SINAMICS S120/S110, SIMOTION D4xx

Connection of F-DIs to F-DOs

Connection of the F-DIs of SINAMICS/SIMOTION with F-DOs of various SIEMENS components

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Preliminary remark

Using various examples, these "Frequently Asked Questions" (FAQ) on the subject of "Safety Integrated" show how to control the drive-integrated safety functions (basic and extended functions) of the SINAMICS S120/S110 as well as the SIMOTION D410/D4x5 by means of fail-safe digital outputs (F-DOs) of various SIEMENS components.

Various examples of the wiring between fail-safe inputs (F-DIs) of SINAMICS/SIMOTION and fail-safe digital outputs of various SIEMENS components are presented.

The terminals of the CU305, the CU310, the CU320, the TM54F, the D410, the D4x5 and the motor modules (EP terminal) are used as F-DIs of the SINAMICS/SIMOTION. The F-DOs of the following components are considered: SIMATIC ET200M, ET200S, ET200pro, the modular safety system (MSS) 3RK3 Basic as well as the SIRIUS 3TK2842 safety relay.

The document structure is arranged according to the various SIMOTION/SINAMICS components. For this reason, information is repeated at various places. It is sufficient to read the relevant chapter for the SIMOTION/SINAMICS component.

General attention should be drawn here to the possibility of controlling the safety functions via PROFIsafe. This variant has many advantages: All the safety functions on the individual drives can be controlled separately. All the safety status signals of the drives are also available on the fail-safe controller via the safety status word. Furthermore, the amount of wiring and the required number of fail-safe modules is reduced. As of version V2.6 SP2 (SINAMICS S120) and V4.1 SP4 (SIMOTION), the STO/SS1/SBC basic functions can also be controlled via PROFIsafe without a license or a safety-capable encoder being required.

Important note

These FAQ have been compiled carefully, but do not claim to be complete in respect of configuration, equipment or any type of contingency. These FAQ do not represent specific customer solutions, but are only intended to provide support for typical problems. The user is responsible for the correct operation of the products described.

These FAQ do not relieve you of the obligation to use the products safely during application, installation, operation and maintenance. By using these FAQ, you agree that Siemens cannot be made liable for possible damage beyond the liability clause described below. We reserve the right to make changes and revisions to these FAQ at all times without prior notice. For deviations between the recommendations in this document and other Siemens publications, such as manuals, then the contents of the other documentation have priority.

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1 Warranty conditions, liability, and support

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2 The formulation of the question

What must be taken into account for the control of the drive-integrated safety functions of the SINAMICS S110/S120 and the SIMOTION D410/D4X5 via fail-safe digital outputs and how is the wiring carried out?

In this FAQ, the above question is answered using various examples.

As already mentioned in the preliminary remark, the document is arranged according to the various SINAMICS and SIMOTION components and shows examples with different fail-safe output modules of the SIEMENS product families: SIMATIC ET200S/M, SIRIUS MSS and SIRIUS 3TK28.

3 Examples for SINAMICS S120 with CU320

WARNING

In accordance with IEC 61131 Part 2, Section 5.2 (2008), only those outputs that have a maximum residual current of 0.5 mA in the "OFF" state may be used for the interconnection of the digital inputs of the CU320 and the EP terminal of the motor module (STO terminals) as well as the digital inputs of the TM54F with digital semiconductor outputs.

These FAQ also describe possibilities of interconnecting modules with a residual current greater than 0.5 mA through the use of additional components (relay module 1 F-RO, contact multiplier module 3TK2830 or a resistor) with the digital inputs mentioned above.

3.1 Control of the basic functions via terminals

This section describes the control of the basic functions via the permissible digital inputs of the CU320 (channel 1) and the EP terminal on the motor module (channel 2).

The wiring for the DI0 on the CU320 and the EP terminal X21 on a booksize single motor module is shown in the examples. Of course the other permissible DIs on the CU320 (DI0 to DI7 on X122 and X132) can also be used. With double motor modules, the EP terminal for the second axis is controlled via X22. On chassis units, the EP terminal is X41. If blocksize power modules are used with the CUA31 or CUA32, the connections of the motor module (EP terminal) are at X210 pins 3 and 4. The following examples demonstrate the wiring.

Further information on terminal assignment can be found in the documentation of the ET200S/M/pro components, the MSS, the SIRIUS 3TK284x safety relays as well as the various SINAMICS manuals.

The digital inputs of the CU320 and the EP terminal on the motor modules draw a very small current which is usually too low for the automatic open-circuit detection (wire break) of the F-DO modules of the ET200 range as well as the MSS. For this reason, a check should always be made whether the open-circuit detection (wire break) of the F-DO components has to be deactivated.

3.1.1 ET200S 4 F-DO (P/M switching) to CU320

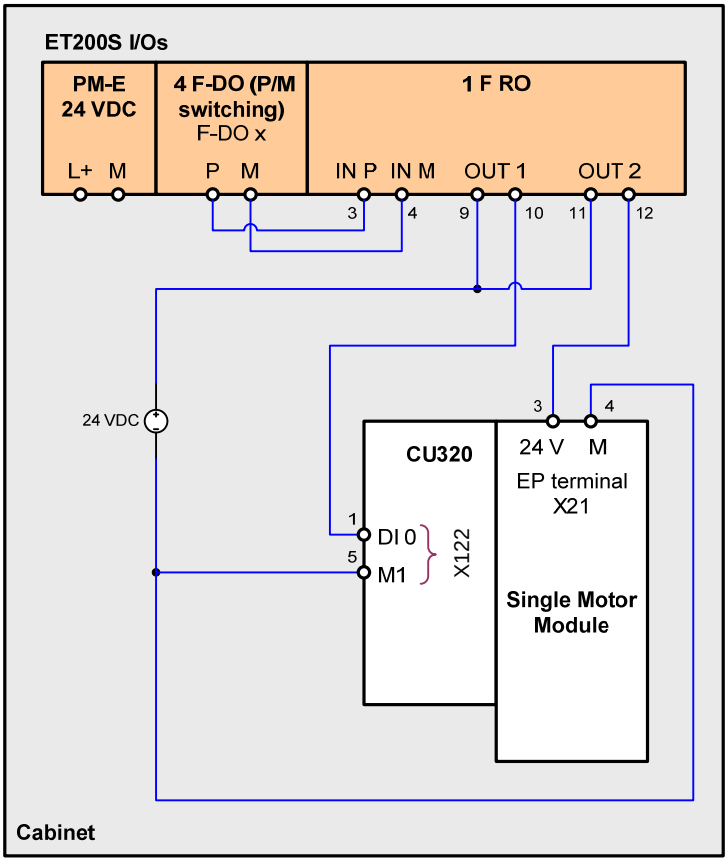


Figure 1: ET200S 4 F-DO (P/M switching) with 1 F-RO to CU320

The variant shown here should be used as **preferred** interconnection between the ET200S 4 F-DO (P/M switching) and SINAMICS. In this type of connection, no problems whatsoever occur with regard to the test pulses of the F-DO module. And for this reason, no adaptations have to be made to the SINAMICS. In addition, no measures have to be taken regarding residual currents, as they do not occur on the 1 F-RO module.

The 1F-RO module switches the outputs internally via two relays. Both relays have readback contacts that are provided via the process image of the controller in the form of a bit. This readback value must be used in the F-program to compare the control signal with the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

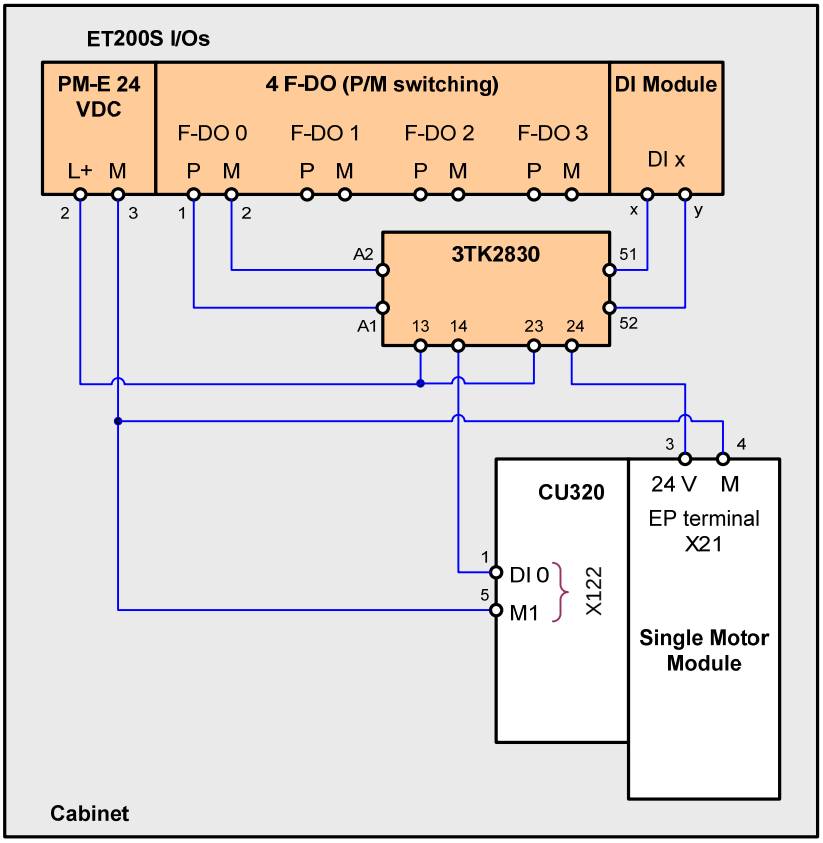


Figure 2: ET200S 4 F-DO (P/M switching) with 3TK2830 to CU320

The contact multiplier module from the 3TK28 series (3TK2830-1CB30 here) can also be used as an alternative to the 1 F-RO module. This module also offers the advantage that no measures need be taken with regard to the residual currents and the test pulses of the 4 F-DO module. The circuit described here should therefore also be considered as a preferred connection.

However, this module has no internal monitoring of the control state and the switching state of the outputs. For this reason, the outputs of the feedback circuit (contacts 51 and 52) must be read back via a digital input module (DI module) and supplied to the F-program. The comparison must then be made in the F-program between the control signal and the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

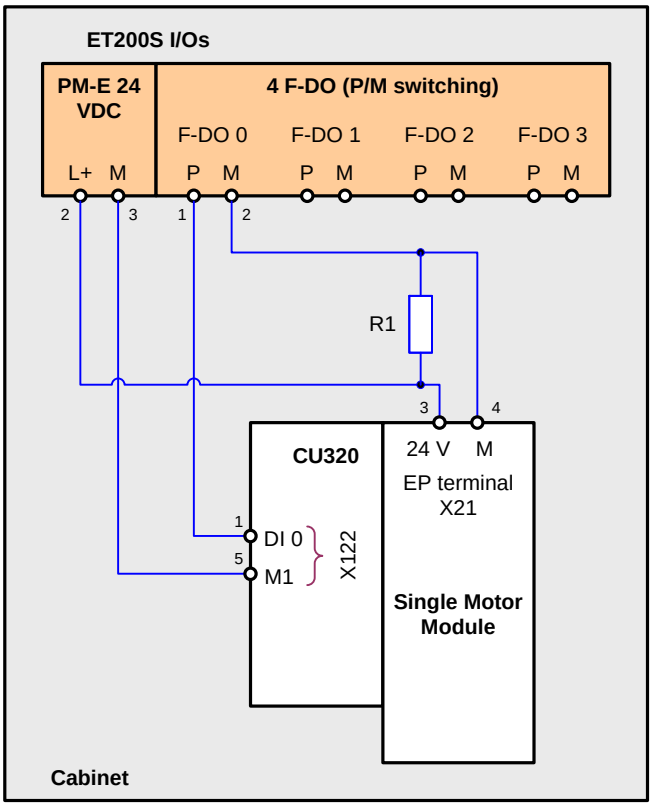


Figure 3: ET200S 4 F-DO (P/M switching) with resistor to CU320

This variant can also be used. However, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the EP terminal.

The maximum permissible residual current of the DIs of the SINAMICS is 0.5 mA. The residual current of the ET200S 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 4 mA at the M channel. The maximum permissible voltage at the DIs of the CU320 and the motor modules at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{4mA} = 1.25k\Omega$$ e.g. R1 = $1.2k\Omega$ can be selected.

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1}$$. For R1 = $1.2k\Omega$, P = 0.69 W.

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

Furthermore, the test pulses (light or dark test) are applied directly at the DIs of the SINAMICS components. The dark test pulses (temporary deactivation with logical 1 on the F-DO) with a duration of <1 ms do not present a problem. The light tests (temporary activation with logical 0 on the F-DO) can take up to 4 ms. The EP terminal of the motor module is scanned every 1 ms and detects this test pulse. In the default setting, the digital inputs on the CU320 are scanned every 4 ms; i.e. this pulse is not detected there.

This does not present a problem when only the STO function is being used (with or without SBC), as usually the associated discrepancy time is significantly greater. However, if the SS1 function is used, discrepancy errors occur. This is because a pulse starts the SS1 timer which may then no longer be stopped (requirement of Stop category 1 in accordance with EN 60204-1). The timers are compared when the discrepancy time has expired. As the timer has only been started on one channel, a discrepancy error occurs. To prevent this, suitable parameter settings must be made to ensure that the test pulse is detected on both channels. The sampling time of the digital inputs on the CU320 must therefore be reduced. The following setting must be made:

p0799 (on CU) = 2 ms.

Also note that the test pulses on the different channels (P and M) of the F-DOs are switched at different times. The time difference may be up to 0.8 s. For this reason, the discrepancy time must be increased as follows:

p9650 = p9850 >= 900 ms.

3.1.2 ET200pro 4/8 F-DI / 4 F-DO (P/M switching) to CU320

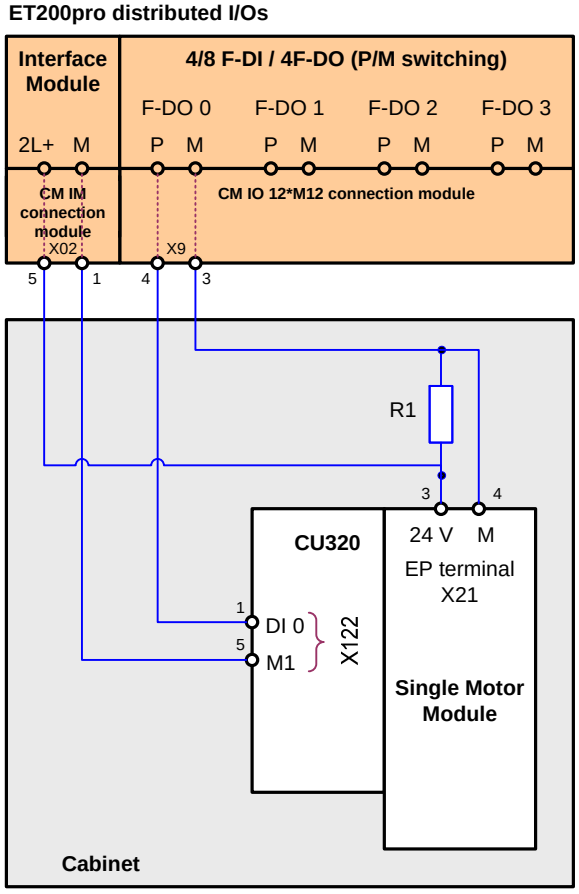


Figure 4: ET200pro 4/8 F-DI / 4 F-DO (P/M switching) with resistor to CU320

With this control, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the EP terminal.

The maximum permissible residual current of the DIs of the SINAMICS is 0.5 mA. The residual current of the ET200pro 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 1.0 mA at the M channel. The maximum permissible voltage at the DIs of the CU320 and the motor modules at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{1mA} = 5k\Omega \text{ e.g. } R1 = 4.7k\Omega \text{ can be selected.}$$

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1}. \text{ For } R1 = 4.7k\Omega, P = 177 \text{ mW}.$$

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

The test pulses for the light and dark test are in a range less than 1 ms and therefore do not require special parameter settings on the SINAMICS.

3.1.3 ET200M 8 F-DO (P/M switching) to CU320

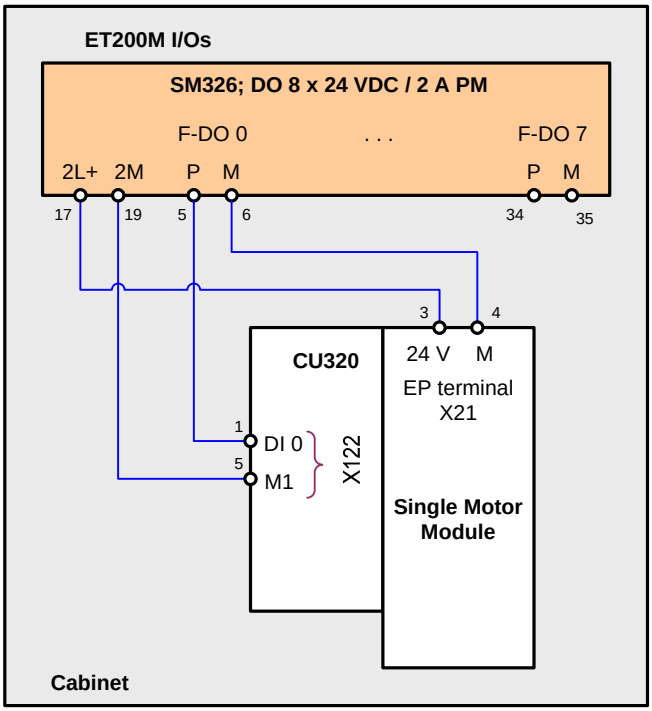


Figure 5: ET200M SM326; DO 8 x 24 VDC / 2 A PM to CU320

The residual currents of the F-DOs of the ET200M 8 F-DO component are maximum 0.5 mA for both the P and the M channel. These values are tolerated by the DIs of the SINAMICS, i.e. no special wiring is required here for a direct connection.

With regard to the test pulses, the P/M switching ET200M F-DO module behaves exactly the same as the 4 F-DO module of the ET200S, i.e. the test pulses (light or dark test) are also applied directly at the DIs of the SINAMICS components. The dark test pulses (temporary deactivation with logical 1 on the F-DO) with a duration of <1 ms do not present a problem. The light tests (temporary activation with logical 0 on the F-DO) can take up to 4 ms. The EP terminal of the motor module is scanned every 1 ms and detects this test pulse. In the default setting however, the digital inputs on the CU320 are scanned every 4 ms; i.e. this pulse is not detected there.

This does not present a problem when only the STO function is being used (with or without SBC), as usually the associated discrepancy time is significantly greater. However, if the SS1 function is used, discrepancy errors occur. This is because a pulse starts the SS1 timer which may then no longer

be stopped (requirement of Stop category 1 in accordance with EN 60204-1). The timers are compared when the discrepancy time has expired. As the timer has only been started on one channel, a discrepancy error occurs. To prevent this, suitable parameter settings must be made to ensure that the test pulse is detected on both channels. The sampling time of the digital inputs on the CU320 must therefore be reduced. The following setting must be made:

p0799 (on CU) = 2 ms.

Also note that the test pulses on the different channels (P and M) of the F-DOs are switched at different times. The time difference may be up to 1.6 s. For this reason, the discrepancy time must be increased as follows:

p9650 = p9850 >= 1700 ms.

3.1.4 ET200M 10 F-DO (P/P switching) to CU320

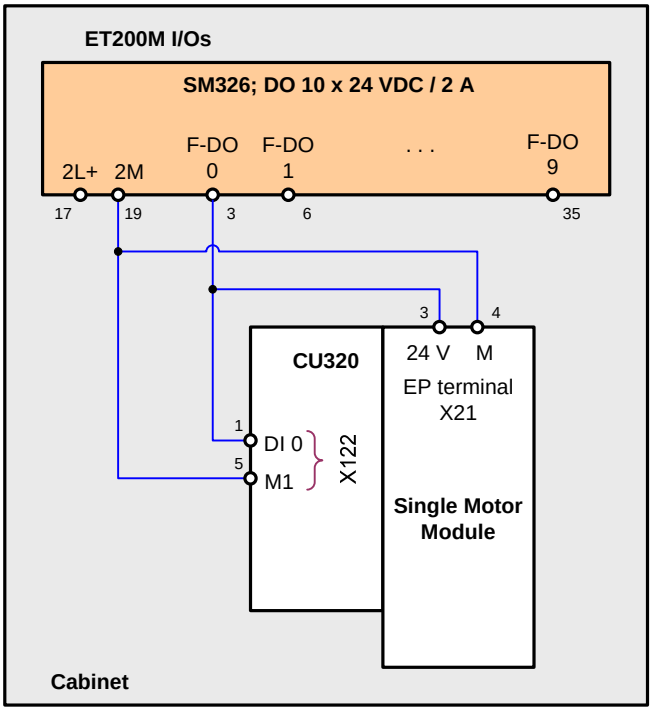


Figure 6: ET200M SM326; DO 10 x 24 VDC / 2 A to CU320

With this F-DO module, the individual F-DOs only have a P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (2M) for five outputs.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the CU320 (channel 1) and the EP terminal on the motor module (channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the light and dark test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

3.1.5 MSS 3RK3 Basic central module to CU320

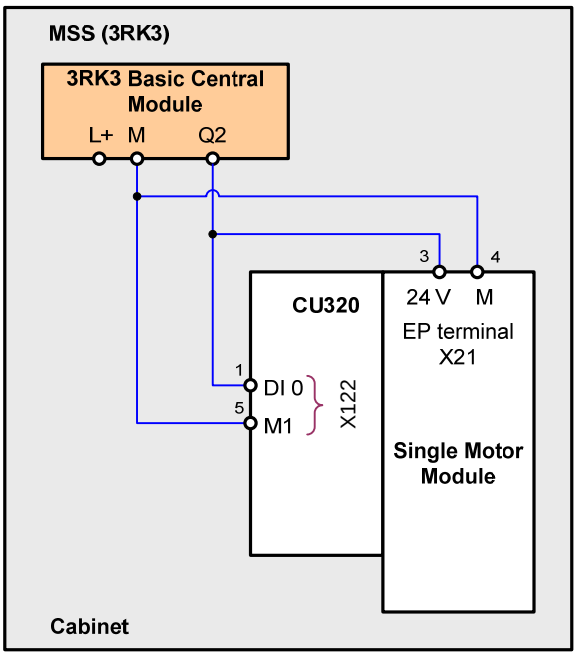


Figure 7: MSS 3RK3 Basic central module to CU320

In this example, the P/P-switching semiconductor output of the MSS Basic central module is used for the control of the safety functions on the SINAMICS. This only has one P output which is doubly connected internally to two semiconductor switches. The M connection is available centrally at the M terminal.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the CU320 (channel 1) and the EP terminal on the motor module (channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the dark test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

3.1.6 SIRIUS 3TK2842 safety relay to CU320

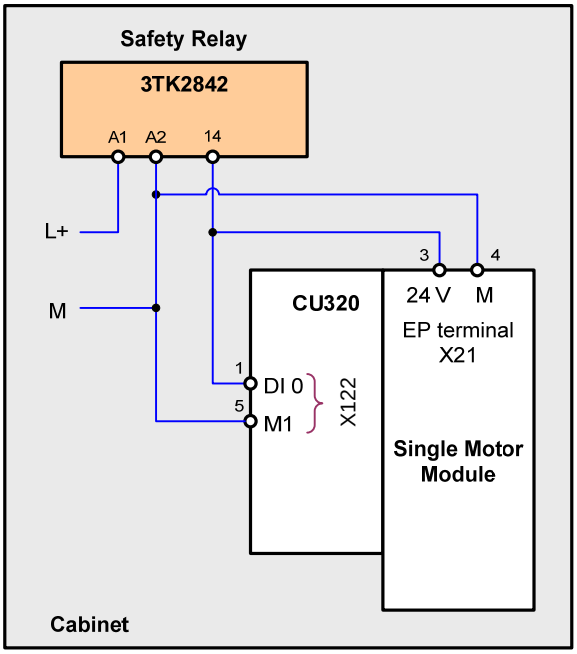


Figure 8: SIRIUS 3TK2842 safety relay to CU320

The 3TK2842 example shows how the safety functions are controlled via the safe electronic outputs of the SIRIUS safety relays. The instantaneous output at terminal 14 is used in the example. The delayed output (terminal 28) can also be used as an alternative. The F-DOs only have one P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (A2).

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the CU320 (channel 1) and the EP terminal on the motor module (channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the dark test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

3.2 Control of the extended safety functions via the TM54F

The extended safety functions can be controlled via the PROFIsafe message frame or the fail-safe TM54F terminal module. This section describes the control of the fail-safe digital inputs (F-DI) of the TM54F via the various F-DO modules of the SIMATIC family, the MSS as well as the SIRIUS 3TK284x safety relays.

Prerequisite for these wiring examples is the use of the TM54F with the following product version (or later):
6SL3055-0AA00-3BA0 Version B.

The wiring for the F-DI0 on terminal X521 of the TM54F is shown in the examples. Of course the other permissible F-DIs (F-DI0 to F-DI9 on X521, X522, X531 and X532) can also be used. In all the examples, the F-DIs of the TM54F should be parameterized as "NC/NC contacts" in the STARTER or SCOUT project.

Further information on terminal assignment can be found in the documentation of the ET200S/M/pro components, the MSS, the SIRIUS 3TK284x safety relays as well as the various SINAMICS manuals.

The digital inputs of the TM54F draw a very small current which is usually too low for the automatic open-circuit detection (wire break) of the F-DO modules of the ET200 range as well as the MSS. For this reason, a check should always be made whether the open-circuit detection (wire break) of the F-DO components has to be deactivated.

The test pulses for the light and dark test of the F-DO modules are not critical for the TM54F, i.e. no parameter adaptations are required here.

3.2.1 ET200S 4 F-DO (P/M switching) to TM54F

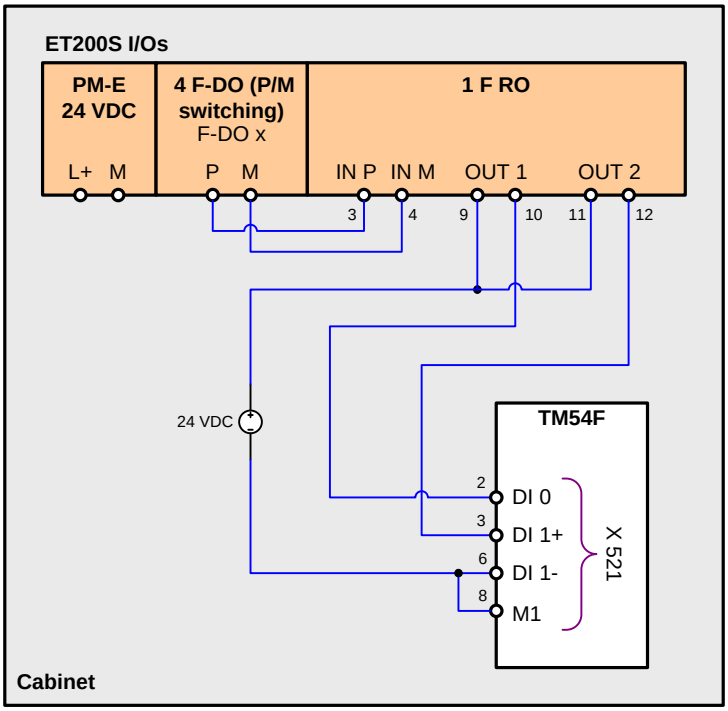


Figure 9: ET200S 4 F-DO (P/M switching) with 1 F-RO to TM54F

The variant shown here should be used as **preferred** interconnection between the ET200S 4 F-DO (P/M switching) and TM54F. With this type of connection no measures have to be taken regarding residual currents, as they do not occur on the 1 F-RO module.

The 1F-RO module switches the outputs internally via two relays. Both relays have readback contacts that are provided via the process image of the controller in the form of a bit. This readback value must be used in the F-program to compare the control signal with the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

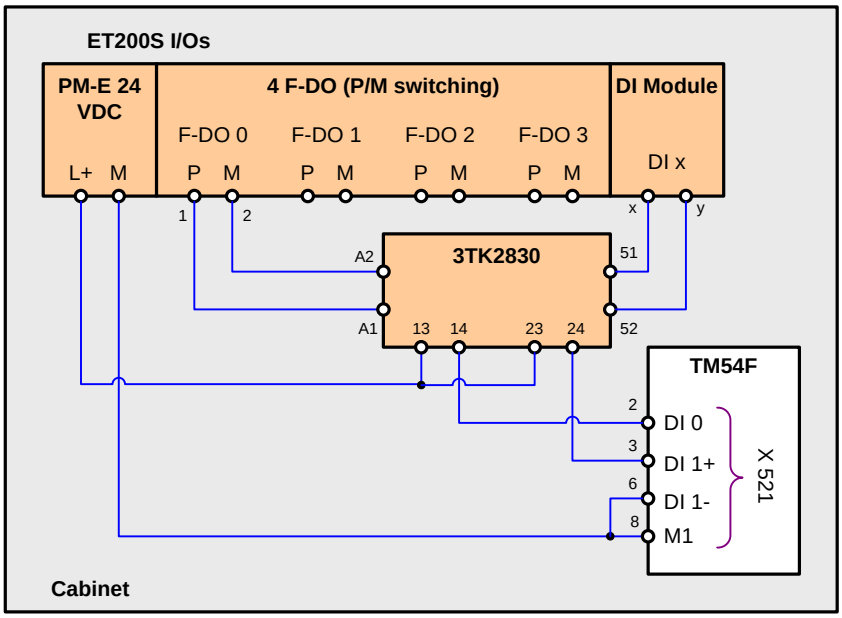


Figure 10: ET200S 4 F-DO (P/M switching) with 3TK2830 to TM54F

The contact multiplier module from the 3TK28 series (3TK2830-1CB30 here) can also be used as an alternative to the 1 F-RO module. This module also offers the advantage that no measures need be taken with regard to the residual currents. The circuit described here should therefore also be considered as a preferred connection.

However, this module has no internal monitoring of the control state and the switching state of the outputs. For this reason, the outputs of the feedback circuit (contacts 51 and 52) must be read back via a digital input module (DI module) and supplied to the F-program. The comparison must then be made in the F-program between the control signal and the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

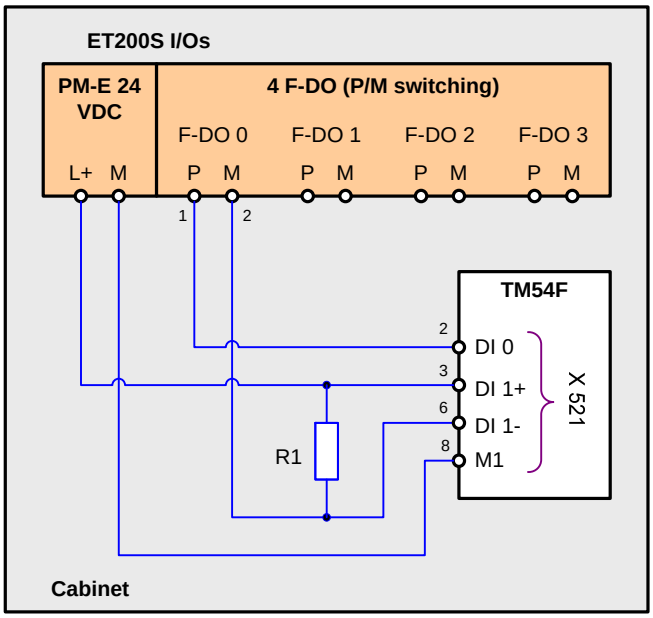


Figure 11: ET200S 4 F-DO (P/M switching) with resistor to TM54F

This variant can also be used. However, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the DI 1- terminal.

The maximum permissible residual current of the F-DIs of the TM54F is 0.5 mA. The residual current of the ET200S 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 4 mA at the M channel. The maximum permissible voltage at the DIs of the TM54F at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{4mA} = 1.25k\Omega$$ e.g. R1 = $1.2k\Omega$ can be selected.

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1}$$. For R1 = $1.2k\Omega$, P = 0.69 W.

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

3.2.2 ET200pro 4/8 F-DI / 4 F-DO (P/M switching) to TM54F

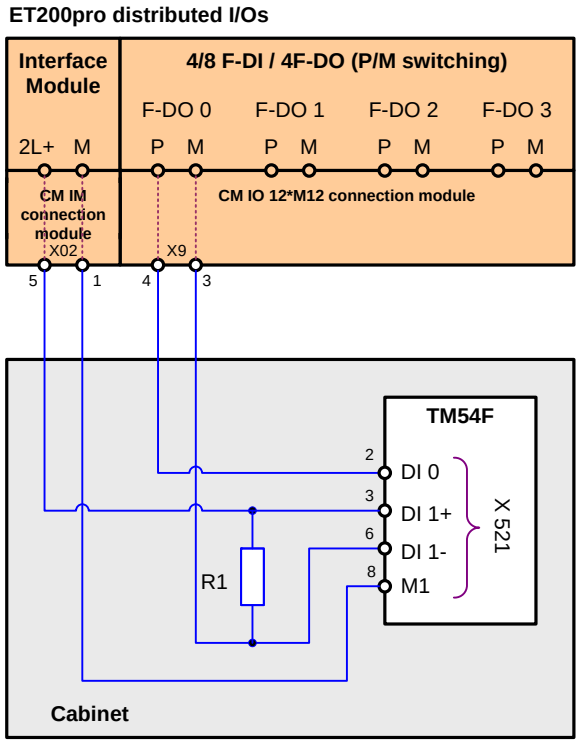


Figure 12: ET200pro 4/8 F-DI / 4 F-DO (P/M switching) with resistor to TM54F

With this control, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the DI 1- terminal.

The maximum permissible residual current of the DIs of the TM54F is 0.5 mA. The residual current of the ET200pro 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 1.0 mA at the M channel. The maximum permissible voltage at the DIs of the TM54F at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{1mA} = 5k\Omega \text{ e.g. } R1 = 4.7k\Omega \text{ can be selected.}$$

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1}. \text{ For } R1 = 4.7k\Omega, P = 177 \text{ mW}.$$

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

3.2.3 ET200M 8 F-DO (P/M switching) to TM54F

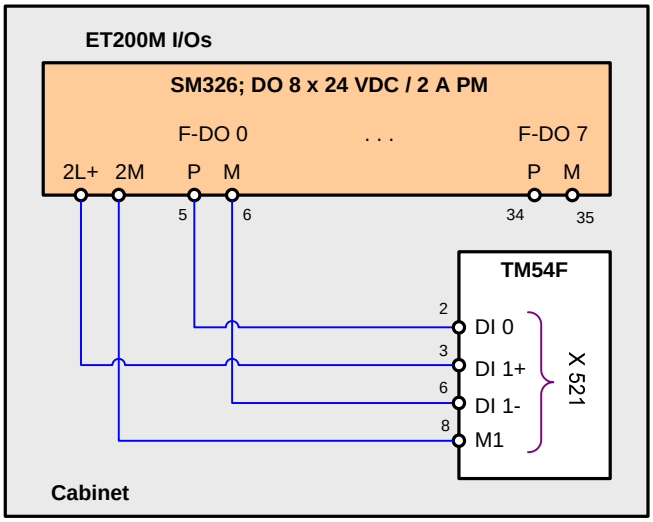


Figure 13: ET200M SM326; DO 8 x 24 VDC / 2 A PM to TM54F

The residual currents of the F-DOs of the ET200M 8 F-DO component are maximum 0.5 mA for both the P and the M channel. These values are tolerated by the DIs of the TM54F, i.e. no special wiring is required here for a direct connection.

3.2.4 ET200M 10 F-DO (P/P switching) to TM54F

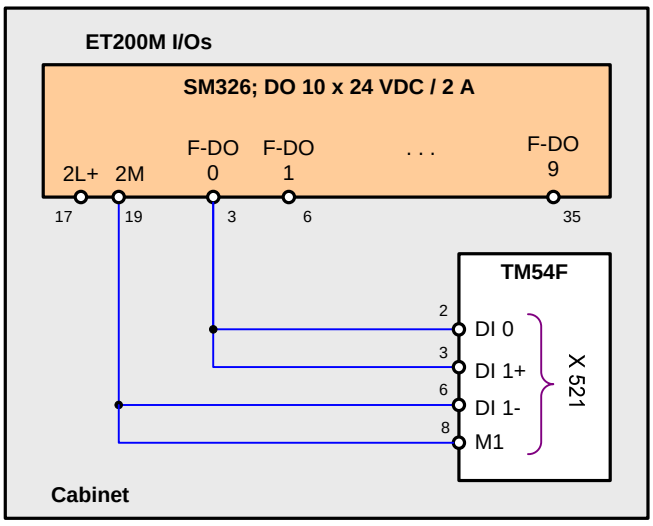


Figure 14: ET200M SM326; DO 10 x 24 VDC / 2 A to TM54F

With this F-DO module, the individual F-DOs only have a P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (2M) for five outputs.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the TM54F may be connected to one F-DO. If there is no wiring

with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the TM54F. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

3.2.5 MSS 3RK3 Basic central module to TM54F

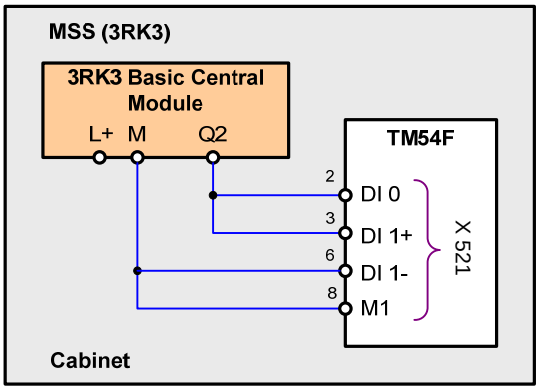


Figure 15: MSS 3RK3 Basic central module to TM54F

In this example, the P/P-switching semiconductor output of the MSS Basic central module is used for the control of the F-DI0 of the TM54F. This only has one P output which is doubly connected internally to two semiconductor switches. The M connection is available centrally at the M terminal.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the TM54F may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the TM54F. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

3.2.6 SIRIUS 3TK2842 safety relay to TM54F

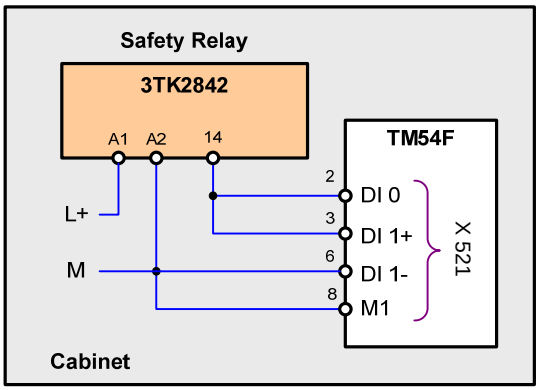


Figure 16: SIRIUS 3TK2842 safety relay to TM54F

The 3TK2842 example shows how the safety functions are controlled via the safe electronic outputs of the SIRIUS safety relays. The instantaneous output at terminal 14 is used in the example. The delayed output (terminal 28) can also be used as an alternative. The F-DOs only have one P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (A2).

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the TM54F may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the TM54F. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

4 Examples for SINAMICS S120 with CU310

Warning

In accordance with IEC 61131 Part 2, Section 5.2 (2008), only those outputs that have a maximum residual current of 0.5 mA in the "OFF" state may be used for the interconnection of the digital inputs of the CU310 and the EP terminal (STO terminals) as well as the digital inputs of the TM54F with digital semiconductor outputs.

These FAQ also describe possibilities of interconnecting modules with a residual current greater than 0.5 mA through the use of additional components (relay module 1 F-RO, contact multiplier module 3TK2830 or a resistor) with the digital inputs mentioned above.

4.1 Control of the basic functions via terminals

This section describes the control of the basic functions via the permissible digital inputs of the CU310 (channel 1) and the EP terminal of the power module (channel 2).

The wiring for the DI0 (on X121) and the EP terminal (on X120) is shown in the examples. Of course the other permissible DIs on the CU310 (DI0 to DI3 on X121) can also be used.

Further information on terminal assignment can be found in the documentation of the ET200S/M/pro components, the MSS, the SIRIUS 3TK284x safety relays as well as the various SINAMICS manuals.

The digital inputs of the CU310 and the EP terminal draw a very small current which is usually too low for the automatic open-circuit detection (wire break) of the F-DO modules of the ET200 range as well as the MSS. For this reason, a check should always be made whether the open-circuit detection (wire break) of the F-DO components has to be deactivated.

4.1.1 ET200S 4 F-DO (P/M switching) to CU310

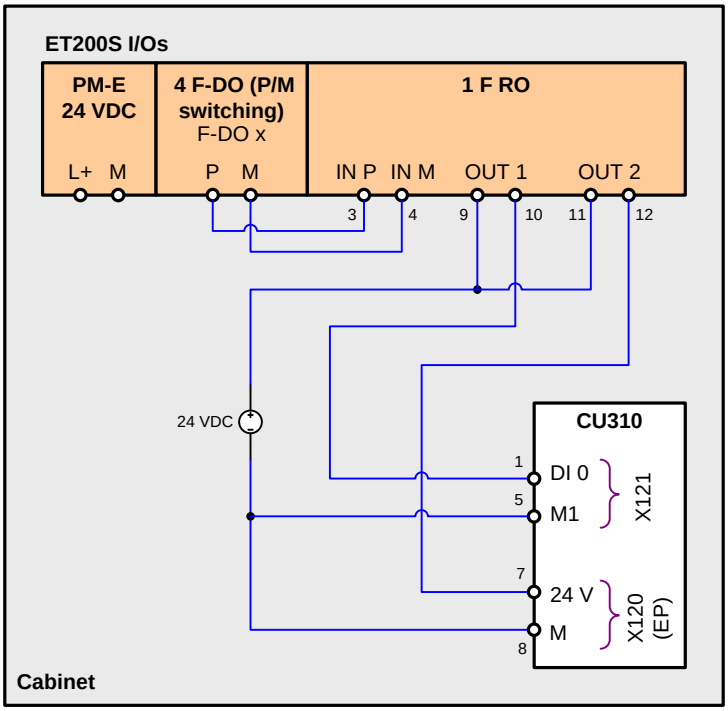


Figure 17: ET200S 4 F-DO (P/M switching) with 1 F-RO to CU310

The variant shown here should be used as **preferred** interconnection between the ET200S 4 F-DO (P/M switching) and SINAMICS. In this type of connection, no problems whatsoever occur with regard to the test pulses of the F-DO module. And for this reason, no adaptations have to be made to the SINAMICS. In addition, no measures have to be taken regarding residual currents, as they do not occur on the 1 F-RO module.

The 1F-RO module switches the outputs internally via two relays. Both relays have readback contacts that are provided via the process image of the controller in the form of a bit. This readback value must be used in the F-program to compare the control signal with the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

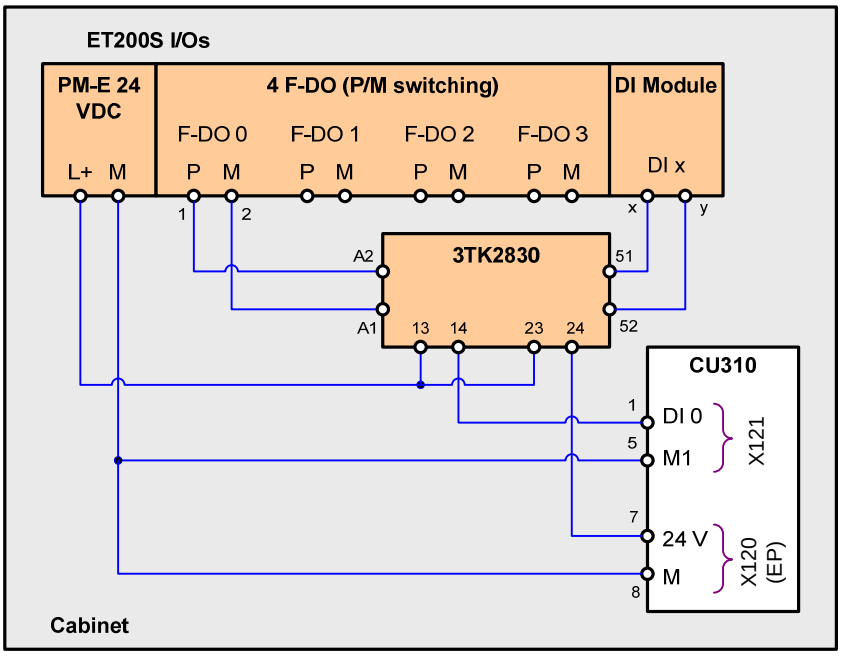


Figure 18: ET200S 4 F-DO (P/M switching) with 3TK2830 to CU310

The contact multiplier module from the 3TK28 series (3TK2830-1CB30 here) can also be used as an alternative to the 1 F-RO module. This module also offers the advantage that no measures need be taken with regard to the residual currents and the test pulses of the 4 F-DO module. The circuit described here should therefore also be considered as a preferred connection.

However, this module has no internal monitoring of the control state and the switching state of the outputs. For this reason, the outputs of the feedback circuit (contacts 51 and 52) must be read back via a digital input module (DI module) and supplied to the F-program. The comparison must then be made in the F-program between the control signal and the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

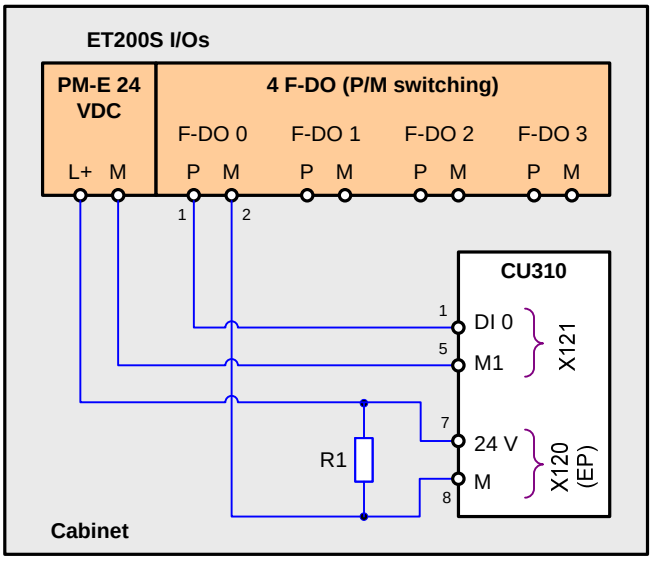


Figure 19: ET200S 4 F-DO (P/M switching) with resistor to CU310

This variant can also be used. However, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the EP terminal.

The maximum permissible residual current of the DIs of the SINAMICS is 0.5 mA. The residual current of the ET200S 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 4 mA at the M channel. The maximum permissible voltage at the DIs or the EP terminal of the CU310 at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{4mA} = 1.25k\Omega$$ e.g. R1 = $1.2k\Omega$ can be selected.

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1}$$. For R1 = $1.2k\Omega$, P = 0.69 W.

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

Furthermore, the test pulses (light or dark test) are applied directly at the DIs of the SINAMICS components. The dark test pulses (temporary deactivation with logical 1 on the F-DO) with a duration of <1 ms do not present a problem. The light tests (temporary activation with logical 0 on the F-DO) can take up to 4 ms. The EP terminal is scanned every 1 ms and detects this test pulse. In the default setting, the digital inputs on the CU310 are scanned every 4 ms; i.e. this pulse is not detected there.

This does not present a problem when only the STO function is being used (with or without SBC), as usually the associated discrepancy time is significantly greater. However, if the SS1 function is used, discrepancy errors occur. This is because a pulse starts the SS1 timer which may then no longer be stopped (requirement of Stop category 1 in accordance with EN 60204-1). The timers are compared when the discrepancy time has expired. As the timer has only been started on one channel, a discrepancy error occurs. To prevent this, suitable parameter settings must be made to ensure that the test pulse is detected on both channels. The sampling time of the digital inputs on the CU310 must therefore be reduced. The following setting must be made:

p0799 (on CU) = 2 ms.

Also note that the test pulses on the different channels (P and M) of the F-DOs are switched at different times. The time difference may be up to 0.8 s. For this reason, the discrepancy time must be increased as follows:

p9650 = p9850 >= 900 ms.

4.1.2 ET200pro 4/8 F-DI / 4 F-DO (P/M switching) to CU310

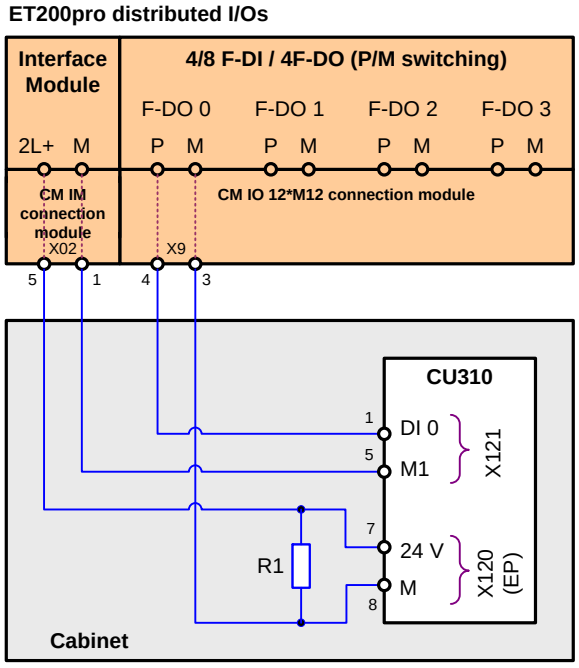


Figure 20: ET200pro 4/8 F-DI / 4 F-DO (P/M switching) with resistor to CU310

With this control, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the EP terminal.

The maximum permissible residual current of the DIs of the SINAMICS is 0.5 mA. The residual current of the ET200pro 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up

to 1.0 mA at the M channel. The maximum permissible voltage at the DIs of the CU310 and the motor modules at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{1mA} = 5k\Omega \text{ e.g. R1 = } 4.7k\Omega \text{ can be selected.}$$

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1} \text{. For R1 = } 4.7k\Omega \text{, P = 177 mW.}$$

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

The test pulses for the light and dark test are in a range less than 1 ms and therefore do not require special parameter settings on the SINAMICS.

4.1.3 ET200M 8 F-DO (P/M switching) to CU310

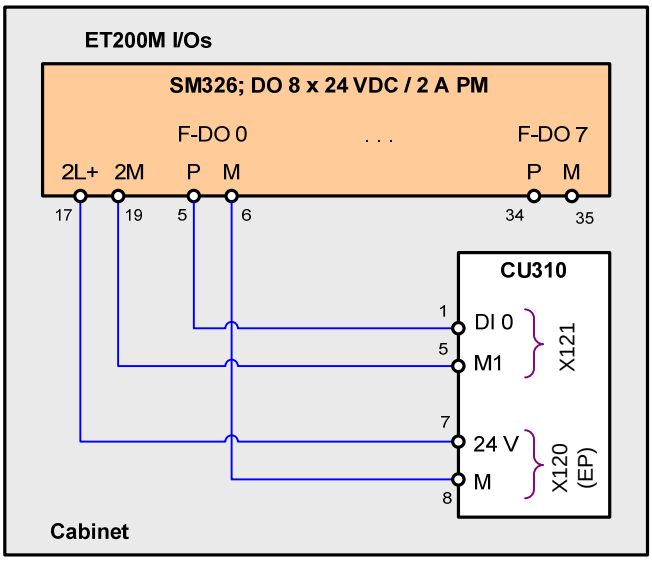


Figure 21: ET200M SM326; DO 8 x 24 VDC / 2 A PM to CU310

The residual currents of the F-DOs of the ET200M 8 F-DO component are maximum 0.5 mA for both the P and the M channel. These values are tolerated by the DIs of the SINAMICS, i.e. no special wiring is required here for a direct connection.

With regard to the test pulses, the P/M switching ET200M F-DO module behaves exactly the same as the 4 F-DO module of the ET200S, i.e. the test pulses (light or dark test) are also applied directly at the DIs of the SINAMICS components. The dark test pulses (temporary deactivation with

logical 1 on the F-DO) with a duration of <1 ms do not present a problem. The light tests (temporary activation with logical 0 on the F-DO) can take up to 4 ms. The EP terminal is scanned every 1 ms and detects this test pulse. In the default setting, the digital inputs on the CU310 are scanned every 4 ms; i.e. this pulse is not detected there.

This does not present a problem when only the STO function is being used (with or without SBC), as usually the associated discrepancy time is significantly greater. However, if the SS1 function is used, discrepancy errors occur. This is because a pulse starts the SS1 timer which may then no longer be stopped (requirement of Stop category 1 in accordance with EN 60204-1). The timers are compared when the discrepancy time has expired. As the timer has only been started on one channel, a discrepancy error occurs. To prevent this, suitable parameter settings must be made to ensure that the test pulse is detected on both channels. The sampling time of the digital inputs on the CU310 must therefore be reduced. The following setting must be made:

p0799 (on CU) = 2 ms.

Also note that the test pulses on the different channels (P and M) of the F-DOs are switched at different times. The time difference may be up to 1.6 s. For this reason, the discrepancy time must be increased as follows:

p9650 = p9850 >= 1700 ms.

4.1.4 ET200M 10 F-DO (P/P switching) to CU310

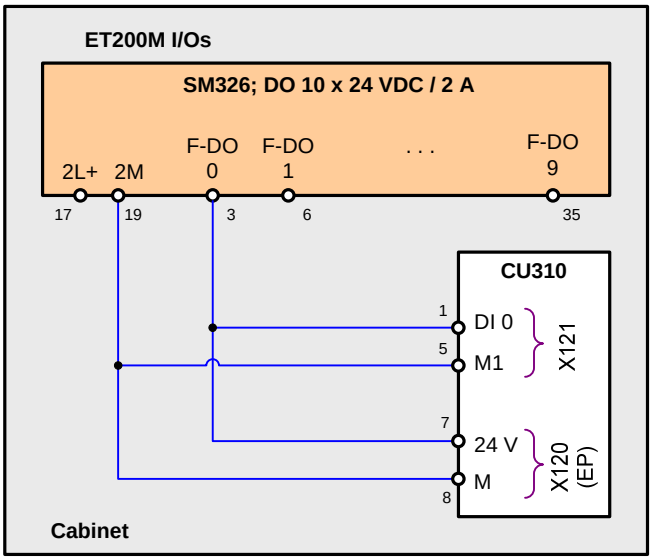


Figure 22: ET200M SM326; DO 10 x 24 VDC / 2 A to CU310

With this F-DO module, the individual F-DOs only have a P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (2M) for five outputs.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the

CU310 (at X121; channel 1) and the EP terminal on the power module (at X120; channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the light and dark test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

4.1.5 MSS 3RK3 Basic central module to CU310

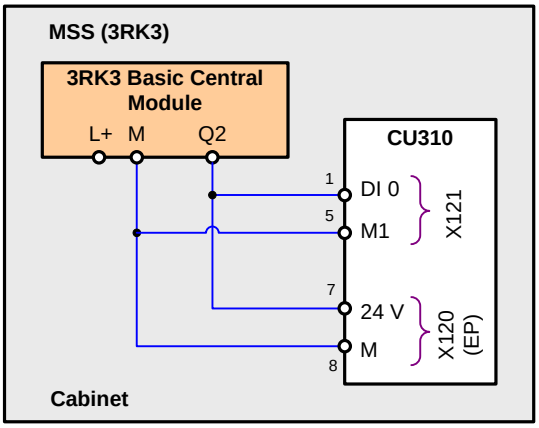


Figure 23: MSS 3RK3 Basic central module to CU310

In this example, the P/P-switching semiconductor output of the MSS Basic central module is used for the control of the safety functions on the SINAMICS. This only has one P output which is doubly connected internally to two semiconductor switches. The M connection is available centrally at the M terminal.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the CU310 (at X121; channel 1) and the EP terminal on the power module (at X120; channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the light test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

4.1.6 SIRIUS 3TK2842 safety relay to CU310

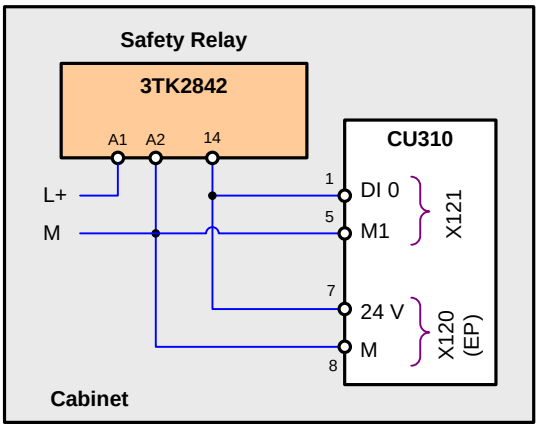


Figure 24: SIRIUS 3TK2842 safety relay to CU310

The 3TK2842 example shows how the safety functions are controlled via the safe electronic outputs of the SIRIUS safety relays. The instantaneous output at terminal 14 is used in the example. The delayed output (terminal 28) can also be used as an alternative. The F-DOs only have one P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (A2).

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both the DI of the CU310 (at X121; channel 1) and the EP terminal on the power module (at X120; channel 2) may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the SINAMICS S120. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

The test pulses for the dark test are also less than 1 ms and therefore special parameter settings on the SINAMICS are not required.

4.2 Control of the extended safety functions via the TM54F

The extended safety functions are also controlled via the PROFIsafe message frame or the TM54F with the CU310.

Prerequisite for these wiring examples is the use of the TM54F with the following product version (or later):
6SL3055-0AA00-3BA0 Version B.

The control via the TM54F is identical for the CU310 to that of the CU320. I.e. the corresponding examples can be found in Section 3.2.

5 Examples for SINAMICS S110 (CU305)

WARNING

In accordance with IEC 61131 Part 2, Section 5.2 (2008), only those outputs that have a maximum residual current of 0.5 mA in the "OFF" state may be used for the interconnection of the digital inputs of the CU305 with digital semiconductor outputs.

These FAQ also describe possibilities of interconnecting modules with a residual current greater than 0.5 mA through the use of additional components (relay module 1 F-RO, contact multiplier module 3TK2830 or a resistor) with the digital inputs mentioned above.

The SINAMICS S110 (CU305) has three fail-safe digital inputs that can be used for the control of the safety functions (basic and extended). A TM54F cannot be connected to this converter. Therefore, no distinction must be made between the basic functions and the extended functions with regard to the wiring.

The wiring for the F-DI0 (on X130) is shown in the examples. Of course the F-DI1 (also on X130) and the F-DI2 (on X131) can also be used. However, note that the control of the basic functions (STO/SS1/SBC) must always be via F-DI0.

Further information on terminal assignment can be found in the documentation of the ET200S/M/pro components, the MSS, the SIRIUS 3TK284x safety relays as well as the various SINAMICS manuals.

The F-DIs of the CU305 draw a very small current which is usually too low for the automatic open-circuit detection (wire break) of the F-DO modules of the ET200 range as well as the MSS. For this reason, a check should always be made whether the open-circuit detection (wire break) of the F-DO components has to be deactivated.

The test pulses for the light and dark test of the F-DO modules are not critical for the CU305, i.e. no parameter adaptations are required here.

5.1 ET200S 4 F-DO (P/M switching) to CU305

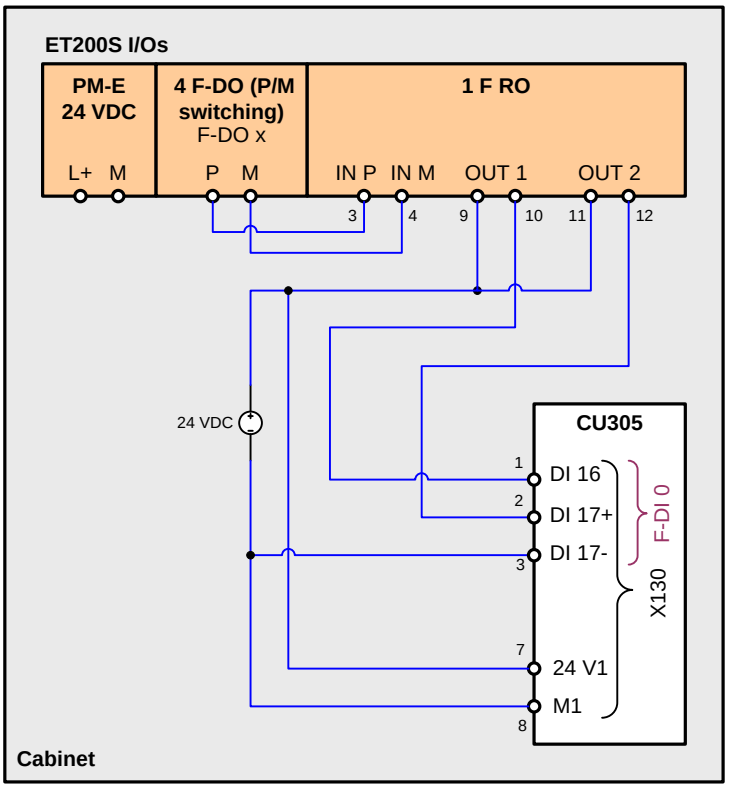


Figure 25: ET200S 4 F-DO (P/M switching) with 1 F-RO to CU305

The variant shown here should be used as **preferred** interconnection between the ET200S 4 F-DO (P/M switching) and SINAMICS. No measures have to be taken here regarding residual currents, as they do not occur on the 1 F-RO module.

The 1F-RO module switches the outputs internally via two relays. Both relays have readback contacts that are provided via the process image of the controller in the form of a bit. This readback value must be used in the F-program to compare the control signal with the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

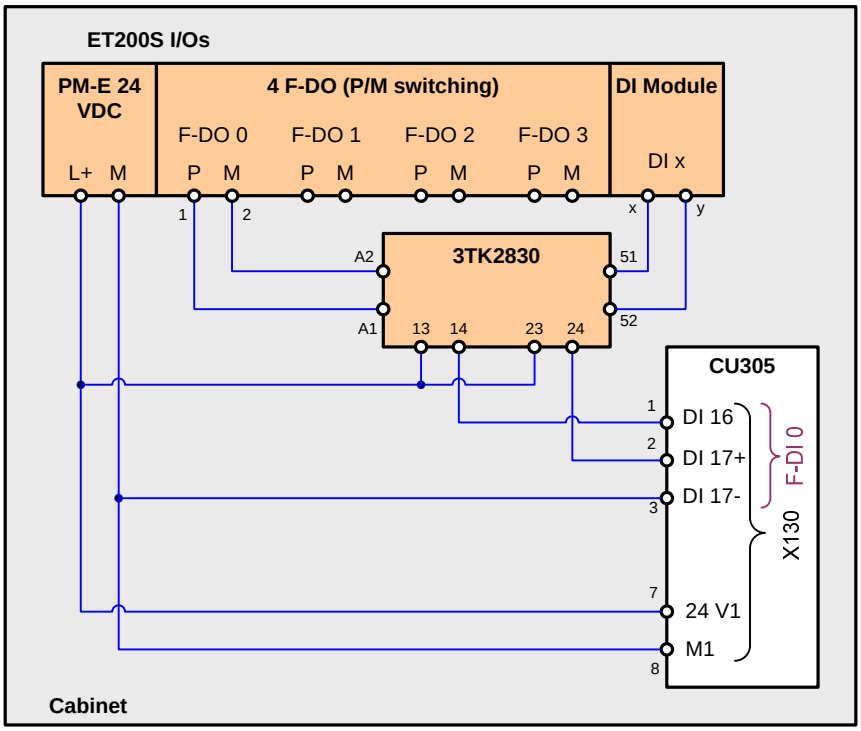


Figure 26: ET200S 4 F-DO (P/M switching) with 3TK2830 to CU305

The contact multiplier module from the 3TK28 series (3TK2830-1CB30 here) can also be used as an alternative to the 1 F-RO module. This module also offers the advantage that no measures need be taken with regard to the residual currents. The circuit described here should therefore also be considered as a preferred connection.

However, this module has no internal monitoring of the control state and the switching state of the outputs. For this reason, the outputs of the feedback circuit (contacts 51 and 52) must be read back via a digital input module (DI module) and supplied to the F-program. The comparison must then be made in the F-program between the control signal and the switching state in order to diagnose any deviations (e.g. through the sticking together of contacts) and to react appropriately.

Note:
The configuration of the monitoring of the control state and the readback value as well as the response to a deviation is the responsibility of the user.

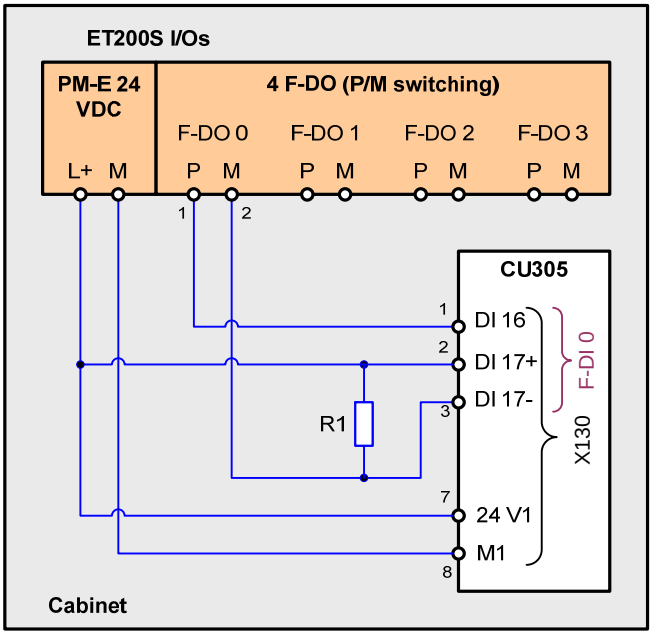


Figure 27: ET200S 4 F-DO (P/M switching) with resistor to CU305

This variant can also be used. However, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the DI 17- terminal.

The maximum permissible residual current of the F-DIs of the CU305 is 0.5 mA. The residual current of the ET200S 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 4 mA at the M channel. The maximum permissible voltage at the F-DIs of the CU305 at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$R1 \leq \frac{5V}{4mA} = 1.25k\Omega$ e.g. R1 = $1.2k\Omega$ can be selected.

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$P = \frac{(28.8V)^2}{R1}$. For R1 = $1.2k\Omega$, P = 0.69 W.

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

5.2 ET200pro 4/8 F-DI / 4 F-DO (P/M switching) to CU305

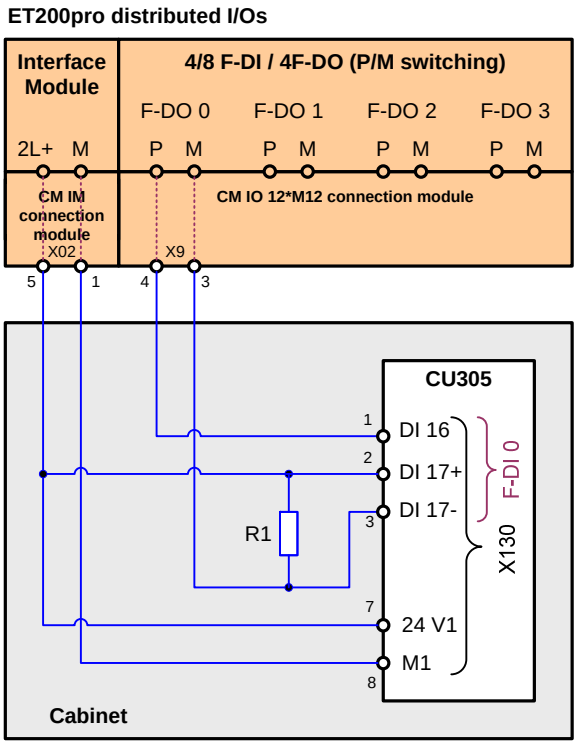


Figure 28: ET200pro 4/8 F-DI / 4 F-DO (P/M switching) with resistor to CU305

With this control, a resistor (R1) must be provided for the M channel of the F-DOs to ensure that the level for logical zero is maintained at the DI 17- terminal.

The maximum permissible residual current of the F-DIs of the CU305 is 0.5 mA. The residual current of the ET200pro 4 F-DO (PM) is maximum 0.5 mA at the P channel, i.e. a resistor is not required here. However, this is up to 1.0 mA at the M channel. The maximum permissible voltage at the DIs of the CU305 at which a LOW level is detected is 5 V. The internal resistance of the DIs is sufficiently high and can be neglected in the following calculation. Therefore, there may be a maximum voltage drop of 5 V at R1, i.e. the following applies for R1:

$$R1 \leq \frac{5V}{1mA} = 5k\Omega \text{ e.g. R1 = } 4.7k\Omega \text{ can be selected.}$$

The power loss at this resistor at constantly applied max. plus tolerance (20%) of non-stabilized power supplies is:

$$P = \frac{(28.8V)^2}{R1} \text{. For R1 = } 4.7k\Omega \text{, P = 177 mW.}$$

The resistor R1 is to be permanently dimensioned for this power loss. If a controlled power supply is used (e.g. SITOP), the max. plus tolerance of the output voltage is 3%. Consequently, there is also less power loss at the resistor.

5.3 ET200M 8 F-DO (P/M switching) to CU305

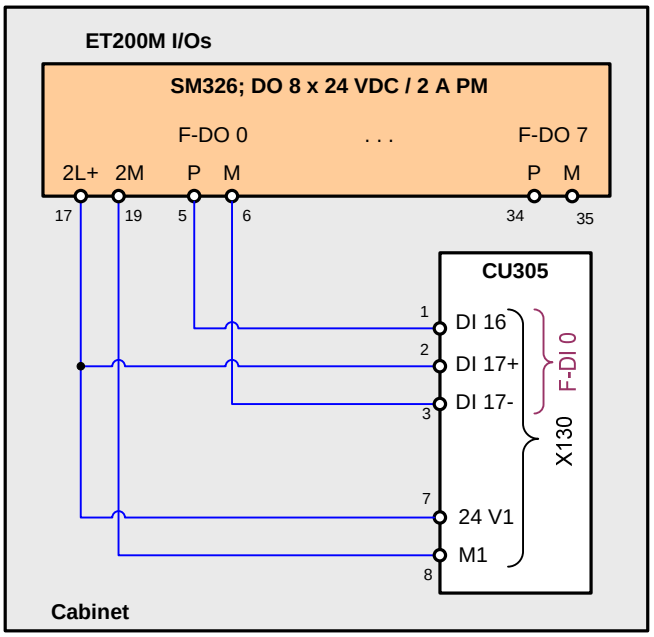


Figure 29: ET200M SM326; DO 8 x 24 VDC / 2 A PM to CU305

The residual currents of the F-DOs of the ET200M 8 F-DO component are maximum 0.5 mA for both the P and the M channel. These values are tolerated by the DIs of the CU305, i.e. no special wiring is required here for a direct connection.

5.4 ET200M 10 F-DO (P/P switching) to CU305

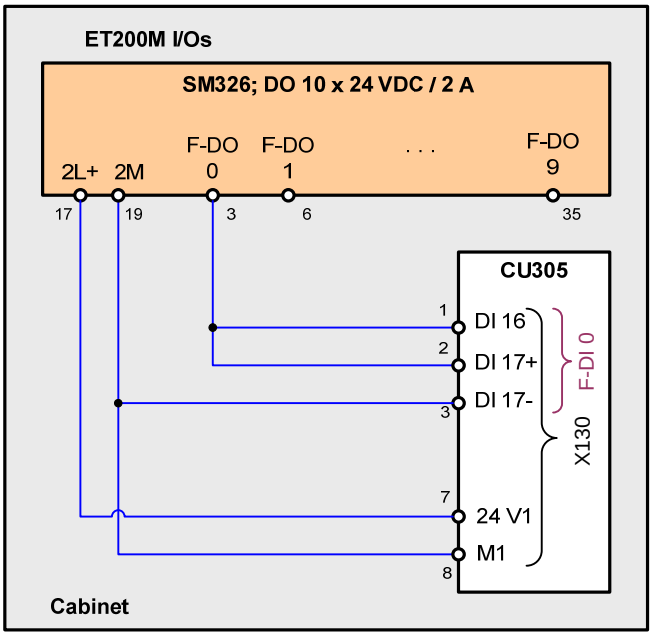


Figure 30: ET200M SM326; DO 10 x 24 VDC / 2 A to TM54F

With this F-DO module, the individual F-DOs only have a P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (2M) for five outputs.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the CU305 may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the CU305. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

5.5 MSS 3RK3 Basic central module to CU305

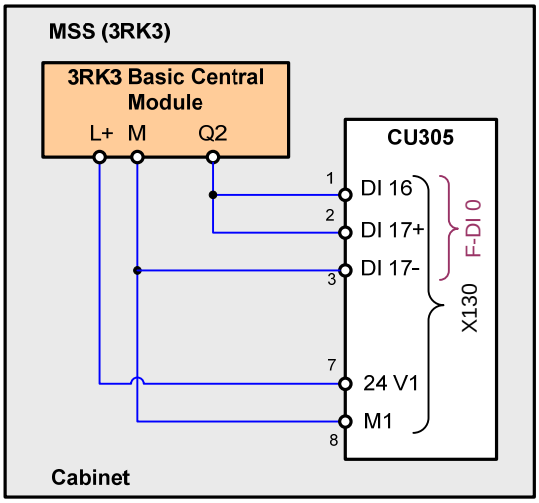


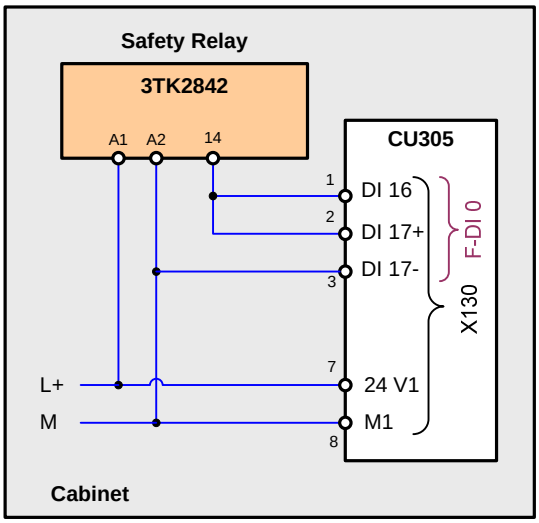
Figure 31: MSS 3RK3 Basic central module to CU305

In this example, the P/P-switching semiconductor output of the MSS Basic central module is used for the control of the F-DI0 of the CU305. This only has one P output which is doubly connected internally to two semiconductor switches. The M connection is available centrally at the M terminal.

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the CU305 may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the CU305. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

5.6 SIRIUS 3TK2842 safety relay to CU305



S

Figure 32: SIRIUS 3TK2842 safety relay to CU305

The 3TK2842 example shows how the safety functions are controlled via the safe electronic outputs of the SIRIUS safety relays. The instantaneous output at terminal 14 is used in the example. The delayed output (terminal 28) can also be used as an alternative. The F-DOs only have one P output which is doubly connected internally to two semiconductor switches. The M connection is available on a common terminal (A2).

For wiring with fault exclusion for cross-circuit to 24 V (e.g. fixed installation within a cabinet, see EN 60204-1:2006, Chapter 13), both channels of the F-DI on the CU305 may be connected to one F-DO. If there is no wiring with fault exclusion for cross-circuit to 24 V, two F-DOs with separate wiring can be used on the two channels of the F-DI of the CU305. These two F-DOs must then be controlled simultaneously.

No measures for residual currents are required for this module, as they are always less than 0.5 mA.

6 Examples for SIMOTION D4x5

WARNING

In accordance with IEC 61131 Part 2, Section 5.2 (2008), only those outputs that have a maximum residual current of 0.5 mA in the "OFF" state may be used for the interconnection of the digital inputs of the SINAMICS Integrated and the EP terminal of the motor module (STO terminals) as well as the digital inputs of the TM54F with digital semiconductor outputs.

These FAQ also describe possibilities of interconnecting modules with a residual current greater than 0.5 mA through the use of additional components (relay module 1 F-RO, contact multiplier module 3TK2830 or a resistor) with the digital inputs mentioned above.

6.1 Control of the basic functions via terminals

There is no difference between the SIMOTION variants D425, D435, D445 and the CU320 of the SINAMICS S120 with regard to the relevant terminals X122 and X132. Therefore, the examples from Section 3.1 can be used for the SINAMICS Integrated.

The examples for the CU320 of the SINAMICS S120 can also be used for the CX32 expansion component. Note however, that only four DIs (DI0 to DI3 on terminal X122) are available for the safety functions.

6.2 Control of the extended safety functions via the TM54F

The extended safety functions are also controlled via the PROFIsafe message frame or the TM54F with the SIMOTION D4x5.

Prerequisite for these wiring examples is the use of the TM54F with the following product version (or later):
6SL3055-0AA00-3BA0 Version B.

The control via the TM54F is identical for the SIMOTION D4x5 to that of the CU320. I.e. the corresponding examples can be found in Section 3.2.

7 Examples for SIMOTION D410

Warning

In accordance with IEC 61131 Part 2, Section 5.2 (2008), only those outputs that have a maximum residual current of 0.5 mA in the "OFF" state may be used for the interconnection of the digital inputs of the SINAMICS Integrated and the EP terminal (STO terminals) as well as the digital inputs of the TM54F with digital semiconductor outputs.

These FAQ also describe possibilities of interconnecting modules with a residual current greater than 0.5 mA through the use of additional components (relay module 1 F-RO, contact multiplier module 3TK2830 or a resistor) with the digital inputs mentioned above.

7.1 Control of the basic functions via terminals

There is no difference between the SIMOTION D410 and the CU310 of the SINAMICS S120 with regard to the relevant terminals X121 and X120. Therefore, the examples from Section 4.1 can be used for the SINAMICS Integrated.

7.2 Control of the extended safety functions via the TM54F

The extended safety functions are also controlled via the PROFIsafe message frame or the TM54F with the SIMOTION D410.

Prerequisite for these wiring examples is the use of the TM54F with the following product version (or later):
6SL3055-0AA00-3BA0 Version B.

The control via the TM54F is identical for the SIMOTION D410 to that of the CU320. I.e. the corresponding examples can be found in Section 3.2.

8 History

Version	Date	Modification
V1.0	12/2009	First Edition