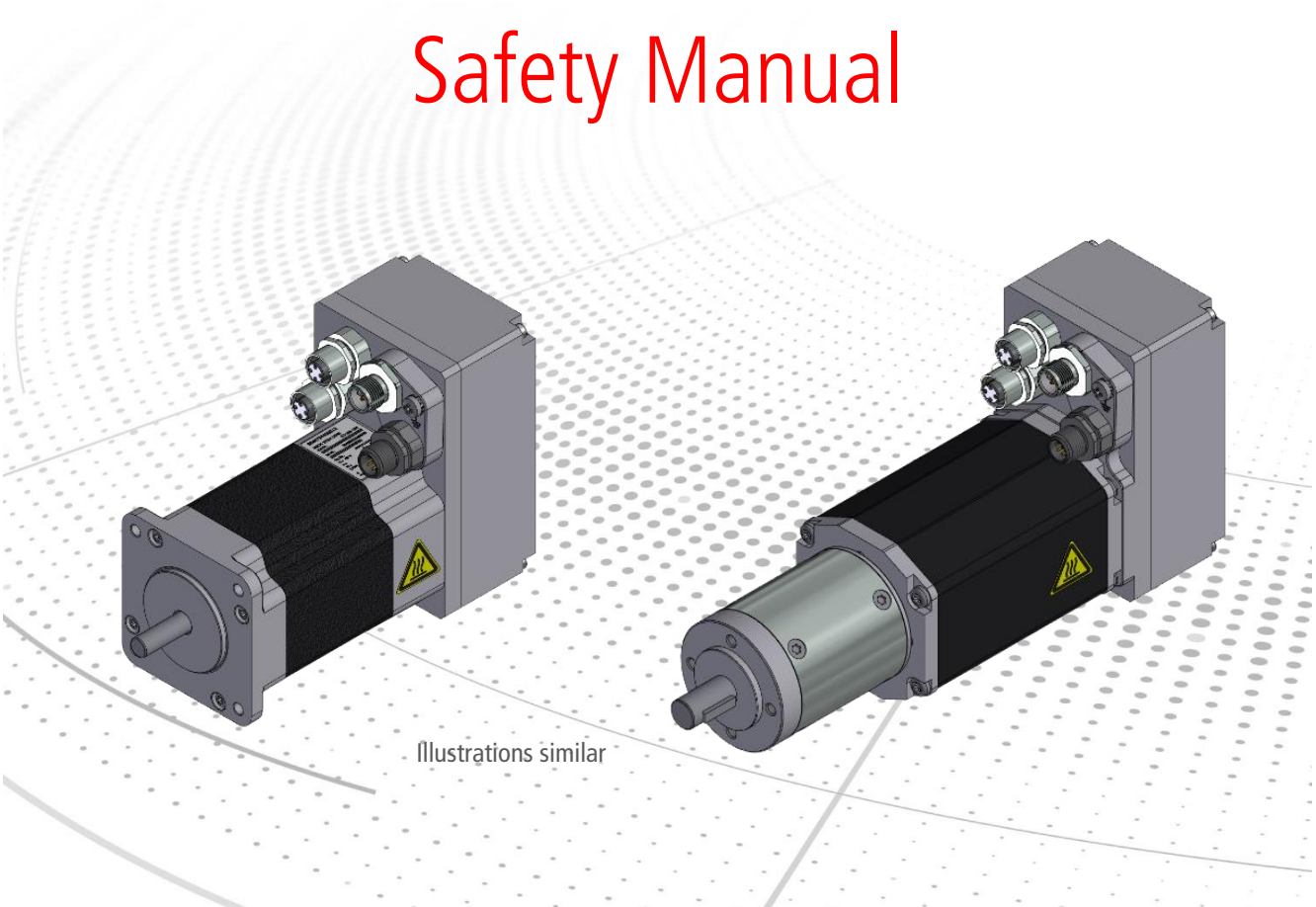
Original

Decentralized Positioning Drives MP Series

Safety Manual



Illustrations similar

DIN EN 61508 / DIN EN 62061: **SIL CL2**
DIN EN ISO 13849: **PL d**
DIN EN 61800-5-2: **Safe Torque Off (STO), Safe Stop 1 (SS1)**

_Basic safety instructions
_Purpose
_General functional description
_General characteristics
_Installation instructions
_Error causes and solutions

Safety Manual

TR-EMO-BA-GB-0023 v00 04/20/2022

Contents

TR-Electronic GmbH
D-78647 Trossingen
Eglishalde 6
Tel.: (0049) 07425/228-0
Fax: (0049) 07425/228-33
E-mail: info@tr-electronic.de
https://www.tr-electronic.com/

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First release	04/20/2022	00

1 General information

This manual contains all safety-relevant information about the integrated safety functions of the encoTRive drive system and includes the following topics:

- General functional description
- Basic safety information with particulars of use
- General characteristics
- Installation instructions
- Error causes and solutions

As the documentation is arranged in a modular structure, this Manual is supplementary to other documentation, such as product data sheets, dimensional drawings, leaflets and interface-specific user manuals etc..

1.1 Applicability

This Manual applies exclusively for the following decentralized encoTRive drive systems with ***PROFINET-IO*** interface:

Type designation: MP-xxx-PN-xA-xxxx

Series	**Performance class**	**Interface**	**Approvals**		**Variant**	**xxx**
			country-spec.	technical		
MP (positioning drive)	060 100 140 180 200	PN (PROFINET)	N (without)	A (with STO/SS1)	**B** (Standard) **K** (customer-specific)	**001** … (serial no.)

The products are labeled with affixed nameplates and are components of a system.

1.2 Associated documentation

- Operator's operating instructions specific to the system
- This safety manual
- Plug assignment
- Interface-specific user manual
- The customer-specific user manual (optional)
- Product data sheet, including dimensional drawing (depending on the drive variant)

1.3 Abbreviations and terms used

DC_{avg}	Average ***D***iagnostic ***C***overage
EMC	***E***lectro-***M***agnetic ***C***ompatibility
ESD	***E***lectro ***S***tatic ***D***ischarge
Functional safety	Part of the overall system safety, which depends on the correct functioning of safety-related systems for risk reduction. Functional safety is ensured when each safety function is executed as specified.
IEC	International Electrotechnical Commission
ISO	***I***nternational ***S***tandard ***O***rganization
$MTTF_d$	***M***ean ***T***ime ***T****o* ***F****ailure,* ***d****angerous* Mean time until a dangerous error occurs
PFD	***P***robability of ***F***ailure on ***D***emand Probability of failure of a safety function
PFH	***P***robability of ***F***ailure per ***H***our Operating mode with high requirement rate or continuous demand. Probability of dangerous failure per hour.
PL	***P****erformance* ***L****evel*: Discrete level, which specifies the capability of safety-related parts of a control to execute a safety function under foreseeable conditions.
SIL	***S***afety ***I***ntegrity ***L***evel: Four discrete levels (SIL1 to SIL4). The higher the SIL of a safety-related system, the lower the probability that the system cannot execute the required safety functions.
VDE	***V***erband ***d***er ***E***lektrotechnik, Elektronik und Informationstechnik (Association for Electrical, Electronic and Information Technologies)
Repeat test (proof test)	Repetitive test to detect hidden dangerous failures in a safety-related system.

1.4 General functional description

The encoTRive drive systems MP-060…200-PN are optionally available with integrated safety technology, which safely switches off the motor torque after activation via a safe digital input and an optional time duration.

- The two functions STO (Safe Torque Off) and SS1 (Safe Stop 1) comply with the standard EN 61800-5-2 “Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional Safety”

- The safety requirement level corresponds to SIL CL2 in accordance with EN 62061 “Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems” and PL d, Cat. 3 in accordance with EN ISO13849-1 “Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design”.

The different configuration options are defined according to customer requirement and set in the factory.

The different selection options are:
- STO or SS1
- the desired SS1 time (e.g. 500 ms or 1000 ms)
- with or without short-circuit monitoring

The selection of the safety-oriented parameters occurs during the order process and is clearly assigned to a device variant. The selected parameters appear in the product data sheet, as well as in the order papers for the respective variant and must be checked for correctness by the user when ordering.

As for drives without safety function, all drive functions are controlled **via the standardized non-safety-oriented PROFINET interface**.

2 Basic safety information

2.1 Definition of symbols and notes

⚠ DANGER	means that death or serious injury will occur if the required precautions are not met.
⚠ WARNING	means that death or serious injury can occur if the required precautions are not met.
⚠ CAUTION	means that minor injuries can occur if the required precautions are not met.
NOTICE	means that damage to property can occur if the required precautions are not met.
	indicates important information or features and application tips for the product used.
	means that appropriate protective measures against ESD according to DIN EN 61340 5-1 Supplement 1 must be applied.

2.2 General risks when using the product

The product, hereinafter referred to as ***encoTRive***, is manufactured according to state-of-the-art technology and accepted safety rules.

Nevertheless, improper use can pose a danger to life and limb of the user or third parties, or lead to impairment of the encoTRive or other property!

Only use the encoTRive in technically perfect condition, and only for its designated use taking safety and hazard aspects into consideration, and with reference to **Associated documentation**! Faults which could threaten safety should be eliminated without delay!

If the encoTRive does not function or only functions incorrectly, further procedure must be agreed with TR-Electronic if necessary.

2.3 Residual risk

According to EN ISO 12100-1 “Safety of machinery – Basic concepts, general principles for design” the residual risk is defined as the risk that remains after applying all protective measures.
The risk itself is defined as the “combination of the probability of occurrence of harm and the severity of that harm”.

Throughout the safety lifecycle, TR-Electronic has applied risk elimination measures and methods according to the state of the art in science and technology - however, residual risks remain when using the encoTRive as intended!

The residual risks are not only specified in this chapter, but at all relevant points of the entire document.

For the risk assessment of the overall system required by the EU Machinery Directive it is therefore necessary to know the **Associated documentation**, including the documented boundary conditions, safety instructions and residual risks and incorporate these into your own risk assessment.

2.4 Intended use

The encoTRive drive system is generally intended as a decentralized positioning drive for setting up and adjustment tasks, or for travel and rotational movements in the industrial area for fixed installation in machines and systems, which are not subject to special electrical and mechanical safety requirements.

The encoTRive drive system with the integrated safety-oriented functions STO (Safe Torque Off) or SS1 (Safe Stop 1) safely switches off the motor torque under defined conditions. With these safety-oriented functions, the encoTRive can be used in machines and systems that require the protection goal "**Safe switch-off of motor torque"**. The complete processing chain of the safety function must then satisfy the requirements of the applied safety standard.
The system manufacturer must check that the characteristics of the encoTRive satisfy his application-specific safety requirements. The responsibility or decision regarding the use of the encoTRive lies with the system manufacturer.

Proper use also includes:

- observing all instructions in the further applicable documents,
- observing the nameplate and any prohibition or instruction signs on the encoTRive,
- observing attached documents,
- operating the encoTRive within the limit values specified in the technical data,
- observing the specified conditions for safe operation of the encoTRive,
- using the checklist in this document

2.5 Improper use

Danger of death, physical injuries and/or damage to property due to improper use of the encoTRive!

⚠ WARNING

NOTICE

- The following areas of use are especially forbidden:
  - Use of safety functions, which are not described in this document and expressly approved
  - In environments with an explosive atmosphere according to ATEX Directive
  - For medical purposes according to the Medical Devices Directive
  - As a step or ladder
  - As a support for tensioning chains and belts

2.6 Conditions

Optional attachments, such as e.g. mechanical brakes, are not designed in accordance with the requirements on functional safety and are therefore not part of the safety functions STO (Safe Torque Off) or SS1 (Safe Stop 1).

In the event of malfunction, overrunning of the drive can be significantly prolonged or the drive can even accelerate. To ensure an active delay of the system, an additional braking system must be provided.

In safe condition, message output C1 = 24 VDC and drive torque-free, the end stage is blocked by the internal connection. Operating voltage is still supplied to the drive. The power to the system must therefore be switched off, when working on the electrical part of the drive.

The prerequisite for safe operation is correct fitting of the drive in the system/ machine. In all cases, the system/machine manufacturer must perform a system/machine-specific risk assessment.

The system/machine manufacturer and the operator are responsible for ensuring that the system or machine complies with the applicable safety requirements.
As proof, the system or machine must be validated by the manufacturer in respect of the safety functions.

All requirements on installation, commissioning and operation must be fulfilled for correct fitting of the drive in the system. These are specified in the respective documents/chapters.

2.7 Integrated safety functions

2.7.1 Mode of operation

A redundant shutdown path is opened with the help of the integrated safety functions Safe Torque Off (STO) or Safe Stop (SS1) through opening of the control circuit I11/I12 or I11/I21. No further torque can be generated and the motor shaft is switched torque-free.
The safety function SS1 also enables an automatic torque switch-off with a time delay.

The following states are signaled to the higher-level control system via message outputs C1 and C2:
C1 = 24 VDC: safe state, the drive is torque-free.
C2 = 24 VDC: Error in safety module

Via PROFINET the safe state is displayed by ERROR “400“ in PNU 947.

In addition, the drive and safety states are signaled by corresponding LEDs.

It is guaranteed that an individual error will not lead to loss of the safety function. Internal errors are detected by means of cyclic self-monitoring, at the latest when the system is next switched off and on again. Depending on the application, this must be performed periodically as part of a maintenance plan.

The integrated safety function enables the user to safely prevent motor generation of torque. The following functions are implemented in this connection:

2.7.2 STO (Safe Torque Off)

⚠ WARNING

NOTICE

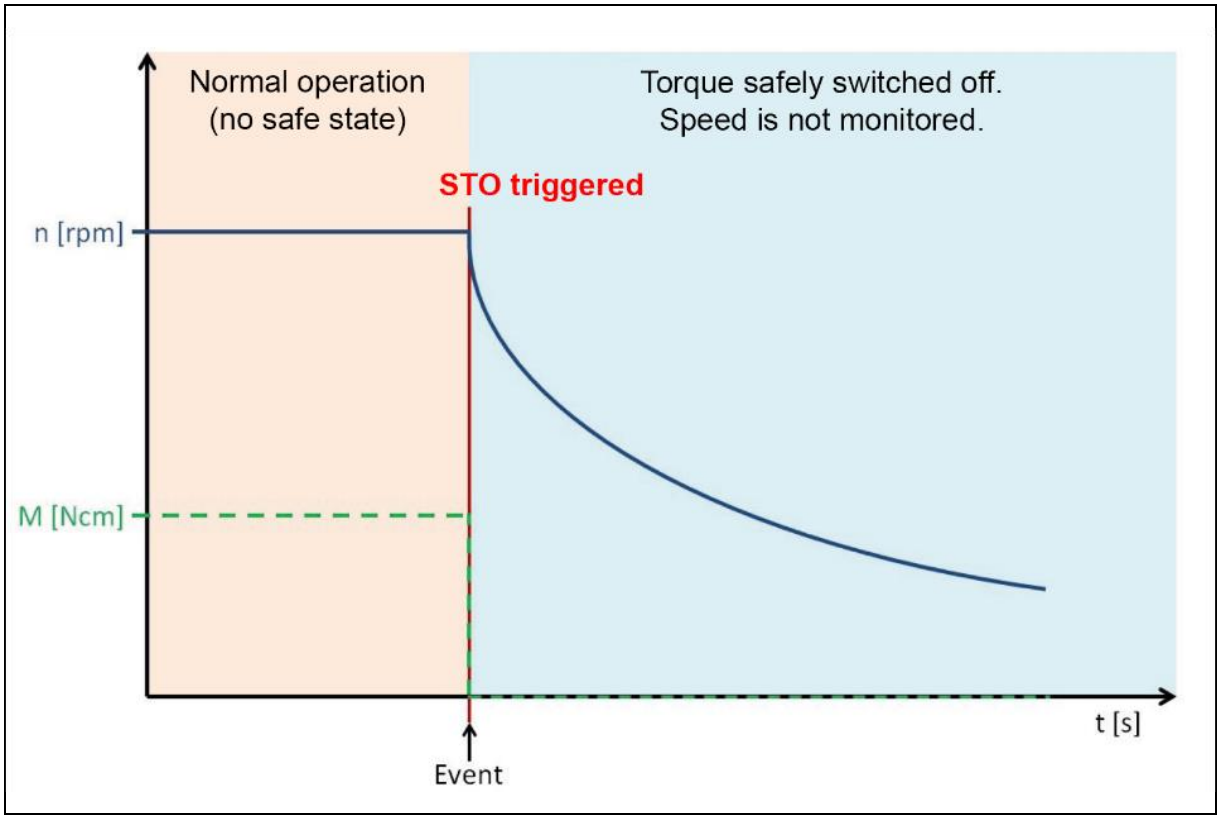
- **Danger of death, serious injury and/or damage to property due to uncontrolled motor shaft movements when the STO safety function is activated.**

  The safety function does not prevent the motor shaft from creeping back (no safe braking), but only active torque generation. The motor shaft can be set in motion by external forces (tensioned spring, suspended load, ...).

  ➢ The system risk analysis must take account of all active components, which influence the passive behavior of the drive.

  ➢ The correct function must first be ensured by a protected test run.

Safe torque switch-off occurs in accordance with EN 61800-5-2. The energy supply to the drive controller is disconnected by a safe mechanism, which corresponds to an uncontrolled stop in accordance with IEC 60204-1, Stop Category 0.



2.7.3 SS1 (Safe Stop 1)

⚠ WARNING

NOTICE

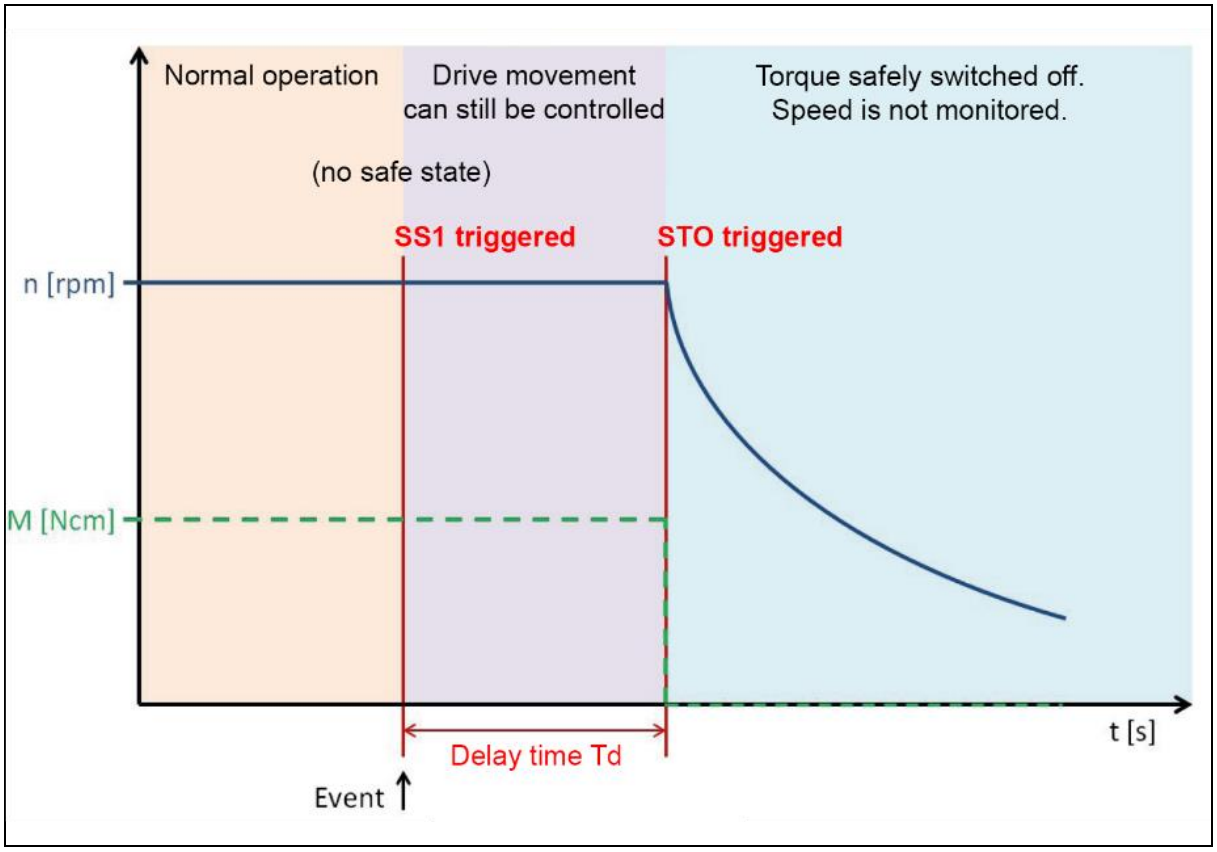
- **Danger of death, serious injury and/or damage to property due to uncontrolled motor shaft movements when the SS1 safety function is activated.**

  The behavior of the drive controller, in the time between triggering of the SS1 function and activation of the time-delayed STO function, is not monitored and does not represent a safe state. At the time of activation of the STO function, the motor shaft can therefore still be in motion.

  ➢ The system risk analysis must take into account that the drive is only in the safe state after activation of the STO function. The behavior of the drive before this point must be viewed as undefined in the worst case scenario.

  ➢ The correct function must first be ensured by a protected test run.

The safety function Safe Stop SS1 can be used, if the torque is not to be switched off immediately after triggering of the safety function, but the drive controller is given a predefined time after which the STO function will be triggered automatically.
During this delay time the drive can still be controlled as normal, in order to e.g. decelerate it in a defined manner, before no further motion control is possible due to triggering of the STO function.
The SS1 function corresponds to the controlled stop in accordance with IEC 60204-1, Stop Category 1.



2.8 Warranty and liability

The General Terms and Conditions ("Allgemeine Geschäftsbedingungen") of TR-Electronic GmbH always apply. These are available to the operator with the Order Confirmation or when the contract is concluded at the latest. Warranty and liability claims in the case of personal injury or damage to property are excluded if they result from one or more of the following causes:

- Improper use of the encoTRive.
- Improper assembly, installation, start-up and programming of the encoTRive.
- Inexpertly performed work on the encoTRive.
- Operation of the encoTRive with technical defects.
- Mechanical or electrical modifications to the encoTRive undertaken autonomously.
- Unauthorized repairs.
- Third party interference and acts of God.

2.9 Organizational measures

- The associated documentation must always be kept accessible at the place of operation of the encoTRive.
- In addition to the associated documentation, the generally valid legal and other binding regulations on accident prevention and environmental protection must be observed and communicated.
- The respective applicable national, local and system-specific provisions and requirements must be observed and communicated.
- The operator is obliged to inform personnel about special operating features and requirements.
- Prior to commencing work, personnel working with the encoTRive must have read and understood the Safety Manual, particularly chapter "Basic safety information".
- The nameplate and any prohibition or instruction symbols applied on the encoTRive must always be maintained in a legible state.
- Do not carry out any mechanical or electrical changes to the encoTRive other than those expressly described in the associated documentation.
- Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

2.10 Choice and qualifications of personnel; basic obligations

- All work on the encoTRive must be carried out by qualified personnel only.
  Qualified personnel includes persons, who, due to their training, experience and instruction, as well as their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorized to carry out the required work by the persons responsible for the safety of the system. They are capable of identifying and avoiding potential hazards.

- The definition of “qualified personnel” also includes an understanding of the standards VDE 0105-100 and IEC 364 (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).

- The responsibility for assembly, installation, commissioning and operation must be clearly defined. The obligation exists to provide supervision for trainee personnel.

2.11 Safety information

- Before starting any work on the encoTRive, the motor must be properly isolated in accordance with the 5 safety rules according to DIN VDE 0105. As well as the main circuits, attention must also be paid to any additional or auxiliary circuits.
  The measures prescribed in DIN VDE 0105 may only be withdrawn when the assembly work on the motor is completely finished.
- As well as the general requirement of care, attention must be paid to the risk of hair or items of clothing being caught in the equipment.
- Take care when touching the encoTRive. Temperatures of over 100°C can occur on the surface of the encoTRive during operation. The temperature must therefore be checked before work can be carried out again on the encoTRive after operation.
- Risk of fire!
  Before assembly, it must be ensured that an adequately large distance is maintained from inflammable materials and cables laid in the immediate vicinity. Furthermore, it must be ensured that heat losses can be adequately dissipated.

⚠ WARNING

- Protective devices must never be rendered inoperative, even during testing.
- Check the direction of rotation of the encoTRive in the uncoupled state before commissioning.

NOTICE

- Ensure that dangerous torques cannot occur on the encoTRive due to commissioning or test adjustments in order to prevent damage to persons or materials.
- Suitable measures must be taken to prevent limbs being trapped by moving actuators.
- All work on the encoTRive must be carried out in accordance with the information and instructions given in this Safety Manual.
- Ensure that no dangerous torques are produced by switching off equipment, machines and systems.
- When electrical components are used in complex systems, unpredictable functions may occur during normal operation of the system if the electrical parts of the system are not properly designed, or due to faulty components. Proper design in accordance with the relevant technical regulations is the responsibility of the system designer and the user.
- When operated in residential environments, the encoTRive can cause high-frequency interference, which may make suppression measures necessary.
- When the encoTRive is installed in a vertical position, it must be ensured that no liquids can get into the bearing.

Continued on next page

Continued

- When installing, make sure that the permissible radial and axial forces on the encoTRive drive shaft are not exceeded. It may be necessary to use suitable output drive elements. Impacts and blows on the output drive shaft must be avoided in order to prevent damage to the electromechanical components.
- Guarantee of IP protection class
  Unused cable openings and access points for adjusting devices must be sealed with blanking plugs. Unused connection plugs must either be provided with a mating connector or a protective cap. The appropriate IP protection class must be selected to meet the relevant requirements.
- Higher IP protection class
  If the encoTRive is operated in an environment that requires a higher protection class, sealing of the shaft and the housing transitions (MP-060…180 with gear) must be provided by the user, e.g. through a radial shaft seal and housing coating or using covers, which keep dust and moisture away from the shaft outlet and housing transitions (MP-060…180 with gear). Alternatively, the MP-200 version with gear can be used. The information on the IP protection class in the respective product data sheet must be observed.

⚠ WARNING

NOTICE

- The cable outlets of the mating connectors must always be secured against being pulled out with a cable strain relief.
- Potential hazards resulting from interactions with other systems and equipment which are or will be installed in the vicinity must be checked. The user is responsible for taking appropriate measures.
- Cables used must be suitable for the temperature range.
- Make sure that the installation environment is protected from aggressive media (acids etc.)
- Opening the encoTRive is forbidden.
- The nameplate specifies the technical characteristics of the encoTRive. If the nameplate is no longer legible or if the nameplate is completely missing, the encoTRive must not be operated.

- **The encoTRive contains components and modules that are at risk from electrostatic discharge, and can be destroyed if not handled properly.**
  - Avoid touching the encoTRive connectors with the fingers. The appropriate protective measures against ESD must be applied.

- **Disposal**
  - If disposal has to be undertaken after the lifespan of the encoTRive, the respective applicable country-specific regulations are to be observed.

3 Transport / Storage

- Shipping information
  - Use only the original packaging.
    Inappropriate packaging material may cause damage to the unit in transit.

- Storage
  - Storage temperature: -20 to +50 °C
  - Store in a dry place

4 Installation instructions

Risk of fire due to high surface temperatures!

Depending on the power output of the drive, surface temperatures of over 100 °C can occur on the encoTRive during operation.

➢ Before assembly, it must be ensured that an adequately large distance is maintained from inflammable materials and cables laid in the immediate vicinity. Furthermore, it must be ensured that heat losses can be adequately dissipated.

- In general, the requirements and acceptance conditions for the complete system must be taken into account for mounting, and the safety information on page 17 must also be observed.
- The encoTRive must be checked for externally visible damage before installation. If any damage is found, the encoTRive must not be installed.
- It must be ensured that the IP protection class can be maintained at the place of installation.
- The unit can be mounted in any position, but the preferred orientation is horizontal.
- The drive must be fixed to a flat surface via the shaft-side flange. The respective mounting data can be found in the associated dimensional drawing.
- All fastening screws must be secured against unintentional loosening.
- The maximum values for the permissible radial and axial forces of the motor shaft can be found in the customer-specific product data sheet.

5 General technical data and installation instructions

5.1 Functional safety

SIL standardization	DIN EN 61508-1 to 7 / DIN EN 62061
SIL level	SIL2 / SIL CL2
PL standardization	DIN EN ISO 13849-1
Performance Level (PL)	PLd / Cat. 3
$MTTF_d$, high	955 a
DC_{avg}, high	91.84 %
PFD	$3.07 * 10^{-5}$
PFH	$3.55\ 10^{-10}$
* PFH in % of SIL2 requirement	< 1 %
T1, repeat test (proof test)	20 years

5.2 Safety functions

DIN EN 61800-5-2, Electrical power drive systems	STO, SS1
Operating mode and requirement rate, DIN EN 61508	high

* with a PFH level below 1 % of the SIL class requirement, a proof test within the entire useful life is not necessary

5.3 Supply

⚠ WARNING

NOTICE

- **Danger of death, serious injury and/or damage to property due to undefined states of the drive controller, caused by common feeding of the power and logic supply!**

  ➢ In order to ensure fault-free operation, a separate voltage source must be provided for the supply of the power unit and the logic unit.

The encoTRive may only be operated on power supplies in accordance with the requirements of PELV (IEC 60364-4-41:2005) or with a safety transformer in accordance with the requirements of IEC 61558-2-6.

An additional fuse of 500 mA (fast) is recommended in the supply line to the logic unit. A 16 A fuse should be provided in the supply line to the power unit (note actual drive power and cable cross-sections used).

Logic unit	
Rated voltage	24 V DC, ± 10 %
non-destructive up to	≤ 28 V DC
Power consumption at rated voltage	< 5 watts
Power unit	
Supply range, variant-dependent	24…48 V DC, see nameplate
non-destructive up to	≤ 54 V DC
Power consumption, variant-dependent	see nameplate
Readiness for operation after switching on	25 s

If the supply for the power unit is connected after the supply for the logic unit, the drive software will generate an error. This must be acknowledged via the relevant fieldbus interface.

Only when the start-up has been completed without error do the digital outputs and LEDs assume their correct state.

5.4 Safety-oriented function inputs

In order to comply with the specified data, only cables with a maximum length of 10 m may be used to connect the safe function inputs.

IN11, IN12, IN21	
Non-destructive voltage range	≤ 35 V DC
Input impedance	4.8 kOhm
Low level	0…4 VDC
High level	18…35 VDC
Galvanic isolation	no
Pulse suppression time (for test pulses of an OSSD signal)	0.15 ms

5.5 Message outputs

NOTICE

- **Risk of damage to the message outputs due to excessively high current flow!**
  - ➢ Current-limiting measures must be implemented to ensure that the current flow does not exceed 50 mA.

C1 = safe state, C2 = error	
Output voltage	24 VDC
Output current	≤ 50 mA
Galvanic isolation	no
Short-circuit resistance	no
Galvanic isolation	no
Output voltage at full load	Supply –1V

5.6 Mechanical

Storage and transport temperature	-20…+50 °C
Ambient temperature in operation ..... (variant-dependent)	See product data sheet for respective article number
Relative humidity ..... (non-condensing)	≤ 90 %
* Protection class ..... (variant-dependent)	See product data sheet for respective article number
Vibration	DIN EN 60068-2-6
MP-060…MP-180.....	5 g
MP-200.....	10 g
Sine	50…2000 Hz, 60 min
Shock	DIN EN 60068-2-29
Acceleration.....	25 g / 6 ms
Shocks per axis	1000

5.7 Connection instructions

NOTICE

- **Risk of damage to the encoTRive drive system due to incorrect installation work!**
  - ➢ Make sure that the plug connectors are not damaged during installation. Bent pins can destroy the drive due to short-circuits.
  - ➢ All plug connectors should only be fitted “hand-tight”.
  - ➢ Connection cables must be laid so that damage during operation, e.g. due to chafing, squeezing or bending, can be excluded.
  - ➢ Tensile stress on cables must be avoided.

The connection configuration can be found in the customer-specific pin assignment.

* MP-200 with gear
The protection class with gears PLE60, PLE80, WPLE60 or WPLE80
(or with comparable gears) is IP54, unless specified otherwise in the product data sheet

MP-200 without gear
The housing protection class is IP54, unless specified otherwise in the product data sheet,
the shaft protection class is IP41

MP-060…180
The protection class is IP40

5.8 Equipotential bonding

Example illustration

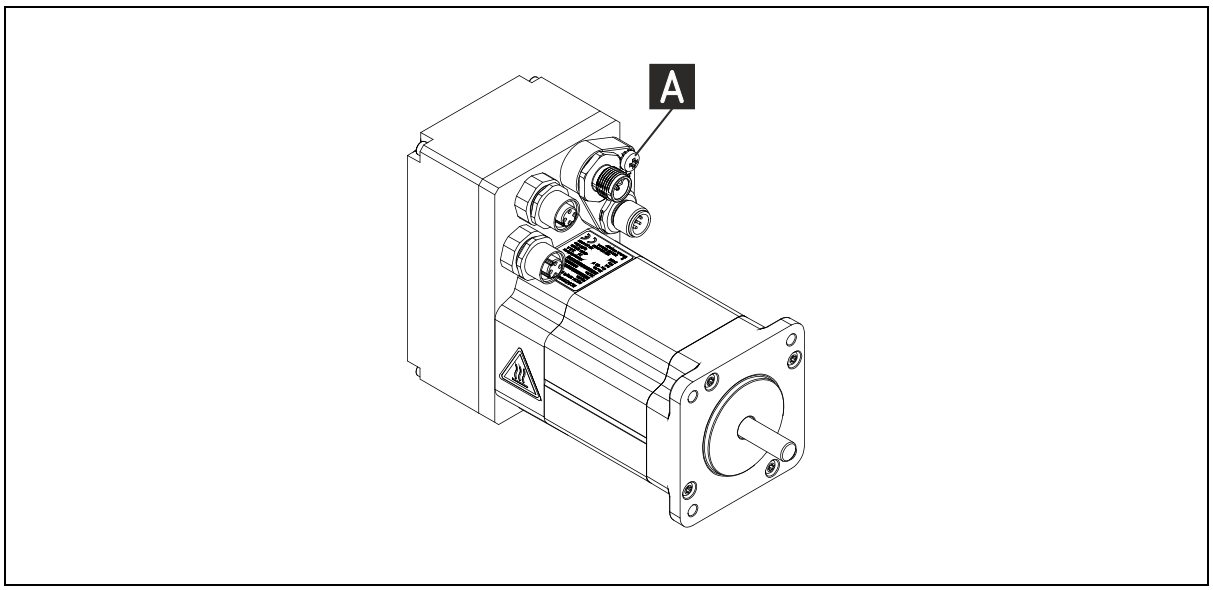


Figure 1: Ground point

A: M5 thread for equipotential bonding

Position and execution can be found in the customer-specific pin assignment.

Shielded connecting cables must be used during installation. Please note that an electrical connection exists between the shielding braid of the connecting cables used and the housing of the drive.

The shielding braid of the connecting cables must be grounded on both sides. These connections must have “EMC-compliant” installation (low inductance, large surface).

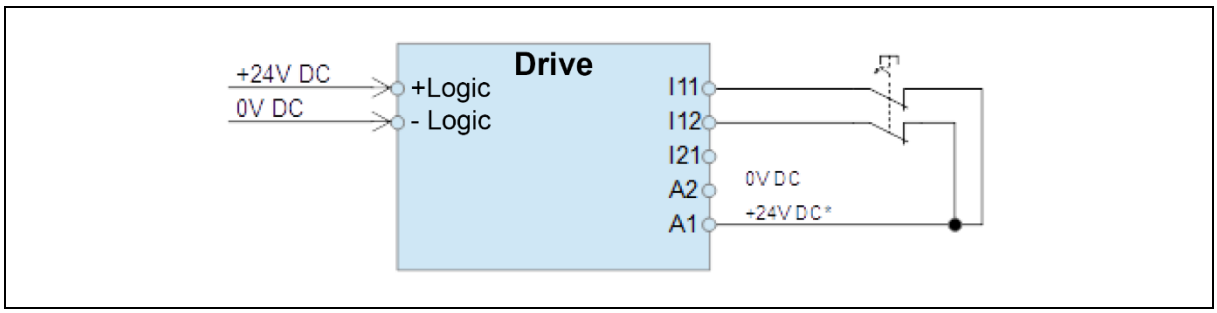
The equipotential bonding is generally installed on the drive side using the thread of the connecting plug and the M5 grounding plug.

Painting or coating the contact points and threaded parts of the connecting plugs is not permitted.

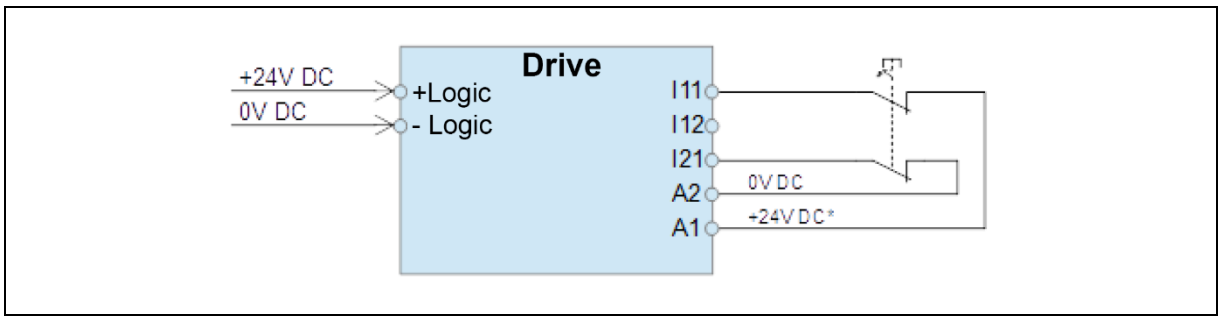
6 Control of the safety-oriented function inputs

Depending on the application, different options are available for control of the integrated safety module, which are implemented by means of specific wiring of inputs I11, I12 and I21. The examples listed below correspond to the “not safe” state, i.e. the drive is not switched torque-free.

Example 1: Two-channel emergency stop control without cross-circuit monitoring (I11, I12)

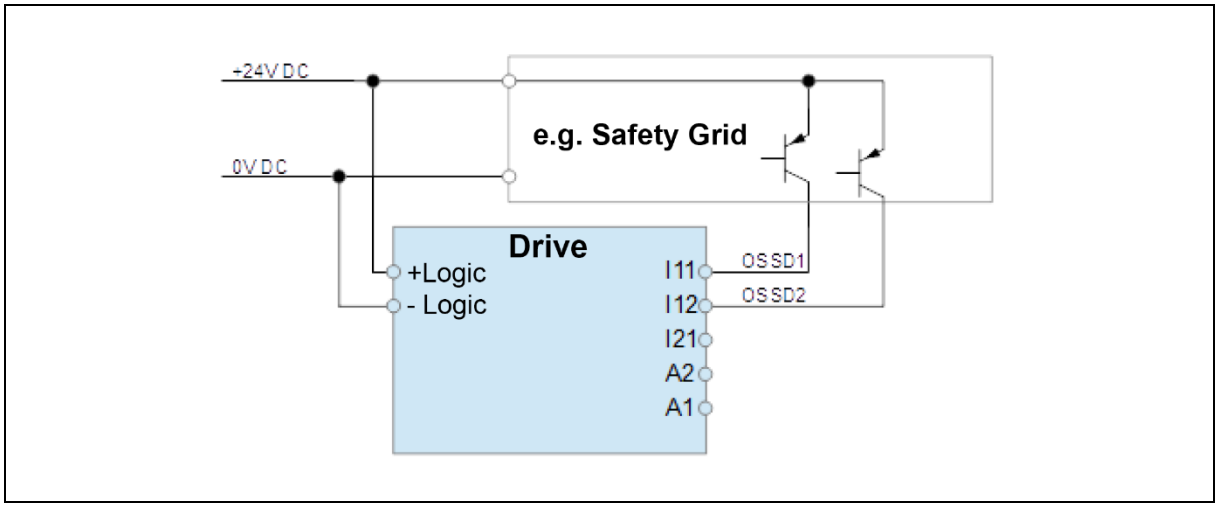


Example 2: Two-channel emergency stop control with cross-circuit monitoring (I11, I21)



Example 3: Two-channel semiconductor control without cross-circuit monitoring (I11, I12)

The following diagram shows the wiring of the encoTRive with integrated safety module when connected to electro-sensitive protective equipment (e.g. safety light grid) or similar devices. It is assumed that the 2-channel input is in non-safe state, if both channels are connected to the supply voltage.



7 Validation of the encoTRive safety functions

This chapter describes the validation of the encoTRive specific safety functions. When this has been done, a validation of the entire system or machine must take place.

The procedure described below should be regarded as an example and is not meaningful for all applications. The system or machine manufacturer must ensure the appropriate functions for his application.

Prerequisites:

⚠ WARNING

NOTICE

- ➢ All specifications in this document and the associated documents have been implemented.
- ➢ In particular, appropriate precautions have been taken based on the risk analysis, to ensure that no hazards can arise during execution of the safety functions, and that damage to property and physical injuries can be excluded.

- The encoTRive drive system has been put into operation and there is communication with the control.

- The drive is in a non-safe state, i.e. the safety circuit is closed via inputs I11/I12 or I11/I21 (with or without cross-circuit monitoring) and the drive controller is enabled.

7.1 STO function

The safety function is triggered, when the safety circuit is interrupted e.g. by an emergency stop switch. It must then be checked whether the motor torque has been switched off and whether the encoTRive motor control outputs error “400” in PNU 947 via the PROFINET interface, denoting the safe state. The safe state is displayed directly on the encoTRive drive system via the message output C1 = 24 VDC.

When validating the STO function, the required time until complete standstill of the system or machine must be taken into account, depending on the application. This depends on the masses present in the system!

In order to restart the drive after the STO function has triggered, at least 1 s must pass, then the safety circuit must be closed again via the inputs used, the error must be acknowledged via the PROFINET interface and after this the drive controller must be activated again.

7.2 SS1 function

As with the STO function, the safety function is triggered, when the safety circuit is interrupted e.g. by an emergency stop switch. It must then be checked whether the customer-specific time set in the factory matches the actual delay time, until the STO function is triggered.

During the delay time the drive continues running unchanged according to the current movement command. **No automatic speed reduction takes place. If necessary, braking must be performed by the user with an appropriate braking ramp!**

For more accurate assessment, on triggering of the SS1 function the WARNING “4096” must be output in PNU 953 via the PROFINET interface.
During validation the behavior of the drive during the delay time must also be observed.

The safe state (PROFINET PNU 947 = 400, message output C1 = 24 VDC) is only reached at the end of the delay time with triggering of the STO-function. Therefore, maintenance of a preset movement profile is not guaranteed!

As with direct triggering of the STO function, it is necessary to check whether the motor torque has been switched off.

In order to restart the drive after the SS1/STO function has triggered, at least 1 s must pass, then the safety circuit must be closed again via the inputs used, the error must be acknowledged via the PROFINET interface and after this the drive controller must be activated again.

8 Safety-oriented error causes and solutions

If the encoTRive drive system changes to the safe state, an error may be present. In this case the message outputs C1 (safe state) and C2 (error in safety module) are set.

Safety-oriented errors are visually displayed via the integrated `Safe State / Error – LED`, output via the digital outputs (C1, C2) and indicated by corresponding warning and error numbers via the fieldbus interface.

The displays, outputs and messages are not safety-oriented.

Fieldbus or device-specific displays and messages are not part of this safety manual and can be found in the customer-specific pin assignment or the interface-specific user manual.

8.1 Optical LED display

The assignment of LEDs can be found in the customer-specific pin assignment.

Safe State (orange)	**Error** (red)	**Cause**	**Solution**
ON	OFF	- Unsafe state, the drive can be moved. The inputs I11, I12 and I21 are controlled, as described in chapter 6 .	Normal state, in relation to the encoTRive safety functions. Irrespective of this, a fieldbus-specific fault may be present, therefore the state of the device-specific `Drive State LED` must be noted.
Flashing	OFF	- Safe state, the drive cannot be moved. The STO or SS1 safety function has been correctly triggered.	If the situation requires a return to the unsafe state again, the safety-oriented function inputs I11, I12 and I21 must be reset again in accordance with chapter 7 on page 27 .
Flashing	ON	- Safe state, the drive cannot be moved. An error has been detected in the safety module.	In order to be able to specify the cause of the error, the error number must be read out via the fieldbus interface, see next chapter “Error and warning messages via the fieldbus interface” on page 30.

8.2 Error and warning messages via the fieldbus interface

The safety-oriented functions are currently only supported by the encoTRive drive system with PROFINET interface. Therefore, for the exact structure of the error array, please refer to the interface-specific user manual for PROFINET, see chapter “Document download” on page 35.

Error messages are generally indicated via PNU 947 and warning messages via PNU 953. Error messages must be acknowledged via the control word PNU 967 after the cause of the error has been eliminated. Warning messages do not need to be acknowledged.

Error messages, PNU 947

No.	Cause	Solution
400	- Safe state, the drive cannot be moved. The STO or SS1 safety function has been correctly triggered.	If the situation requires a return to the unsafe state again, the safety-oriented function inputs I11, I12 or I21 must be reset again in accordance with chapter 7 on page 27 .
401	Safe state, the drive cannot be moved. An STO error has been detected in the safety module.	-
	Subindex 1 = 1 - The synchronization time of ≤ 1 s between inputs I11 and I12 or I11 and I21 has been exceeded. - A short-circuit was detected between inputs I11 and I12 or I11 and I21 (cross-circuit).	- The switching process for both inputs must occur within one second. - Make sure that no short-circuit is present between the two inputs. - When the error has been eliminated, it must be acknowledged via PNU 967. An attempt can then be made to trigger the safety function again.
	Subindex 1 ≥ 2 - An exception error has occurred	Try to restart the encoTRive drive system, if this measure is unsuccessful, the encoTRive drive system must be replaced.
402	- Safe state, the drive cannot be moved. An STO error has been detected in the internal communication.	Try to restart the encoTRive drive system, if this measure is unsuccessful, the encoTRive drive system must be replaced.

Warning messages, PNU 953

No.	Cause	Solution
4096 (Bit 12)	- The SS1 safety function has been correctly triggered. The safe state (STO) occurs after expiry of the SS1 delay time.	If the situation requires a return to the unsafe state again, the safety-oriented function inputs I11, I12 or I21 must be reset again in accordance with chapter 7 on page 27 .
8192 (Bit 13)	- The synchronization time of ≤ 1 s between inputs I11 and I12 or I11 and I21 has been exceeded.	See solution above under error no. 401, Subindex = 1

9 Replacing the drive

The following points must be noted when replacing the encoTRive drive system:

- The new encoTRive drive system must have the same article number as the encoTRive drive system being replaced; any deviations must be expressly clarified with TR-Electronic.

- The new encoTRive drive system must be installed in accordance with the specifications and requirements in chapter "Installation instructions" on page 20 .

- The new encoTRive drive system must be connected in accordance with the specifications in the chapter "General technical data and installation instructions" on page 21 and the interface-specific user manual.

- As the configuration of the safety-oriented parameters is clearly assigned to an article number (drive variant), these must also be the same when replacing the drive with the same article number and no settings must be made to the encoTRive drive system in respect of the safety function. Only the unsafe drive parameters must be reset via the PROFINET interface as in the original encoTRive drive system, and referencing for initial calibration of the internal positioning system to the machine reference point must be performed.

- When recommissioning the replaced encoTRive drive system, correct functioning must be ensured first of all by means of a protected test run.

10 Checklists

We recommend that you print out and work through the checklists during commissioning, during replacement of the encoTRive drive system, during replacement of system components or maintenance of a previously accepted system and store these as part of the overall system documentation.

Documentation basis	Date	Edited	Checked

10.1 General

Sub-item	To note	Can be found under	yes
Present safety manual has been read and understood	–	Document no.: TR-EMO-BA-GB-0023	☐
Check that the encoTRive drive system can be used for the present automation task on the basis of the specified safety requirements	• Intended use • Compliance with all technical data	• Chapter Intended use, page 11 • Chapter Document download -> Product data sheets, page 35 • Chapter General technical data and installation instructions, page 21	☐
Supply voltage	• The power supply used must satisfy the specified requirements	• Chapter Supply, page 22	☐
Correct • electrical installation (shielding) • network installation	• Observance of basic rules for installation • Observance of wiring standards • Observance of guidelines, which are made available by the respective fieldbus user organizations	• Chapter General technical data and installation instructions, page 21 • Interface-specific user manual see chapter Document download, page 35	☐
• After commissioning • When replacing components of the system or machine (e.g. connecting cables, pushbuttons etc.) • When replacing the encoTRive drive system • Maintenance	• Validation of the overall system or machine in respect of the safety functions • Validation of the encoTRive safety functions	• The operator's system- or machine-specific checklist • Checklist for validation of the encoTRive safety functions, page 33 • Chapter Validation of the encoTRive safety functions, page 27 • Chapter Replacing the drive, page 31 • Chapter Maintenance, page 34	☐

10.2 Validation of the encoTRive safety functions STO, SS1

The following points on the checklist contain the necessary minimum tests for validation of the safety function. They serve as an overview and should facilitate performance. The functions must be checked in the specified order, as the points follow on from each other. The system or machine manufacturer must ensure the appropriate functions for his application.

Also see the chapter "Validation of the encoTRive safety functions" on page 27.

Test	Process	Result
Step 1, STO	Depending on the control of the safe inputs, bring the running motor into the safe state by switching the signals I11/ I12 or I11/ I21 (trigger STO). Check whether ERROR “400” has been set.	
Step 2, SS1	If a delay time is configured, Step 1 must also be performed. The motor reaches safe state after expiry of the delay time. Check whether a WARNING has been set first of all and ERROR “400” after triggering of the STO.	
Step 3, reset	Step 1 and 2 must be executed. ERROR “400” can only be acknowledged if the safe inputs have been reset.	

11 Maintenance

Cyclic self-monitoring is integrated into the safety module, which is performed at the latest when the system is next switched off and on again. However, a manual check of the safety functions should be performed at an interval of one year. The time period must also be reduced depending on the application.

During the inspection the parameterization and wiring must be assessed for signs of manipulation. In addition, the safety functions must be tested as described in chapter “Validation of the encoTRive safety functions” on page 27. These are the minimum requirements.

Further tests must be performed depending on the application. The drive functions beyond the STO or SS1 function do not require any maintenance.

In the case of faults, please contact TR-Electronic directly.

Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

12 Document download

Safety Manual

Designation	Link
MP series decentralized positioning drives	www.tr-electronic.de/f/TR-EMO-BA-GB-0023

Interface-specific user manuals

Designation	Link
PROFINET	www.tr-electronic.de/f/TR-EMO-BA-DGB-0019

Pin assignments (noted in the product data sheet)

Link
www.tr-electronic.com/service/downloads/pin-assignments

Product data sheets

depending on the article number
on request from TR-Electronic

EU Declaration of Conformity

Link
Positioning drives: www.tr-electronic.de/f/TR-EMO-KE-DGB-0021