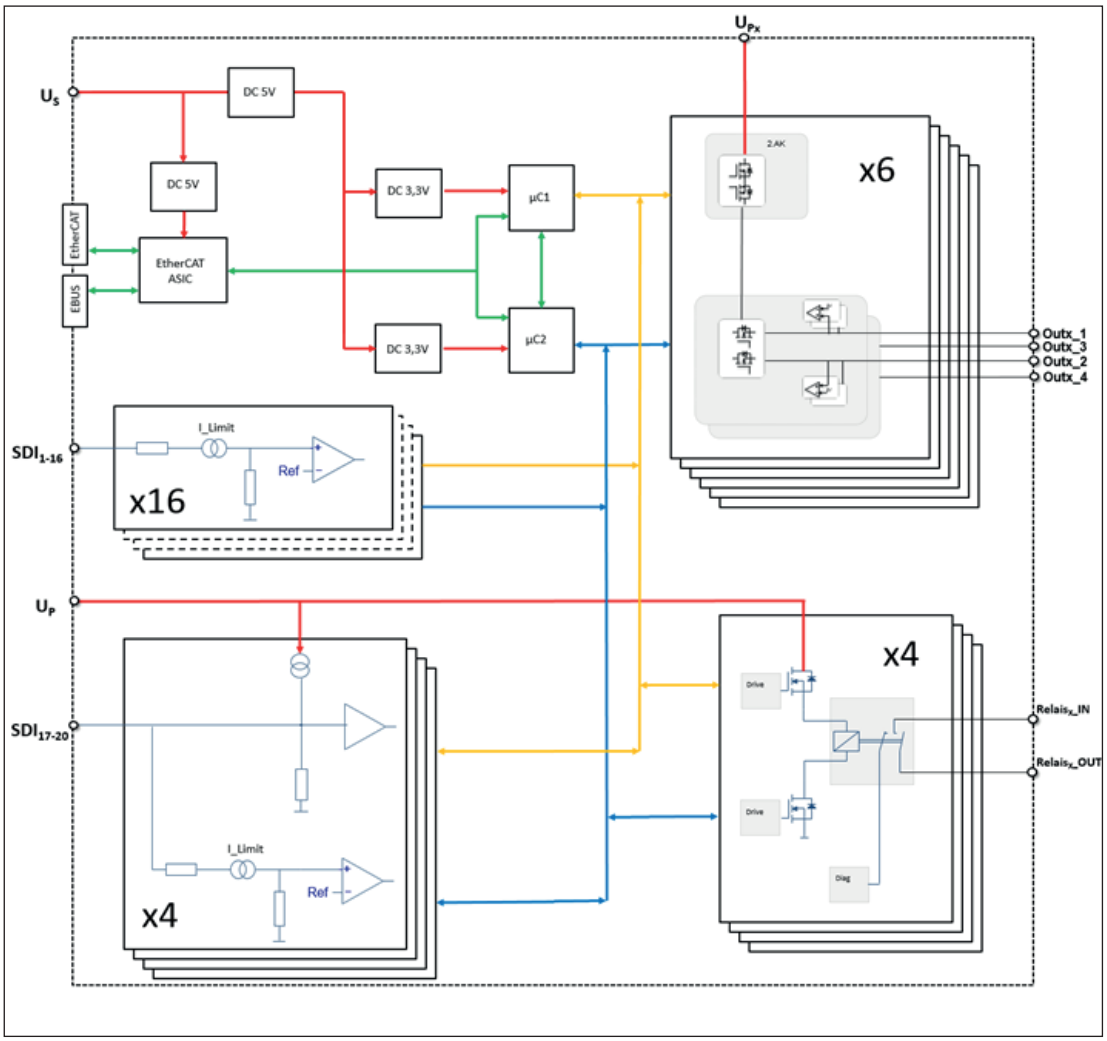
If an external freewheeling diode is not used for inductive loads, the permissible maximum load can be taken from the following characteristic curve.




*Characteristic curve - inductive load*

## 3.12 Block diagram of the CTMP1960-2600

The following block diagram shows the basic structure of the CTMP1960-2600.
The sub-modules shown exist several times according to the information on the sub-modules.




*Block diagram CTMP1960-2600*

## 3.13 Dimensions


*CTMP1960-2600 Dimensions*

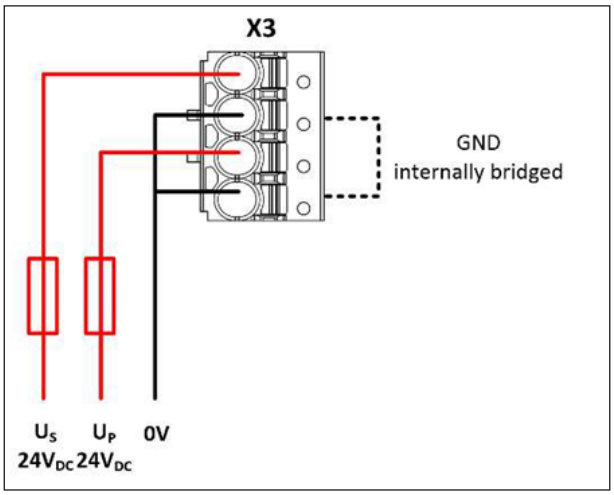
Width: 230.5 mm - Height: 100 mm - Depth: 58.6 mm

## 3.14 Wiring examples

### 3.14.1 Inputs and outputs

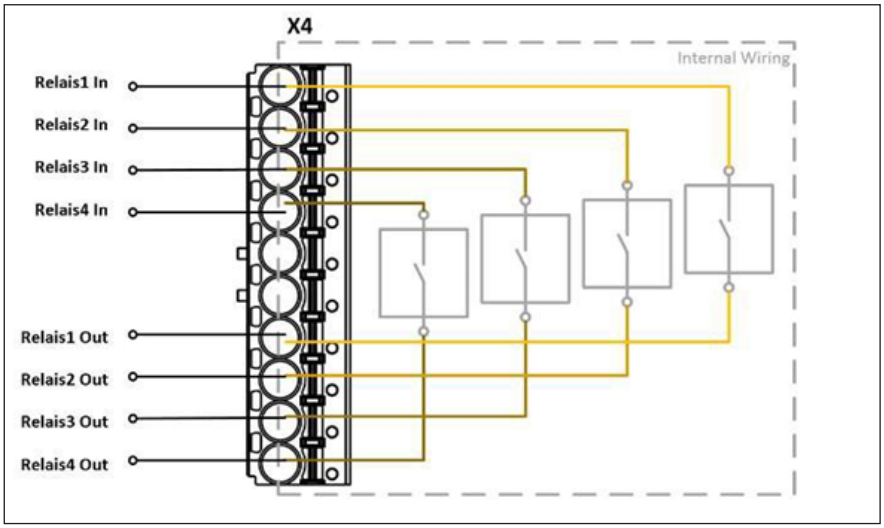
Examples of the wiring of the individual connections of the CTMP1960-2600 are shown in the following.

**Power supply X3**
The X3 connection is for the supply of power to the CTMP1960-2600.
The internal logic and the E-bus connection are supplied via $U_S$, while $U_P$ supplies the relays and the safe inputs (safety mat operation mode). The GND connections are internally bridged.




*Power supply X3*

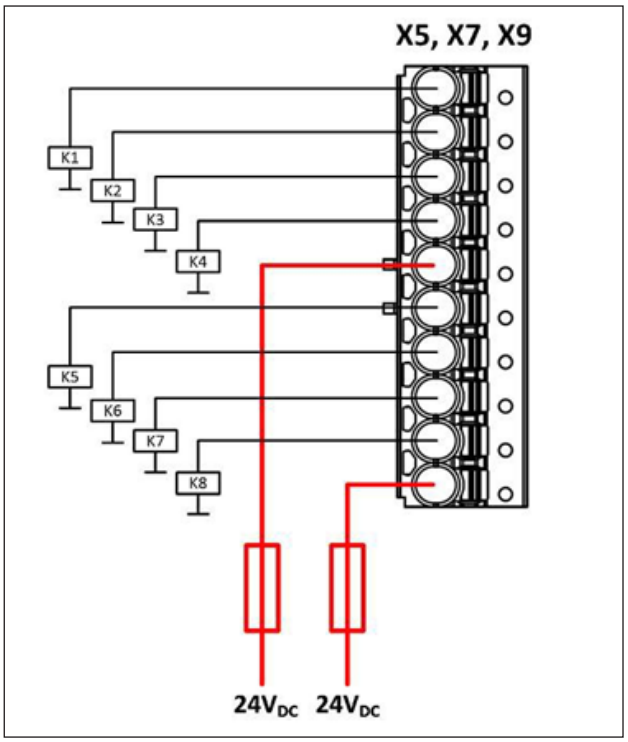
**Potential-free relay contacts X4**
The relay contacts (four relays each with one make contact) are fed out to the X4 connection.
The area surrounded by the dotted line shows the make contacts of the individual relays.




*Relay contact X4*

**Digital outputs X5, X7 and X9**

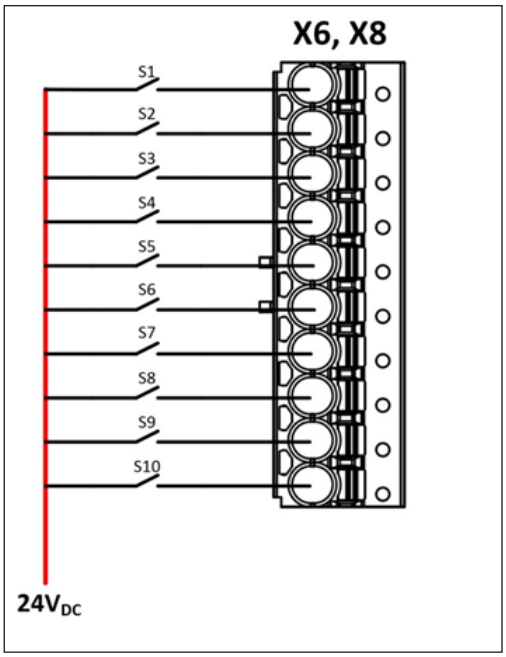
Connection X5, X7 and X9 must be supplied with 24 VDC on contacts 5 and 10.
These each supply four outputs. The connected actuator is not fed back to the CTMP1960-2600; instead it is wired directly to GND.




*Digital outputs X5, X7 and X9*

**Digital inputs X6, X8**

The digital inputs are supplied with 24VDC signals. In the default setting, static or clocked signals are supported. Safe outputs of the CTMP1960-2600 can also be selected as the clock signal source.




*Digital inputs X6 and X8*

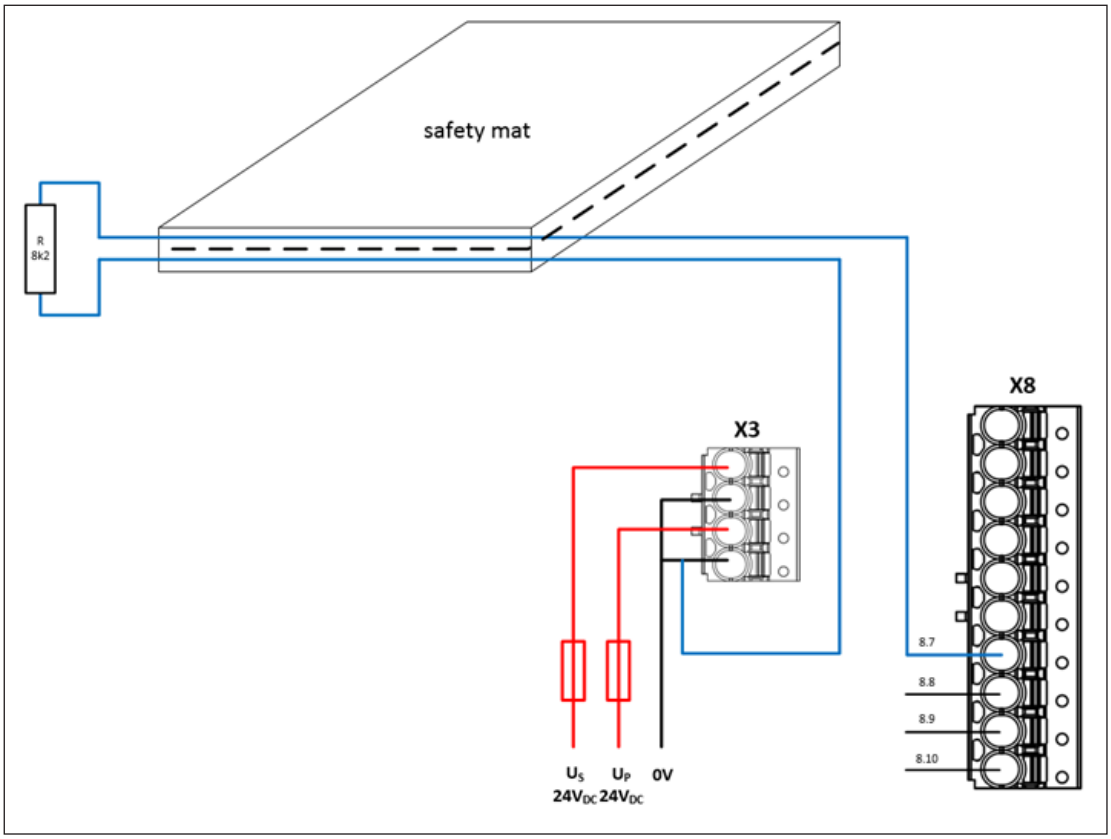
**Safety mat connection example**

Inputs 8.7 to 8.10 on connection X8 of the CTMP1960-2600 can be configured for a safety mat operation mode. Only safety mats operating according to the resistance-change principle may be used. Only 8K2 (8.2 kΩ) termination resistors are supported.

CAUTION

**Safety mat wiring**

The ground connection of the safety mat used must be fed back to the CTMP1960-2600 in accordance with the following diagram.

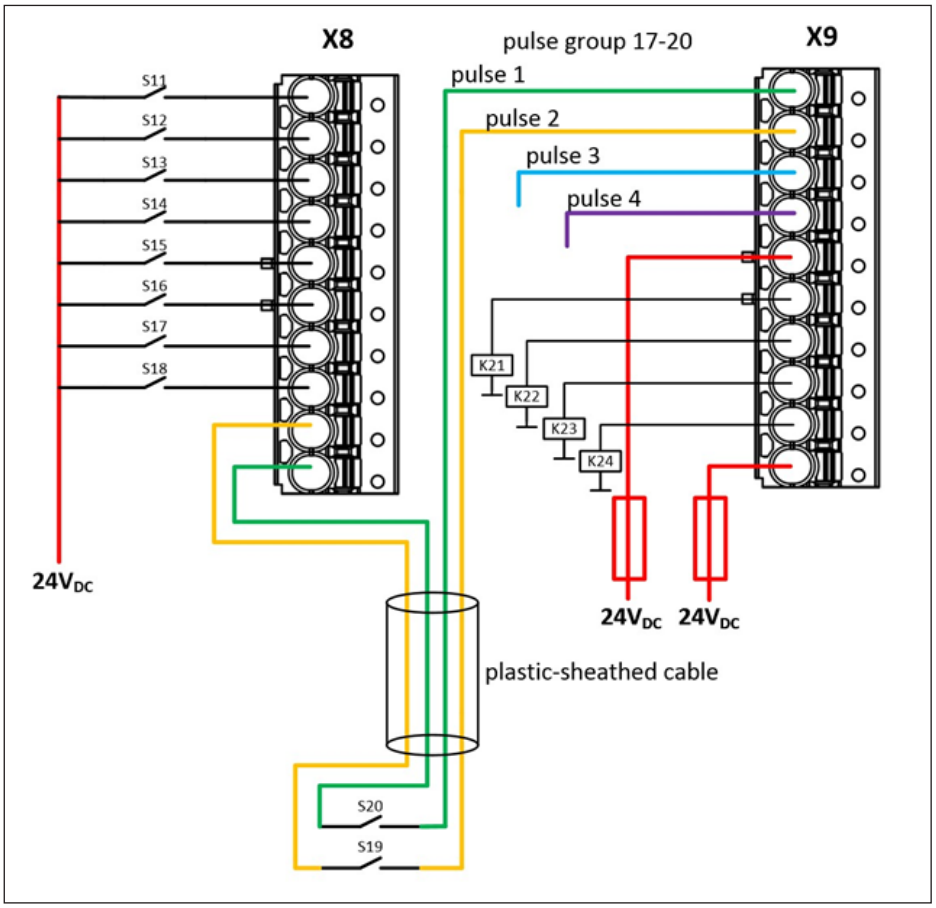



*Safety mat wiring*

### 3.14.2 Clocked signals

All output groups (four outputs each) can be configured as clock outputs. The test pulses of the groups can be set accordingly via parameters.

If a sensor such as a key switch (represented here by S19 and S20) is two-channel wired within one single non-metallic sheathed cable, the two channels must be fed from different clock sources. This makes it possible to detect cross-circuits or external power supplies within the common non-metallic sheathed cable and to achieve a high level of diagnostic coverage.
.




*Wiring example – clock outputs to inputs*

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# Summary

# 4 Operation

## 4.1 Environmental conditions

Please ensure that the NUMSafe components are only transported, stored and operated under the specified conditions (see technical data)!


**Risk of injury!**

The NUMSafe components must not be used under the following operating conditions. under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation) in corrosive environments in an environment that leads to unacceptable soiling of the NUMSafe component.

**Electromagnetic compatibility**

The NUMSafe components comply with the current standards on electromagnetic compatibility with regard to spurious radiation and immunity to interference in particular.
However, in cases where devices such as mobile phones, radio equipment, transmitters or high-frequency systems that exceed the interference emissions limits specified in the standards are operated near NUMSafe components, the function of the NUMSafe components may be impaired.

## 4.2 Installation

### 4.2.1 Safety instructions

Before installing and commissioning the NUMSafe components please read the safety instructions in the foreword of this documentation.

### 4.2.2 Transport / storage

Use the original packaging in which the components were delivered for transporting and storing the NUMSafe components.


**Note the specified environmental conditions**

Please ensure that the digital NUMSafe components are only transported and stored under the specified environmental conditions (see technical data).

## 4.2.3 Mechanical installation

### 4.2.3.1 De-energized condition


**Serious risk of injury!**

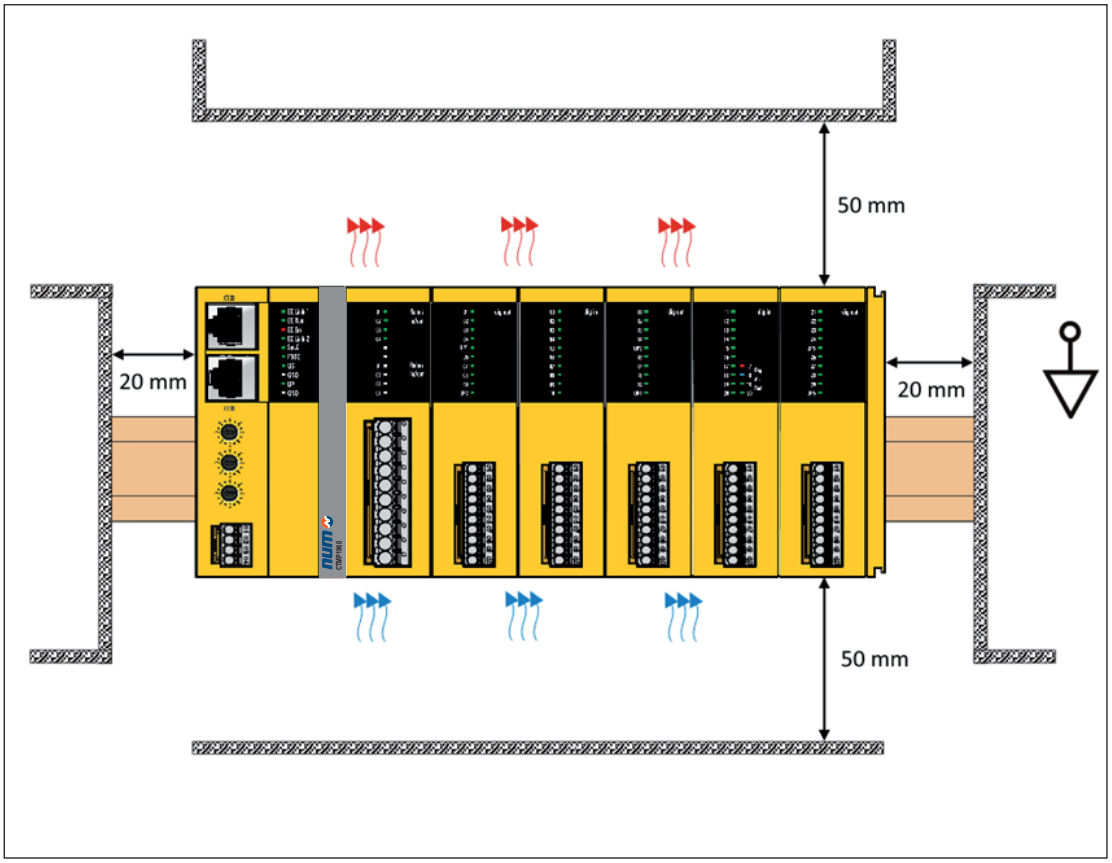
Bring the bus system and the controller into a safe, de-energized state before installing, disassembling or wiring of the controller!.

### 4.2.3.2 Control cabinet / terminal box

For operation, the NUMSafe compact controller must be installed in a control cabinet or terminal box with IP54 protection class according to IEC 60529 as a minimum.

### 4.2.3.3 Installation position and minimum distances

For the prescribed installation position the mounting rail is installed horizontally and the mating surfaces of the NUMSafe compact controller point towards the front (see illustration below).
The controller is ventilated from below, which enables optimum cooling of the electronics through convection.
The direction indication “down” corresponds to the direction of positive acceleration due to gravity..

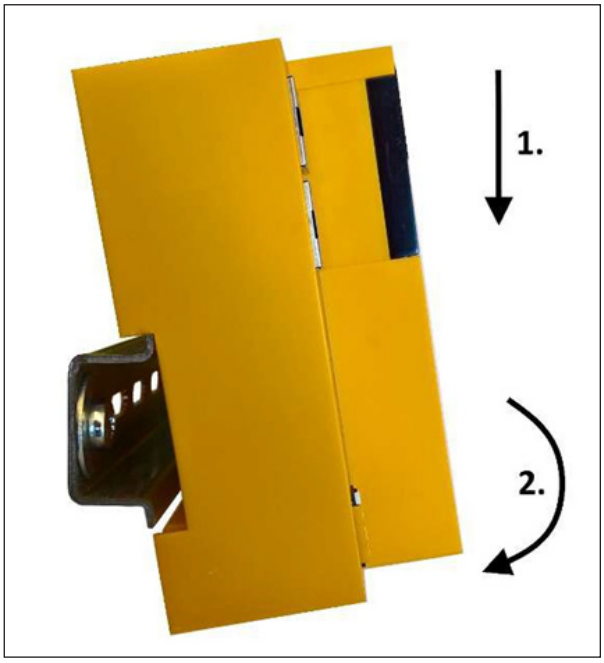



*Installation position and minimum distances*

In order to ensure optimum convection cooling, the distances to neighboring devices and to control cabinet walls must not be smaller than those shown in the diagram.

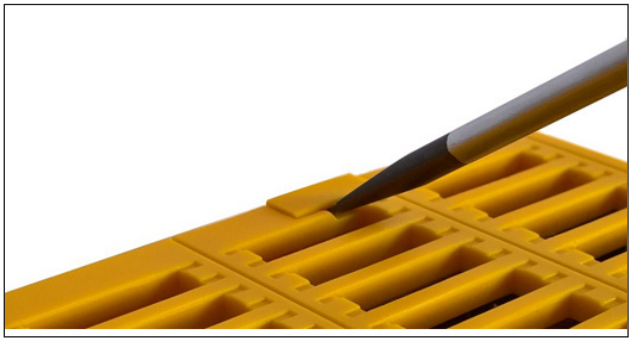
### 4.2.3.4 Installation on mounting rails

The CTMP1960-2600 is mounted on a DIN rail by inserting the device onto the DIN rail and then pressing it down onto the rail as shown in the diagram below. In the case of flat DIN rails it may be better to position the controller to the DIN rail from below and to snap it upwards onto the rail.

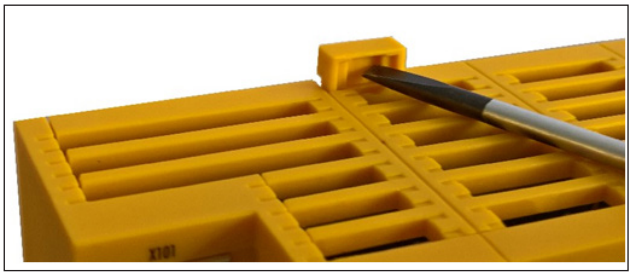



*Mounting the CTMP1960-2600 on the DIN rail*

The CTMP1960-2600 is released from the DIN rail by opening the two clamps on top of or underneath the device. To do this, insert a screwdriver into the recess provided and open the clamp until it latches.



*DIN rail clamp closed*



*DIN rail clamp opened*

### 4.2.4 Electrical installation

#### 4.2.4.1 Overvoltage protection

If protection against overvoltage is necessary in your system, provide an overvoltage protective circuit (surge filter) for the power supply to the NUMSafe compact controller.

#### 4.2.4.2 Wiring

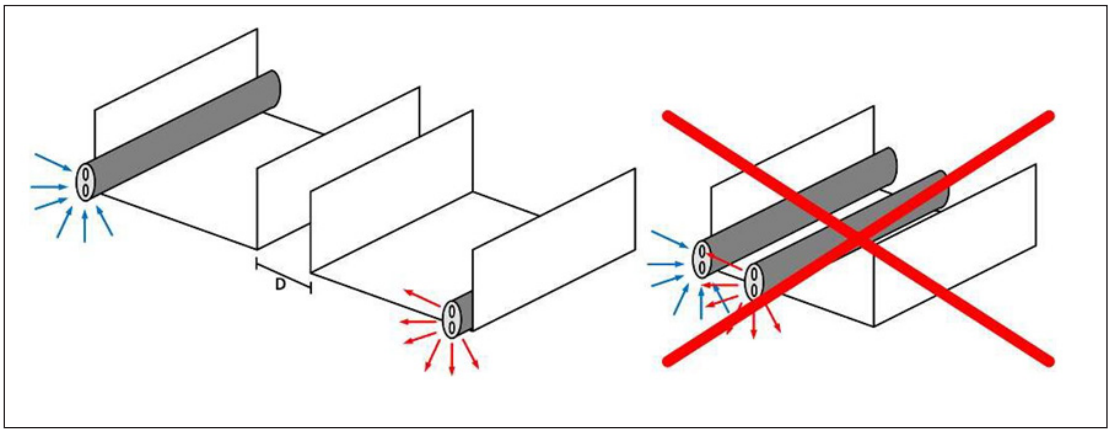
The connectors support the push-in wiring of individual wires and fine-wire conductors with wire-end sleeves. In the case of multi-wire and fine-wire conductors, the latch must be depressed to connect the conductor with the contact point.

Depress the latch with a screwdriver, insert the conductor and release the latch.

*X5 Depressing the latch*

### 4.2.4.3 Signal cables

**Cable routing**




*Cable routing*

**Route the signal cable separately**

The signal cable must be routed separately from potential sources of interference, such as motor supply cables, 230 VAC power cables etc.!
Interference caused by cables routed in parallel can influence the signal form of the test pulses and thus cause diagnostic messages (e.g. sensor errors or OpenLoad errors).
D: Distance between the cable ducts should be as large as:
- blue arrows: signal line
- red arrows: potential source of interference.

The common routing of signals together with other clocked signals in a common cable also reduces the maximum propagation, since crosstalk of the signals can occur over long cable lengths and cause diagnostic messages.

## 4.3 Configuration of CTMP1960-2600 with “CODESYS Safety for EtherCAT Safety Module”


**Do not change the register values!**

Do not change any of the CoE objects in the NUMSafe terminals.
Any modifications (e.g. via “CODESYS Safety for EtherCAT Safety Module”) of the CoE objects would permanently set the terminals to the Fail-Stop state.

### 4.3.1 Configuration requirements

The following system requirements apply to smaller “CODESYS Safety for EtherCAT Safety Module” projects with a maximum of 100 blocks, a maximum of 10 visualisations and a maximum of 8 fieldbus devices:

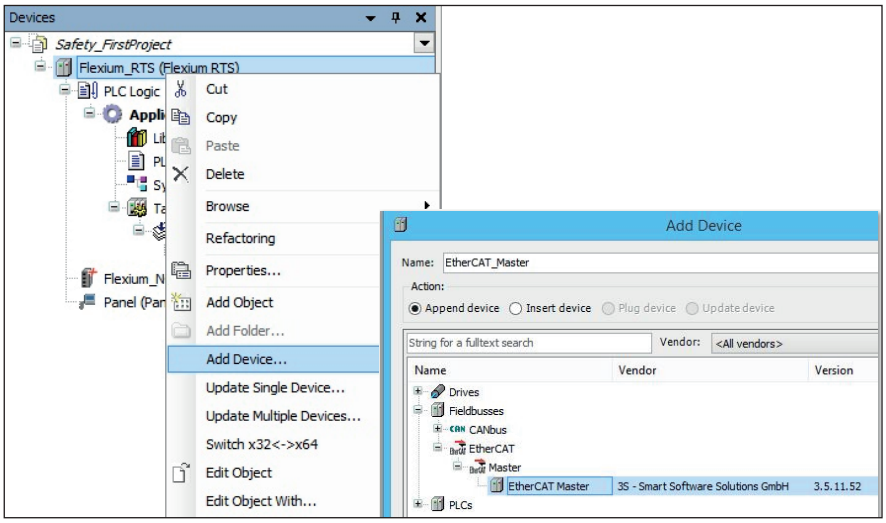
- 1 GB RAM
- 1 GHz Pentium
- 1 GB free hard disc space
- Screen resolution 1024 x 768.

### 4.3.2 NUM EtherCAT Gateway

See NUM EtherCAT terminals CTMG and CTMT Operating manual M00032.

### 4.3.3 Adding an EtherCAT Master to the device tree

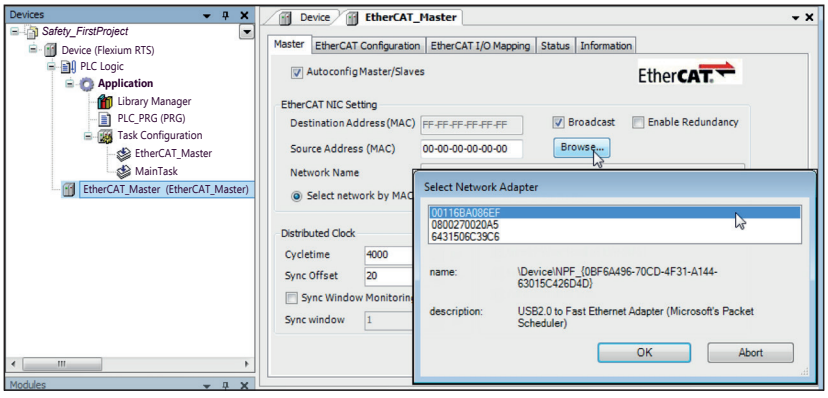
A right-click on the controller opens the context menu, from which the *“Add device...”* command is selected. The “EtherCAT Master” device is then selected in the following dialog.




*Inserting an EtherCAT Master*

### 4.3.4 Adapting the EtherCAT Master settings

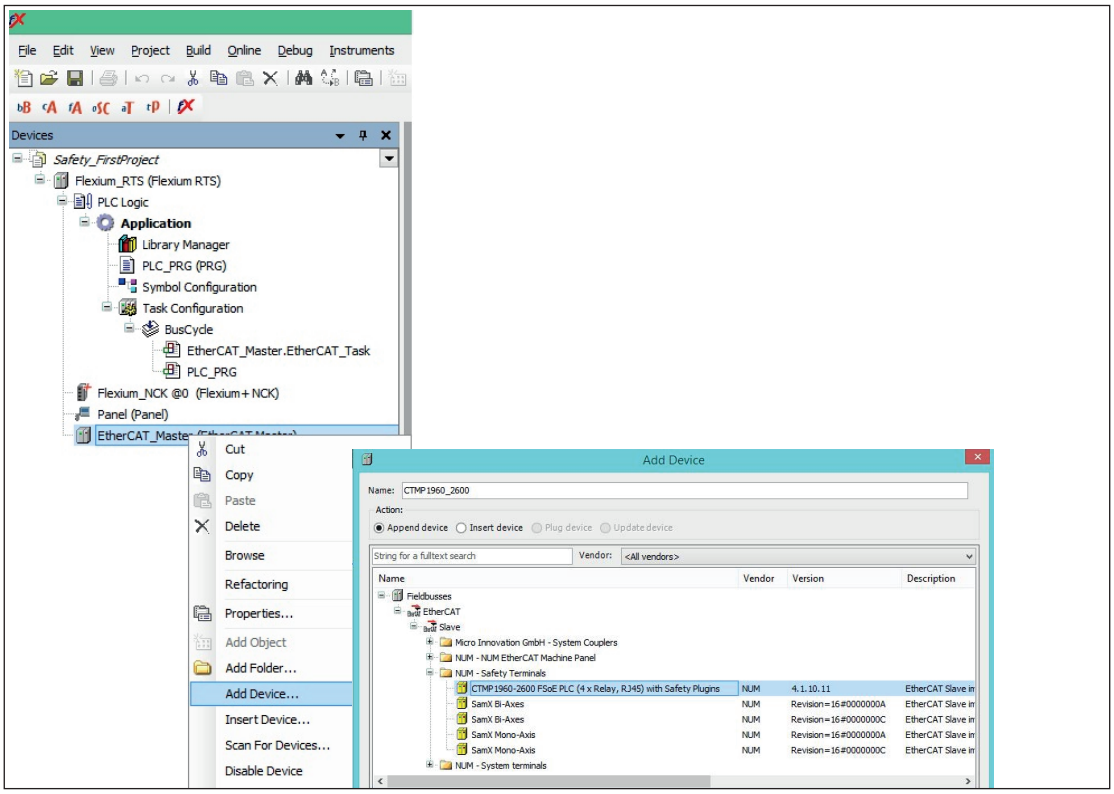
A double-click on the *“EtherCAT Master”* device in the device tree opens the associated editor for setting the parameters. In this example the desired network adaptor is selected and the dialog is quit with *“OK”* .




*EtherCAT Master - settings*

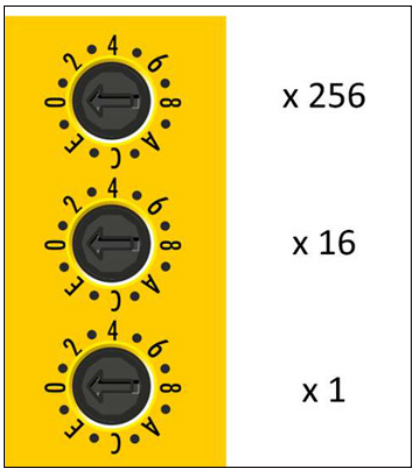
### 4.3.5 Adding a CTMP1960-2600

A right-click on the EtherCAT_Master opens the context menu, from which the *"Add device..."* command is selected. The *"CTMP1960-2600"* device is then selected in the following dialog.




*Adding a CTMP1960-2600*

## 4.4 Address setting of the NUMSafe compact controller




*Address selection switch of the CTMP1960-2600*

The NUMSafe address of the controller must be set with the three rotary switches on the housing of the CTMP1960-2600 NUMSafe controller. NUMSafe addresses between 1 and 4095 are available.

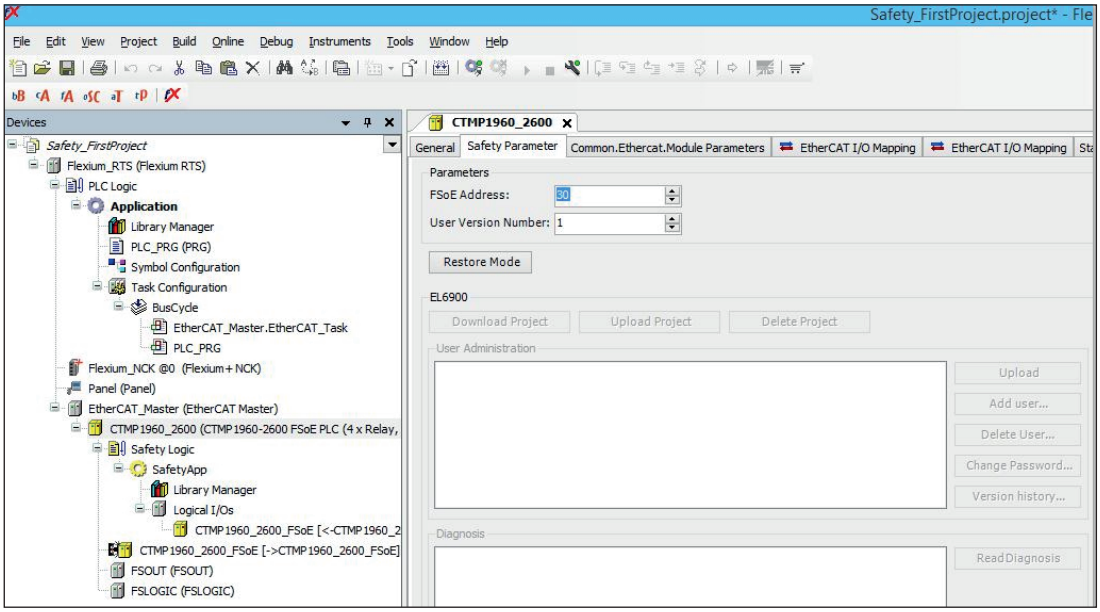
| **Rotary switch** | | | **Address** |
|---|---|---|---|
| **1 (top)** | **2 (center)** | **3 (bottom)** | |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 2 | 2 |
| 0 | 0 | 3 | 3 |
| … | … | … | … |
| 0 | 0 | F | 15 |
| 0 | 1 | 0 | 16 |
| 0 | 1 | 1 | 17 |
| … | … | … | … |
| 0 | F | F | 255 |
| 1 | 0 | 0 | 256 |
| 1 | 0 | 1 | 257 |
| … | … | … | … |
| F | F | F | 4095 |


**NUMSafe address**

Each NUMSafe address must be unique within a network!
The address 0 is not a valid address.

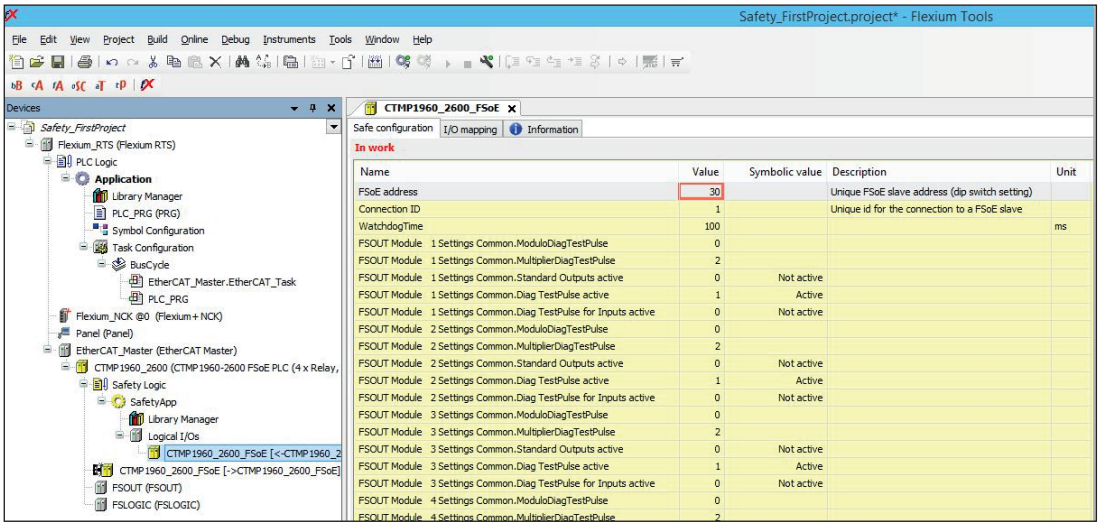
### 4.4.1 Entering the NUMSafe Address in the System Manager

The NUMSafe address set at the Rotary switch must be entered under the Safety Parameter tab of the CTMP1960-2600 device.




*Entering NUMSafe addresses and under the “Safe Configuration” tab of the CTMP1960-2600 Logical I/O*

and under the “Safe Configuration” tab of the CTMP1960-2600 Logical I/O



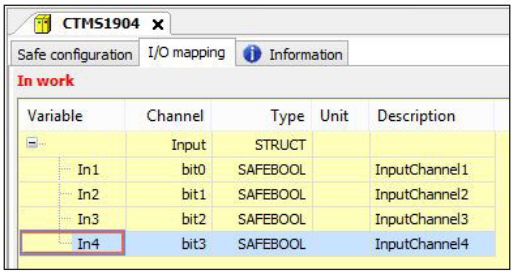

*Entering NUMSafe addresses*

### 4.4.2 Adding other NUMSafe terminals

Using the same method applied for the CTMP1960-2600, other NUMSafe terminals (CTMS1904 and CTMS2904) can be added as well and the FSoE address is also set in the same manner.

### 4.4.3 Settings of the parameters of the Logical I/Os

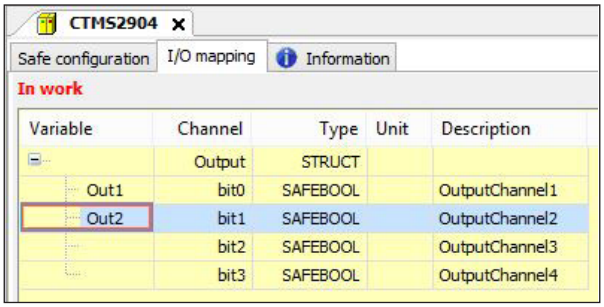
In the next step the addresses of the logical devices are set. To this end the FSoE address “2” is set for the “CTMS1904” module and the address “3” for “CTMS2904”.



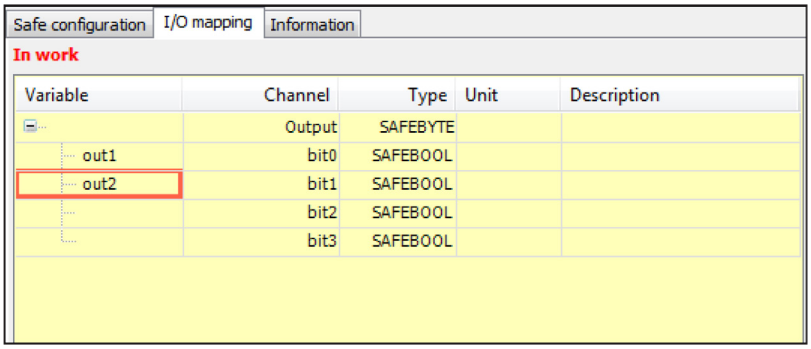

*Logical I/Os - settings*

### 4.4.4 Definition of the I/O mapping of the Logical I/Os

Variables can be assigned to the individual channels of the module on the second tab of the editor. This is defined for the two modules as shown below:

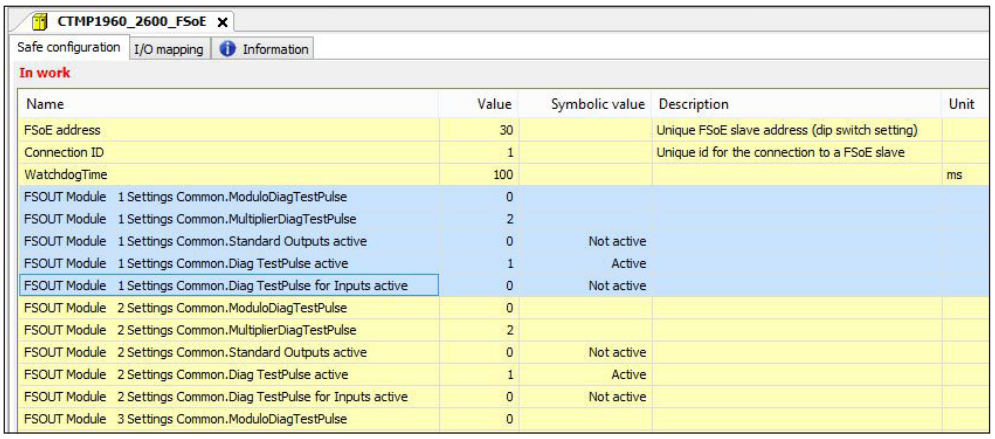



*CTMS1904 logical I/Os - I/O mapping*




*CTMS2904 logical I/Os - I/O mapping*

## 4.4.5 Parameters configuration of CTMP1960-2600 Logical I/Os




| Name | Value | Symbolic value | Description | Unit |
|---|---|---|---|---|
| FSoE address | 30 | | Unique FSoE slave address (dip switch setting) | |
| Connection ID | 1 | | Unique id for the connection to a FSoE slave | |
| WatchdogTime | 100 | | | ms |
| FSOUT Module 1 Settings Common.ModuloDiagTestPulse | 0 | | | |
| FSOUT Module 1 Settings Common.MultiplierDiagTestPulse | 2 | | | |
| FSOUT Module 1 Settings Common.Standard Outputs active | 0 | Not active | | |
| FSOUT Module 1 Settings Common.Diag TestPulse active | 1 | Active | | |
| FSOUT Module 1 Settings Common.Diag TestPulse for Inputs active | 0 | Not active | | |
| FSOUT Module 2 Settings Common.ModuloDiagTestPulse | 0 | | | |
| FSOUT Module 2 Settings Common.MultiplierDiagTestPulse | 2 | | | |
| FSOUT Module 2 Settings Common.Standard Outputs active | 0 | Not active | | |
| FSOUT Module 2 Settings Common.Diag TestPulse active | 1 | Active | | |
| FSOUT Module 2 Settings Common.Diag TestPulse for Inputs active | 0 | Not active | | |
| FSOUT Module 3 Settings Common.ModuloDiagTestPulse | 0 | | | |

*Logical Output settings*

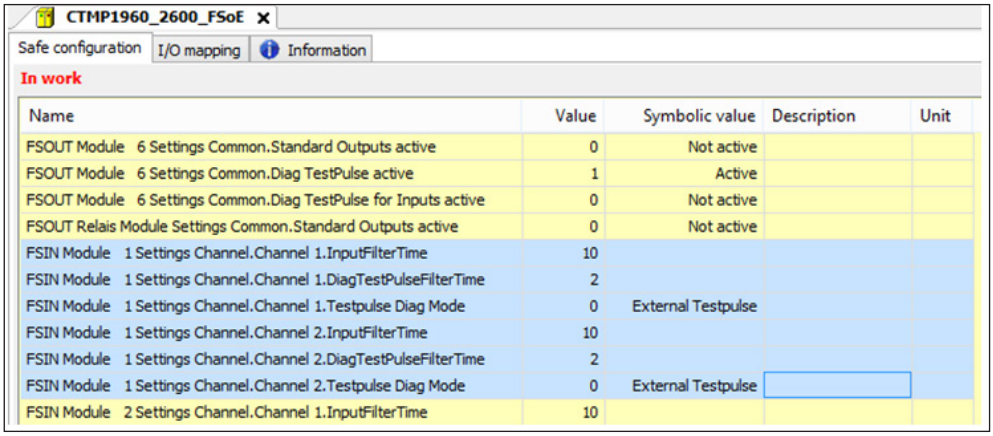
### Overview of output parameters

| PrmName | Index | Meaning | Value |
|---|---|---|---|
| **FSOUT Module 0 Settings Common** | 8000:00 | Settings for output module 0 (outputs 01 - 04) | - |
| **ModuloDiag TestPulse** | 8000:01 | Test frequency of the clocking<br>All modules used are processed in succession in one logic cycle respectively. With Modulo=0 the test is carried out in each cycle in the respectively current module; with Modulo=1 only every second pass and so on. | 0 |
| **MultiplierDiag TestPulse** | 8000:02 | Duration of the clocking 1 = 400 µs (this value will need to be increased according to the connected load if the outputs are open circuit or in the case of very small output currents) | 1 |
| **Standard Outputs active** | 8000:03 | 0 = standard outputs deactivated<br>1 = standard outputs are ANDed with the safe outputs | 0 |
| **Diag TestPulse active** | 8000:04 | 0: Clocking of the outputs deactivated<br>1: Clocking of the outputs activated | 0 |
| **Diag TestPulse for Inputs active** | 8000:05 | 0: Clocking of the outputs for local inputs deactivated<br>1: Clocking of the outputs for local inputs activated.<br>If 1 is set here the parameter DiagTestPulseActive is also set to 1. | 0 |

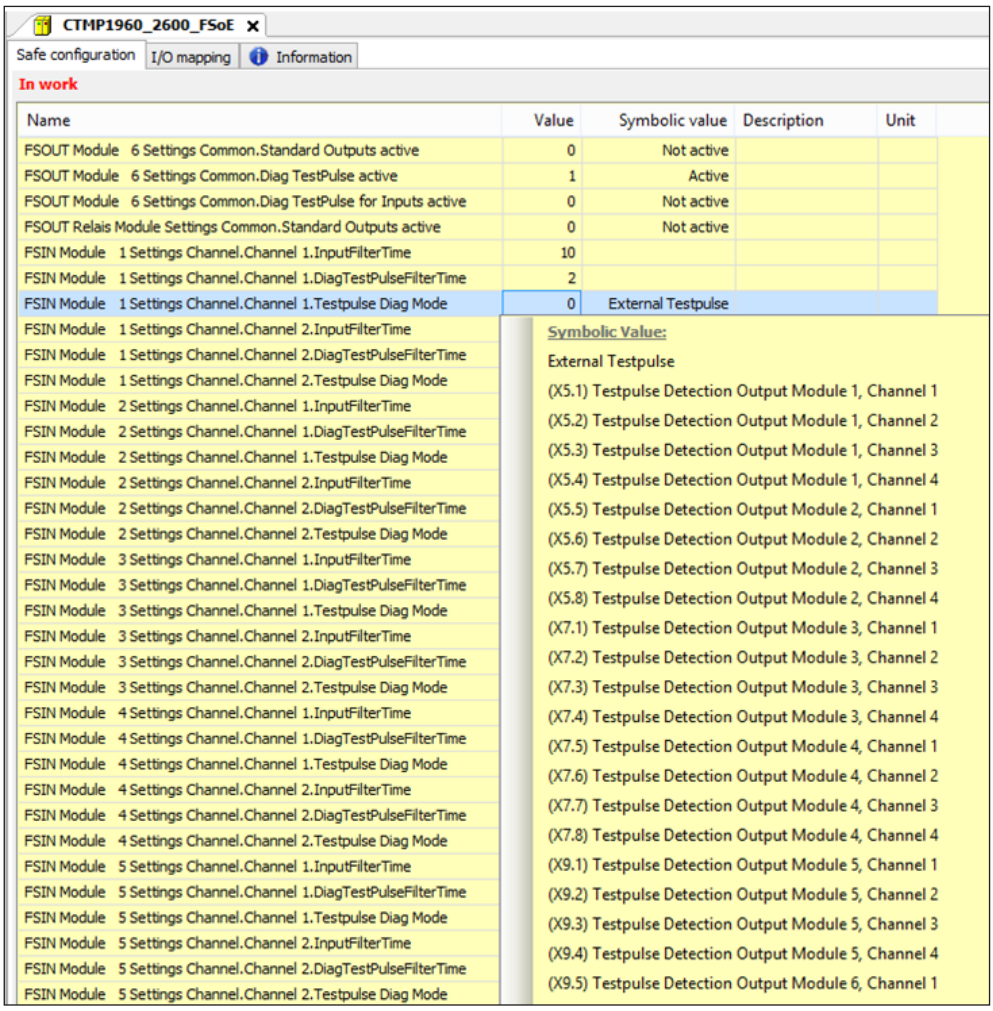

**Parameter Diag TestPulse for Inputs active**

If this parameter is activated, all outputs of this module are switched on and can be used as test pulses for controller inputs. In this setting the parameter *DiagTestPulseActive* must be set to 1.

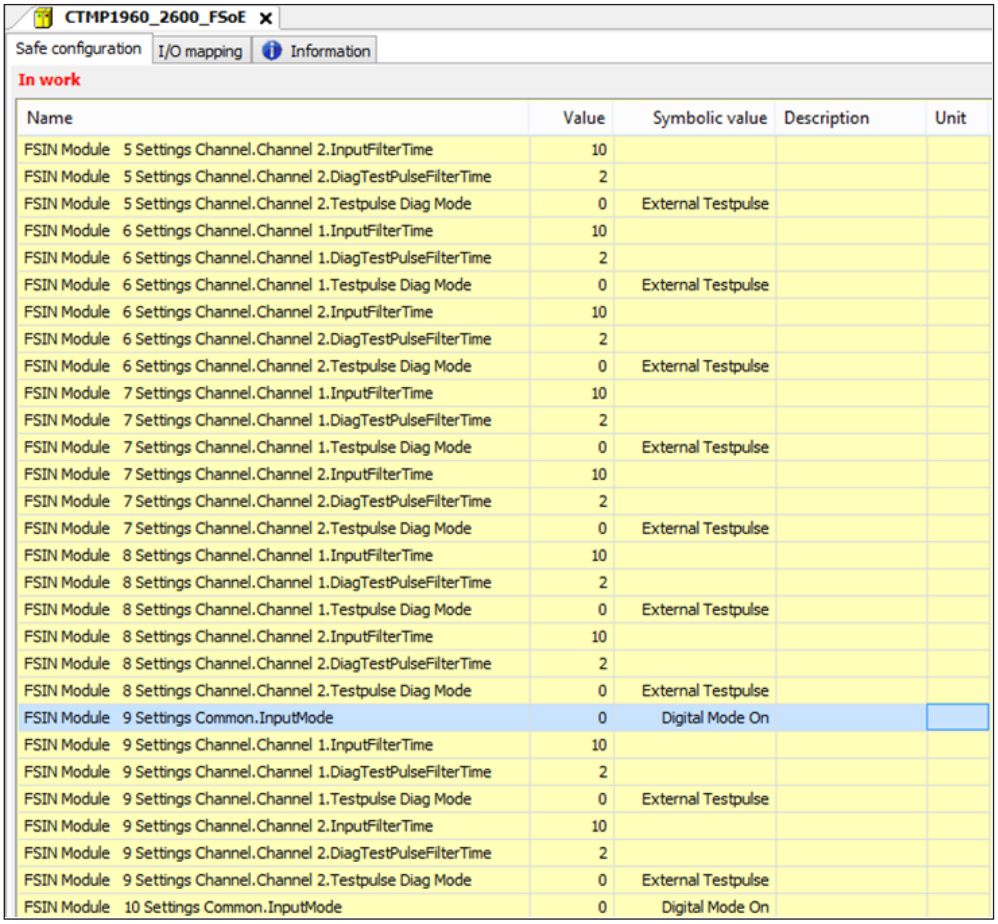
Corresponding parameters exist under the indices 8000:0 to 8050:0 for the output modules 1 to 6. The module 8060:0 exists for the relay module.
The corresponding parameters are set for each input module on the Safety Parameter tab.



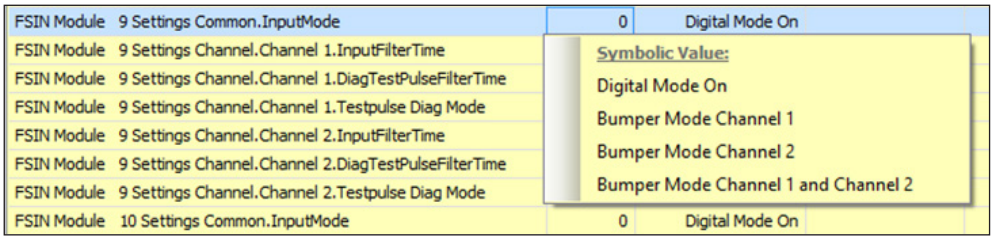

*Logical Input settings*




*Logical Input Test settings*




*Logical Input 9, 10 Common Input settings*




*Logical Input 9, 10 Common Input settings configuration*

**Overview of input parameters**

| PrmName | Index | Meaning | Value |
|---|---|---|---|
| **FSIN Module 1 Settings Channel** | 8071:00 | Settings for input module 1 (inputs 01 - 02) | - |
| **Channel1. InputFiltertime** | 8071:01 | Filter time for an input in the unit 100 µs. After the expiry of this time the signal state is transmitted to the logic on an edge change at the input. This value must be adapted to the length of the test pulses if they are used. | 10 (1 ms) |
| **Channel1. DiagTestPulse FilterTime** | 8071:02 | Filter time for an input in the unit 100 µs. This time must elapse before a measurement of the momentary signal state is carried out after an edge change. This value should be adapted to the length of the test pulses if they are used. | 3 (300 µs) |
| **Channel1. TestPulse Diag Mode** | 8071:03 | The output channel from which the test pulse is expected must be set here. | *External Testpulse* or drop-down list of the CTMP1960 outputs |
| **Channel2. InputFiltertime** | 8071:04 | Filter time for an input in the unit 100 µs. After the expiry of this time the signal state is transmitted to the logic on an edge change at the input. This value must be adapted to the length of the test pulses if they are used. | 10 (1 ms) |
| **Channel2. DiagTestPulse FilterTime** | 8071:05 | Filter time for an input in the unit 100 µs. This time must elapse before a measurement of the momentary signal state is carried out after an edge change. This value should be adapted to the length of the test pulses if they are used. | 3 (300 µs) |
| **Channel2. TestPulse Diag Mode** | 8071:06 | The output channel from which the test pulse is expected must be set here. | *External Testpulse* or drop-down list of the CTMP1960 outputs |
| | | | |
| **FSIN Module 9 Settings Common** | 80F0:00 | Settings for input module 9 (inputs 17 - 18).<br>This setting exists only for modules 9 and 10. | - |
| **InputMode** | 80F0:03 | Only input modules 9 and 10 support the parameters *Digital Mode On* and *Bumper Mode On*. All other modules are set to *Digital Mode On* and cannot be changed by the user. | - Digital Mode On<br>- Bumper Mode On |

Corresponding parameters are available for input modules 1 to 10 (inputs 01 to 20) under the indices 8071:0 to 80E1:0 (in $10_{hex}$ steps - 8071, 8081, 8091, 80A1 and so on).

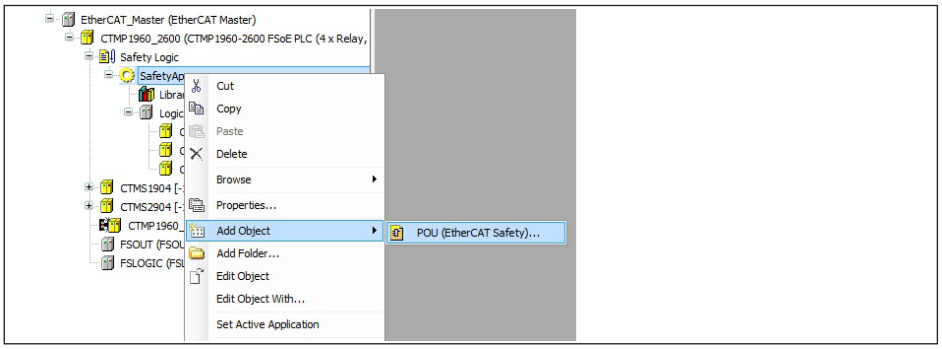
The input modules 9 and 10 have additional parameters under indices 80F0:0 and 8100:0 with which the operation modes *Digital Mode On* and *Bumper Mode On* can be set.

### 4.4.6 Parameters configuration of CTMS1940 and CTMS2904 Logical I/Os

For Parameters configuration of CTMS1940 and CTMS2904 Logical I/Os, respectively refer to:
- NUMSafe CTMS1904 Digital inputs terminals - Operating manual M00034EN
- NUMSafe CTMS2904 Digital outputs terminals - Operating manual M00035EN.

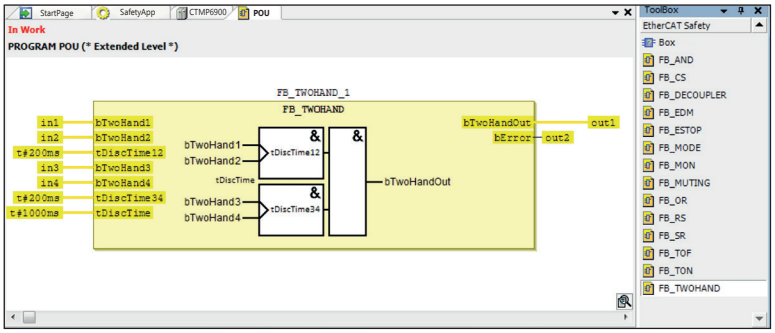
### 4.4.7 Creation of a program (POU)

A POU is added via the SafetyApp context menu or via the menu command *“Project* è *Add Object* è *POU (EtherCAT Safety)”*




*Addition of a POU*

The “FB_TWOHAND” function block is inserted in the editor of the added POU – this is done by selecting the FB in the Tools overview and moving it to the “Start here” field on the desktop by drag&drop.

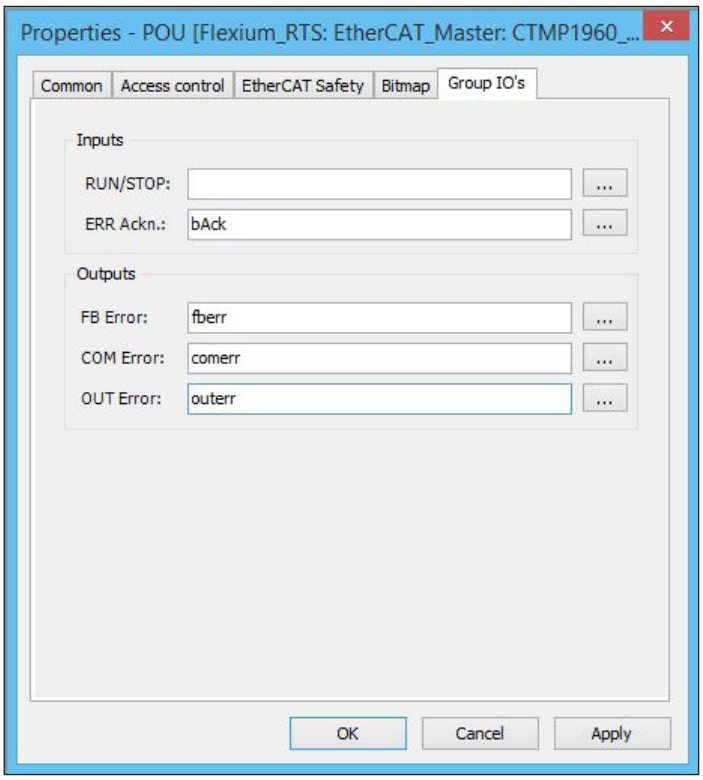



*Addition of the “FB_TWOHAND” FB*

The inputs and outputs of the function block are connected with variables according to the diagram above.

### 4.4.8 Setting the group I/Os of the “POU” program

The group I/Os are set in the properties of the newly created POU (right-click on the POU in the device tree - *“Properties”*). These variables control the state of the POU and can signal errors.




*POU - Properties*

#### NUMSafe group inputs

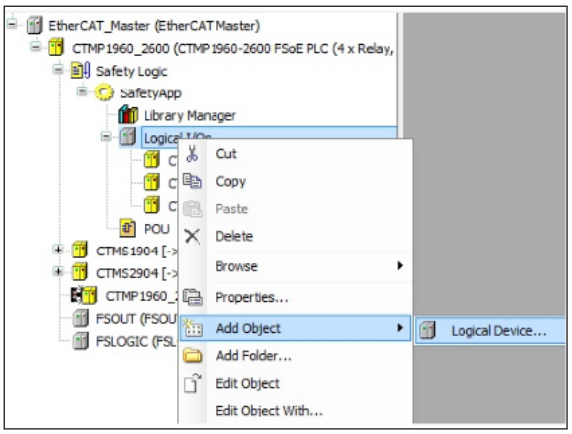
| Name | Permitted type | Description | |
|---|---|---|---|
| **RUN** | FB-Out<br>Standard-In | TRUE: | The function blocks assigned to the NUMSafe group are executed. When the input is not linked it is in the TRUE state. |
| | | FALSE: | All of the NUMSafe group assigned function blocks are at a STOP state and thus all associated outputs are in a safe state. |
| **ERR Ack** | FB-Out<br>Standard-In | All pending errors in the assigned function blocks and in the NUMSafe connections are acknowledged by the FALSE->TRUE->FALSE signal sequence. | |

#### NUMSafe group outputs

| Name | Permitted type | Description | |
|---|---|---|---|
| **FB ERR** | NUMSafe-Out<br>FB-In<br>Standard-Out | TRUE: | At least one assigned function block has an error. |
| | | FALSE: | All assigned function blocks have no errors. |
| **COM ERR** | NUMSafe-Out<br>FB-In<br>Standard-Out | TRUE: | At least one NUMSafe connection of NUMSafe group has an error. |
| | | FALSE: | All NUMSafe connections of the NUMSafe group have no errors. |
| **OUT ERR** | NUMSafe-Out<br>FB-In<br>Standard-Out | FALSE: | Always FALSE, since the CTMP6900 has no local outputs. |

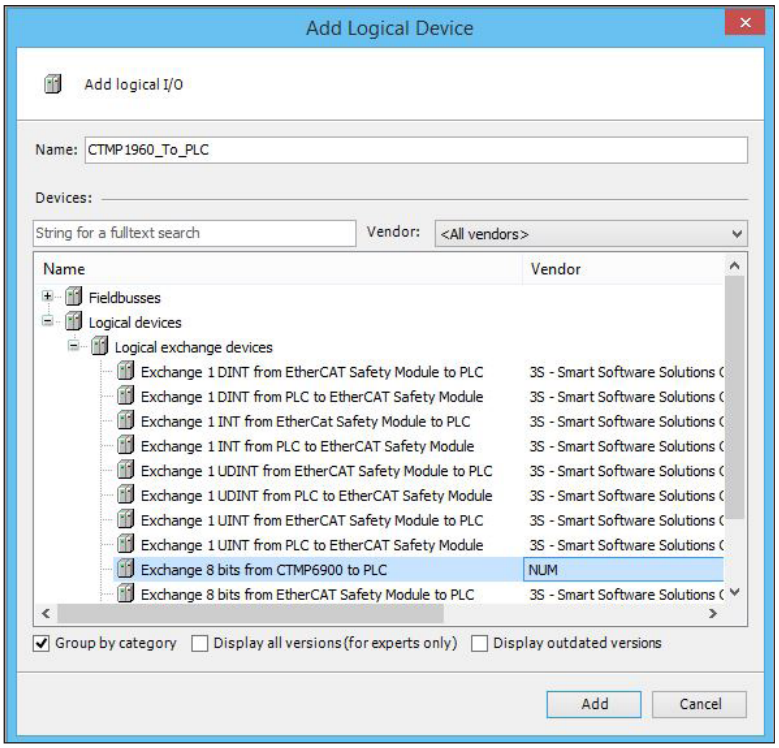
### 4.4.9 Addition of logical devices for data exchange

Now further logical devices are added which will handle the exchange of data with the standard controller later on.
To do this the “Add logical device” dialog is called ( *“context menu of logical I/Os ➔ Add Object ➔ Logical Device”* ).




*Addition of a logical device*

The device “8 bits exchange object from CTMP6900 to PLC” is selected from the dialog and is given the name “CTMP1960_to_PLC”.

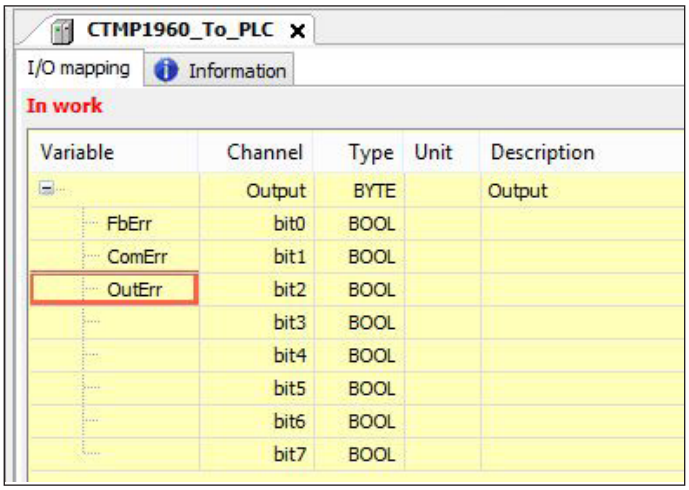



*Addition of a logical device – exchange device*

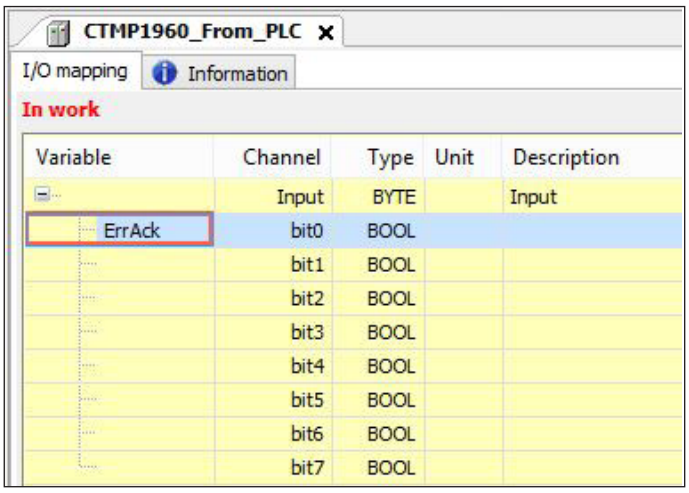
In a similar way a logical device “8 bits exchange object from PLC to CTMP6900” is created with the name “*CTMP1960_From_PLC*”.

### 4.4.10 Definition of the variables of the exchange objects

Double-clicking on the newly added logical devices opens the associated editor. The variables are entered here as shown below. These variables are subsequently connected with a global variable list of the standard controller.



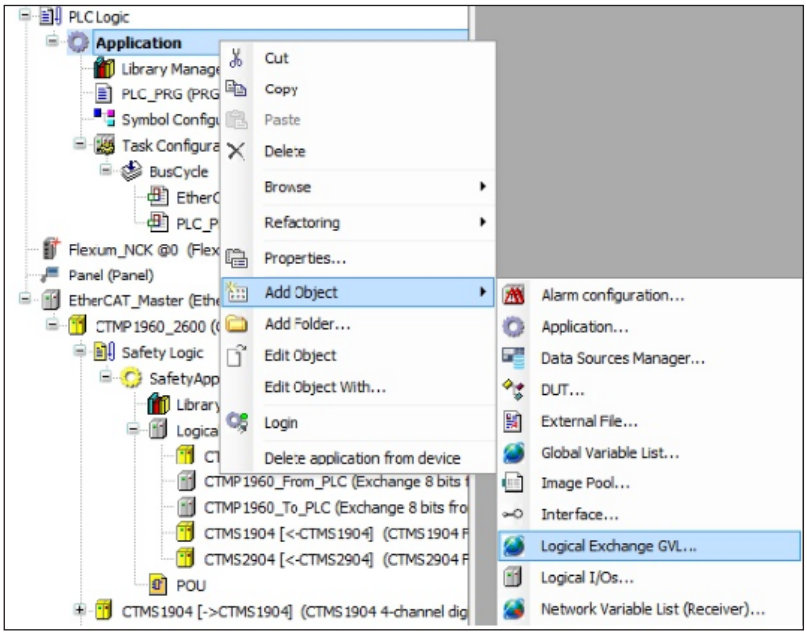

*Logical device CTMP1960-2600 --> PLC: variable definition*




*Logical device PLC --> CTMP1960-2600 variable definition*

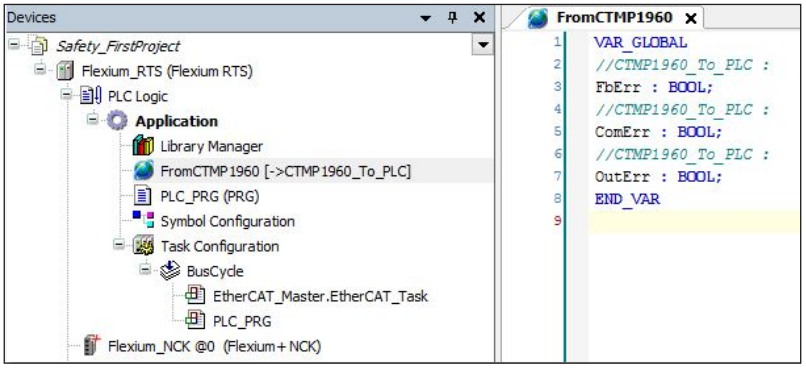
### 4.4.11 Addition of global variable lists for the logical exchange

Now GVLs for the logical exchange are added to the device tree (*“context menu of the application* è *Add Object* ➔ *GVL for logical exchange”*).




*Addition of a GVL for logical exchange*

The new GVL (with the name “FromCTMP1960”) is added to the device tree. A double-click opens its editor. The variables of the logical device “CTMP1960-2600_To_PLC” are now mapped to this GVL in the lower section of the editor.

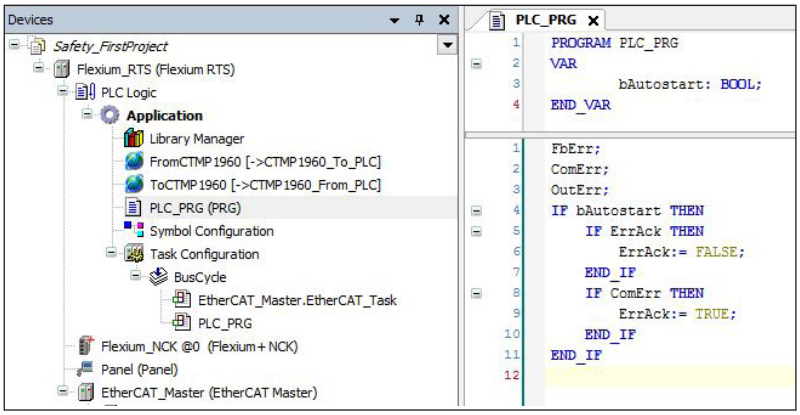



*GVL - Assignment of the logical I/Os*

The GVL “*FromCTMP1960*” is created in a similar way and connected with the logical I/Os of “*CTMP1960_To_PLC*”.

### 4.4.12 “PLC_PRG” program

The variables of the safety application are read and written via the “PLC_PRG” program.
The `FbErr`, `ComErr` and `OutErr` variables were inserted so that the states can be monitored.
If `bAutostart` is set, the `ErrAck` flag is set for one cycle in the case of an error in the safety block (recognised via `ComErr`) so that the error is acknowledged in the safety controller.




*PLC_PRG program*

### 4.4.13 CTMP1960-2600 user and version administration

#### 4.4.13.1 Overview of safety access protection

Rights can be assigned in such a way in the project user management that safety objects of a project can be created or modified only by certain user groups (“Safety Developer”).
The entire access protection of “CODESYS Safety for EtherCAT Safety Module” safety applications is realised by the user management in the project.

It is urgently recommended to configure a user management with safe access protection for each project!
Without user management in the project, each person who collaborates in the project possesses all rights to the standard and safety applications in the project!.

#### 4.4.13.2 User management in the project

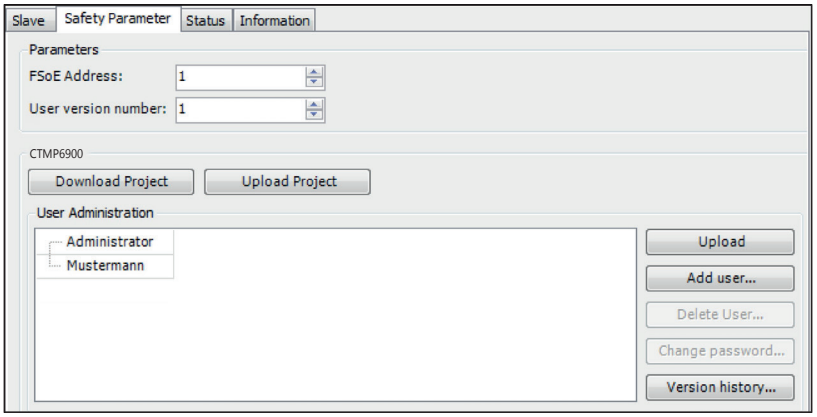
In a project without user management each user possesses **all rights**. The project manager must ensure that the safety application is worked on only by persons qualified to do so.

**Creation of a new project without a user management template**
If a new project is created as an *“empty project”* , then the project manager must create a suitable user management for the safety application of the project. Refer to the Standard CODESYS online help for the exact procedure and detailed information on the creation of this user management in the project.
In order to facilitate the selection of the safety specific commands for the developer, *“Safe”* or *“Safety”* is placed in front of the commands that are relevant for the safety developer when assigning rights.
In the rights objects the safety objects are easily recognisable by the suffix *“(Safety)”* after the object.

If the developer does not have the rights for a particular operation, he can logon during the operation using a user name with more rights.

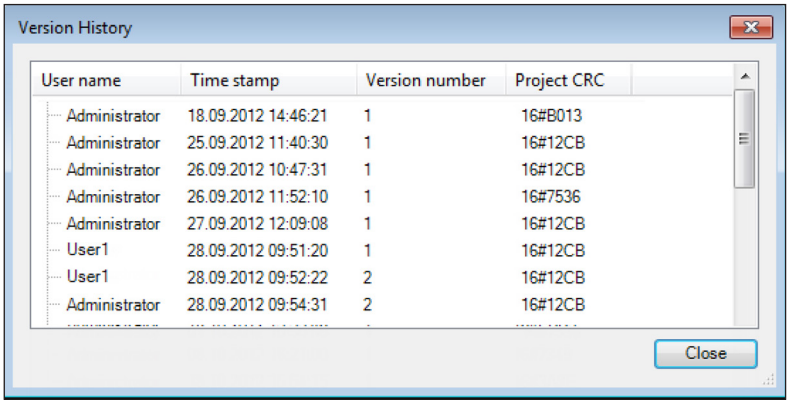
### 4.4.13.3 User management – EtherCAT safety module

In addition to the standard user management of CODESYS, the safety controller offers its own user management. This allowsusers to be setup with the associated passwords. These data must be entered during “Project Download”. Before changes are made to this user management, the current version of the user management must be loaded from the safety controller into the CODESYS project ( *“Upload”* button in the *“User Administration”* section).




*User management – EtherCAT safety modules*

| | |
|---|---|
| “Upload” | Transfer of the current user management of the safety controller into CODESYS for display and editing. |
| “Add user…” | The creation of a new user. The input of the administrator password is necessary for this. |
| “Delete user...” | The deletion of the selected user. The input of the administrator password is necessary for this. |
| “Change password...” | The current password must be entered before a new password can be defined. |
| “Version history” | After the execution of the command the version history is read from the safety controller. |



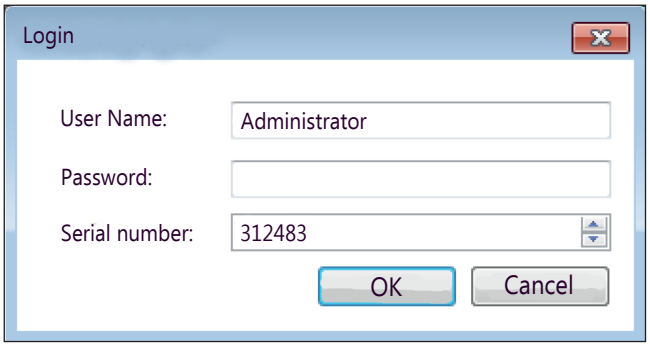

*Safety module version history*

### 4.4.13.4 Access protection with link to source control

If a source control is used, then a user management corresponding to the user management in the project must also be set up in the source control.

### 4.4.14 Loading the project into the CTMP1960-2600

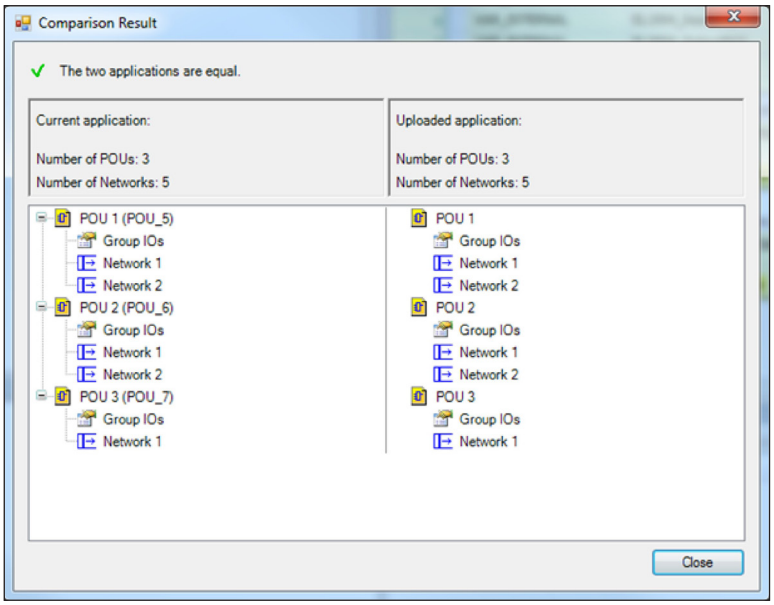
selected, the *«Administrator»* user will be used. The download procedure is actuated from the «Safety parameters» tab of the editor for the node of the EtherCAT safety controller.
The user password and the serial number of the terminal must be entered in order for the data record to be accepted by the terminal.




*Login dialog*

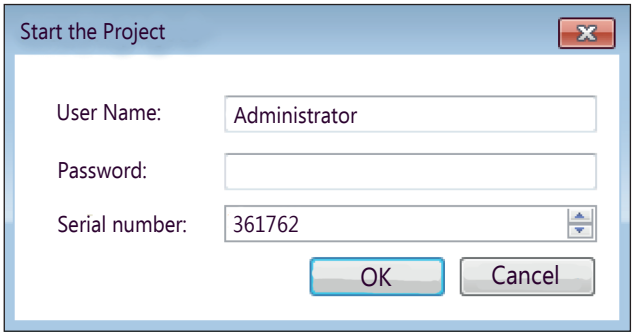
A re-translation takes place automatically after the download of the application in order to check the generated code. To do this the translated code is decompiled again and compared at source code level. By means of this diverse method the function of the compiler is checked at each download. Both random and systematic errors are thereby determined.

The result of the comparison (same or different) is displayed to the user. The number of function blocks and networks compared is also indicated. If equality is determined the download is valid and can be confirmed by the user via the offered dialog box.



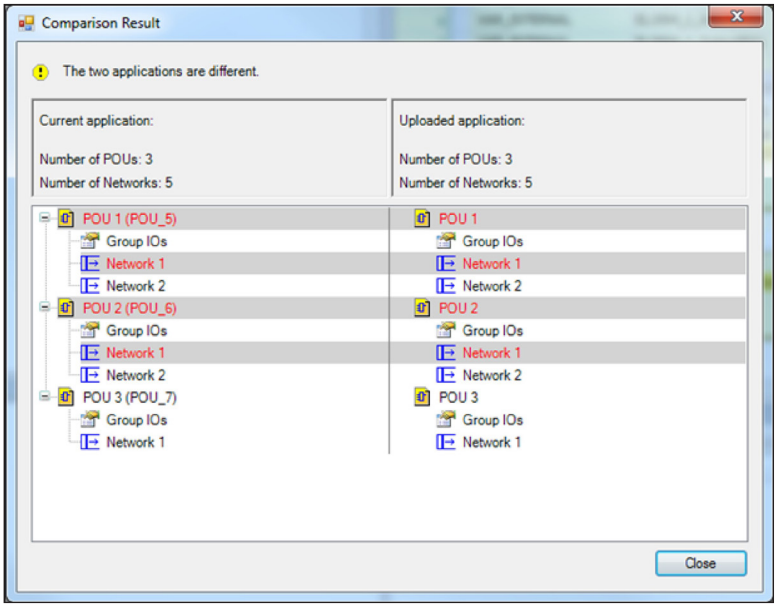

*Dialog: Comparison result = “same projects”*

If equality is determined the download is valid and can be confirmed by the user. After entering the user name and password again the enabling data record is loaded to the controller. Afterwards the controller is ready to start. The application must be started from the user program.
This is done by a rising edge of the variables defined in the group I/Os.




*Dialog for loading the enabling data record*

If a difference is found the download is not valid and cannot be confirmed. The corresponding confirmation dialog is not offered to the user in this case. Instead, the user is shown where (in which block or network, IO image or parameter) the discrepancy occurred.




*Dialog: Comparison result = “different projects”*

## 4.5 Project design limits of the CTMP1960-2600

**Project design limits**

The maximum project design size of the CTMP1960-2600 is limited by the available memory. This is managed dynamically. The values specified in the following table are therefore only guide values and may differ from the actual values, depending on the safety project.

| | |
|---|---|
| Process image size | max. 1486 bytes per data direction<br>(maximum memory size 0x1E00 for 3 buffers, ie with the same size of input and output process data, a maximum size of 1280 bytes per data direction is possible. Only straight start addresses are possible, so fill bytes must be taken into account). |
| **NUMSafe connections** | 128 max.<br>(up to 255 CRCs in total; 1 CRC is required for a NUMSafe connection with 1 or 2 byte safe data.) |
| **Supported hardware for CTMP1960-2600 NUMSafe connections** | CTMS1904<br>CTMS2904<br>NUM-SAMX |
| **Safe data per NUMSafe connection** | Maximum 126 byte (telegram length 255 byte) |
| **NUMSafe blocks** | Maximum 512 (ESTOP with complete input and output mapping) |
| **NUMSafe groups** | 128 max. |
| **NUMSafe user** | 40 max. |
| **Standard PLC inputs** | Dynamic (memory-dependent), max. 1024 byte |
| **Standard PLC outputs** | Dynamic (memory-dependent), max. 1024 byte |

**NUMSafe connection**

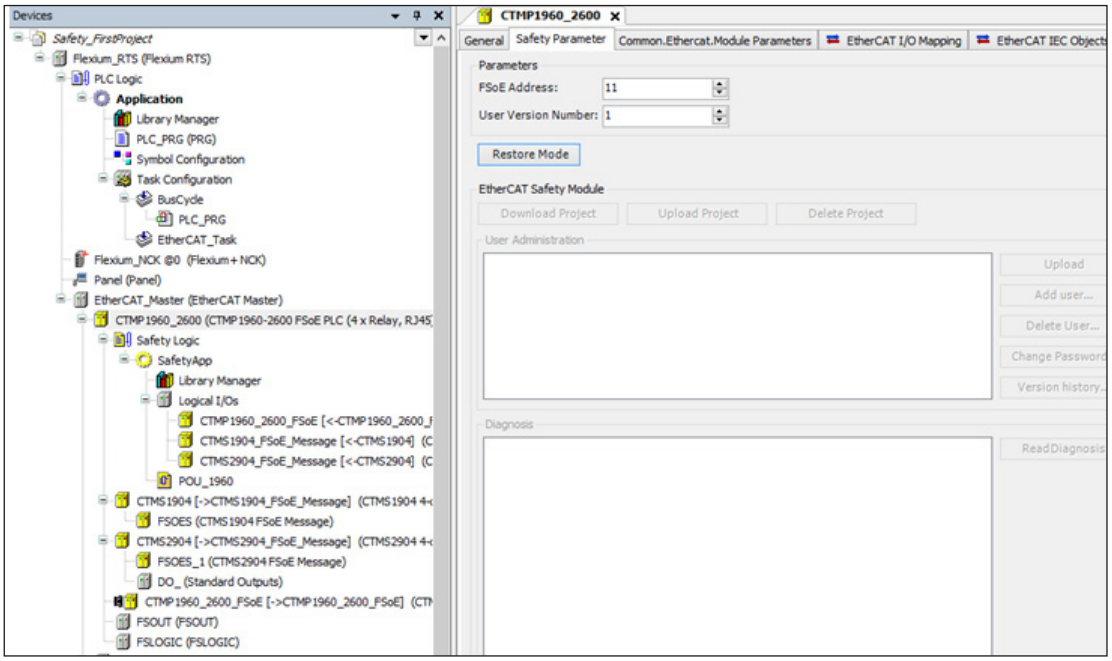
Only one NUMSafe connection is possible between two NUMSafe components. For communication with a CTMP6900, for sample, a connection with up to 14 bytes safe user data can be used.

00/**

## 4.6 Backup/Restore

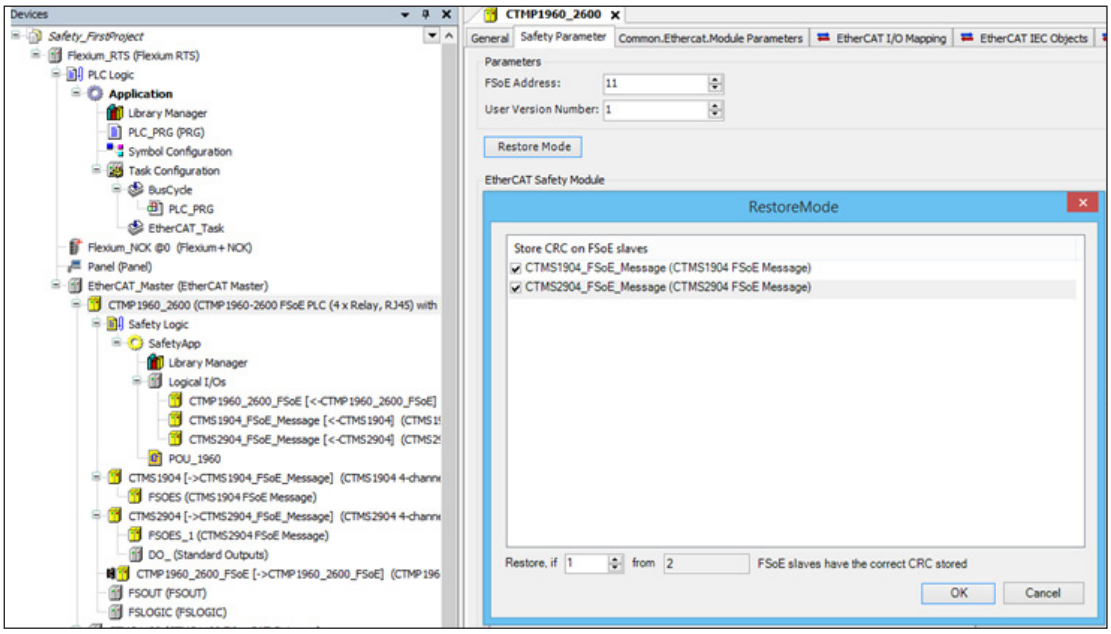
Following the exchange of a CTMP1960-2600, the previous project can be loaded to the new device using the Backup/Restore mechanism.

In order to be able to use this functionality, the Backup/Restore mechanism must be enabled in the safety project pushing “*Restore Mode*” when User is the *Administrator*.




*Backup/Restore*

The dialog “*RestoreMode*” lists all slave safety devices (CTMS1904 or CTMS2904) which support this function and are managed into the CTMP1960-2600 safety application.



*Backup/Restore lists*

Checkboxes allow to define which slaves should save a checksum.
In the lower field of the dialog the user can define the minimum number of these slaves that must have the right checksum to restore the project automatically after the CTMP1960-2600 has been replaced

**Restore**

If a project that doesn’t match the system is loaded during restore, this will only be detected when distributed CRCs are checked. The previous project is than deleted from the logic terminal. This cannot be undone.

**Password**

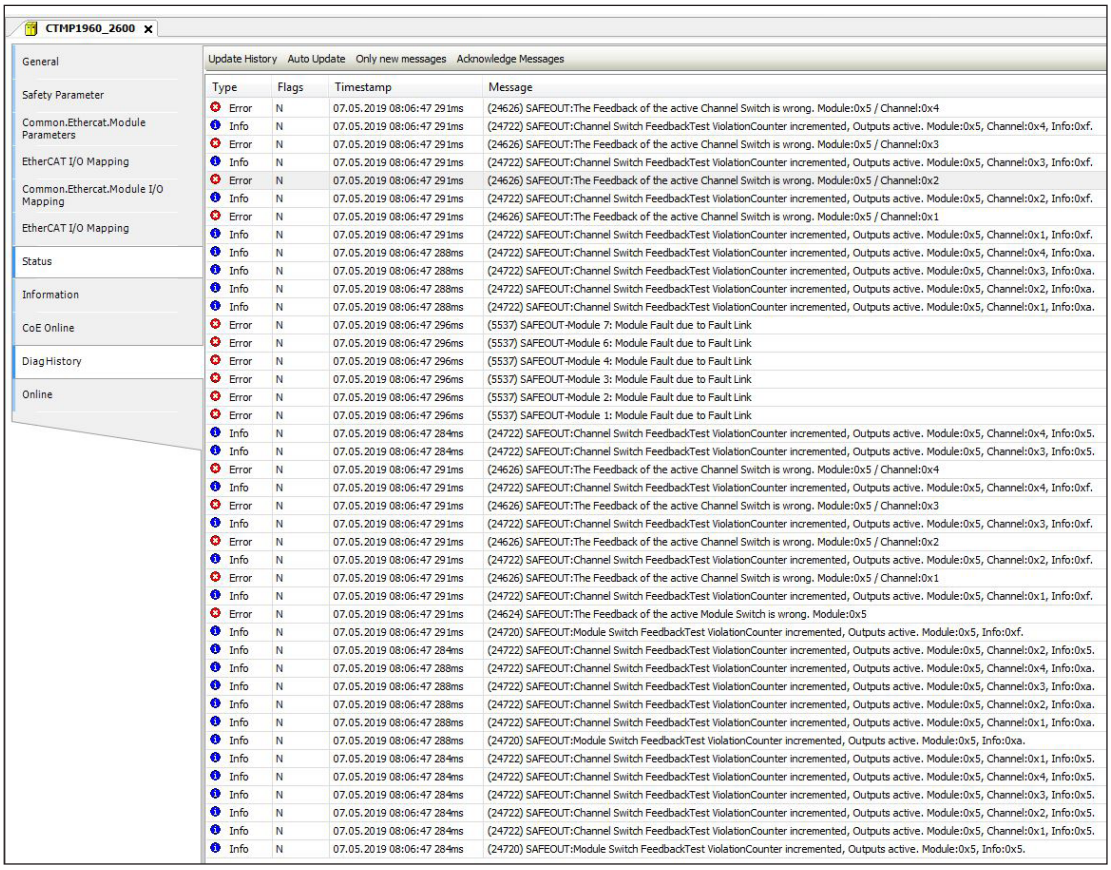
The administrator password of the EtherCAT Safety Module to be changed must be identically.

## 4.7 Diag History tab

Any errors that occur in the CTMP1960-2600 are stored in the their diag history.
The diag history can be viewed by selecting the CTMP1960-2600 in the I/O tree structure and then selecting the *Diag History* tab.

Use the *Update History* button to fetch the current from the CTMP1960-2600.

Error within the logic; the function blocks and the connections are stored with a corresponding timestamp.




*Diag History*

## 4.8 Diagnostics

### 4.8.1 Diagnostic LEDs


*Diagnostic LED*

**LED EC Link1 (green)**

| LED | State | Meaning |
|---|---|---|
| **EC Link 1** | off | No connection on the incoming EtherCAT segment. |
| | on | Upstream EtherCAT device or EtherCAT Master connected. |
| | flashes | Communication with upstream EtherCAT device or EtherCAT Master. |

**LED EC RUN (green)**

| Display | | Meaning |
|---|---|---|
| | permanently off | EtherCAT State INIT (Initialisation) |
|  | flashing uniformly | EtherCAT State PREOP (Pre- Operational) |
|  | flashing slowly | EtherCAT State SAFEOP (Safe- Operational) |
| | permanently on | EtherCAT State OP (Operational) |
|  | flashing rapidly | EtherCAT State BOOT (Bootstrap Modus) |

### LED EC Err (red)

The LED lights up red when there is an EtherCAT error.

### LED EC Link2 (green)

| LED | State | Meaning |
|---|---|---|
| EC Link 2 | off | No connection to the downstream EtherCAT line. |
| | on | Downstream EtherCAT device connected. |
| | flashes | Communication with downstream EtherCAT device. |

### LED Splc (green/red) / FSoE

| Splc (green) | Splc (red) | FSoE | Meaning |
|---|---|---|---|
| off | off | off | No safety-projekt on the CTMP1960-2600. |
| off | blink code | on | Error code of Safety Logic<br>1 - Function block error in Safety Logic<br>2 - Communication error in Safety Logic<br>4 - Other error in Safety Logic<br>(Combinations are possible, error code numbers are added). |
| **off** | permanent flashing | on | Global Shutdown or Global Fault. |
| **blink code** | off | on | Safety Logic loaded but not in RUN. |
| **permanent flashing** | off | on | Safety Logic loaded and in RUN.<br>Customized Mode active. |
| **on** | off | on | Safety Logic loaded and in RUN.<br>Customized Mode NOT active. |

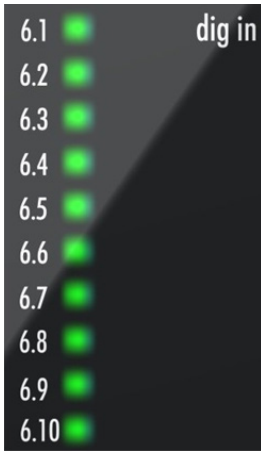
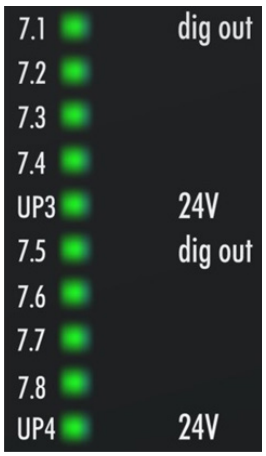
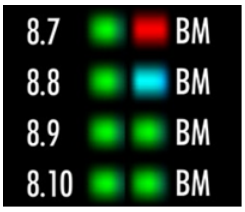
### LED Us

The $U_S$ LED lights up as soon as the 24 $V_{DC}$ voltage is present at the $U_S$ connection.

### LED Up

The $U_P$ LED lights up as soon as the 24 $V_{DC}$ voltage is present at the $U_P$ connection.

## 4.8.2 Status LEDs

| Relais LEDs | Digital inputs | Digital outputs | Inputs 17 - 20 |
|---|---|---|---|
|  |  |  |  <br>LED left green - Digital Mode On<br><br>LED right blue - Bumper Mode On |

## 4.8.3 Diagnostic objects


**Do not change CoE objects!**

Do not make any modifications to the CoE objects in the NUMSafe components! Any modifications of the CoE objects will permanently set the NUMSafe components to the Fail-Stop state.

### Index $F984_{hex}$: Device Info Data C1

CoE object $F984_{hex}$ currently displays internal temperature and voltage values for the NUMSafe component.

| Index | Name | Meaning | Flags | Default |
|---|---|---|---|---|
| F984:01 | Voltage C2 | Voltage µC2 | RO | $0_{dec}$ |
| **F984:02** | Temperature C1 | Temperature µC1 | RO | $0_{dec}$ |
| **F984:03** | Firmware CRC C1 | CRC of the firmware on µC1 | RO | - |
| **F984:04** | Vendor data CRC C1 | CRC of the vendor data on µC1 | RO | - |

### Index F985$_{hex}$: Device Info Data C2

CoE object F985$_{hex}$ currently displays internal temperature and voltage values for the TwinSAFE component.

| Index | Name | Meaning | Flags | Default |
|---|---|---|---|---|
| F985:01 | Voltage C1 | Voltage µC1 | RO | $0_{dec}$ |
| **F985:02** | Temperature C2 | Temperature µC2 | RO | $0_{dec}$ |
| **F985:03** | Firmware CRC C2 | CRC of the firmware on µC2 | RO | - |
| **F985:04** | Vendor data CRC C2 | CRC of the vendor data on µC2 | RO | - |

**Diagnostics history**

Any errors, which occur during operation of the NUMSafe component, such as overtemperature or undervoltage, are entered in the diagnostics history with a corresponding timestamp.

### Index F100$_{hex}$: FSLOGIC status

CoE object F100$_{hex}$ shows the current status of the NUMSafe component.

| Index | Name | Meaning | Flags | Default |
|---|---|---|---|---|
| F100:01 | Safe Logic State | Status of the internal logic:<br>0: OFFLINE<br>1: RUN<br>2: STOP<br>3: SAFE<br>4: ERROR<br>6: START<br>8: PREPARE<br>10: RESTORE<br>11: PROJECT-CRC-OK | RO | $0_{bin}$ |
| **F100:02** | Cycle Counter | Life cycle counter, which is incremented with each TwinSAFE logic cycle. | RO | $0_{bin}$ |

### 4.8.4 Cycle time of the safety project

The processing time of the CTMP1960-2600 can be read from the CoE objects listed below. To determine the cycle time, it has to be multiplied with 1.25, because this is the factor used internally for generating a delay time before the next cycle.

**Index $FEA0_{hex}$: CTRL Diag Data**

| Index | Name | Meaning | Flags | Default |
|---|---|---|---|---|
| FEA0:09 | Actual Safety Control Task Execution Time | Current execution time of the CTMP1960, when Logic State = 1 (RUN)<br>Cycle time = 1.25 * value<br>(Mean value over 64 cycles) | RO | $0_{hex}$ |
| **FEA0:0A** | Min Safety Control Task Execution Time | Minimum execution time of the CTMP1960, when Logic State = 1 (RUN)<br>Cycle time = 1.25 * value | RO | $0_{hex}$ |
| **FEA0:0B** | Max Safety Control Task Execution Time | Maximum execution time of the CTMP1960, when Logic State = 1 (RUN)<br>Cycle time = 1.25 * value | RO | $0_{hex}$ |
| **FEA0:15** | Actual Safety Control Task Execution Time | Current execution time of the CTMP1960, when Logic State <> 1<br>Cycle time = 1.25 * value<br>(Mean value over 64 cycles) | RO | $0_{hex}$ |
| **FEA0:16** | Min Safety Control Task Execution Time | Minimum execution time of the CTMP1960, when Logic State <> 1<br>Cycle time = 1.25 * value | RO | $0_{hex}$ |
| **FEA0:17** | Max Safety Control Task Execution Time | Maximum execution time of the CTMP1960, when Logic State <> 1<br>Cycle time = 1.25 * value | RO | $0_{hex}$ |

A reset of the minimum and maximum values is possible by writing a value to CoE object 0x1C32: 08.

### 4.8.5 Diagnosis History

The diagnostic messages are saved by the NUMSafe device in a dedicated CoE object under 0x10F3 and can be read out by the application.

Both the control entries and the history itself can be found in the CoE object 0x10F3. The entry Newest Message (0x10F3:02) contains the subindex of 0x10F3, which contains the latest diagnostic message, e.g. 0x06 for diagnostic message 1.

**Index $10F3_{hex}$: Diagnosis History**

| Index | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 10F3:0 | Diagnosis History | | | | |
| **10F3:01** | Maximum Messages | Maximum number of stored messages. A maximum of 64 messages can be stored. After that the respective oldest messages are overwritten. | UINT8 | RO | 0x40 ($64_{dec}$) |
| **10F3:02** | Newest Message | Subindex of the latest message. | UINT8 | RO | 0x00 ($0_{dec}$) |
| **10F3:03** | Newest Acknowledged Message | Subindex of the last confirmed message. | UINT8 | RW | 0x00 ($0_{dec}$) |
| **10F3:04** | New Messages Available | Indicates that a new message is available. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| **10F3:05** | Flags | Set via the startup list. If set to 0x0001, the diagnostic messages are additionally sent by emergency to the EtherCAT master. | UINT16 | RW | 0x0000 ($0_{dec}$) |
| **10F3:06** | Diagnosis Message 001 | Diagnostic message 1. | BYTE[32] | RO | {0} |
| **...** | ... | ... | | ... | ... |
| **10F3:45** | Diagnosis Message 064 | Diagnostic message 64. | BYTE[32] | RO | {0} |

**Structure of the diagnostic messages**

- DiagCode (4 bytes) – in this case always 0x 0000 E000
- Flags (2 bytes) - diagnosis type (info, warning or error), timestamp and number of parameters contained (see the following table)
- Text ID (2 bytes) – ID of the diagnostic message as a reference to the message text from the ESI/XML
- Timestamp (8 bytes) – local slave time in ns since switching on the NUMSafe device
- Dynamic parameters (16 bytes) - parameters that can be inserted in the message text (see following table).

### Flags in diagnostic messages

| Data type | Offset | Description | |
|---|---|---|---|
| UINT16 | Bits 0 to 3 | DiagType (value) | |
| | | 0 | Info message |
| | | 1 | Warning message |
| | | 2 | Error message |
| | | 3…15 | Reserved |
| | Bit 4 | If the bit = 1, the timestamp contained in the message is the local timestamp of the NUMSafe device. The age of the diagnostic message can be deduced by calculation with the current timestamp from the CoE object 0x10F8. | |
| | Bits 5 to 7 | Reserved | |
| | Bits 8 to 15 | Number of parameters in this diagnostic message. | |

### Dynamic parameters in the diagnostic messages

| Type | Data type | Description | |
|---|---|---|---|
| Flags parameter 1 | UINT16 | Describes the type of parameter 1 | |
| | | Bits 12 to 15 = 0 | Bits 0 to 11 = data type of parameter 1<br><br>0x0001 - BOOLEAN<br>0x0002 - INT8<br>0x0003 - INT16<br>0x0004 - INT32<br>0x0005 - UINT8<br>0x0006 - UINT16<br>0x0007 - UINT32<br>0x0008 - REAL32<br>0x0011 - REAL64<br>0x0015 - INT64<br>0x001B - UINT64 |
| Parameter 1 | Data type in accordance with flags | Value of parameter 1 | |
| Flags parameter 2 | UINT16 | See Flags parameter 1 | |
| Parameter 2 | Data type in accordance with flags | Value of parameter 2 | |
| ... | | | |

## 4.9 Behavior when restarting

If the NUMSafe logic program is restarted due to an EtherCAT restart or a login / logout on the logic component (without a download), all NUMSafe groups to which NUMSafe Connections are assigned go to the ERROR state.

NUMSafe logic components with local inputs and outputs can have NUMSafe groups that have no NUMSafe connections assigned. If these NUMSafe groups use local outputs, these would be set after an EtherCAT restart without error acknowledgment. If this behavior is not wanted, this must be taken into account in the corresponding NUMSafe logic.

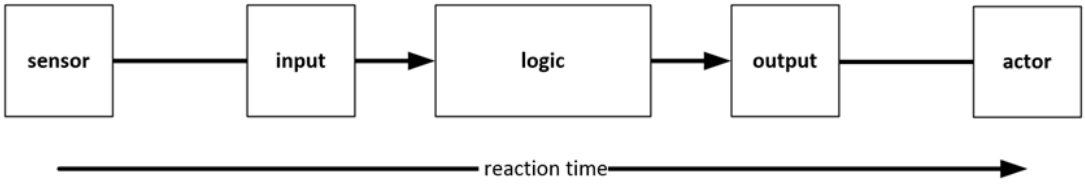

**Local outputs in NUMSafe groups without NUMSafe connections**

If local outputs are not allowed to be switched on automatically after a restart of the NUMSafe logic (in NUMSafe groups in which no NUMSafe connections are created), this must be taken into account by the user application.

## 4.10 Reaction times of local signals

### Typical reaction time of the local input and output

The typical reaction time is the time that is required to transmit information from the sensor to the actuator, if the overall system is working without error in normal operation.




*Reaction time of local signals*

| **Definition** | Description |
|---|---|
| **RTSensor** | Response time of the sensor, until the signal is made available at the interface. Typically provided by the sensor manufacturer. |
| RTInput | Reaction time of the CTMP1960-2600 safe input. This time depends on the parameter settings of the input module. In this case from the setting Channel x.InputFilterTime. |
| RTLogic | Reaction time of the controller. This is the internal cycle time of the controller and typically ranges from 500 µs to 10 ms for the CTMP1960-2600, depending on the size of the safety project. The actual cycle time can be read from the controller. |
| **RTOutput** | Reaction time of the output. This is typically between 2 and 3 ms. |
| **RTActor** | Response time of the actuator.<br>This information is typically provided by the actuator manufacturer. |

The typical response time is based on the following formula:

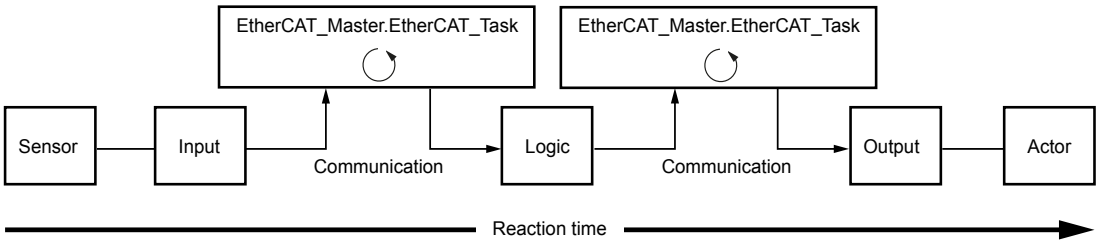
$$RT_{Gesamt} = RT_{Sensor} + RT_{Input} + RT_{Logic} + RT_{Output} + RT_{Actor}$$

## 4.11 NUMSafe reaction times

The NUMSafe terminals form a modular safety system that exchanges safety-oriented data via the Safety- over-EtherCAT protocol. This chapter is intended to help you determine the system's reaction time from the change of signal at the sensor to the reaction at the actuator

**Typical reaction time**

The typical reaction time is the time that is required to transmit information from the sensor to the actuator, if the overall system is working without error in normal operation.




*Typical reaction time*

| **Definition** | Description |
|---|---|
| **RTSensor** | Reaction time of the sensor until the signal is provided at the interface. Typically supplied by the sensor manufacturer. |
| RTInput | Reaction time of the safe input, such as CTMS1904.<br>This time can be found in the technical data. In the case of the CTMS1904 it is 4 ms. |
| RTComm | Reaction time of the communication This is typically 3x the EtherCAT cycle time, because new data can only be sent in a new Safety-over-EtherCAT telegram. These times depend directly on the higher-level standard controller (cycle time of the PLC/NC). |
| RTLogic | Reaction time of the logic terminal. This is the cycle time of the logic<br>terminal and typically ranges from 500 µs to 10 ms for the CTMP1960-2600, depending on the size of the safety project. The actual cycle time can be read from the terminal. |
| **RTOutput** | Reaction time of the output terminal. This typically lies within the range of 2 to 3 ms. |
| **RTActor** | Reaction time of the actuator. This information is typically supplied by the actuator manufacturer. |
| **WDComm** | Watchdog time of the communication. |

This results in the following equation for the typical reaction time:

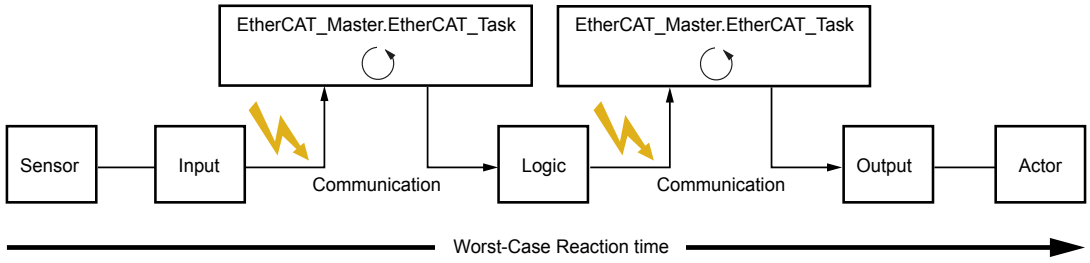
$$ReactionTime_{typ} = RT_{Sensor} + RT_{Input} + 3 * RT_{Comm} + RT_{Logic} + 3 * RT_{Comm} + RT_{output} + RT_{Actor}$$

with, for example

$$ReactionTime_{typ} = 5ms + 4ms + 3 * 1ms + 10ms + 3 * 1ms + 3ms + 20ms = 48ms$$

### Worst-case reaction time

The worst case reaction time is the maximum time required to switch off the actuator in the case of an error.




*Worst-case reaction time*

This assumes that a signal change occurs at the sensor and is transmitted to the input.

A communication error occurs at precisely the moment when the signal is to be transferred to the communication interface. This is detected by the logic following the watchdog time of the communication link. This information should then be transferred to the output, but a further communication error occurs here.

This error is detected at the output following the expiry of the watchdog time and leads to the switch-off.

This results in the following equation for the worst-case reaction:

$$ReactionTime_{max} = WD_{Comm} + WD_{Comm} + RT_{Actor}$$

with, for example

$$ReactionTime_{max} = 2 * 15ms + 20ms = 50ms$$

## 4.12 Reaction times Bumper mode

If the operating mode BumperMode is set for inputs 8.7 to 8.10, safety mats or safety bumpers can be evaluated at these inputs. The connection diagram can be found under Inputs and outputs [} 32].

In this operation mode, the inputs give out a pulsed voltage. The pulse-pause-ratio and thus also the typical response times are dependent on the internal cycle time of the CTMP1960-2600.

Typical reaction times can be found in the following table. The given times indicate the reaction time from switching the input to the response at the local output of the CTMP1960-2600.

| Cycle time CTMP1960-2600 (value from 0xFEA0:09) | Typical pulse-pause-ratio (Switch On- / Switch Off time) | **Typical reaction time** |
|---|---|---|
| 1.1 - 2.5 ms | 20 ms / 10 ms | 9 ms - 31 ms |
| 4.2 - 6.0 ms | 50 ms / 30 ms | 27 ms - 94 ms |
| 7.2 - 9.0 ms | 80 ms / 50 ms | 40 ms - 139 ms |
| 9.8 - 13.0 ms | 100 ms / 70 ms | 56 ms - 186 ms |
| 13.4 - 19.5 ms | 170 ms / 100 ms | 86 ms - 292 ms |

For a maximum possible configuration of the CTMP1960-2600, a value of 350ms can be used as a worst case estimate for the response time.

## 4.13 Reaction times ambient conditions

The NUMSafe logic components check the environmental conditions, such as all internal and external voltages and the temperature, within the logic cycle time.

In the case of a maximum configuration on the NUMSafe logic, an error reaction can be expected typically after 10 seconds for over- or undervoltage, as well as over- or under-temperatures.

## 4.14 Maintenance

The CTMP1960-2600 NUMSafe compact controller is maintenance-free!


**Observe the specified environmental conditions!**

Make sure that the NUMSafe compact controller is stored and operated only within the specified environmental conditions (see Technical Data).

If the NUMSafe compact controller is operated outside the permitted temperature range it will switch to the Global Fault state.

### 4.14.1 Cleaning

Protect the NUMSafe compact controller from impermissible soiling during operation and storage!

The NUMSafe Compact Controller may not be operated any longer if it has been exposed to impermissible soiling!


**Have dirty NUMSafe compact controllers inspected!**

The user is not permitted to clean the NUMSafe controller!
Please send dirty NUMSafe controllers to the manufacturer for inspection and cleaning!

## 4.15 Service life

The NUMSafe compact controllers have a service life of 20 years.

Due to the high diagnostic coverage within the lifecycle no special proof tests are required.

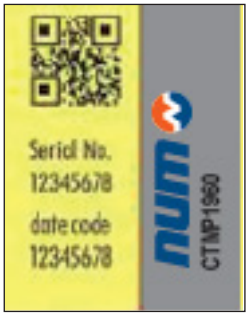
The NUMSafe controllers carry a data code, which is composed as follows:

Date Code: CW YY SW HW

| Legend | | Example: Datecode 08160201 | |
|---|---|---|---|
| **CW** | Calendar week of manufacture | Calendar week | 08 |
| **YY** | Year of manufacture | Year: | 2016 |
| **SW** | Software version | Software version | 02 |
| **HW** | Hardware version | Hardware version | 01 |

In addition, the NUMSafe compact controllers carry a unique serial number. The serial number and DateCode are lasered on the front of the device.

Postal address and model name are lasered on the back.




*CTMP1960-2600: Laser image - serial number / data code*


*CTMP1960-2600: Laser image on the back side*

### 4.15.1 Decommissioning


**Serious risk of injury!**

Bring the bus system and the NUMSafe compact controller into a safe, de-energized state before starting with the disassembly of the NUMSafe compact controller!

**Disposal**

In order to dispose of the device, it must be removed and fully dismantled.

- Housing components (polycarbonate, polyamide (PA6.6)) are suitable for plastic recycling.
- Metal parts can be sent for metal recycling.
- Electronic parts such as circuit boards must be disposed of in accordance with national electronics scrap regulations.

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# Summary

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# 5 Appendix

## 5.1 NUM Support and Service

NUM and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to NUM products and system solutions.

**NUM AG**

Battenhusstrasse 16
CH - 9053 Teufen
Phone: +41 71 335 0411
+41 71 333 3587
e-mail sales.ch@num.com
service.ch@num.com

### 5.1.1 NUM branches and partner companies NUM Support

Please contact your NUM branch office or partner company for local support and service on NUM products!
The contact addresses for your country can be found in the list of NUM branches and partner companies: www.num.com. You will also find further documentation for NUM components there.

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

# CERTIFICATE

**No. Z10 083009 0013 Rev. 00**

**Holder of Certificate:** **NUM AG**
Battenhusstrasse 16
9053 Teufen
SWITZERLAND

**Certification Mark:**

**Product:** **Safety components**
**NUMSafe Compact Controller**

**Model(s):** **CTMP1960-2600**

**Parameters:**

| | |
|---|---|
| Safety integrity level | up to SIL 3 |
| Category | Cat. 4 |
| Performance level | PL e |

**Tested according to:**
2006/42/EC
EN 61508-1:2010
EN 61508-2:2010
EN 61508-3:2010
EN ISO 13849-1:2023
EN IEC 62061:2021
EN 61511-1:2017

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. This certificate is valid until the listed date, unless it is cancelled earlier. All applicable requirements of the Testing, Certification, Validation and Verification Regulations of TÜV SÜD Group have to be complied. For details see: www.tuvsud.com/ps-cert

**Test report no.:** NT104238T

**Valid until:** 2029-12-02

**Date,** 2025-01-08

( Matthias Ramold )

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