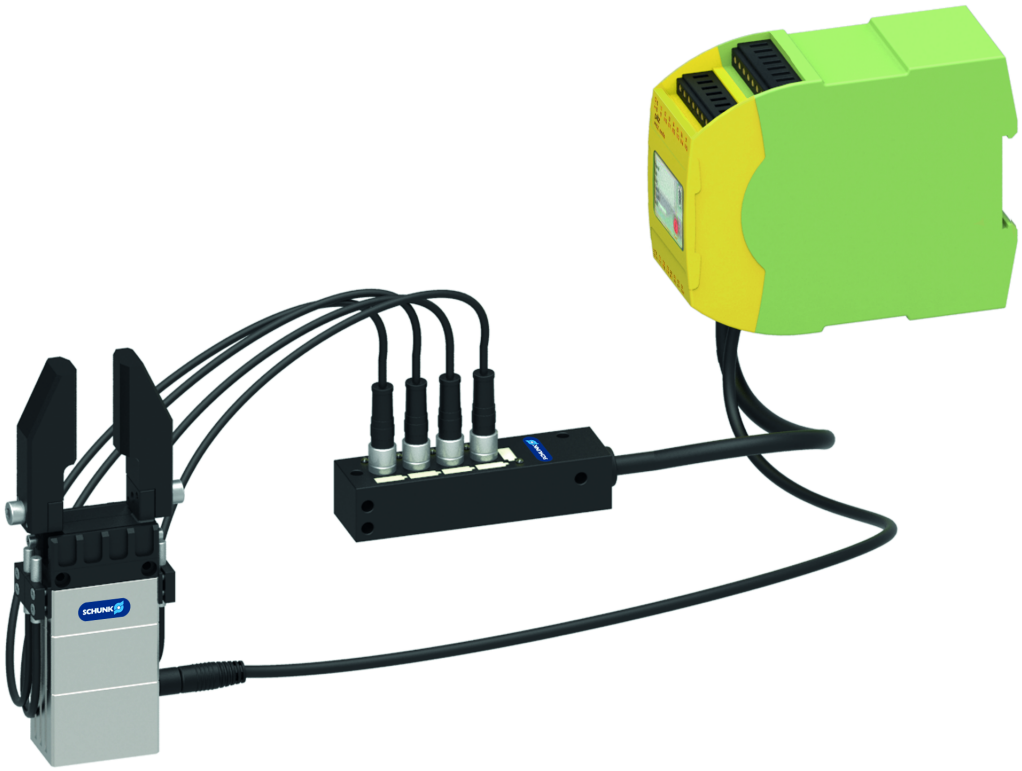
System description

Electric gripper EGP with safety functions



Superior Clamping and Gripping

Imprint

Technical changes:

We reserve the right to make alterations for the purpose of technical improvement.

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thank you for trusting our products and our family-owned company, the leading technology supplier of robots and production machines.

Our team is always available to answer any questions on this product and other solutions. Ask us questions and challenge us. We will find a solution!

Best regards,

Your SCHUNK team

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1 General

1.1 About this manual

This manual contains the information for a system configuration of the EGP electric gripper with a safety control system for implementing the safety functions SOS (safe operating stop) and STO (safe torque shutdown).

This system description does not constitute a complete documentation. For each application, a risk assessment has to be prepared and applicable standards must be identified and applied.

In addition to these instructions, the documents listed under Applicable documents [▶ 4] are applicable.

1.2 Applicable documents

- Assembly and operating manual for gripper EGP
- Assembly and operating manual of the sensor - IN 40 *
- DGVU Certificate, Certificate No. MF 15008 *
- DGVU Certificate, Certificate No. MF 17022 *
- Secure control documentation (installation and programming guide) **

The documents marked with an asterisk (*) can be downloaded on our homepage **schunk.com**

SCHUNK assumes no responsibility for the currentness, correctness and completeness of the documents indicated with (**).

1.3 Components for the system setup

NOTE

For monitoring of redundant sensor signals, SCHUNK recommends inductive proximity switches *IN 40*.

The following components are required for the system setup:

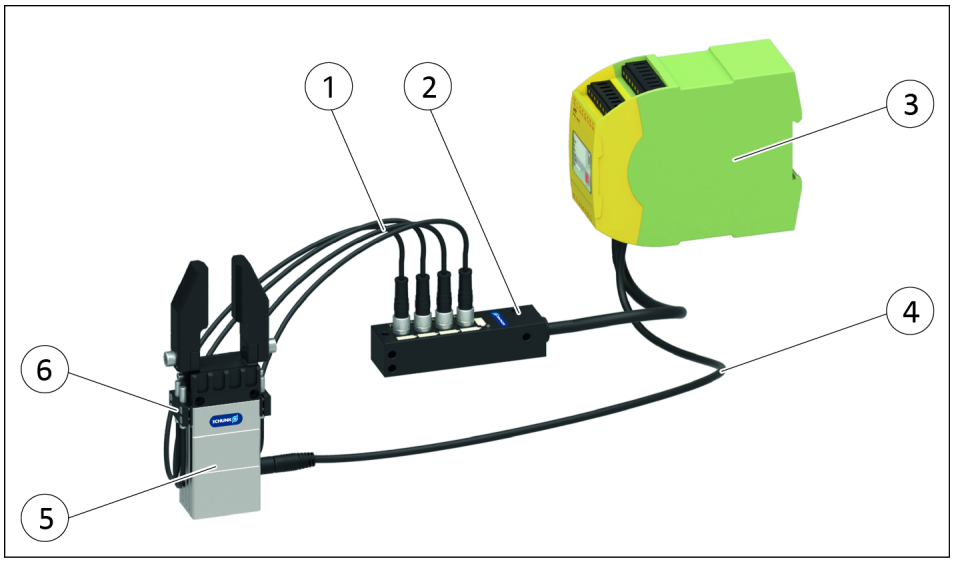
- Electric gripper EGP
- 4 x sensors
  – e. g. inductive proximity switches IN 40/S-M8, SCHUNK Id-No. 0301474
- Sensor bracket (2x)
  – SCHUNK Id-No. 9700901
- Spacer sleeve for adjusting the sensor position
  – SCHUNK Id-No. 5509536
- Sensor distributor
- Safety control system
  – e. g. PILZ *PNOZmulti* or LTI *SMC1-Z10*

2 Technical data

Notes on the technical data are included in the respective documentation of the individual components, Applicable documents [▶ 4].

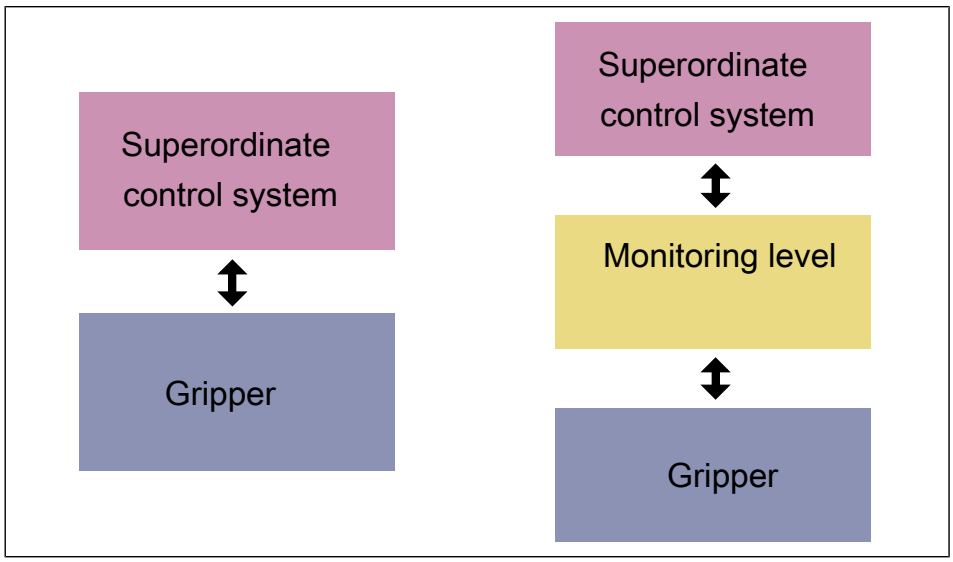
3 Design and description

3.1 Example system setup Systemaufbau



Example system setup with safety control system

1	Sensor *IN 40*	4	Gripper power supply cable
2	Sensor distributor	5	gripper
3	Safety control system (e.g. PILZ *PNOZmulti*)	6	Sensor bracket



Setup, conventional (left) and with safety function (right)

3.2 Description

During the system setup, a monitoring level is created with a safety control between the system's superordinate control and the gripper.

As a result, the position of the gripper fingers can be monitored independently of the superordinate control and, if necessary, the gripper can be disconnected from the supply voltage and thereby placed to a safe state.

The monitoring level differentiates between two modes:

- Monitored operation
- Released operation

In monitored operation mode, the functions of the monitoring level are active.

In released operation mode, the functions are not active and hazards may arise. In released operation mode, the customer must ensure that the plausibility of the sensor signals is monitored and evaluated.

The monitoring level comprises two safety functions and the evaluation logic:

- Safe Operating Stop (SOS)
  - Safe monitoring of the position of the gripper fingers

    Cross-attached sensors monitor the position of the gripper fingers.
- Safe Torque Off (STO)
  - Safe deactivation path of the gripper

    The gripper is deactivated by switching off the power supply.
- Evaluation logic
  - The monitored positions are evaluated by the safety control. If necessary , the control makes the decision to place the gripper in safe state and maintains this state.

4 Functional description

4.1 Definition of the safe state of the gripper

The safe state of the gripper is a state in which no danger to person or machine arises from the gripper.

For the system setup, this means that there are the following two safe states depending on the position of the gripper fingers:

- Safe state 1
  - **Position of the gripper fingers is defined**

    The gripper maintains its position and gripping force to avoid losing a workpiece that it may be holding.
- Safe state 2
  - **Position of the gripper fingers is not defined**

    To avoid crushing, the power to the gripper is disconnected.

The change from safe state 1 to safe state 2 is made as soon as the position of the gripper fingers is undefined.

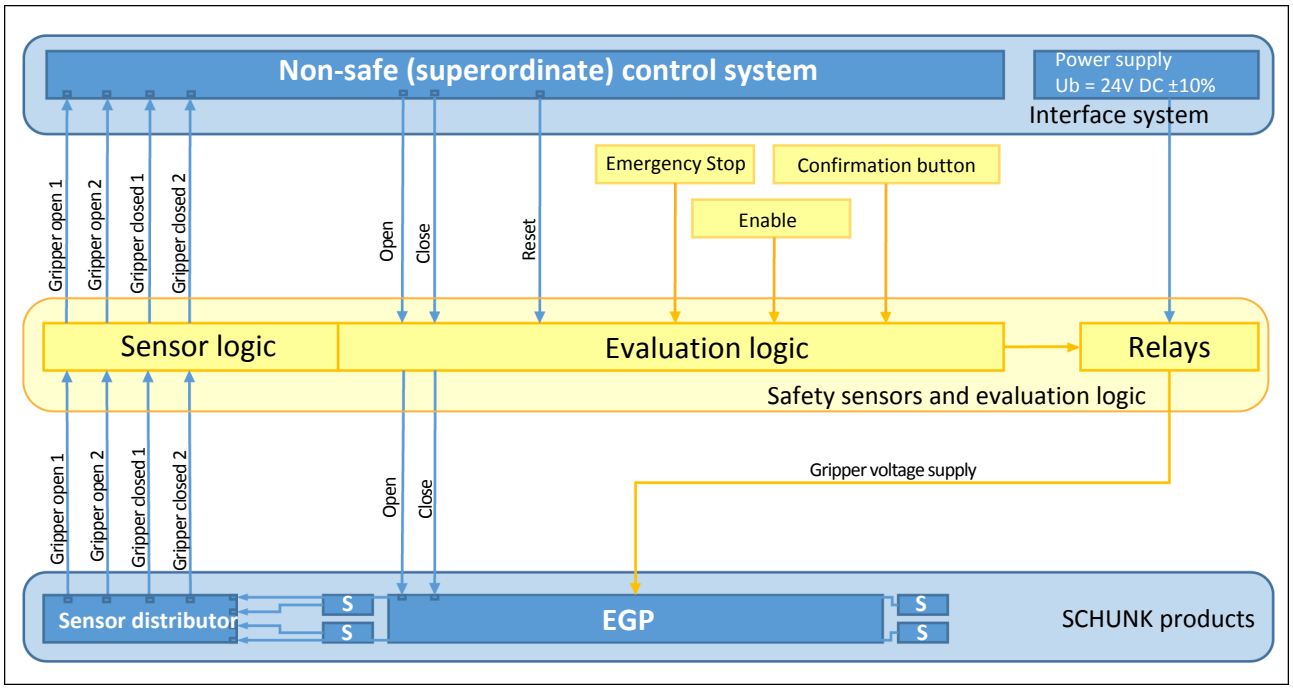
This is the case, for example, when a gripped workpiece is removed by force application from the gripper during monitored operation, no release or the logical release signal low or Emergency Stop. If a workpiece is removed, the gripper fingers move until a signal change is made to one of the sensors (overrun traverse). If the configured gripping force is very low, it is possible that the gripper fingers maintain the position without an overrun.

The switch from safe state 2 to safe state 1 is is not allowed.

It is possible to exit safe state 1 by reenabling or confirming.

Exiting safe state 2 is only possible by solving and acknowledging the existing fault and then reenabling. This prevents unwanted or unexpected reactivation. Alternatively, agreeing and subsequent confirmation can ensure that the gripper is powered until the confirmation button is released or cut off (panic function).

4.2 Block diagram



Block diagram

4.3 Superordinate control system

The superordinate control system can be run in safe on non-safe mode. There are no special requirements for the superordinate control system. It must be ensured that the connections are made for safety technology comply with the requirements of EN ISO 13849-1.

When using a safe superordinate control system, the sensor and evaluation logic that must be executed safely can be implemented in the superordinate control system. In this case, no additional control system is needed.

It must be ensured that the safety connections comply with the application-specific requirements of EN ISO 13849-1.

If an external relay is used, it may be necessary to use additional signals for monitoring and safe state change. When using integrated safe relays, this may be adopted by the safety control system.

NOTE

In release mode, the superordinate control must check the plausibility of the redundant sensor signals provided by the safety control system. In release mode, the sensor signals are merely looped through the safety control system.

4.4 Safety control system

The safety control system provides the power supply U_B – e.g. via a safety relay – for the gripper. The safety control system can deactivate the power supply safely and uses this function as a safe shutdown path.

The safety control system receives the target values *Open*, *Close*, *Reset*, *Enable*, *Emergency Stop* and *Confirm* from the superordinate control system.

The position of the gripper fingers is transmitted to the safety control system via the inputs *Gripper Opened 1*, *Gripper Opened 2*, *Gripper Closed 1* and *Gripper Closed 2*.

The status of the gripper fingers is forwarded to the superordinate control system via the output signals *Gripper Opened 1*, *Gripper Opened 2*, *Gripper Closed 1* and *Gripper Closed 2*.

Processing of the sensor signals for further use in the customer-specific application must be performed by the superordinate control system.

In maintenance mode and in emergency stop, the safety control system carries out a plausibility check of the sensor signals.

In release mode, the sensor signals must be checked for plausibility by the superordinate control system. If this plausibility check is not carried out, an incorrectly set or defective sensor or a gripper that does not operate correctly cannot be detected in release mode.

The four sensors signals are provided to the superordinate control system for further processing by the safety control system.

Information on the operating mode is provided by the safety control system via the two-channel safety inputs *Enable*, *Emergency Stop* and *Confirm*.

4.5 Program sequence

The following diagram shows a model of the behavior of the application software as a state machine. This is divided into three levels. The levels are divided up based on the state behaviors.

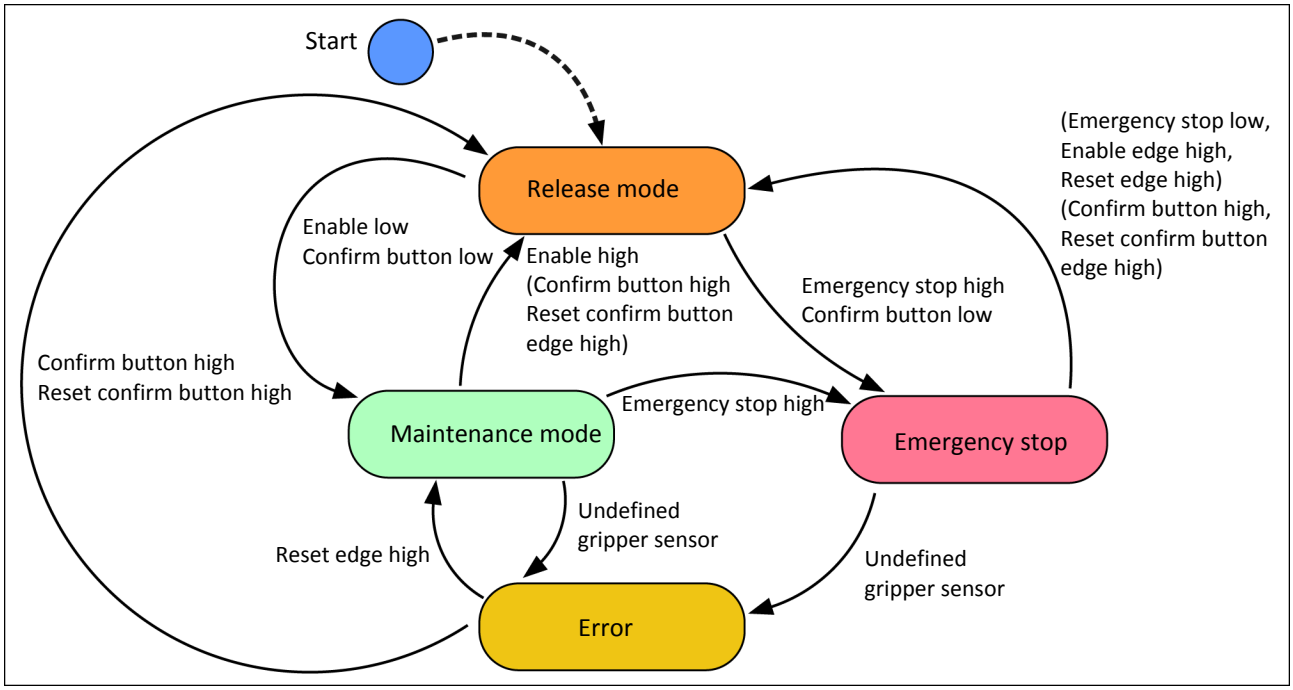


Diagram of state machine

Each state transition is represented by an arrow in the direction of the new state. If the transition condition is true, the state transition occurs.

The application software has three basic behaviors:

- **Release mode**
  - Unchecked transmission of all signals from the gripper to the higher-level control and vice versa.
  - Only in release mode can the gripper be opened or closed.
- **Maintenance mode and emergency stop**
  - Transfer the system to the safe state 1. The target values of the superordinate control system are frozen and the gripper position is maintained.
- **Error**
  - Transfer the system to the safe state 2 by disconnecting power from the gripper. The target values of the superordinate control system are frozen. Setting the error output.

5 Assembly and installation

5.1 Assembly

Information on installation and settings can be found in the respective documentation of the individual components, Applicable documents [▶ 4].

Notes

- For the gripper, a total of four sensors must be mounted for the redundant monitoring of the sensor signals.
- To avoid common errors, power the sensors only from a power source that ensures that the sensors are not operating outside their specifications.
- The safety control system and the sensors must be connected via the same power supply.
- The safety control system monitors its own power supply, U=24 V -20 % ... +25%.
- If the voltage exceeds or falls below the upper or lower voltage limit, the power supply of the gripper is switched off and the safety control system must be restarted.
- The sensors must be configured so that the overrun traverse of the gripper after a workpiece loss is short enough that there is no danger. However, the overrun traverse must be long enough for the safety control system to be able to detect the overrun via the sensor signals, Commissioning checklist [▶ 15].

Overview

- ➢ Install and connect the gripper.
- ➢ Install the sensor bracket on the gripper.
- ➢ Install the sensor distributor between the sensor cable and the safety control system. Connect the sensor distributor to the safety control system.
- ➢ Install, connect and configure the sensors on the gripper.
- ➢ Install and connect safe control system.

5.2 Commissioning

Information on the status displays and commissioning of the individual components can be found in the respective documentation of the individual components, Applicable documents [▶ 4].

NOTE

The operator can use the following checklist to describe and take the commissioning settings into account. The checklist does not lead to full compliance with the legal requirements applicable to the end effector. The forms and processes required for customer-specific application must be observed.

For any modification of the customer-specific application, e. g. when gripping different workpieces, the following points must be repeated:

- Commissioning, including adjustment of the sensors
- Risk assessment
- Documentation of commissioning

If existing settings can be adopted (e.g. if grip width and risk potential due to workpiece weight remain unchanged), this can be substantiated as non-critical by performing the risk assessment again.

NOTE

During operation, the overrun traverse must be checked at regular intervals in case of component loss, Commissioning checklist [▶ 15].

5.3 Commissioning checklist

NOTE:
SCHUNK also recommends using this checklist for the forms and processes required by EN ISO13849 and the standards applicable to the customer-specific application.

1. Check correct electrical wiring ☐

All components must be connected as specified in the connection diagram. Connection of the cables and the wiring must be carried out according to the relevant standards.

2. Check the power supply to the sensors ☐

The sensors are powered from the same power supply as the safety control system or specification-compliant operation is ensured by another measure.

Other measure: _____

3. Apply configuration to the safety control system (only if necessary) ☐

Insert the chip card with the configuration or insert the chip card and transfer configuration via the USB interface.

4. Identify the gripper ☐

I.D. gripping: _____

O.D. gripping: _____

Force-fit gripping or form-fit clamping:

_____

Gripping force adjustment (%):

_____

5. Identify workpiece ☐

The workpiece to be gripped is uniquely identifiable.

Name/Revision: _____

Dimensions [mm]: _____

Workpiece weight (kg): _____

Grip width of the workpiece (mm): _____

Gripping height or spacing of the upper edge of gripper to the force application point (mm):

_____

Tolerances (mm):_____

Residual stroke = Space between fingers
in *Gripper Open* position – grip width workpiece, residual stroke [mm]:

_____

6. Adjust the sensors ☐

Adjust the four sensors, see the Assembly and Operating Manual of the sensor.

Position the sensors: _____

7. Measure the overrun traverse when the component is lost ☐

In monitored operation, measure the overrun traverse when the component is lost.

To avoid crushing, remove the gripped workpiece using a suitable tool.

The safety control system recognizes the movement and switches off the power supply to the gripper.

Overrun traverse = gripping width of workpiece - Position of gripper fingers after pulling out the workpiece

Position of the gripper fingers:

_____

Evaluate overrun traverse in risk assessment and, if necessary, take suitable measures to reduce the risk potential.

Appropriate measures:_____

_____

8. Identify ambient conditions: ☐

Clean/dry: _____

Ambient temperature [°C]

Cycles per minute: _____

9. Assess risk and minimize, if necessary ☐

Assess risk based on potential hazard, e. g. crushing during overrun. Evaluate hazard from overrunning and implement appropriate measures, if necessary.

Appropriate measures:_____

_____

_____

_____

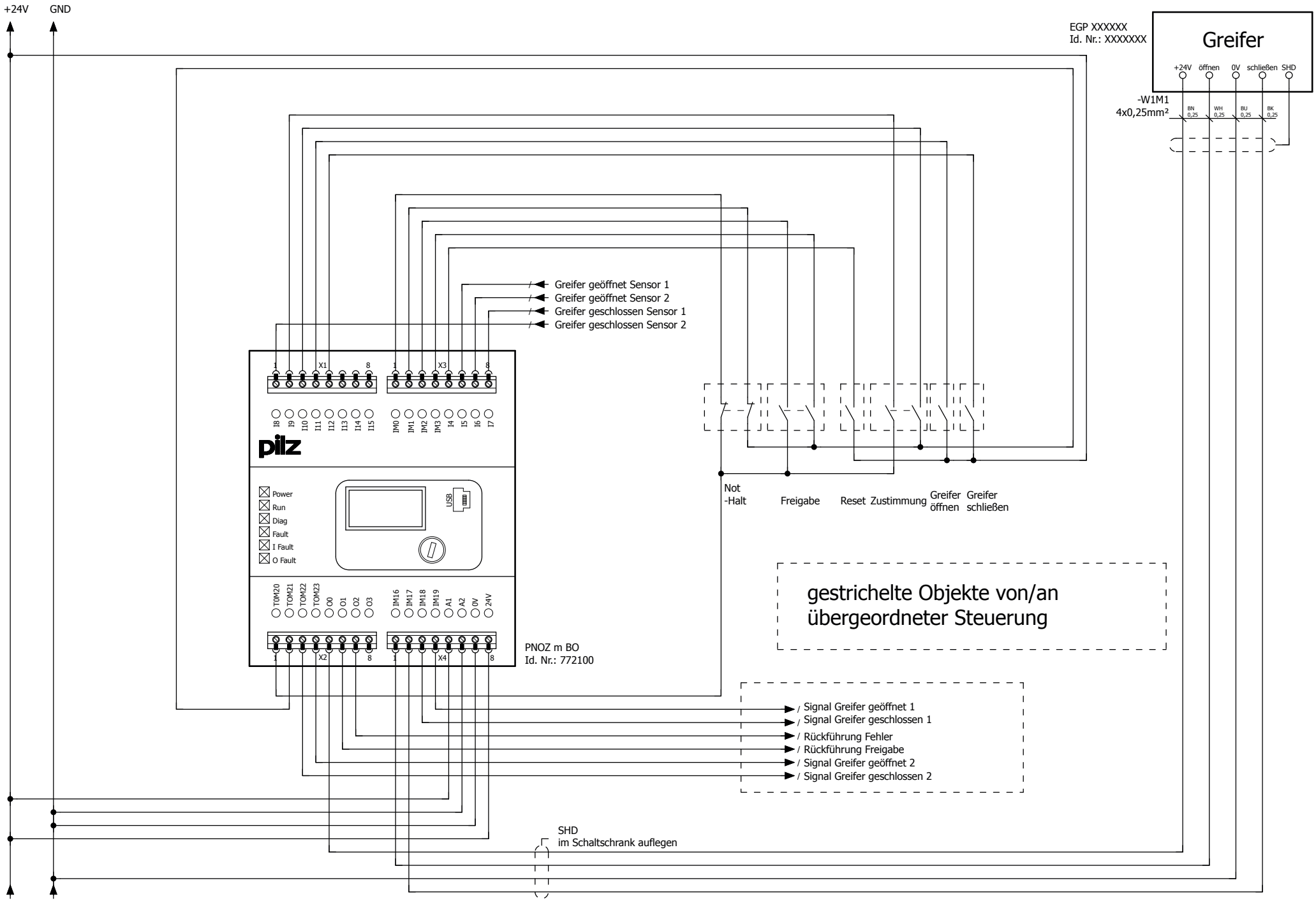
_____

Date of the check: Name of the checker: Signature:

_____ _____ _____

6 Appendix

Further information



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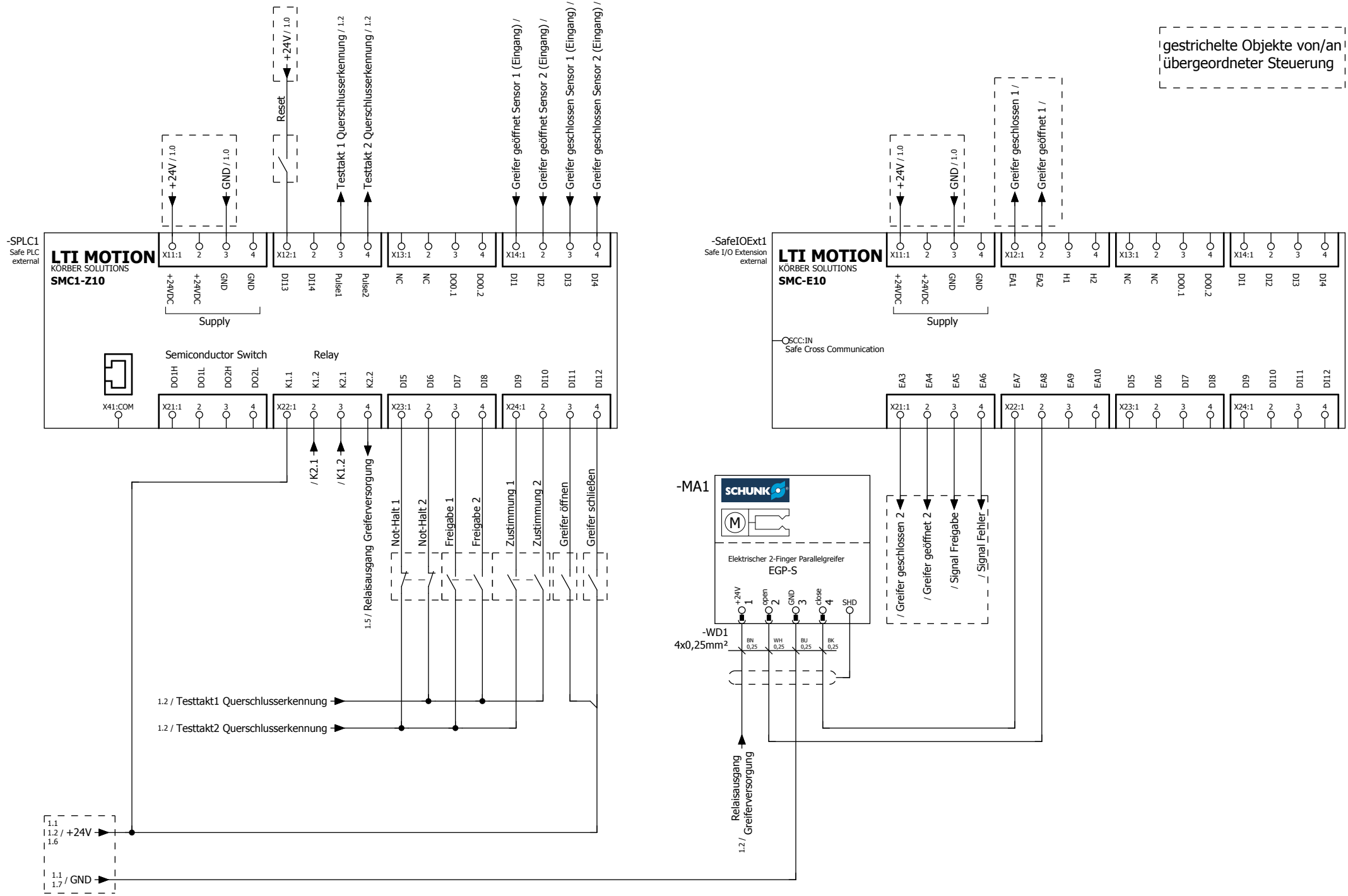

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