Higher-level safe switch-off of the power supply of functionally non-safe standard modules

Wiring Examples

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens’ products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit [http://www.siemens.com/industrialsecurity](http://www.siemens.com/industrialsecurity).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit [http://support.industry.siemens.com](http://support.industry.siemens.com).

### Question

How can you implement higher-level safe switch-off of the power supply of functionally non-safe standard modules?

### Answer

The relevant SIMATIC standard output modules are listed on the HTML page. The associated wiring examples are in this document.
# Table of contents

1. Examples with 3TK28 ................................................................. 4
2. Examples with ET 200S PM-E F pm ................................................. 8
3. Examples with ET 200S PM-E F pp ............................................... 12
4. Example with ET 200SP F-PM-E pm ........................................... 15
5. Example with ET 200SP F-PM-E pp ............................................. 16
6. Example with ET 200SP and 3TK28 ............................................. 17
7. Example with 4F DO and 1F RO pm switching .............................. 18
8. Example with 4F DO and external safety relay pp switching .......... 21
9. Example with 4F DO and external safety relay pm switching .......... 23
10. Example with Voltage Divider .................................................. 25
11. Example with ET 200L Compact Device .................................... 26
12. Example with S7-300/400 standard DO .................................... 27
13. Requirements to be met for the application ............................... 28
  13.1 Limits of the higher-level safety circuit ................................. 28
  13.2 Requirements for the power supply ................................. 28
1 Examples with 3TK28

Example 1: Higher-Level Safety Circuit of the outputs with Safety Device 3TK28 (or similar Devices)

Figure 1-1

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

WARNING

Attend to the specified ampacity in the manual of the 3TK28. Do not exceed the ampacity.
Example 2: Higher-Level Safety Circuit of the outputs with Safety Device 3TK28 (or similar Devices)

Figure 1-2

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

![Diagram of a higher-level safety switch-off circuit with 3TK28]

WARNING

Attend to the specified ampacity in the manual of the 3TK28. Do not exceed the ampacity.

Higher-level safe switch-off
Entry-ID: 39198632, V1.7, 07/2015
Example 3: Higher-Level Safety Circuit of the outputs with Safety Device 3TK28 (or similar Devices)

Figure 1-3

WARNING
Attend to the specified ampacity in the manual of the 3TK28. Do not exceed the ampacity.
Example 4: Higher-Level Safety Circuit of the outputs with Safety Device 3TK28 (or similar Devices)

Figure 1-4

Warning:
Attend to the specified ampacity in the manual of the 3TK28. Do not exceed the ampacity.
2 Examples with ET 200S PM-E F pm

Example 1: Higher-Level Safety Circuit of the outputs with ET 200S PM-E F pm

Figure 2-1

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10
Example 2: Higher-Level Safety Circuit of the outputs with ET 200S PM-E F pm

Figure 2-2

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

Bus / Process

Backplane bus
IM 151

PM-E F pm
SIL2/PLd
PM-E F pm
SIL1/PLc

Electronic

DO
DO
AO
Relais-DO

PM
Electronic supply

M
Load voltage supply

24V DC

Electronic

Analog controlling element

24V
Example 3: Higher-Level Safety Circuit of the outputs with ET 200S Compact Device with PM-E F pm

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

Figure 2-3
Example 4: Higher-Level Safety Circuit of the outputs with ET 200S Compact Device with PM-E F pm

Figure 2-4
3 Examples with ET 200S PM-E F pp

Example 1: Higher-Level Safety Circuit of the outputs with ET 200S PM-E F pp

Figure 3-1

Electrical isolation by standard optocoupler respectivaly magnet coupler according to VDE 0884-10

WARNING
Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
Example 2: Higher-Level Safety Circuit of the outputs with ET 200S PM-E F pp

Figure 3-2

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

WARNING

Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
Example 3: Higher-Level Safety Circuit of the outputs with ET 200S PM-E F pp

Figure 3-3

**WARNING**

Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
4 Example with ET 200SP F-PM-E pm

Example 1: Higher-level safety circuit with F-PM-E pm switching

Figure 4-1

Note
SIL1/Cat.2/PLc and SIL2/Cat.3/PLd applications can also only be implemented jointly with an F-PM-E in one voltage segment.
5 Example with ET 200SP F-PM-E pp

Example 1: Higher-level safety circuit with F-PM-E pp switching

Figure 5-1

Note

SIL1/Cat.2/PLc and SIL2/Cat.3/PLd applications can also only be implemented jointly with an F-PM-E in one voltage segment.
6 Example with ET 200SP and 3TK28

Example 1: Higher-level safety circuit with fail-safe device 3TK28

Figure 6-1

Note

SIL1/Cat.2/PLc and SIL2/Cat.3/PLd applications can also only be implemented jointly with an F-PM-E in one voltage segment.
7 Example with 4F DO and 1F RO pm switching

Example 1: Higher-Level Safety Circuit with 4 F-DO and 1 F-RO

Figure 7-1

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0894-10
Example 2: Higher-Level Safety Circuit of the outputs with 4F DO and 1F RO pm switching

Figure 7-2

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10

Backplane bus IM 151

PM-E 4F-DO 1F-RO

24V DC

Load voltage supply 24V DC

ET200S

Bus / Process

SIL2/PLd

SIL1/PLc

DO DI/DO AO

Electronic

Electronic

Electronic

Analyzer controlling element
Example 3: Higher-Level Safety Circuit of the outputs with 4F DO and 1F RO pm switching

Figure 7-3

Safety shutdown possible:
- X3 & Q6
- X4 & Q7

Electronic supply
24V DC

ET200S

Backplane bus

Electronic isolated
safety shutdown possible

not isolated
safety shutdown not possible

ET200ecoPN

PROFnet

Electronic IL+ supply
24V DC

P1

P2

X1

X2

X3

X4

OUT

IN

2M

Load supply

not isolated
safety shutdown not possible

M

24V DC

P

M

P

M

8 DO DC 24V/1,3A 4+M12

Entry-ID: 39198632, V1.7, 07/2015
Example 1: Higher-Level Safety Circuit of the outputs with 4F DO and external safety relay pp switching

Figure 8-1

Electrical isolation by standard optocoupler respectivaly magnet coupler according to VDE 0884-10

WARNING
Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
Example 2: Higher-Level Safety Circuit of the outputs with 4F DO and external safety relay pp switching

WARNING

Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
Example 1: Higher-Level Safety Circuit of the outputs with 4F DO and external safety relay pm switching

Figure 9-1

Electrical isolation by standard optocoupler respectively magnet coupler according to VDE 0884-10
Example 2: Higher-Level Safety Circuit of the outputs with 4F DO and external safety relay pm switching

Figure 9-2
10 Example with Voltage Divider

Example: Higher-Level Safety Circuit of the outputs over voltage divider

Figure 10-1
WARNING

Due to the PP switch-off, you must make sure that the complete wiring from the PP switch via the all standard DO channels in the switch-off group to the actuator are protected against short-circuits to the P potential.
12 Example with S7-300/400 standard DO

Higher-Level Safety Circuit of the outputs with S7-300/400 standard DO

This chapter shows an example with S7-400. But applies analogously to S7-300.

Figure 12-1

Electrical isolation by standard optocoupler respectivaly magnet coupler according to VDE 0884-10

Only valid for S7-400 modules: A separate shutdown of the potential groups is not possible (only all 4 potential groups (L1+…L4+) together).
13 Requirements to be met for the application

13.1 Limits of the higher-level safety circuit

Since safety-critical errors in the standard DOs cannot be discovered in the module through self-tests, "diagnostics" has to be done indirectly via the controlled process. The safety controller does not react as long as the incorrectly controlled process remains harmless. It triggers a switch-off only if the process does something unwanted or becomes potentially dangerous.

Thus, the error reaction times for errors in the standard DOs depend on the process being controlled and evaluation of its feedback and not on the S7's specified short error detection times.

The safety process data must

[1.] Be functionally safe.
[2.] Be read in via fail-safe input modules (e.g. F DI).
[3.] Be processed by the fail-safe CPU for output commands.
[4.a] Be output by the fail-safe output module for controlling the associated safety relay or
[4.b] Be output by the fail-safe power module PM-E F.

If the expected behavior is not fulfilled by the process side (either because of a process error or because of defective standard DOs), the standard DOs are to brought into a safe status by the higher-level safety circuit.

In particular, you must take the error tolerance time of the process into account here. A possibly incorrectly controlled process is of no danger during this error tolerance time.

13.2 Requirements for the power supply

For operation, you need a fail-safe power supply to master overvoltages at P and M (24V). This also masters any possible common cause errors on the power supply side.

This power supply must be SELV / PELV. Therefore, the maximum output voltage is \( U_{m} = 60 \text{ V DC} \), and you must provide 3.75 kV as test voltage for the safe isolation.

All other circuits connected must be SELV / PELV. All the M signals must be connected with each other to prevent differences of potential.