

SIMATIC

ET200SP Safety engineering with AS-Interface in the SIMATIC ET 200SP, including typical circuit diagram




Function Manual

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Legal information

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indicates that death or severe personal injury will result if proper precautions are not taken.
 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.
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indicates that minor personal injury can result if proper precautions are not taken.
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Legal information

1.1 Legal information

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About this documentation

2.1 Additional documentation

This documentation and the associated sample files are available free of charge in the Internet (<http://support.automation.siemens.com/WW/view/en/109769506>) for downloading.

2.2 Purpose of the documentation

This documentation provides the introduction to communication via the AS-Interface and AS-i Safety, and uses a typical circuit diagram to show how safety functions can be implemented with AS-i in the ET 200SP distributed I/O system.

Further information on the topic of AS-i can be found in the AS-i System Manual (<https://support.automation.siemens.com/WW/view/de/51579885>) and on the Internet (<https://www.siemens.com/as-interface>).

2.3 Target group

This documentation contains information for the following target groups:

- Decision makers
- Technologists
- Configuration engineers
- Commissioning engineers

2.4 Required knowledge

A general knowledge of the following areas is needed to understand this documentation:

- Low-voltage controls and distribution
- Digital circuit logic
- Automation technology
- AS-Interface
- Safety engineering
- SIMATIC STEP 7 or TIA Portal

Introduction

3.1 AS-Interface

3.1.1 AS-Interface basics

AS-Interface is an industrial fieldbus system and international standard in accordance with IEC/EN 62026-2.

AS-Interface (in short: AS-i) stands for "Actuator Sensor Interface". It was developed to connect numerous individual sensors and actuators in a system to the PLC as simply as possible:

- Straightforward bus system with space-saving slave modules directly in the field
- Data transmission and power supply over a single unshielded 2-wire flat cable
- Extremely fast installation and integrated fast connection system (insulation piercing method)
- Real-time capable system response time
- Economically attractive replacement for elaborate cable harnesses

AS-Interface transmits standard signals and safe signals, e.g. for safety doors or emergency stop buttons, together on one AS-i cable.

With safety-related sensors in particular, the savings potential can be fully exploited because the dual cabling for two-channel safety sensors is only necessary up to the safe AS-i input module.

For safety sensors with integrated AS-i interface, the sensor cables and their protected routing are completely eliminated.

The safe AS-i signals are transmitted directly to a safe PLC, where they can be further processed.

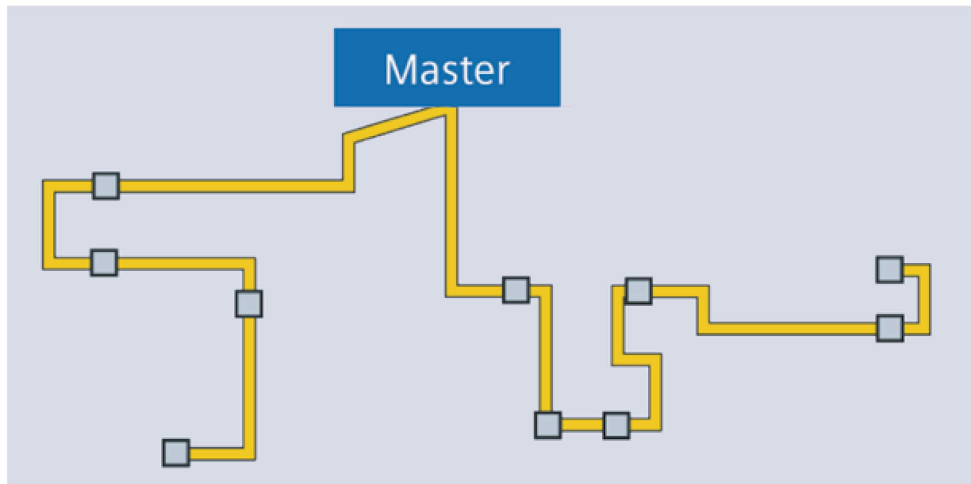
Siemens AS-i masters and Siemens AS-i modules are integrated in SIMATIC STEP 7, and can be inserted into the configuration at the click of a mouse.

- Familiar work environment since the procedure for the AS-Interface network configuration with Siemens AS-i modules is the same as for other SIMATIC components.
- Problem-free data management and documentation because the configuration of the Siemens AS-i master and the associated AS-i network along with all other SIMATIC controller components is stored in one STEP 7 project.
- In the STEP 7 program, the AS-i signals are accessed in the same way as by other I/O modules.
- Safe AS-i signals are easily forwarded to the F-CPU or SINUMERIK via the Siemens F-CM AS-i Safety ST module, without external PC programs or additional file management.

3.1.2 Network structure

Linear, star, and tree topologies are supported by the AS-Interface, making assembly practical with hardly any restrictions.

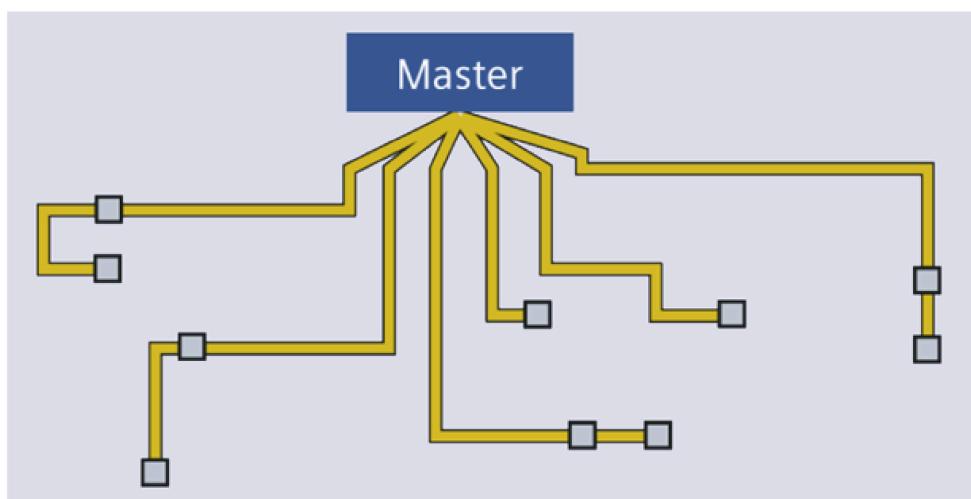
Linear structure



■ Nodes

All devices are connected to a continuous cable.

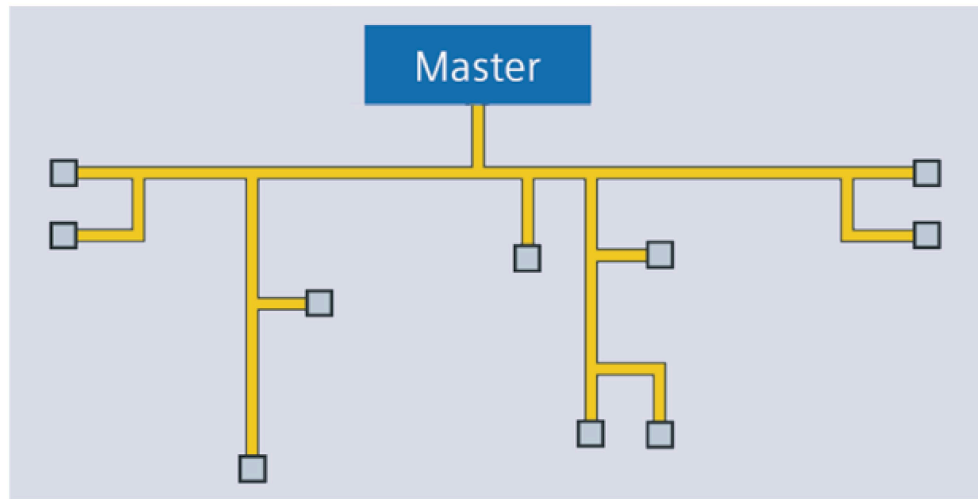
Star structure



■ Nodes

The nodes are connected to one another in a star-shaped structure.

Tree topology



■ Nodes

The tree topology is similar to the star topology, but with any number of branches.

3.1.3 Creating an AS-Interface network

An AS-i network always comprises a master, an AS-i power supply unit, and the AS-i slaves. AS-i is a single master system, i.e. a master module collects the data from multiple AS-i slaves and transfers it to the process image of the PLC. From the perspective of the PLC CPU, the AS-i master acts like an I/O module with numerous inputs and outputs.

AS-i master and AS-i slaves are connected to one another via an AS-i cable. The AS-i master and the AS-i slaves are positioned freely on the cable.

The AS-i cable has only two wires: ASI+ and ASI-. The AS-i master and all AS-i slaves only have to be connected to these two wires. Slaves in the IP65 version are easily connected to the AS-i flat cable.

To supply power to the AS-i network, an AS-i power supply unit can be connected to the AS-i cable at any position.

The AS-i power supply unit contains a data decoupling circuit that enables the AS-i communication signals and the direct voltage to supply the modules and sensors to run on the same AS-i cable. Parallel connection of two AS-i power supply units is not permissible. This is in order to maintain the function of the data decoupling.

In an AS-i network with repeaters, a new segment is inserted downstream of each repeater; each repeater requires a separate AS-i power supply unit.

The AS-Interface is designed as a single-master system with cyclic polling.

An AS-i network always contains only one master, which queries the data of all the nodes at regular, defined intervals.

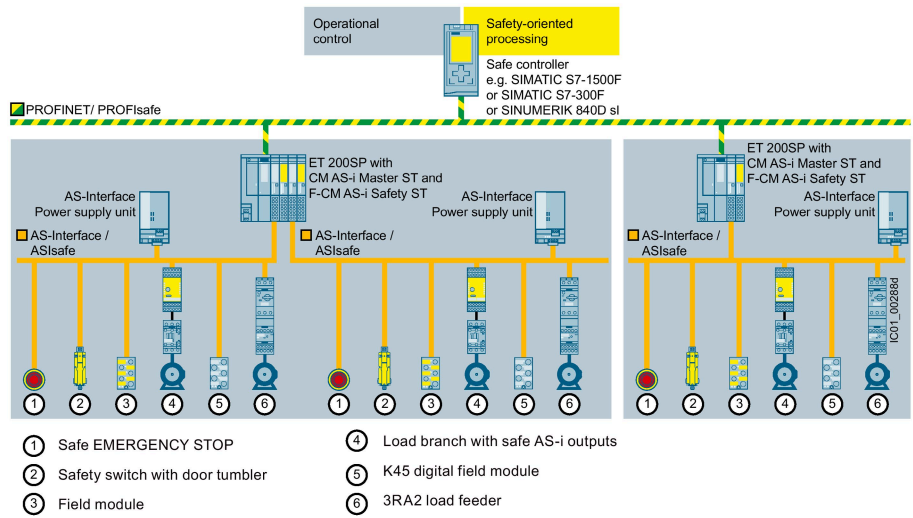


Figure 3-1 AS-Interface configuration with AS-i Master modules in the ET 200SP

3.1.4 Number of nodes

An AS-i network contains a maximum of 62 slaves with unique AS-i addresses. The AS-i master can manage 31 different addresses for the data exchange, whereby it can subdivide and reference each address as an A address or B address.

Slaves with standard addressing can be set to an address in the range 1 ... 31.

Slaves with extended addressing have address numbers followed by A or B. They are set to an address in the range 1A ... 31A or 1B ... 31B (often referred to as A/B slaves for short).

All slaves, whether with standard or extended addressing, are operated together on one AS-i network. The AS-i master automatically manages the addresses.

Backup AS-i slaves always use standard addressing. Slaves with standard addressing or extended addressing can be used for acknowledgment and other non-safety-related signals.

3.1.5 Network extension

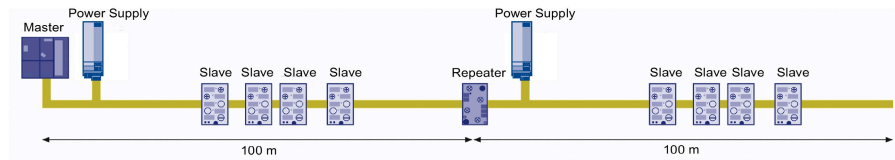


Figure 3-2 Network extension – previously a maximum of 100 m per segment

An AS-i line can be up to 100 m long without additional components. Repeaters can be used to increase the maximum possible cable length. Two repeaters can be connected in series, which can extend the network to 300 m as a linear structure. A separate AS-i power supply unit must be provided in each new segment.

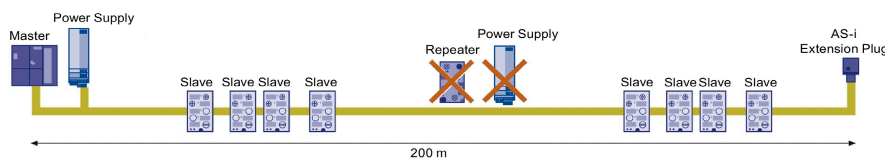


Figure 3-3 Network extension - now with AS-i extension plug, max. 200 m per segment

An extension plug can be used to double the length of an AS-i line to 200 m. Repeaters cannot be connected in series when they are used in conjunction with AS-i extension plugs. A maximum distance of 400 m between the master and slave and a total cable extension of 600 m can be achieved by using 2 repeaters and one extension plug per segment (master in the middle of the network). Repeaters can be connected in parallel in a star configuration, each with up to 200 m long segments.

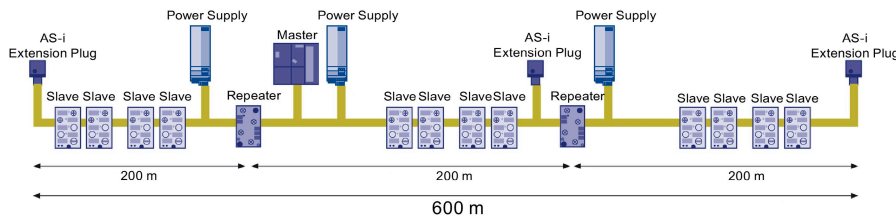


Figure 3-4 The maximum network extension with an AS-i extension plug is 200 m per segment, with only one repeater connected in series between master and any slave.

3.1.6 AS-i Safety

AS-i Safety enables safety-related components – such as EMERGENCY-STOP devices, protective door switches or safety light arrays – to be integrated in an AS-Interface network. The safety-related slaves are fully compatible with the familiar AS-Interface components (masters, slaves, power supplies, repeaters, etc.) in accordance with IEC 62026-2 and are operated in conjunction with them on the yellow AS-Interface cable.

The transmission method for safety-related signals is approved for applications up to PL e according to EN ISO 13849-1 and up to SIL 3 according to EN 62061.

As usual, nodes on the AS-Interface bus are controlled in operation by the standard program of the higher-level SIMATIC (F) CPU or by a SINUMERIK controller.

In order to implement safe functions, the information from the safe and standard nodes must be combined logically, and additional parameters set. The configuration of the safety functions depends on which safety solution is being used:

In conjunction with the modular safe AS-i master, which is formed by combining the CM AS-i Master ST and F-CM AS-i Safety ST modules in an ET 200SP station, all safety functions and combinations are configured via STEP 7 and processed in the controller (F-CPU) by the fail-safe program.

The AS-i communication modules in the ET 200SP facilitate the use of an AS-Interface under fail-safe SIMATIC or SINUMERIK controllers.

Tasks are allocated as follows:

- Acquisition of safety-related signals is via safe input slaves on the AS-Interface bus. Further signals can be detected through F-DI modules of the SIMATIC.
- Evaluation and processing of signals is via the fail-safe SIMATIC or SINUMERIK controller
- Reaction via safe output modules on the AS-Interface bus or via F-DQ modules of the SIMATIC

Simple combination of the CM AS-i Master ST and F-CM AS-i Safety ST modules in one ET 200SP station results in a powerful, safety-related router between PROFINET (or PROFIBUS) and PROFIsafe and AS-Interface, which can be expanded further in a modular fashion with further I/O modules of the ET 200SP.

In this way, it is possible to create expansion versions for almost all cases. Besides the single AS-i master, double, triple or generally multiple masters can also be realized with or without fail-safe functionality.

Note

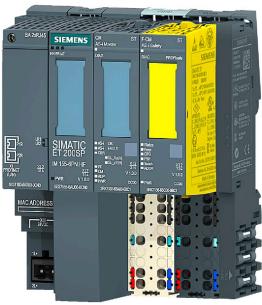
The SIRIUS 3RK3 modular safety system, MSS for short, with connection to AS-Interface can be used for a safety application without a fail-safe controller (F-CPU). This system is not covered in this documentation. Further information can be found on the Internet (<http://www.siemens.de/sirius-mss>).









AS-i Safety is also referred to as ASIsafe.

3.2 AS-i Safety product overview



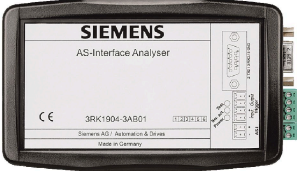
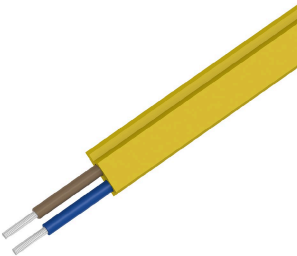
This section provides an overview of ASIsafe components as well as the accessories available to help you assemble, install, and use these components. The tables contain images of the products and their features.




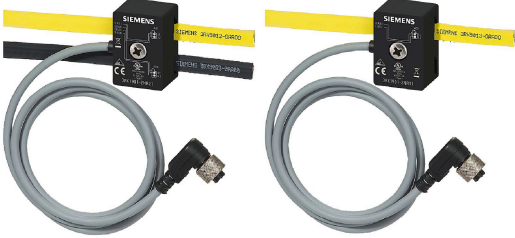

AS-i safety components

Product	Features
<p data-bbox="113 570 596 597">F-CM AS-i Safety ST and CM AS-i Master ST</p> 	<p data-bbox="756 570 1422 646">Expansion of a standard AS-Interface network to include safety-related communication through an F-CM AS-i Safety ST fail-safe communication module.</p> <p data-bbox="756 655 1369 732">The F-CM AS-i Safety ST module has no AS-i master functionality. A CM AS-i Master ST module is required for operation of the AS-i network.</p> <ul data-bbox="756 746 1430 1449" style="list-style-type: none"> • Gateway between PROFIsafe and ASIsafe, without master functionality • Expands a standard AS-i network to include safety-related communication (ASIsafe) • Monitoring of up to 31 safety-related input slaves • Control of up to 16 safety-related AS-i output slaves or switch-off groups • Power supplied from the AS-i voltage • Various interconnection types (1oo1 and 1oo2) may be used • A parameterizable input delay from 0 ms to 150 ms can be assigned to each channel • Startup test can be activated for each channel • Discrepancy monitoring can be configured for each channel • Sequential monitoring can be set for each channel • Channel-wise passivation • Test for 0 signal before reintegration • 8 LED displays for status and error diagnostics

<p>Safe modules</p>  <p>K45F K20F SlimLine Compact</p>	<p>Easy integration of safe signals, both in the control cabinet and in the field</p> <ul style="list-style-type: none"> • IP65 / IP67 or IP20 degree of protection • Compact dimensions from a width of 17.5 mm • Inputs: <ul style="list-style-type: none"> – Two single-channel inputs / one two-channel input – Four single-channel inputs / two two-channel inputs • Standard position switch or magnetically operated switch can be connected • Versions also available with two standard outputs 		
<p>3SU1 EMERGENCY STOP command devices</p> 	<p>Simple, direct connection of tried-and-tested command devices to ASIsafe</p> <ul style="list-style-type: none"> • Enclosure with IP65 / IP67 degree of protection • EMERGENCY STOP directly on AS-Interface via integrated modules • Metal or plastic version • Any combination of pushbuttons, indicator lights, and toggle switches can be controlled with just one cable • AS-i F adapter in IP20 degree of protection 		
<p>3SF1 position switches</p> <table border="1" data-bbox="159 1085 782 1351"> <tr> <td data-bbox="159 1085 542 1351"> <p>Position switches</p>  </td> <td data-bbox="550 1085 782 1351"> <p>With tumbler</p>  </td> </tr> </table>	<p>Position switches</p> 	<p>With tumbler</p> 	<p>Conventional wiring of safety functions no longer required</p> <ul style="list-style-type: none"> • IP65 degree of protection • Direct connection of position switches to AS-i • Available with separate actuator or tumbler • Encased in plastic or metal
<p>Position switches</p> 	<p>With tumbler</p> 		

System components and accessories

Function / product	Properties
<p>Power supply units and data decoupling</p> 	<p>The AS-i power supply unit allows the simultaneous transmission of data and power on the same two-wire line. Alternatively, a combination of a standard power supply unit and AS-i data decoupling can be used.</p> <ul style="list-style-type: none"> • Various levels (3 A, 5 A, 8 A etc.) • Ground fault detection included • AS-i power supply unit (30 V) with integrated data decoupling • 30 V power supply units without data decoupling • AS-i data decoupling modules
<p>Addressing unit for commissioning</p> 	<p>Simple address assignment to the slaves with wiring test during commissioning</p> <ul style="list-style-type: none"> • Addressing of all nodes in the AS-Interface network (standard and A/B slaves) • Readout of the slave profile (IO, ID, ID2) and ID1 code • Adjusting the slave parameters for commissioning • Measurement of the AS-Interface voltage • Enables direct setting of outputs and reading in of inputs in a slave • Readout of the code table of safe input slaves • Saving of complete plant configurations
<p>Analyzer for maintenance and service</p> 	<p>Quality assessment of an AS-Interface network with report printout and frame recording for on-site and remote diagnostics</p> <ul style="list-style-type: none"> • Checks quality and proper functioning of AS-Interface installation • Transfers data to a PC/PG via an RS 232 interface • Software-based evaluation • Automatic generation of test reports • Advanced trigger functions for accurate analysis • Bundle error display for support of preventive diagnostics • Process data can be monitored online
<p>Cable</p> 	<p>Rapid replacement and connection to AS-Interface thanks to piercing technology</p> <ul style="list-style-type: none"> • Trapezoidal profile prevents reverse polarity • Cables for various application conditions made of correspondingly optimized material

Range extension Extension plug 		Repeater 	Lower infrastructure costs, more possibilities of use and greater freedom for plant planning <ul style="list-style-type: none"> • Extension of an AS-i segment to a max. of 200 m with extension plug (without additional power supply unit) • Extension by one bus segment with AS-i Repeater Maximum combined extension increases to 600 m or more (with parallel connection of repeaters)
Compact distributor 			
M12 branches 			
Overvoltage protection 		Protection against overvoltage on AS-i <ul style="list-style-type: none"> • Special module: Overvoltage protection 	

Note

Ground fault detection is integrated into the CM AS-i Master ST, AS-i power supply units and the data decoupling unit

Circuit diagram example

4.1 Knowledge required

The following application example shows how conventional safety functions, such as emergency stop shutdown and protective door monitoring in the ET 200SP system can be configured and programmed with AS-Interface via the TIA Portal.

Knowledge required

The following knowledge and skills are required:

- Fundamentals of functional safety
- Fundamentals of AS-Interface
- Fundamentals in STEP 7 programming

4.2 Operating principle

4.2.1 Overview

Protective doors are frequently used to fence off danger zones. These are monitored for position and, if necessary, the area from which the hazard emanates is switched off. If the machine continues to present a hazard even after switching off, access can be prevented for this period by a tumbler. An emergency stop command device is additionally monitored for shutting down the machine in an emergency. CM AS-i Master and F-CM AS-i Safety are used to connect to the fail-safe controller.

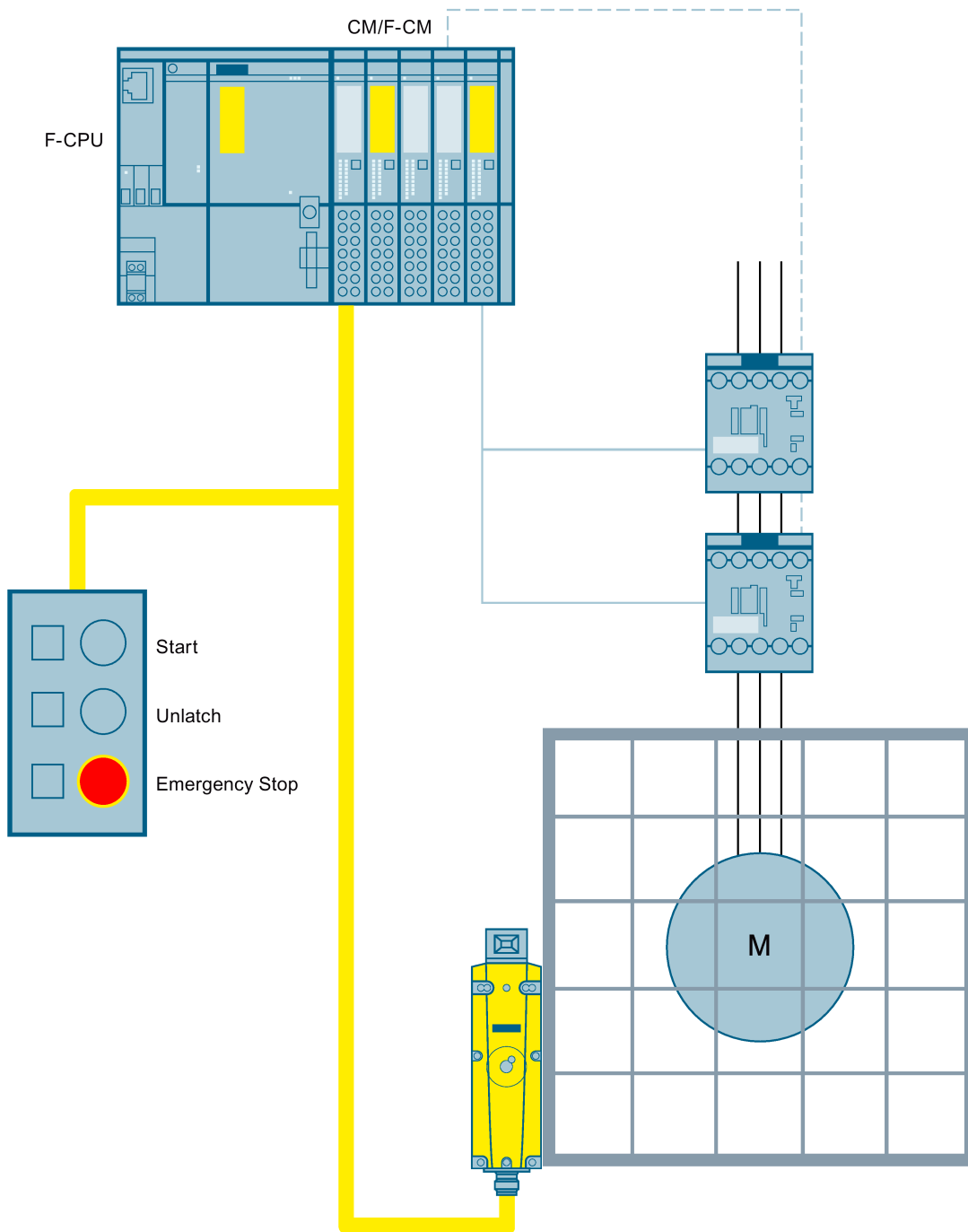


Figure 4-1 Circuit diagram example

The fail-safe controller monitors the emergency stop command device and the safety switch on two channels. Both devices have an integrated AS-i slave and are thereby connected to the AS-Interface. The two signals are transmitted to the fail-safe controller using the combination of CM AS-i Master and F-CM AS-i Safety (ET 200SP station modules).

The protective door position is monitored by a safety switch. In addition, the door is locked by means of a tumbler integrated in the safety switch. When the command to release the door is issued by means of a toggle switch, safety switch-off of the power contactors takes place via the fail-safe controller. On expiry of a set time, the tumbler is unlocked and access to the machine is enabled.

After the door has been closed and locked again, and the feedback circuit of the power contactors is closed, the Start button can be used to switch on again. When the emergency stop command device is actuated, the fail-safe controller also switches off the power contactors in a safety-related way. If the emergency stop command device is reset and the feedback circuit is closed, the Start button can be used to switch on again. Start pushbuttons and toggle switches are also read in via the AS-Interface.

The "Stopping in an emergency" safety function is designed up to SIL 3 or PL e.

The "Protective door monitoring" safety function is designed up to SIL 2 or PL d.

Safety function	Description	Requirement
SF1	If the emergency stop command device is actuated, the machine is shut down safely.	SIL 3 or PL e
SF2	If the protective door is opened, the machine is shut down safely.	SIL 2 or PL d

Note

Non-safety-related tumbler via integrated standard output of 3SF1324-1S.21-1BA4: The protective door tumbler is not a safety function (non-safety-related control of the solenoid). It can be used to safeguard the production process.

If during the risk assessment a safety level for the tumbler was defined in addition to the protective door monitoring, it is then possible to use a mechanical safety position switch with tumbler 3SE53 without an integrated AS-i slave. This means that control of the tumbler solenoids can take place via a fail-safe digital output on the F-PLC, for example.

Note

Taking account of fault exclusions, the use of only one safety switch with or without tumbler is permissible up to SIL 2 or PL d. Further information is contained in the PDF under the following link "concerning the use of safety switches up to SIL 2 or PL d (<http://support.automation.siemens.com/WW/view/de/35443942>)".

4.2.2 Emergency stop

The emergency stop command device is a component that is widely used to protect people, equipment and the environment against possible hazards, and to initiate stopping in an emergency. Equipment, functional aspects and design guidelines for emergency stop are listed in EN ISO 13850. The EN 60204-1 standard must also be observed.

The emergency stop command device with its two positive opening contacts is monitored by the F-CPU. If the emergency stop is actuated, the F-CPU switches the downstream actuators off via safe outputs in accordance with Stop Category 0 as per EN 60204-1. Before restarting or acknowledging the emergency stop shutdown, a check is made as to whether the contacts of the emergency stop command device have been closed and the feedback circuit of the downstream actuators is closed.

To connect the two normally closed contacts of the emergency stop command device to the AS-i bus, an AS-i interface module with two safe inputs (3SU1401-2EE60-6AA0) is installed in the enclosures of the command devices.

Note

Emergency stop is not a way of reducing the risk. "Emergency stop" is a supplementary safety function. (When "emergency stop" is operated, the motor must be shut down).

4.2.3 Monitoring the position of the protective door and tumbler function

The position of the protective door is monitored by a SIRIUS 3SF1 position switch. The position switch detects the position of the protective door by a separate actuator. This moves into the position switch when the protective door closes.

The SIRIUS 3SF1 position switch also contains an integrated tumbler which can keep the protective door closed during operation and thus prevent entry into the danger zone. An actuator mounted on the protective door moves into the positively-driven position switch with tumbler. The SIRIUS 3SF1 position switch with tumbler used here has a spring-actuated lock. This means that door is held shut in the de-energized state and the door is unlocked by applying a voltage.

Operating principle: If the door is closed and no voltage is applied, a locking mechanism moves into the separate actuator, which prevents the door from being opened. If a voltage is applied, the locking mechanism is drawn out of the separate actuator by a solenoid, which unlocks the tumbler.

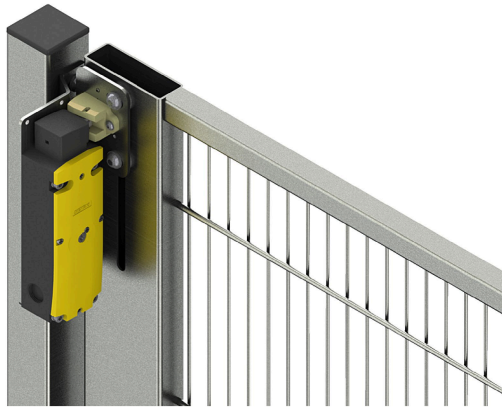


Figure 4-2 Position switch with tumbler

The SIRIUS 3SF1 position switches are equipped with mechanical protection against incorrect locking. This ensures that the door or locking mechanism can only be locked if the door is closed.

The SIRIUS 3SF1 position switch has an integrated AS-i slave, in contrast to the 3SE5 standard position switch.

Two contacts are evaluated internally in order to reach the required (SIL 2 or PL d) safety level. If one of the contacts is defective, opening of the protective door is still detected by the second contact. Failure of a contact is detected by a discrepancy monitor, which prevents a renewed switch on until the fault has been rectified.

There are basically three different combinations for forwarding the contacts of the AS-i position switch with tumbler as ASIsafe channel 1 and 2 to the controller for evaluation:

3SF13 version	ASIsafe channel 1	ASIsafe channel 2
3SF13 ... 1BA1	1st normally closed contact of actuator	Normally closed contact of solenoid
3SF13 ... 1BA3	1st normally closed contact of actuator	2nd normally closed contact of actuator
3SF13 ... 1BA4	1st and 2nd normally closed contacts of actuator	Normally closed contact of solenoid

Version 3SF13 ... 1BA3

In the 1BA3 version, both ASIsafe channels are supplied with a normally closed actuator contact. The signaling contact of the solenoid for the tumbler is not taken into account. This means that the user program cannot be used to evaluate whether the door is actually locked (diagnostics not possible). The 1BA3 version must be parameterized in the TIA Portal as 1oo2 (equivalent). The discrepancy time must be adapted to the conditions where the position switch is installed. The default setting of the discrepancy time (500 ms) is normally suitable for this position switch.

Version 3SF13 ... 1BA1

In contrast to the 1BA3 version, the signaling contact (normally closed contact) of the solenoid is evaluated as the second ASIsafe channel in the 1BA1 version. This means that the user program can be used to evaluate whether the door is actually locked (diagnostics possible). However this means that the two ASIsafe channels run asynchronously, resulting in the following requirement on the machine operator:

Each time unlocking the door is requested, the door also has to be opened. In the parameter assignment of the position switch, a 1oo2 evaluation (equivalent) must be set with the "Discrepancy time unlimited" option, whereby the F-CM AS-i Safety module expects a zero crossing of both ASIsafe channels before reclosing becomes possible. Therefore, in the case of a door release request without subsequent door opening, the F-CPU would prevent a hot restart of the machine.

Version 3SF13 ... 1BA4

In the 1BA4 version, for the first ASIsafe channel both normally closed contacts of the actuator are already linked in the switch and automatically evaluated for discrepancy. Therefore, for this version it must be ensured that the discrepancy analysis is deactivated (1oo1 evaluation) in the configuration of the AS-i slave in the TIA Portal. The signaling contact (normally closed contact) of the solenoid is evaluated as the second ASIsafe channel. This means that the user program can be used to evaluate whether the door is actually locked (diagnostics possible). The 1BA4 version of the 3SF1 position switch thus offers the advantage that with a door release request the door does not then have to be opened immediately. Nevertheless, malfunctioning of the tumbler solenoid can still be diagnosed by evaluating the signaling contact.

For this reason, a 1BA4 version of the 3SF1 position switch is used in the application example described here.

See the figure below:

- 1st normally closed contact of actuator (state: door closed): 11 / 12
- 2nd normally closed contact of actuator (state: door closed): 21 / 22
- Normally closed contact / signaling contact of the solenoid (state: tumbler active): 41 / 42
- Control of the solenoid (state: door release inactive): E1 / E2

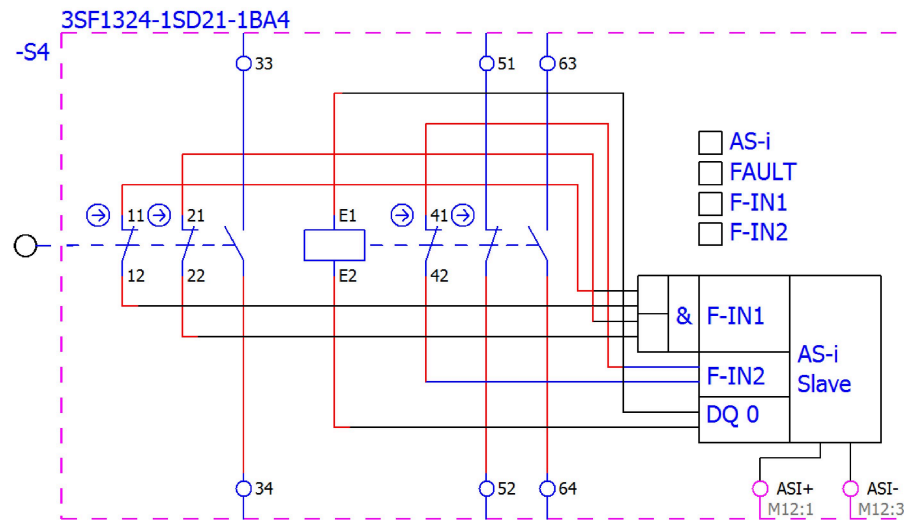


Figure 4-3 3SF1324-1SD21-1BA4 internal circuit diagram

4.2.4 Control and monitoring of the actuator

In order to achieve PL e according to ISO 13849-1 or SIL 3 according to IEC 62061, the shutdown of the machine is designed redundantly. Here, two SIRIUS 3RT2 contactors are used and their correct functioning is monitored by the failsafe controller (feedback circuit monitoring) through their auxiliary contacts (mirror contacts). The mirror contacts can be read by a standard input module.

If one of the two contactors welds, the second contactor can continue to ensure a safe shutdown. The welding of a contact is detected by the feedback circuit monitoring at the next signal change, and a new switch on is prevented until the fault is rectified.

4.3 Hardware and software components

4.3.1 Validity

This application example is valid for:

- All SIMATIC F controllers
- STEP 7 Professional as from V 15

4.3.2 Components used

The application was created with the following components.

Hardware components

Component	Quantity	Article No.	Note
Power supply	1	6EP1333-2BA20	SITOP PSU100S 24 V/5 A
Fail-safe S7-CPU	1	6ES7512-1SK01-0AB0	CPU 1512SP F-1 PN ET 200SP including server module
PROFINET bus adapter	1	6ES7193-6AR00-0AA0	Bus adapter 2 x RJ45 plug sockets
SIMATIC Memory Card	1	6ES7954-8LC02-0AA0	SMC 4 MB
AS-Interface communication module	1	3RK7137-6SA00-0BC1	CM AS-i Master
AS-Interface safety communication module	1	3RK7136-6SC00-0BC1	F-CM AS-i Safety
Digital input module	1	6ES7131-6BF00-0CA0	DI 8X24VDC HF
Fail-safe digital output module	1	6ES7136-6DB00-0CA0	F-DQ 4X24VDC/2A PM HF
Base unit	1	6ES7193-6BP20-0DC0	Light base unit 20 mm, type C0 (new load group)
Base unit	1	6ES7193-6BP20-0BC1	Dark base unit 20 mm, type C1 (jumpered to the left)
Base unit	1	6ES7193-6BP00-0DA0	Light base unit 15 mm, type A0 (new load group)
Base unit	1	6ES7193-6BP00-0BA0	Dark base unit 15 mm, type A0 (jumpered to the left)
3SU AS-Interface enclosure	1	CIN 20180516133320114162	EMERGENCY STOP mushroom pushbutton Illuminated pushbutton, toggle switch
Safety position switch	1	3SF1324-1SD21-1BA4	With tumbler and auxiliary release
Power contactor	2	3RT2015-1BB42	S00 AC-3 7A
AS-i power supply unit	1	3RX9501-0BA00	IN: 120 V ... 230 V AC, OUT: 3 A AS-i
AS-i cable	1	3RX9010-0AA00	100 m roll, rubber

Software components

Component	Quantity	Article No.	Note
STEP 7 Professional	1	6ES7810-5CC12-0YA5	V 15.1
STEP 7 Safety Advanced	1	6ES7833-1FA15-0YA5	V 15.1

4.3.3 Example of wiring

The wiring example is available for download in the Internet (<http://support.automation.siemens.com/WW/view/en/109769506>) as a PDF and EPLAN macro.

4.3.4 Sample data and projects

The following table contains all the files and projects used in this example.

Component	Note
E-Stop_SIL3_Protective_door_tumbler_SIL2_AS-i.zap15_1	TIA Portal project
Wiring_E-Stop_SIL3_Protective_door_tumbler_SIL2_AS-i.emp	EPLAN macro
E-Stop_SIL3_Protective_door_tumbler_SIL2_AS-i_de.set	SET file

4.4 TIA Portal configuration

4.4.1 TIA Portal engineering

The supplied TIA Portal project contains the example configuration. The most important settings for reuse in one's own project are shown in this section.

NOTICE
Loss of safety function
The settings shown below contribute toward meeting the required safety. Changes to the settings may lead to a loss of the safety function.

In the following, the hardware configuration of the ET 200SP F-CPU is performed with I/O and the AS-i slaves.

After a new CPU 1512SP F-1 PN has been created in the project, the ET 200SP station is configured. In addition to the CM AS-i Master ST and F-CM AS-i Safety ST ET 200SP modules, a fail-safe digital output module and a standard digital input module are needed for this typical circuit diagram. The order numbers are to be taken from the table "Components used" (Section 4.3.2 (Page 28)).

4.4.2 Configuration of the ET 200SP modules CM AS-i Master ST and F-CM AS-I Safety ST

Note

Configuration of the CM AS-i Master ST

A detailed guide to configuring CM AS-i Master ST is available in the "Configuration" Section of the "AS-Interface Master CM AS-i Master ST

(<https://support.industry.siemens.com/cs/ww/view/71756485>)" Manual.

Configuration of the F-CM Safety ST

A detailed guide to configuring the F-CM Safety ST is available in the "Configuration" Section of the "ET 200SP Failsafe Module F-CM AS-i Safety ST

(<https://support.industry.siemens.com/cs/ww/view/90265988>)" Manual.

Programming the safety program in SIMATIC STEP 7 Safety Advanced

Programming of the safety program in SIMATIC STEP 7 Safety Advanced is described in detail in the "SIMATIC Industry Software SIMATIC Safety - Configuration and Programming

(<https://support.industry.siemens.com/cs/ww/de/view/54110126>)" Manual.

CM AS-i Master ST and F-CM AS-i Safety ST can also be configured under SIMATIC S7 Distributed Safety in STEP 7 classic. Here the comfort functions and diagnostics may be restricted in comparison to TIA Portal STEP 7 (Safety Advanced).

4.4.3 Configuring ET 200SP System

In this example, an ET 200SP F-CPU is configured with TIA Portal V15.1. In other versions, the representation may be slightly different; it then applies analogously.

The steps shown apply correspondingly if an ET 200SP station is used with an interface module (e.g. IM 155-6 PN ST) on a SIMATIC F-CPU (e.g. CPU 1515F-2PN). Alternatively to the SIMATIC F-CPU, a fail-safe SINUMERIK controller can be used. The safety program is always executed in the safe controller.

Configure the CM AS-i Master ST and F-CM AS-i Safety ST modules in the ET 200SP station.

Procedure:

1. Open your STEP 7-project in the TIA Portal.
2. Add your ET 200SP station from the hardware catalog.
3. Switch to the device view of the ET 200SP station.
4. Select the CM AS-i Master ST module from the ET 200SP folder in the "Hardware catalog" window.

Communication module > AS-Interface > CM AS-i Master ST > 3RK7137-6SA00-0BC1.
Ensure that the selected version is the same as that of your device, otherwise update the FW.
5. Drag & drop the selected AS-i Master to the next free slot of your ET 200SP station. The CM AS-i Master ST module is plugged into a light base unit.
6. Select the F-CM AS-i Safety ST module from the ET 200SP folder in the "Hardware catalog" window: Communication module > AS-Interface > F-CM AS-i Safety ST > 3RK7136-6SC00-0BC1. Ensure that the selected version is the same as that of your device, otherwise update the FW.
7. Drag & drop the selected F-CM AS-i Safety ST module directly to the right of the AS-i Master in your ET 200SP station. Select a dark base unit for the F-CM AS-i Safety ST module.
8. Open the Properties window of the CM AS-i Master ST and switch to the AS-Interface tab in the "General" area. Create a new AS-i network by clicking the "Add new subnet" button.

Circuit diagram example

4.4 TIA Portal configuration

Result:

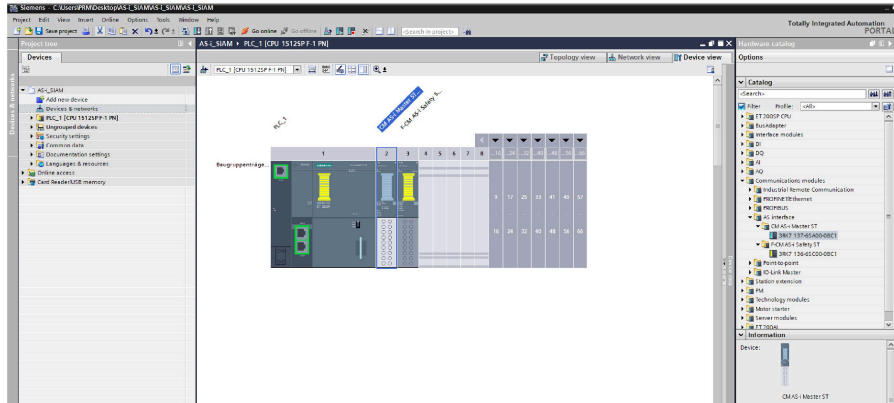


Figure 4-4 Adding the two AS-i modules to the ET 200SP station

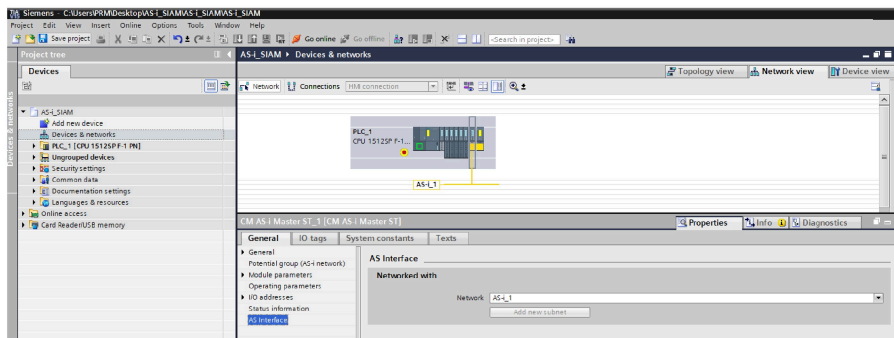


Figure 4-5 Creating a new AS-i network

9. Insert the F-DQ 4x24VDC/2A PM HF module on the right of the F-CM module, and activate its 1st channel in its "DQ parameters".

10. Insert the DI 8x24VDC HF module and a server module on the right of the F-DQ module.

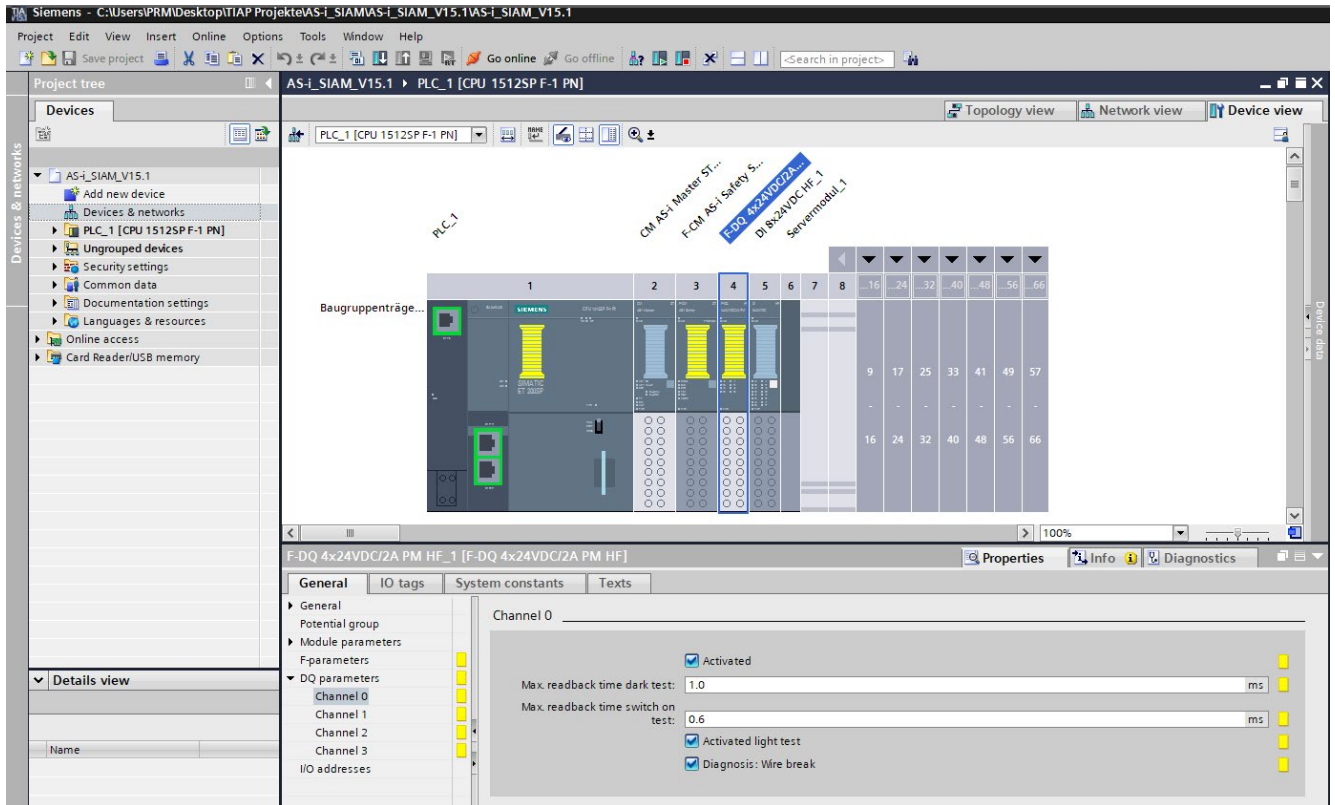


Figure 4-6 Complete configuration of the ET 200SP station

Note

The setting of the correct base units (light or dark) must be observed for all four modules.

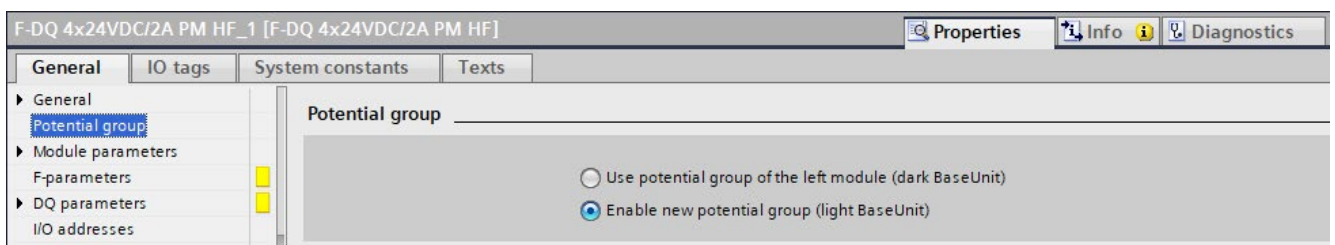


Figure 4-7 Selecting the correct base unit

4.4.4 Adding AS-i slaves

Configure an AS-i slave in the AS-i subnet.

In the following example, an emergency stop command device is connected to an ASIsafe F adapter. Other AS-i (ASIsafe) slaves can be correspondingly configured.

Procedure:

1. Open the Network view of your project.
2. Select the ASIsafe F adapter in the "Hardware catalog" window from the folder: Field devices > AS-Interface > Command and signaling devices > F adapter > ASIsafe F-ADAP, 2 F-DI > 3SU1400-4AA0
3. Drag & drop the selected AS-i slave into the empty space below your ET 200SP station.
4. Connect the emergency stop command device to the AS-i network created in Chapter 4.4.3 by moving the port (yellow square) of the F adapter with drag & drop to the port of the CM AS-i Master ST. Connecting the AS-i slave to the AS-i network automatically assigns the next free AS-i address. If required, the address can be changed in the Properties window of the AS-i slave.

Result:

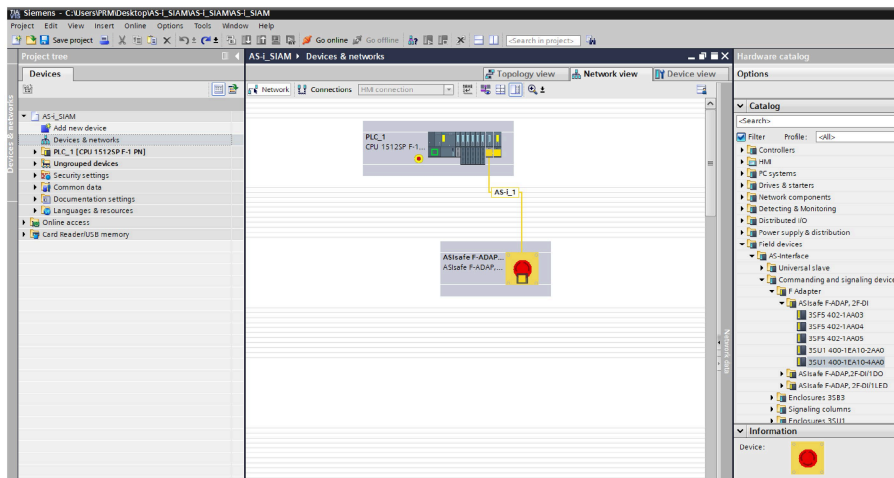


Figure 4-8 Adding and connecting an AS-i slave

5. Perform the steps listed above for two further AS-i slaves:

- ASIsafe position switch with tumbler (Field devices > AS-Interface > Detecting devices > Position switches > Operation with tumbler > ASIsafe POS-SWITCH-LOCK)

- AS-i 3SU1 (Field devices > AS-Interface > Command and signaling devices > 3SU1 enclosure > AS-i 3SU1, 4DI/3DO, AB)

Tip: Display the AS-i addresses on the slaves by activating the "Show addresses" function (symbol with eye in the menu bar of the network view, above the empty area).

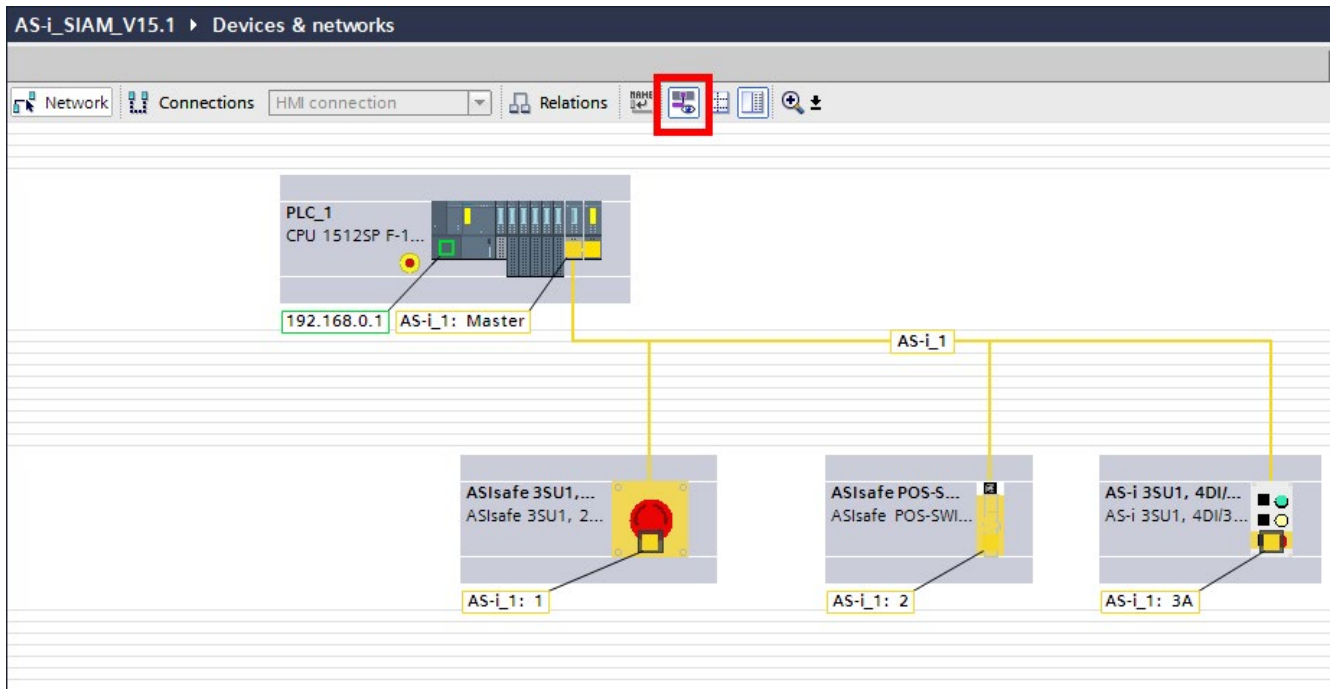


Figure 4-9 Display addresses

4.4.5 Setting F parameters

To set the F parameters, open the "General" dialog box of the F-CM AS-i Safety ST in the device view of the ET 200SP station.

Settings made in the "F parameter" tab affect the fail-safe communication of the module with the F-CPU.

The individual parameters are explained briefly below. Further information may be found in the "SIMATIC Safety - Configuring and Programming (<https://support.automation.siemens.com/WW/view/de/54110126>)" Manual.

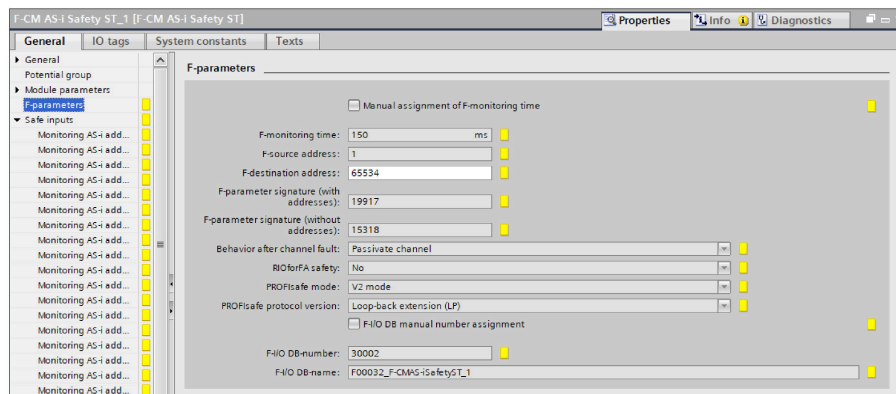


Figure 4-10 Parameters of the F-CM AS-i Safety ST

The **F monitoring time [ms]** is the PROFIsafe monitoring time for the safety-related communication between F-CPU and F I/O. If the F-I/O does not receive a valid safety message frame from the F-CPU within the parameterizable monitoring time, the F module passivates with a "communication error". The F monitoring time can assigned manually or on a module-specific basis (check "Manual assignment of monitoring time") or be assigned centrally in the F parameters of the CPU for all I/O modules.

Via the **F source address**, the F-I/O module F-CM AS-i Safety ST is uniquely assigned to an F-CPU with the corresponding F source address. The F-source address must be unique throughout the network.

The **F destination address** is the PROFIsafe address and uniquely identifies source (F-CPU) and destination (F module). The PROFIsafe addresses must be unique across stations and the network. To prevent incorrect parameter assignment, the F destination address is assigned automatically. When changing the F destination address manually, its station-wide uniqueness is checked automatically, but not its network-wide uniqueness. This has to be ensured by the user him/herself.

Behavior after channel faults: In the event of a channel fault, the F-CM AS-i Safety ST F-I/O module only ever passivates the faulty channel(s).

In this example, the default settings are accepted for the F parameters of the F-CM AS-i Safety ST module.

4.4.6 Configuring safe AS-i slave monitoring

To change the safe I/O addresses and AS-i slave parameters, open the Properties dialog box of the F-CM AS-i Safety ST in the device view of the ET 200SP station.

Under the "Safe inputs" tab there is an entry for each AS-i address in the range 1 ... 31. Initially, all addresses for safe evaluation are deactivated. Select the tab for monitoring AS-i address 1, and activate the "Activate input monitoring" option.

The individual module parameters are explained briefly below.

Tip: Clicking the green arrow to the right of the "Name" field to switch directly between the F parameter dialog window of F-CM AS-i Safety ST and the fail-safe AS-i slave.

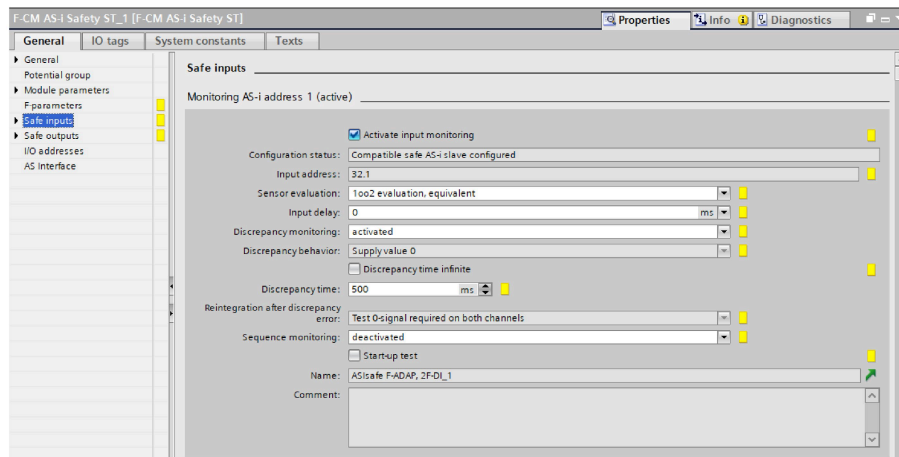


Figure 4-11 Setting the safe input monitoring of the F-CM AS-i Safety ST

By activating the **input monitoring**, you can enable the corresponding AS-i slave as an input channel for signal processing in the safety program. The AS-i address must be assigned to a safe AS-i input slave.

The **configuration status** provides information about whether a safe AS-i slave is configured at this AS-i address ("Compatible safe AS-i slave configured"). Free AS-i addresses or those occupied by a non-safe AS-i slave can also be configured (configuration status: "AS-i slave missing"). The safe AS-i slaves can be inserted later.

Input address: The input bit address of the input channel for the signal processing in the safety program is shown here. It is calculated automatically from the start of the inputs entered in the "Addresses" tab.

Encoder evaluation: Two options are available here.

For the **1oo1 evaluation**, the encoder is present once and connected to a single channel on the first input of the safe AS-i slave. To achieve this, jumper the second input of the AS-i slave. Instead of the jumper, you can also connect another single-channel sensor to the second input. Only when both inputs supply an ON signal does the F-CM AS-i Safety ST module transfer the "1" value to the safety program (the two inputs are ANDed). A discrepancy analysis is not performed in the 1oo1 evaluation.

In the **1oo2 evaluation, equivalent** both inputs of the safe AS-i slave are occupied, either by a 2-channel encoder or by two single-channel encoders. The two single-channel sensors then belong together functionally as a pair, e.g. two position switches of one door monitoring. The input signals are compared internally for equivalence. A discrepancy analysis is possible in the 1oo2 evaluation equivalent.

To suppress coupled-in interference or brief switching pulses, you can set an **input delay** for each AS-i slave.

For fail-safe inputs, the **discrepancy monitoring** for equivalence is used to infer errors from the time characteristic of two signals with the same functionality. If different levels for two associated input signals are detected after the input delay time has expired, the discrepancy analysis is started. A check is made to determine if the difference has disappeared after expiration of an assignable time period, the so-called **discrepancy time**. If not, there is a discrepancy error. Before reclosing, the signal value 0 must be present at both inputs.

The **discrepancy behavior** determines the value that is made available to the safety program in the F-CPU during the discrepancy, i.e. while the discrepancy time is running. This parameter is permanently set to "Provide 0 value".

Reintegration after discrepancy error: This parameter is permanently set to "Test 0 signal necessary on both channels". A discrepancy error is not considered to be rectified until an "OFF" signal is present again at both input channels. Reintegration of the PROFIsafe channel is then possible.

The **sequence monitoring** monitors the sequence of the signals of the channel pair when there is a signal change OFF >>> ON at the inputs of the safe AS-i slave.

If the **Startup test** parameter is activated, the value transferred to the safety program is kept at the substitute value "0" until the connected sensor has been correctly actuated at least once.

You can specify the start address of the process image in the "I/O addresses" tab of the Properties dialog box of the F-CM AS-i Safety ST. Which actual bit in the safety program is accessed, for example for a safe input slave, can be found in the "Input address" described above.

The "I/O addresses" tab also appears in the Properties dialog box of the AS-i slaves. Taking the example of the AS-i F adapter, a distinction is made between "Digital I/O" and "Safe inputs". Under "Digital I/O", the data area of the communication is set with the AS-i master. This area in the user program can be accessed e.g. for diagnostic purposes. Under "Safe inputs", the same input bit as under the AS-i address in the Properties dialog box of the F-CM AS-i Safety (see "Input address") is present. As described above, this bit is accessed in the safety program.

Emergency stop and pushbutton and toggle switch are in an enclosure together with the two necessary AS-i slaves (a safety slave and a standard slave). The two installed slaves are configured separately in the TIA Portal.

The safe monitoring of the position switch is then configured as follows. The explanation of the individual parameters can be found in Section 4.4.5 (Page 36). A 1oo1 evaluation is selected to monitor the position switch because the switch used (version 3SF13 ... 1BA4) is already monitored for discrepancy (see Section 4.2.3 (Page 25)).

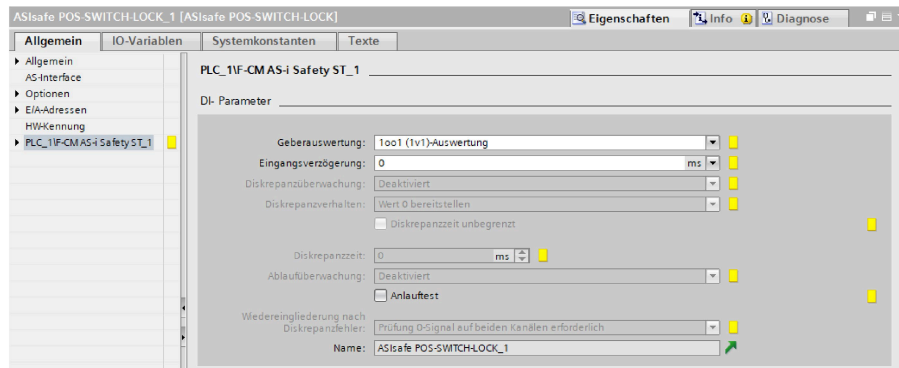


Figure 4-12 Configuration of the position switch

The position signal of the position switch is transferred to the safety program as a safe input bit. The address of the safe input is shown in the following figure (I32.1 in this example).

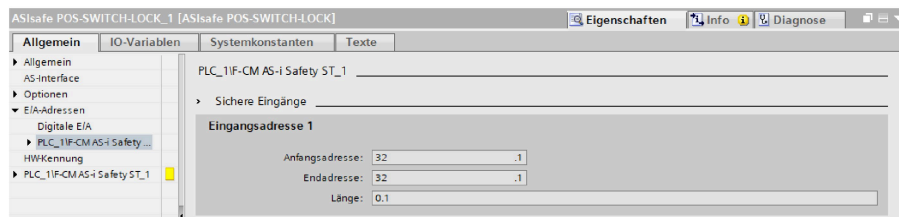


Figure 4-13 Address for reading out the position of the position switch

The solenoid for releasing the door tumbler is controlled via a standard output of the AS-i slave installed in the position switch (output bit 0, see "Digital I/O"; Q0.0 in this example).

The read back signal (normally closed contact) of the solenoid is the second fail-safe channel of the AS-i slave (see Section 4.2.3 (Page 25), 1BA4 version). Since it is directly processed to a fail-safe digital input bit (in this example I32.1, see below) with the first fail-safe channel in the F-CM AS-i Safety ST module, the read-back signal of the solenoid is accessed via the associated standard input bit of the AS-i slave installed in the position switch (input bit 0, see "Digital I/O"; in this example IO.0).

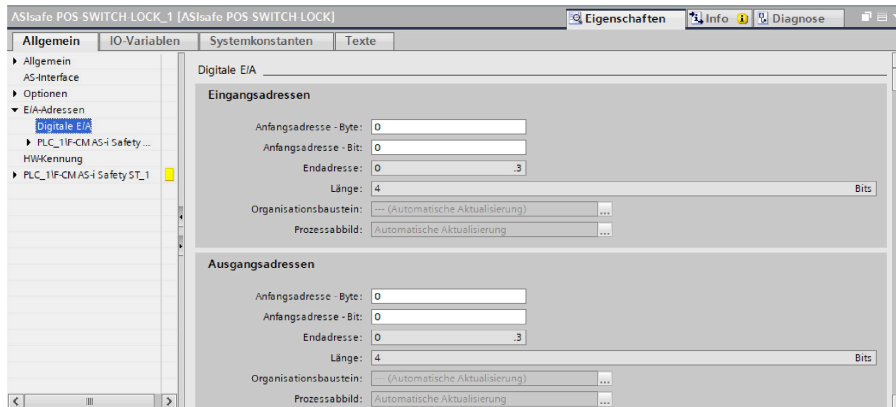


Figure 4-14 Address for controlling the solenoid

The safe monitoring of the emergency stop command device is then configured as follows.

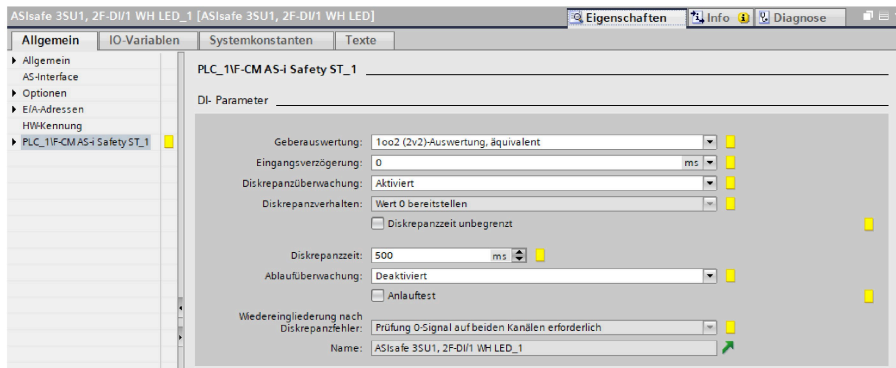


Figure 4-15 Configuration of the emergency stop command device

Finally, the F-DQ module is configured to control the redundant contactors. Here again, the F parameters remain unchanged (default setting). The setting of the safe monitoring can be taken from the following figure.

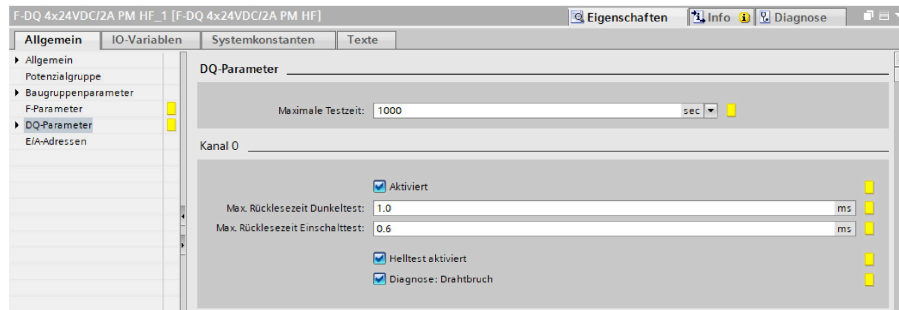


Figure 4-16 Configuration of the F-DQ module

Note

Unused channels, such as channels 1 to 3 of the F-DQ module, should be deactivated for reasons of clarity and improved performance. For this purpose, the check is removed from "Activated" for the corresponding channels. For the F-CM AS-i Safety ST module, the user must activate the input channels required for the configured AS-i slaves.

4.4.7 Minimum number of slaves for AS-i Safety applications

In a normal application, an AS-i network contains more than 5 AS-i slaves.

However, only 3 AS-i slaves are used for this example. In this case, the specifications in EN 60262-2 (AS-i specification) for the minimum cycle time and minimum number of slaves for AS-i Safety applications must be observed.

In an AS-i network with at least 5 different slave addresses in the numerical part of the address, each safety component functions as intended. "In the numerical part of the address" means that two slaves with the addresses 5A and 5B are counted here as 1 address, whereas two slaves with the addresses 10A and 11B are counted as 2 addresses. For the count, it is irrelevant whether or not these are safety slaves.

With less than 5 slave addresses, only restricted plant availability is possible, i.e. instead of an "ON" signal in the safety transmission report, it is possible to switch back to the "OFF" safe state, since the affected safety component cannot execute the report for the "ON" signal quickly enough in the short bus cycle time. An "OFF" signal remains of course in the safe state "OFF".

The TIA Portal outputs a corresponding warning message on compilation if not enough slaves have been configured as AS-i slaves in the TIA project.

An AS-i Safety network usually still functions with fewer slaves. However, to avoid an unwanted shutdown, the rules in the standard should be observed. The F-CM AS-i Safety module offers a simple solution for this, without installing additional slaves.

Open the Properties dialog of the F-CM AS-i Safety, and navigate to the "Safe outputs" tab. Select the vector group 0, and set the option "Activate output control". The F-CM AS-i Safety module now generates an AS-i address internally. At the same time, an associated virtual module (AS-i Safe Out Ctrl) is configured on the AS-i subnet, so that the AS-i master is instructed to accept the additional AS-i address into the cyclic operation.

Repeat this step four more times, so that a total of 5 additional AS-i addresses are activated in the F-CM AS-i module. These act as a "base load" in the AS-i network, irrespective of the number of other AS-i modules in the AS-i network.

If your AS-i network has enough modules, you can correspondingly deactivate the output control in the vector groups of the F-CM AS-i Safety.

When a vector group is activated, additional safe output bits are made available. Do not interconnect these safe output bits in the safety program if the vector group is only used to increase the number of slaves.

You can use the vector groups of the F-CM AS-i Safety and the associated safe output bits as required to control safe AS-i output modules in the AS-i network (see e.g. Art. No. 3RK1405-1SG15-0AA2). In this case, you use the safe output bits in the safety logic of the safety program in a similar way as for F-DQ modules of the ET 200SP. This Function Manual does not include a detailed example for this application.

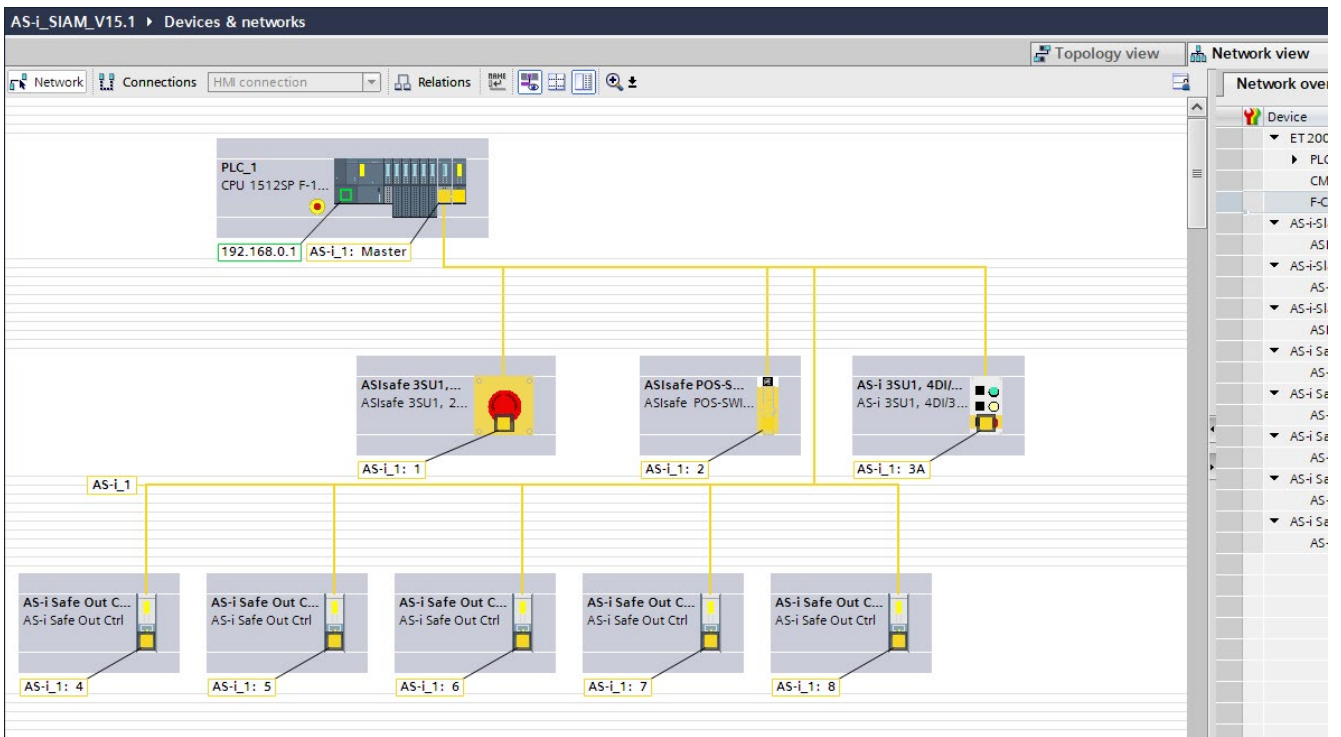


Figure 4-17 Hardware configuration with virtual slaves

4.4.8 Assigning fail-safe addresses to ET 200SP

After setting the F parameters of the F-CM AS-i Safety ST module, the PROFIsafe-/F destination address still has to be assigned to the extended module (real hardware).

Fail-safe ET 200SP modules do not have DIP switches with which you can assign the unique F destination address (= PROFIsafe address) to each module. Instead, assign the PROFIsafe address directly from STEP 7. F destination addresses are assigned in the hardware configuration for the F module. An assignment is necessary when a system is commissioned for the first time, for example. The F destination address can only be assigned if the PROFINET device name is also assigned.

Open the shortcut menu of the F-CM AS-i Safety ST (right click on the F-CM AS-i Safety module) and select "Assign F destination address". In the dialog which then appears, identify the F-CM AS-i Safety ST module, and then assign the PROFIsafe address.

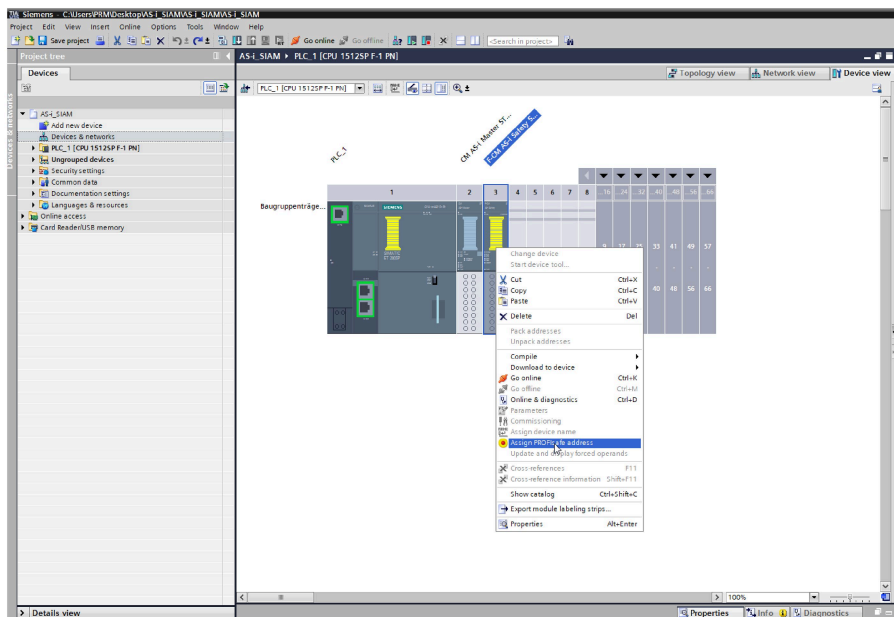


Figure 4-18 Assigning the PROFIsafe address

Repeat the described procedure for assigning the fail-safe address for the F-DQ module.

4.4.9 Teaching ASIsafe code sequences

To perform safety-related communication, each safe AS-i input slave sends a code sequence over the AS-i bus. To prevent a mix-up of AS-i input slaves on the AS-i bus, each AS-i input slave sends a different code sequence. The code sequences are permanently stored in the AS-i input slave.

During initial commissioning, the F-CM AS-i Safety ST module must teach the code sequences of all safe AS-i input slaves present on the AS-i bus.

As soon as the F-CM AS-i Safety ST module detects a new code sequence, the code sequences are automatically taught. Confirm the transfer of the code sequences into the memory to prevent unauthorized changes to the AS-i component. Two methods of accepting code sequences are available:

Transfer the code sequences via STEP 7 online access:

Open the F-CM AS-i Safety ST shortcut menu and select "Online & Diagnostics". Change to the "Functions > ASIsafe code sequences" tab. The "Teach ASIsafe code sequences" dialog contains an overview of the code sequences of the existing safety-related AS-i slaves. Start the acceptance of the code sequences read on the AS-i bus into the memory of the F-CM AS-i Safety ST module in this dialog. To do so, click the "Transfer taught code sequences" button.

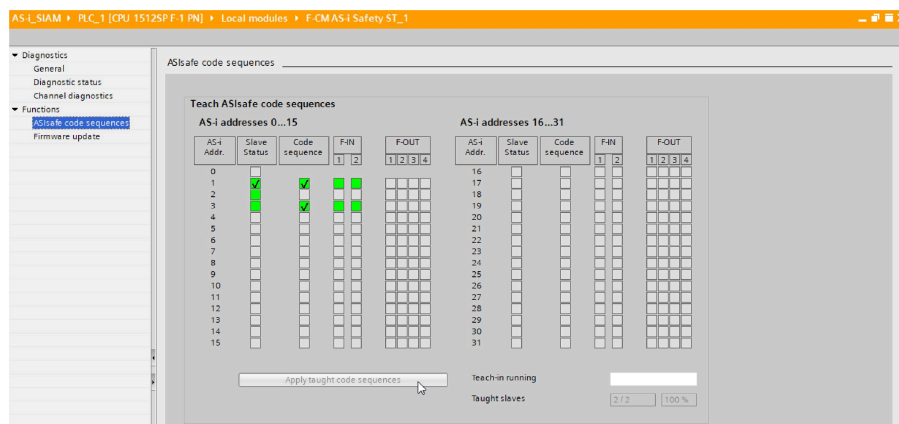


Figure 4-19 Accepting code sequences

Transfer the code sequences with the "TEACH" button:

As an alternative, the "TEACH" button can be used to provide an easy way of transferring taught code sequences. The "TEACH" button can be used, for example, to transfer code sequences of modules replaced during operation. However, it is also suitable for initial commissioning.

The "TEACH" pushbutton is connected to the terminals "TEACH1" and "TEACH2" (terminals 1 and 2) of the base unit of the F-CM AS-i Safety ST module.

Press the "TEACH" button for at least 3 s. This action causes all currently taught code sequences that are unique and consistent to be transferred to the non-volatile memory. Next, the input data of the safe AS-i input slaves is evaluated, allowing reintegration in the safety program.

Further information on the topic of code sequences can be found in the "T 200SP fail-safe module F-CM AS-i Safety ST (<https://support.industry.siemens.com/cs/ww/de/view/90265988>)" Manual in the "Code sequences" section.

4.5 TIA Portal programming

In this typical circuit diagram, the focus is on the safety-related switching of the machine. Therefore, operational switching is not taken into account, and no standard user program is programmed. In this example, the user must implement the operational switching – adapted to the conditions of the machine – in their program with the aid of the "operativeOn" variable in the DB "DataToSafety" via the FB "StartStop".

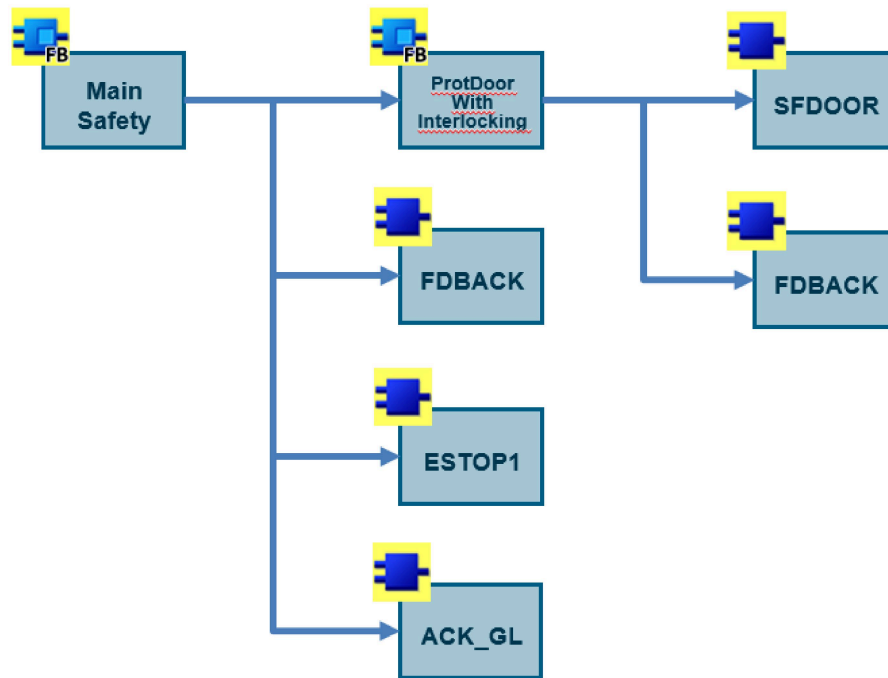


Figure 4-20 Safety program

The MainSafety function block is called cyclically by an F-runtime group. This contains all other safety-related program parts.

Reintegration of passivated channels

The ACK_GL instruction in STEP 7 Safety is used for this purpose. It generates an acknowledgment for the simultaneous reintegration of all F-I/O or channels of the F I/O of an F runtime group after communication faults or F I/O / channel faults.



Figure 4-21 Call ACK_GL

Examples of events that lead to passivation:

- Wire break in an F-DQ module
- Fault on a AS-i safety slave, e.g. slave failure or discrepancy fault at the safety inputs

Note

If a fault occurs in the hardware (e.g. wire break detected), depending on the fault it may take several seconds before the module detects the rectification of the fault. The acknowledgment does not have an effect until after this.

Data exchange between standard user program and safety program

In the event of inadequate programming, data corruption resulting in a CPU/ system stop may occur in the communication between standard user program and safety program (see (<https://support.industry.siemens.com/cs/document/19183712/what-should-you-do-if-the-f-cpu-goes-into-stop-mode-and-the-message-data-corruption-in-the-safety-program-appears-in-the-diagnostics-buffer-?dti=0&lc=en-WW>)).

Therefore two global data blocks should be used to exchange data between the standard user program and the safety program.

- DataToSafety
- DataFromSafety

The values in the DataToSafety data block are written by the standard user program and read by the safety program. The values in the DataFromSafety data block are written by the safety program and read by the standard user program. Since this example does not contain a standard user program, these two global data blocks were not included. They should be added by the user of this example.

Note

Further information on the data exchange between standard user program and safety program can be found in the "SIMATIC Safety - Configuring and Programming" Manual. (<https://support.industry.siemens.com/cs/ww/en/view/54110126>)

Commissioning and operation

5.1 Commissioning

5.1.1 Preparation

1. Download the "E-Stop_SIL3_Protective_door_tumbler_SIL2_AS-i.zap15_1" project file. Link: . (<http://support.automation.siemens.com/WW/view/en/109769506>)
2. Save the file in any folder on your computer.
3. Set the IP address of the PG/PC so that the PG/PC is in the same subnet as the CPU.
4. Connect the PG/PC to the Ethernet interface of the CPU 1512SP F-1 PN using an Ethernet cable.

The following IP address has been used for this application example:

CPU S7-1512SP F-1 PN

IP address: 192.168.0.1

Subnet mask: 255.255.255.0

5.1.2 Load S7 project into the CPU

1. Open "TIA Portal V15.1".
2. Switch to the project view.
3. Click "Project > Dearchive" in the menu bar of the TIA Portal.
4. Click "Browse" and dearchive the project.
5. Set the CPU 1512SP-1 F-1 PN to STOP.
6. Right mouse click in the project topology on "PLC_1 [CPU1512SP F-1 PN] and then on "Load into device > Hardware and software (changes only)".
7. In the open window, select the desired interface and click "Start search".
8. Select the CPU on the basis of the MAC address, and the click "Load".

Note

The IP address and the device name are automatically assigned when the project is loaded into the CPU.

9. Confirm the dialog by clicking "Load".
10. Click "Finished" when the loading process has finished.

5.1.3 Assigning PROFIsafe addresses

For safe communication between the F-CPU and the fail-safe modules (F-CM AS-i Safety and F-DQ), the correct PROFIsafe addresses must be assigned to the modules. To do this, follow the steps in Section 4.4.8. (Page 44)

Note

Since the PROFIsafe address is stored in the electronic coding element of the ET 200SP slot, this step is only necessary if a PROFIsafe address is missing, or if a different one was assigned.

Now set the CPU 1512SP F-1 PN to RUN.

Note

All red LEDs of the fail-safe modules should go out after the PROFIsafe addresses have been assigned. If this is not the case, there may be a fault in the wiring.

Apart from that, the ASIsafe code sequences still have to be read. The procedure for loading the code tables is described in Section 4.4.9 (Page 45) "Teach ASIsafe code sequences".

5.2 Using the application

Starting a machine

No.	Action	Note
1	Close the protective door.	
2	Move the toggle switch into the position that locks the protective door.	The voltage in the solenoid is switched off and the locking mechanism moves into the actuator. The protective door is locked.
3	Unlock the emergency stop button.	
4	Press the start pushbutton.	After the emergency stop button has been unlocked, acknowledgment is required. The machine starts.

Unlock and open the protective door

No.	Action	Note
1	Move the toggle switch into the position that unlocks the protective door.	The machine switches off and runs down.
2	Wait for the parameterized delay time before unlocking the protective door.	In this example: 5 seconds After the time has expired, the solenoid is supplied with power, and moves the locking mechanism out of the actuator. The protective door is unlocked.
4	Open the protective door.	

Acknowledging other faults in the safety function

If another fault occurs in the safety function, the machine is immediately switched off and a restart is prevented. Proceed as follows to acknowledge the fault.

Possible faults that are acknowledged in this way include:

- Cross circuit between the two emergency stop channels.
- External voltage on the fail-safe outputs
- Withdrawing a fail-safe module
- Contact welding of a contactor

No.	Action	Note
1	Check the LEDs on the fail-safe modules. If one red LED illuminates, a fault in the hardware has been detected. Search for the fault by means of the online diagnostics in the TIA Portal.	
2	If all LEDs are green, the safety program has detected a fault. Look at the variable table to find the fault.	The #fault and #ackReg variables of the ProtDoorWithInterlocking block instructions can help with the search.
3	Eliminate the fault.	
4	Close the protective door.	
5	Unlock the emergency stop button.	
6	Move the toggle switch to lock the protective door.	The voltage in the solenoid is switched off and the locking mechanism moves into the actuator.
7	Press the start pushbutton.	Passivated channels of the fail-safe modules are re-integrated. Faults detected by the safety program are acknowledged. The machine starts.

5.3 Evaluating the safety function

An evaluation is made according to both EN ISO 13849-1 and EN 62061 with the Safety Evaluation Tool (SET) (<http://siemens.de/safety-evaluation-tool>).

The result of the evaluation - the SET file (<http://support.automation.siemens.com/WW/view/en/109769506>)- is added to the SIOS entry of this document.

Appendix

6.1 Service and Support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round-the-clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs and application examples – all information is accessible with just a few mouse clicks here (<https://support.industry.siemens.com>).

Technical Support

The Technical Support of Siemens Industry provides you with fast and competent support regarding all technical queries with a variety of customized portfolio elements – from basic support to customized support contracts.

Send queries to Technical Support using the web form (<https://www.siemens.de/industry/supportrequest>).

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- Plant data services
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- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the Service Catalog (<https://support.industry.siemens.com/cs/sc>).

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" (<https://support.industry.siemens.com/cs/ww/de/sc/2067>) app. The app is available for Apple iOS, Android and Windows Phone.

6.2 Links and literature

No.	Topic
11	Siemens Industry Online Support (https://support.industry.siemens.com)
12	Link (http://support.automation.siemens.com/WW/view/en/109769506) to the entry page of the application example
13	Project file (http://support.automation.siemens.com/WW/view/en/109769506)

6.3 Version history

Version	Date	Change
V1.0	09/2019	First edition
V2.0	08/2020	Correction: Non-safety-related tumbler via integrated standard output of 3SF1324-1S.21-1BA4

