

SIRIUS 3RA6 Reversing Starter with AS-i Mounting Module Local Safety Shutdown at SIL 1 acc. to IEC 62061 / PL c acc. to EN ISO 13849-1:2006

SIRIUS

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Question

How can I use the local inputs of the AS-i mounting module of the 3RA6 reversing starter?

What safety category can be achieved with the local inputs of the AS-i mounting module?

Answer

One example is the monitoring of the limit position of a conveyor belt.

SIL 1 according to IEC 62061 resp. PL c according to EN ISO 13849-1:2006 (in the following ISO 13849-1) can be achieved.

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1 Introduction

Based on the functional safety standards IEC 62061 and ISO 13849-1 it is possible to perform a qualitative and quantitative assessment of safety functions with non-safety-related (standard) components.

Examples of such non-safety-related (standard) components are the switching and protection devices of the SIRIUS Innovation series. These devices are frequently used in applications aimed at the protection of assets.

This FAQ describes how two position switches with a positively-opening contact can be monitored by using the local inputs of the AS-i mounting module, so as to initiate the safe shutdown of the 3RA6 at level SIL 1 according to IEC 62061 or PLC according to ISO 13849-1 or category 2 according to EN 954-1. Operation of the position switch will cause the 3RA6 compact feeder to disconnect. In this example, a drive unit will be shut down.

The machine under consideration uses a drive to move a lifting mechanism to two defined conveyor levels. The drive is controlled by means of a compact feeder type RA62 (reversing starter). The pick-up and place-down positions of the lifting unit are monitored in automatic mode with the help of proximity switches. These proximity switches are registered and analyzed by the SIMATIC controller. For the purpose of servicing and maintenance, the stop positions effective in automatic mode can be exceeded. In the setup mode, however, the upper and lower limit positions are monitored by mechanical position switches for the reason of machine safety. This disconnection at the end position of the lifting drive is then effected through direct analysis of the position switches at the local inputs of the AS-i mounting module. This direct shutdown becomes also effective when an incident occurs (e.g. failure of one proximity switch).

1.1 Notes regarding the S7 program

- The feedback information from the motor starter profile is analyzed non-safety-related and at cyclic intervals via AS-i in the SIMATIC S7 CPU.
- Due to the standardized process data of the motor starter profile for an AS-i slave, the upper and lower end positions of the operated position switches must be determined through logic analysis in SIMATIC.
- After analysis via the AS-i bus, the output for the deactivated direction of movement must be reset in the controller.
- Accordingly, the output for the opposite direction can be reset in the controller.
- Logic assignment of process data and process images:

| Compact feeder status | Inputs | | | | Outputs | |
|--|------------------------------------|----------|-------------|-----------------|---------------------------------|---------------------------------|
| | D0 | D1 | D2 | D3 | D0 | D1 |
| | Compact feeder ready for operation | Motor ON | Group fault | General warning | Motor "direction of rotation 1" | Motor "direction of rotation 2" |
| Normal mode | X | | | | | |
| AUX Power deactivated, undervoltage, overvoltage | | | X | | | |
| Output 1 (Motor ON) set via master | X | X | | | X | |
| Output 1 (Motor ON) set via master | X | X | | | | X |
| Overload | X | | X | X | | |
| Limit position switch open | X | | X | | | |

Note

The upper and lower end position of the operated position switches must be determined through logic analysis of the process image in SIMATIC, because:

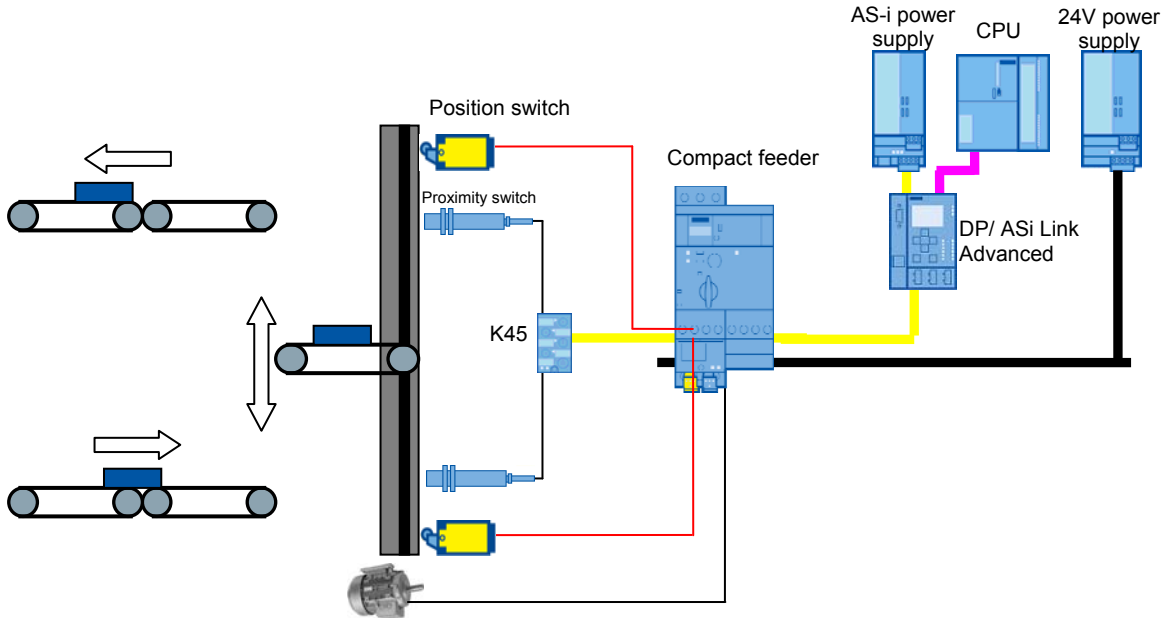
- the image is identical for both motor rotation directions
- the image is identical for the "open" states of both limit position switches.

1.2 Customer benefits

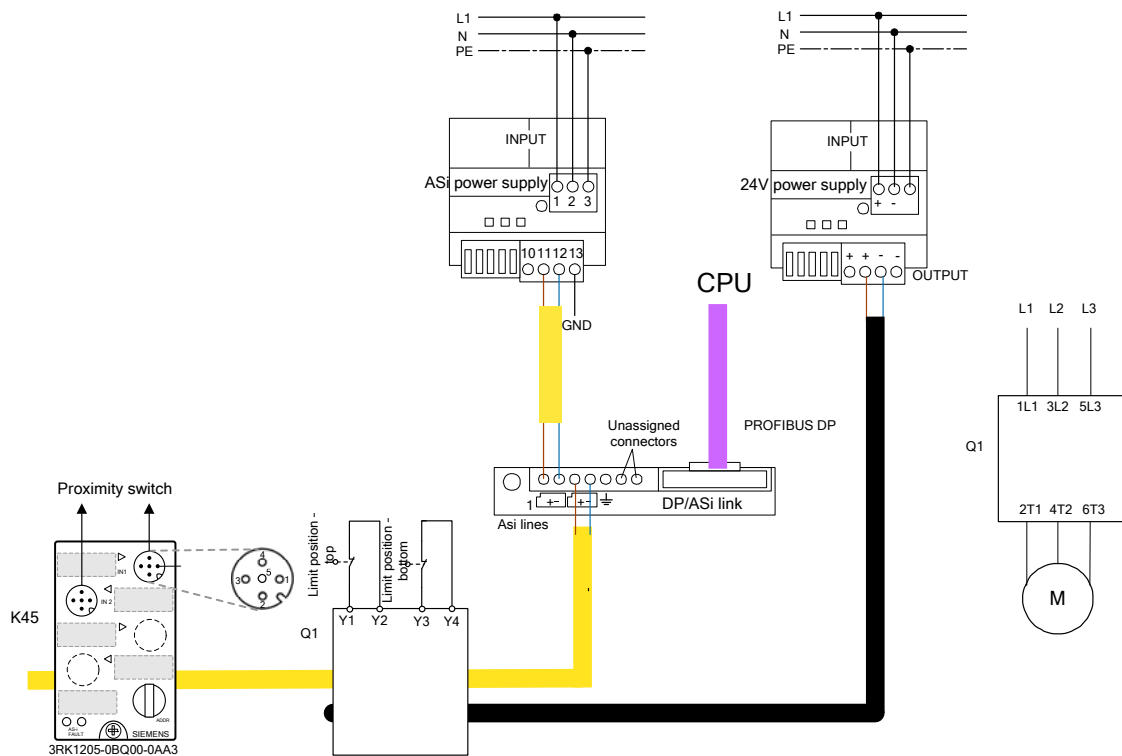
- The very simple wire connections secure machine protection for 2 limit positions
- Quick disconnection independently of bus and PLC cycle times
- Standstill in compliance with stop category 0 according to EN60204-1
- Saves time and money through quick installation and commissioning and very easy wiring
- Extremely durable, maintenance-free, robust and reliable
- Easy to retrofit and locally restricted "safety – control range"

2 Setup and Wiring

2.1 Hardware setup – overview



2.2 Wiring of the hardware components



3 Evaluation according to IEC 62061 and ISO 13849-1

3.1 Safety functions

Further considerations are based on the following safety function:

| safety function | |
|-----------------|--|
| SF 1 | The motor must be switched off when the position switch for clockwise rotation is actuated. |
| SF 2 | The motor must be switched off when the position switch for counterclockwise rotation is actuated. |

The safety function listed above is evaluated below according to the two standards IEC 62061 and ISO 13849-1.

The same components are involved in safety functions 1 and 2. Therefore, they are only evaluated once in this example.

3.2 Evaluation according to IEC 62061

Parameters for the calculation of PFH_D for "Detection" (position switch) and "Responding" (Compact Feeder)

| Parameter | Value | Reason | Definition |
|---|--|--|------------|
| B10 position switch Compact Feeder | 1 * 10 ⁶ 3 * 10 ⁶ | Manufacturer specifications | Siemens |
| Ratio of Dangerous Failures position switch Compact Feeder | 0,2 0,5 | Manufacturer specifications (20%) (50%) | |
| T1 Useful life time | 175.200h (20Jahre) | Manufacturer specifications | |
| C Number of actuations of position switch Number of actuations of Compact Feeder | 0,125/ h 10/ h | Assumptions: Actuated once per shift, every 8 hours. Actuation may take place every day of the year (365 days). Actuated 10 times per hour,. | User |
| DC Diagnostic Coverage | 0 (0%) | No fault reaction is initiated. (Worst case). | |

Evaluation Parameters

| | | Definition |
|-----------------|---|------------|
| Fault exclusion | based on the use of the local input for safety related switching off at 3RA6 | Siemens |

Summary

| | | IEC 62061 | |
|----------|---|--|--|
| | | SIL CL | PFH _D |
| Detect | 1 | Hardware Fault Tolerance: HFT = 0 Ratio of Dangerous Failures: SFF = 0 (0%) Use of proven components | 2.50 * 10 ⁻⁰⁹ Architecture: Basic subsystem architecture A |
| Evaluate | | Fault exclusion | |
| Respond | 1 | Hardware Fault Tolerance: HFT = 0 Safe Failure Fraction: SFF = 0 (0%) Use of proven components | 1.66 * 10 ⁻⁰⁷ Architecture: Basic subsystem architecture A |
| Result | 1 | SIL CL of all tasks of the supplementary safety function is at least 1. PFH _D (=1.69 * 10 ⁻⁰⁷) of the entire supplementary safety function fulfills the requirements of SIL1. | |

3.3 Evaluation according to ISO 13849-1

Parameters for the calculation of $MTTF_d$ for "Detection" (position switch) and "Responding" (Compact Feeder)

| Parameter | Value | Reason | Definition |
|---|------------------------------|---|------------|
| B10 position switch Compact Feeder | $1 * 10^6$ $3 * 10^6$ | Manufacturer specifications | Siemens |
| Ratio of Dangerous Failures position switch Compact Feeder | 0,2 0,5 | Manufacturer specifications (20%) (50%) | |
| d_{op} Mean operating time in days per year | 365 days per year | Assumptions: Actuation takes place every day of the year (365 days). | User |
| h_{op} Mean operating time in hours per day | 24 hours per day | | |
| t_{cycle} Mean time between the start of two consecutive cycles of the component position switch Compact Feeder | 8 h/cycle 0.1 h/cycle | Assumptions: There is an interval of 8 hours between each actuation (one shift). The Compact Starter is operated 10 times per hour. | |

Interim results (are identical in this example for position switch and compact Feeder):

| Interim results | | Reason |
|----------------------|--------------|---|
| $MTTF_d$ | high | $MTTF_d \geq 30$ years |
| DC | none | DC=0% |
| Measures against CCF | not relevant | |
| Category | 1 | System behavior: A single fault can result in the loss of the safety function |

Evaluation of Parameters

| | | Festlegung |
|-----------------|--|------------|
| Fault exclusion | based on the use of the local input for safety related switching off at 3RA6 | Siemens |

Summary

| ISO 13849-1 | | |
|-------------|----|---|
| | PL | Probability of dangerous failure per hour (PFH _D) |
| Detect | c | $1,14 * 10^{-06}$ (from Annex K; see note) |
| Evaluate | | Fault exclusion |
| Respond | c | $1,14 * 10^{-06}$ (from Annex K; see note) |
| Result | c | PL of all tasks of the supplementary safety function is at least c. |

Note: The $MTTF_d$ for each channel is limited to max. 100 years!

3.4 Summary

| | IEC 62061 | | ISO 13849-1 | |
|----------|-----------------|------------------|-----------------|---|
| | SIL CL | PFH _D | PL | Probability of dangerous failure per hour (PFH _D) |
| Detect | 1 | $1,2 * 10^{-09}$ | c | $1,14 * 10^{-06}$ |
| Evaluate | Fault exclusion | | Fault exclusion | |
| Respond | 1 | $4,5 * 10^{-10}$ | c | $1,14 * 10^{-06}$ |
| Result | SIL1 | | PL c | |

4 Literature

4.1 Literature

The following list is by no means complete and only provides a selection of related references.

Table 4-1

| | Source | Title |
|-----|----------------|--|
| \1\ | Brochure | Functional safety of Machines and Systems – Easy Implementation of the European Machinery Directive (Order no.: E20001-A230-M103-V1) |
| \2\ | Technical book | Patrick Gehlen Funktionale Sicherheit von Maschinen und Anlagen Umsetzung der Europäischen Maschinenrichtlinie in der Praxis (Publicis Corporate Publishing, ISBN: 978-3-89578-366-1) |

4.2 Internet links

The following list is by no means complete and only provides a selection of useful information.

Table 4-2

| | Subject | Title |
|-----|----------------------------------|---|
| \1\ | Reference to this document | http://support.automation.siemens.com/WW/view/en/45147736 |
| \2\ | Siemens I IA/DT Customer Support | http://support.automation.siemens.com |
| \3\ | Safety Evaluation Tool | http://www.siemens.de/safety-evaluation-tool |
| \4\ | Safety Integrated | http://www.siemens.com/safety-integrated |