# FSPS-21 PROFIsafe safety functions module
## User's manual

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## User's manual

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# 1

# Safety instructions

## Contents of this chapter

The chapter describes the warning symbols used in this manual and refers to the safety instructions which you must obey when you install or connect an option module. If you ignore the safety instructions, injury, death or damage can occur. Read this chapter before you start the installation.

## Use of warnings and notes

Warnings tell you about conditions which can cause injury or death, or damage to the equipment. They also tell you how to prevent the danger. Notes draw attention to a particular condition or fact, or give information on a subject.

The manual uses these warning symbols:

**WARNING!**
Electricity warning tells about hazards from electricity which can cause injury or death, or damage to the equipment.

**WARNING!**
General warning tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.

**WARNING!**
Electrostatic sensitive devices warning tells you about the risk of electrostatic discharge which can cause damage to the equipment.

## Safety in installation and maintenance

**WARNING!**
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation or maintenance work.

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# Introduction to the manual

## Contents of this chapter

This chapter describes the compatibility of the FSPS-21 module, gives a list of recommended reading and related manuals, and provides a link to product certificates.

## Applicability

This manual applies to the FSPS-21 safety functions fieldbus module, revision A.

## Compatibility

### ■ Drives

The FSPS-21 safety fieldbus module is compatible with:

- ACS880 drives
    - ACS880 primary control program version 2.80 or later
- ACS580 drives
    - ACS580 standard control program version 2.05 or later
- ACS380 drives
    - ACS380 machinery control program version 2.05 or later
- DCS880 drives
    - DCS880 machinery control firmware version 2.06 or later

◼ **Tools**

- Drive composer pro: version 1.7 or later
- For ABB PLCs: Automation builder 1.0 or later - required licenses are:
  - DM200-TOOL for Automation Builder and
  - DM220-FSE for functional safety.
- For Siemens PLCs: SIMATIC Step 7 V5.5 + S7 Distributed Safety V5.4 and SIMATIC Step 7 (TIA Portal) + Step 7 Safety Advanced

◼ **PLCs**

For example, the following controller stations are supported:

- ABB AC500-S Safety PLC
- Siemens SIMATIC Fail-safe S7 PLC

**Note:** Other PLCs which support PROFIsafe over PROFINET can also be used with FSPS-21.

◼ **Protocol**

The FSPS-21 module is compatible with Ethernet standards IEEE 802.3 and IEE 802.3u and it supports the PROFINET IO protocol.

All PROFINET IO masters that support:

- GSDML file version 2.33
- PROFINET IO protocol according to IEC standards 61158 and 61784
- PROFINET IO conformance class B

are compatible with the PROFINET IO module. FSPS-21 module supports PROFIsafe version V2 (IEC 61784-3-3).

## Supported safety functions

This manual provides instructions for creating and using these safety functions (according to EN/IEC 61800-5-2):

- Safe torque off (STO)
- Safe stop 1 (SS1-t)

## Target audience

The manual is intended for qualified persons who design the safety application, plan the installation as well as install and commission the safety application. Read the manual

before starting work on the safety application. You must know the fundamentals of safety technology, electricity, wiring, electrical components and electrical schematic symbols.

## Purpose of the manual

The manual explains how to install the FSPS-21 module and configure and commission the supported safety functions. It describes how to meet and maintain safety life cycle requirements of the FSPS-21 module to ensure required safety performance and specified safety integrity.

## Recommended reading

This manual is based on the following standards. It is recommended that you are familiar with these standards before implementing safety-related systems.

- EN/IEC 61800-5-2: Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional. (Includes safety function definitions.)
- EN ISO 13849-1: Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
- EN/IEC 62061: Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
- EN 60204-1: Safety of machinery – Electrical equipment of machines – Part 1: General requirements.
- PROFIsafe System Description – Safety Technology and Application. Version April 2016. Order Number 4.342.

Before starting the implementation of safety-related systems, it is highly recommended to read and understand the following manuals, which will also be referred to in the later chapters of this manual.

- Functional safety; Technical guide No. 10 (3AUA0000048753 [English])
- Safety and functional safety; A general guide (1SFC001008B0201 [English])
- firmware and hardware manuals of the drive.

For a complete list of related standards and directives, see section *Related standards and directives*.

## Exclusion of liability

ABB is not responsible for the implementation, verification and validation of the overall safety system. It is the responsibility of the system integrator (or other party) who is responsible for the overall system and system safety.

The system integrator (or other responsible party) must make sure that the entire implementation complies with the instructions in this manual, all relevant standards,

directives and local electrical code, and that the system is tested, verified and validated correctly.

# Cybersecurity disclaimer

This product can be connected to and to communicate information and data via a network interface. The HTTP protocol, which is used between the commissioning tool (Drive Composer) and the product, is an unsecured protocol. For independent and continuous operation of product such connection via network to commissioning tool is not necessary. However it is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, prevention of physical access, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Notwithstanding any other provision to the contrary and regardless whether the contract is terminated or not, ABB and its affiliates are under no circumstances not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

# Terms and abbreviations

| Term | Description |
|---|---|
| Cat. | Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4. (EN ISO 13849-1) |
| CCF | Common cause failure (%) (EN ISO 13849-1) |
| Control unit | The part in which the control program runs. |
| Control word | 16-bit or 32-bit word from a controller to the controlled device with bit-coded control signals (sometimes called the Command word). |
| Cyclic communication | Communication in which messages are sent cyclically at pre-defined intervals |
| DC | Diagnostic coverage (EN ISO 13849-1) |
| DCP | Discovery Control Protocol. A protocol that allows the master controller to find every PROFINET IO device on a subnet. |
| DI | Digital input |
| Drive | Frequency converter for controlling AC motors |
| EMC | Electromagnetic compatibility |
| ESD | Electrostatic discharge |
| E-stop | Emergency stop |

| Term | Description |
|---|---|
| Fail-safe mode | The functional safety module has activated the drive STO function as a result of an error (in some cases, after a delay). To exit this mode and continue normal operation, reboot the functional safety module. |
| Fault reaction function | Function that is initiated when a fault within the safety component is detected by the component's diagnostic function. (62061-3.2.18, modified) |
| FIT | Failure in time: 1E-9 hours (IEC 61508) |
| GSD file | General Station Description file, an ASCII-format device description file in a specified form. Each different slave type on the PROFINET IO network needs to have its own GSD file. GSD files in PROFINET IO are written in GSDML. |
| IGBT | Insulated gate bipolar transistor |
| LSB | Least significant bit |
| MAC address | Media Access Control address |
| MRM | Media redundancy manager |
| MRP | Media redundancy protocol |
| MSB | Most significant bit |
| $MTTF_D$ | Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions (EN ISO 13849-1) |
| $PFD_{avg}$ | Average probability of dangerous failure on demand (IEC 61508) |
| PFH | Average frequency of dangerous failures per hour (IEC 61508) |
| PL | Performance level. Levels a...e correspond to SIL (EN ISO 13849-1) |
| PLC | Programmable logic controller |
| Power drive systems (Safety-related), PDS (SR) | Adjustable speed electrical power drive system suitable for use in safety-related applications |
| Profile | Adaptation of a communication protocol for a certain application field (for example drives) |
| PZD | PD, Process data |
| Response time | The internal response time of the functional safety module, that is, the time in which the STO control output of the functional safety module reacts after receiving a request. (Usually this is not the same as the time from the request to the safe state of the machine application.) See also term Safety function response time (SFRT). |
| Safe state | STO is active. The drive STO circuit is open, modulation stops and motor coasts. |
| Safety function response time | Worst case elapsed time following an actuation of a safety sensor connected to a fieldbus before the corresponding safe state of its safety actuator(s) is achieved in the presence of errors or failures in the safety function channel. |
| Safety module; functional safety module | Part of a safety system, a physical entity. For example: FSPS-21, FSO-21. |
| Safety-related parameter | Parameters which have direct impact to the behavior of the safety function of the application, eg, trip limit parameter for a safely limited speed function. Unauthorized access to these parameters is prevented with a password. |

| Term | Description |
|---|---|
| SC | Systematic capability (IEC 61508) |
| SFF | Safe failure fraction (%) (IEC 61508) |
| SIL | Safety integrity level (1...3) (IEC 61508) |
| SILCL | Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061) |
| SS1 | Safe stop 1 (IEC/EN 61800-5-2) |
| SS1-t | Safe stop 1, time controlled |
| Status word | 16-bit or 32-bit word from a controlled device to the controller with bit-coded status signals |
| STO | Safe torque off (IEC/EN 61800-5-2) |
| Stop category | There are three categories of stop functions defined by IEC/EN 60204-1:<br>• stop category 0: an uncontrolled stop where power to the machine actuators is removed immediately (for example, STO)<br>• stop category 1: a controlled stop where the machine actuators have power for stopping, after which the power is removed (SS1)<br>• stop category 2: a controlled stop where the machine actuators continue to have power (SS2). |
| $T_1$ | Proof test interval. Defines the probabilistic failure rate (PFH or $PFD_{avg}$) for the safety function or subsystem. Performing a proof test at a maximum interval of $T_1$ is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any $T_1$ values given cannot be regarded as a guarantee or warranty. |
| Validation | Confirmation by, for example, analysis that the safety system meets the functional safety requirements of the specific application. |
| Verification | Confirmation by, for example, testing that the safety system meets the requirements set by the specification. |
| VSD | Variable speed drive |
| Zero speed | For safety functions, the zero speed limit indicates the completion of the safe stopping function. |
| $\lambda_d$ | Dangerous failure rate |
| $\lambda_s$ | Safe failure rate |

# Certificates

The valid TÜV, PROFINET and PROFIsafe certificates are available on the ABB online library (www.abb.com/drives/documents).

# Related manuals

| Name | Code |
|---|---|
| **Drive hardware manuals** | |
| ACS880-01 hardware manual | 3AUA0000078093 |
| ACS880-04 hardware manual | 3AUA0000128301 |

| Name | Code |
|---|---|
| ACS880-04 single drive module packages hardware manual | 3AUA0000138495 |
| ACS880-14 and -34 single drive module packages hardware manual | 3AXD50000022021 |
| ACS880-04XT drive modules (500 to 1200 kW) hardware manual | 3AXD50000025169 |
| ACS880-04FXT drive module packages hardware manual | 3AXD50000274444 |
| ACS880-07 (45 to 630 kW) hardware manual | 3AUA0000105718 |
| ACS880-07 (560 to 2800 kW) hardware manual | 3AUA0000143261 |
| ACS880-17 (160 to 3200 kW) hardware manual | 3AXD50000020436 |
| ACS880-37 (160 to 3200 kW) hardware manual | 3AXD50000020437 |
| ACS880-17 (132 to 355 kW) hardware manual | 3AXD50000035158 |
| ACS880-37 (132 to 355 kW) hardware manual | 3AXD50000035159 |
| ACS880-104 inverter modules hardware manual | 3AUA0000104271 |
| ACS880-107 inverter units hardware manual | 3AUA0000102519 |
| ACS880-11 hardware manual | 3AXD50000045932 |
| ACS880-31 hardware manual | 3AXD50000045933 |
| ACS580-01 drives (0.75 to 250 kW, 1.0 to 350 hp) hardware manual, frames R1-R9 | 3AXD50000044794 |
| ACS580-01 drives (0.75 to 250 kW, 1.0 to 350 hp) hardware manual, frames R0-R9 | 3AXD50000018826 |
| ACS580-04 hardware manual | 3AXD50000015497 |
| ACS580-07 drives (75 to 250 kW) hardware manual | 3AXD50000045815 |
| ACS580-07 (250 to 500 kW) hardware manual | 3AXD50000032622 |
| ACS380 hardware manual | 3AXD50000029274 |
| DCS880 hardware manual | 3ADW000462 |
| Supplement for functional safety converters DCS880 | 3ADW000452 |
| **Drive firmware manuals** | |
| ACS880 primary control program firmware manual | 3AUA0000085967 |
| ACS580 standard control program firmware manual | 3AXD50000016097 |
| ACS380 machinery control program firmware manual | 3AXD50000029275 |
| DCS880 firmware manual | 3ADW000474 |
| **Option manuals** | |

| Name | Code |
|---|---|
| FSPS-21 safety functions fieldbus module user's manual | 3AXD50000158638 |
| ACX-AP-x assistant control panels user's manual | 3AUA0000085685 |
| ACS-BP-S Basic control panel user's manual | 3AXD50000032527 |
| Manuals and quick guides for I/O extension modules, fieldbus adapters, etc. | |
| **Drive PC tool manual** | |
| Drive composer start-up and maintenance PC tool user's manual | 3AUA0000094606 |
| **General safety guides** | |
| Functional safety; Technical guide No. 10 | 3AUA0000048753 |
| Safety and functional safety; A general guide | 1SFC001008B0201 |
| AC500-S Safety User Manual V1.2.1 | 3ADR025091M0209 |
| PLC Automation with AC500 V3 and Automation Builder 2.4.0 Instruction Manual | 3ADR010583 |
| PLC Automation with AC500 V2 and Automation Builder 2.4.0 Instruction Manual | 3ADR010582 |

You can find manuals and other product documents in PDF format on the Internet. See www.abb.com/drives/documents. For manuals not available in the Document library, contact your local ABB representative.

For additional ABB safety information and solutions visit http://www.abb.com/safety.

# 3

# Safety system information and considerations

## Contents of this chapter

This chapter contains general safety considerations and information you must take into account when you apply the safety functions.

## Applying FSPS-21 safety functions

To ensure that the application where FSPS-21 and its safety functions are used is safe to use and fulfils all necessary safety requirements, it is necessary to take into account the requirements of the local (machinery) safety legislation (eg, Machinery Directive) and/or of the applicable functional safety standards (eg, ISO 13849-1).

To make safe applications and implementing safety functions requires systematic approach / process, where risk assessment is the basis of all safety requirements. These processes are described in global ISO & IEC machinery safety and/or functional safety standards (eg, ISO 12100, 13849-1, IEC 62061). These are also introduced in *Functional safety; Technical guide No. 10* (3AUA0000048753 [English]).

Before you take into use any system where FSPS-21 with its safety functions is used, and also every time you modify any application parameters or the configuration related to safety, you must check the safety and correct operation of the entire system by verifying and validating it according to the system safety verification plan. See chapter *Verification and validation (page 215)*.

# Meeting the requirements of the Machinery Directive

If the machine, where the FSPS-21 module is part of a safety system, is going to be sold or taken into use in Europe, it is the responsibility of the machine builder / OEM / system integrator to make sure that the machine is safe to use and all relevant essential health and safety requirements (EHSR) of the Machinery Directive are fulfilled. The requirements in the applicable standards must also be met and the safety module must be used according to all instructions provided in this manual.

# Responsibilities

ABB as a component manufacturer is only responsible of the safety and conformity of their manufactured products, not of the systems, where these products are used.

If you detect any failure in safety functions, contact your local ABB representative.

# Intentional misuse

Use the safety module according to the instructions given in the user's manual. ABB is not responsible for any damage caused by the misuse of the module.

The module is not designed to protect a machine against intentional misuse or sabotage.

# Safety-related parts

The safety module and the drive Safe torque off (STO) channel/function are safety relevant, and the rest of the drive is considered as not safety relevant, for example, the drive regular I/O cannot be used for requesting safety functions on the safety module.

# Limitations of Safe torque off (STO) function

The Safe torque off function can be used for stopping the drive in the operational mode. If a running drive is stopped by using the STO function, the drive stops by coasting. STO function can also be used for prevention of unexpected start-up according to the limitations of IEC 60204-1, 5.4 and ISO 14118.

The Safe torque off function does not disconnect or isolate the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on any electrical parts of the system (including drive and the motor) can only be carried out after proper isolating procedure, which must be followed to make sure that the maintained part of the system is properly isolated.

# Overall system stopping performance

A safety function always consists of other components in addition to FSPS-21. The overall safe stopping time of the entire system must be according to the requirements of the risk assessment. This means that the dangerous movement of the machine must be stopped before any dangerous situation can occur.

Safety function response time and the FSPS-21 module response times are specified in section *Response times (page 243)*.
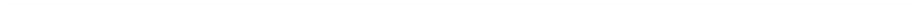
# 4

# Overview of the FSPS-21 module and the Ethernet network

## Contents of this chapter

This chapter contains on overview of the Ethernet network and the FSPS-21 module.

## Module overview

The FSPS-21 is an option module for ABB Drives drive families ACS880, ACS580, ACS380 and DCS880 which enables the connection of the drive to an Ethernet network and a safety PLC.

The intended use of the FSPS-21 safety option module is to safely stop the PDS(SR) (VSD, drive). The module provides two safety functions, STO and SS1-t, which are activated via PROFIsafe over PROFINET. It is also possible to use the module to control the PDS(SR) over PROFINET.

Through the FSPS-21 module you can:

- start and stop the drive and reset drive faults
- give speed or torque reference to the drive
- read drive status word bits
- write to drive control word bits
- perform safety functions

The protocol used to access these functionalities over the Ethernet is:

- PROFINET IO – Communication protocol
- PROFIsafe over PROFINET IO

    **Note:** ABB recommends that you use only PROFINET compatible Ethernet switches and cables in the PROFIsafe communication bus.

The module supports 10 Mbit/s and 100 Mbit/s data transfer rates and automatically detects the data transfer rate used in the network.

The FSPS-21 module supports two safety functions which are activated from a safety PLC:

- **Safe torque off (STO)**:This safety function activates the STO function in the drive, this is, opens the drive STO circuit. The motor coasts to a stop (stop category 0).
- **Safe stop 1 (SS1-t)**: This safety function stops the motor safely by ramping down the motor speed to zero speed (stop category 1). When the drive indicates that zero speed is reached, this safety function activates the drive STO. If zero speed has not been reached within the SS1-t monitored time limit, this safety function activates the drive STO.

The module is installed into an option slot on the drive control unit. See the drive manuals for module placement options.

### ■ Safety-related parameters

The configuration of the FSPS-21 safety functions module does not include any safety-related parameters. For other parameters, see section *Drive parameters related to FSPS-21 module configuration*.

### ■ Diagnostics

The FSPS-21 module performs extensive auto diagnostics tests during the power-up and runtime operation on internal parts as well as the communication and STO connection between the module and the drive.

**Fault reaction function**

The module activates STO and goes into Fail-safe mode if it detects a fault in:

- the STO connection between the FSPS-21 module and the drive STO connector.
- the internal parts of the module (CPU, memory, etc).

The module activates STO and goes into the Passivation state if it detects a fault in:

- the PROFIsafe communication between the module and the safety PLC.

The fault reaction function activates the fail-safe mode as described in chapter *FSPS-21 module modes (page 146)*.

### ■ Automatic acknowledgement

FSPS-21 only has an automatic acknowledgement method for a safety function. This means that when the safety function request is removed, the FSPS-21 automatically enters the Operational state. Automatic acknowledgement also takes place during module start-up.

Manual acknowledgement can only be programmed into a safety PLC. For more information on FSPS-21 states, see section *States (page 37)*.

⚠ **WARNING!**
FSPS-21 module has automatic acknowledgement method. Make sure that the system is designed so that this does not cause unacceptable risk, eg, due to automatic start of the drive.

## Ethernet network

Ethernet standards support a variety of physical media (coaxial cable, twisted pair, fiber optics) and topologies (bus and star).

The FSPS-21 module supports twisted pair as the physical media. FSPS-21 supports star topology, daisy chain topology and ring topology

The maximum length for an Ethernet segment on twisted pair media is 100 meters. All twisted pair media between the Ethernet node and the switch or router must be shorter than 100 meters, including media within patch panels.

### ■ Example topology of the Ethernet link

The figures below show example topologies for an Ethernet network with FSPS-21.

Star topology

Daisy chain topology using integrated Ethernet switch

# 5

# Safety functions

## Contents of this chapter

This chapter describes the safety functions supported by the FSPS-21 module.

## Safety functions

### ■ STO

The STO function brings the machine safely into a no-torque state and/or prevents it from starting accidentally. The STO function in the FSPS-21 module activates the drive STO function, that is, opens the STO circuit in the drive. This prevents the drive from generating the torque required to rotate the motor. If the motor is running when the STO function is activated, it coasts to a stop.

For more information on the STO function in the drive, see the drive hardware manual.

The operation of the STO function is described in the time diagram and table below.
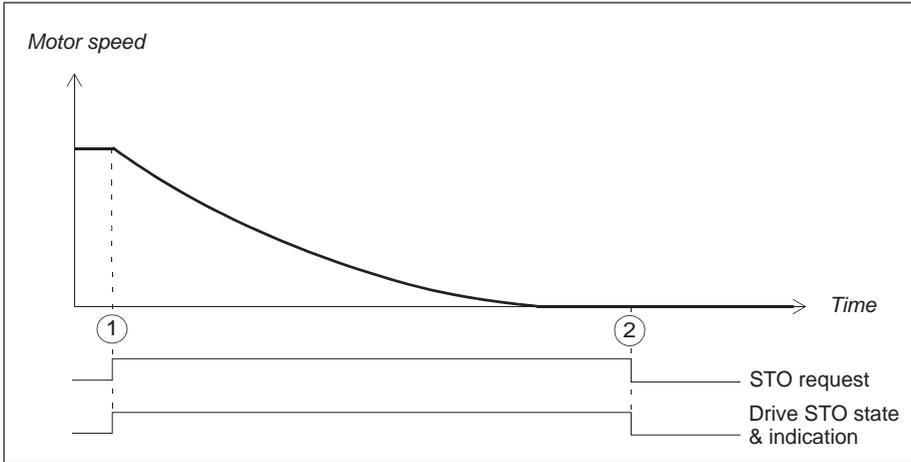
| Step | Description |
|------|-------------|
| 1 | The STO request is received from the safety PLC. The module activates the drive STO function. The STO indications in the drive and safety PLC go on. |
| 2 | The STO request is removed from the safety PLC. The STO function is deactivated and the indications go off. |

### ■ SS1 with time monitoring

The SS1-t function stops the motor safely by ramping down the motor speed. The FSPS-21 module activates the drive STO function when zero speed limit, defined with parameter **21.06 Zero speed limit**, is reached (*21.06 Used zero speed level* for DCS880).

The SS1 function uses drive parameter **23.23 Emergency stop ramp** to define the stop ramp. For ACS880, ACS580 and ACS380, see section *Drive parameters related to FSPS-21 module configuration (ACS880, ACS580 and ACS380) (page 56)* for more information. For DCS880, see section *Drive parameters related to FSPS-21 module configuration (DCS880) (page 57)*.

The FSPS-21 module monitors the stop ramp with a time limit. If the motor speed does not reach the user-defined zero speed limit within the specified time limit, the module activates the drive STO function, the motor coasts to a stop, and FSPS-21 creates a fault (0x7AA0).

The SS1 time limit 0.0...3276.7 s is set by the safety PLC in PS3 telegram SS1-t_time variable, see section *ABB_PS3 profile F-Output user data (page 145)*.

The operation of the SS1 with time monitoring (SS1-t) is described in the timing diagrams below.

**Note:** The controlled stop of SS1-t can fail undetected, therefore SS1-t cannot be applied if this failure can cause a dangerous situation in the final application.

**Timing diagrams**

*SS1-t function normal operation*



A       SS1-t delay for STO: Time after which the module activates the drive STO function re-gardless of the motor speed. The value is received from the safety PLC in each SS1-t activation request, see section *ABB_PS3 profile F-Output user data (page 145)*.

B       Zero speed (drive parameter 21.06): Speed limit for activating the drive STO function.

C       Safety function response time (depends on system configuration). For more information see chapter *Technical data*.

| Step | Description |
|------|-------------|
| 1 | The SS1-t request is received from the safety PLC. The module starts a counter for time A. The SS1-t indication (Off3) in the drive and safety PLC goes on. |
| 2 | After time C has elapsed, the drive starts to ramp down the motor speed. Drive para-meters define the deceleration ramp (emergency stop ramp). |
| 3 | The motor speed reaches the user-defined zero speed limit (B) and the module activates the drive STO function. |
| 4 | The SS1-t request is removed from the safety PLC. The STO and SS1 functions are automatically acknowledged and the indications go off. |

*SS1-t function, pulse request*



A    SS1-t delay for STO: Time after which the module activates the drive STO function re-
     gardless of the motor speed. The value is received from the safety PLC in each SS1-t
     activation request, see section *ABB_PS3 profile F-Output user data (page 145)*.

B    Zero speed (drive parameter 21.06): Speed limit for activating the drive STO function.

C    Safety function response time (depends on system configuration). For more information
     see chapter *Technical data*.

| Step | Description |
|------|-------------|
| 1 | The SS1-t request is received from the safety PLC. The module starts a counter for time A. The SS1-t indication (Off3) in the drive and safety PLC goes on. |
| 2 | After time C has elapsed, the drive starts to ramp down the motor speed. Drive para-meters define the deceleration ramp (emergency stop ramp). |
| 3 | The SS1-t request is removed from the safety PLC. |
| 4 | The motor speed reaches the user-defined zero speed limit (B) and the module activates the drive STO function. |
| 5 | The STO indications quickly go on and off, and SS1 indication is removed.<br>**Note:** The time STO state was active might not be seen on PLC. |

*SS1-t function, time delay passed*



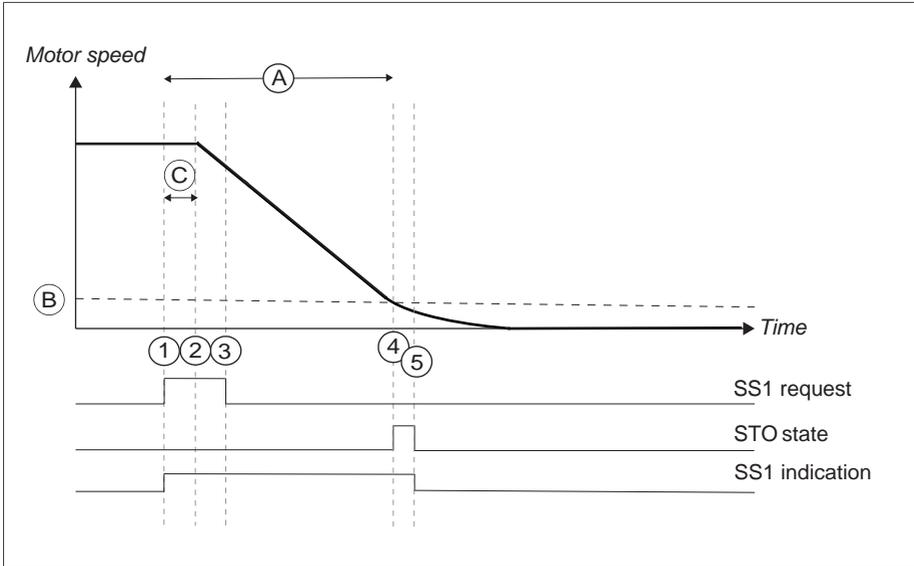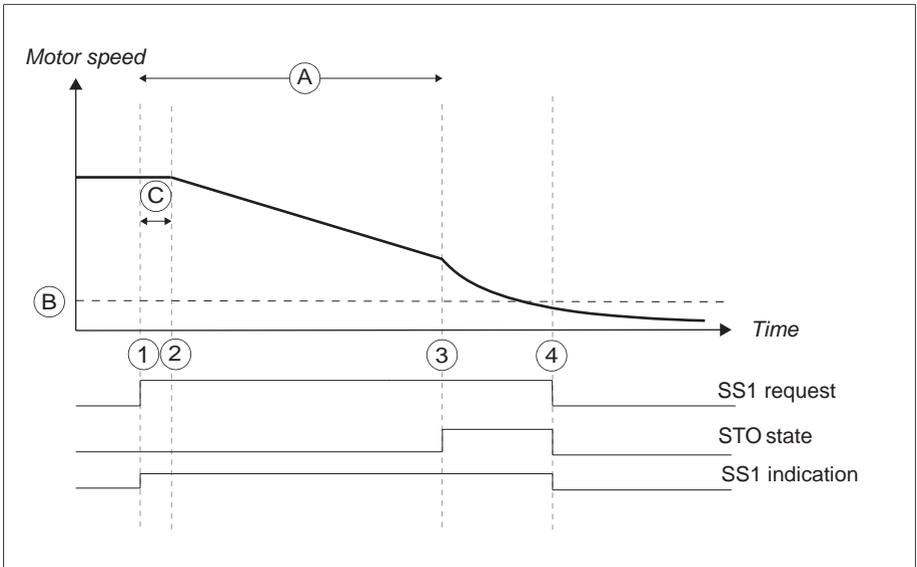| | |
|---|---|
| A | SS1-t delay for STO: Time after which the module activates the drive STO function re-gardless of the motor speed. The value is received from the safety PLC in each SS1-t activation request, see section *ABB_PS3 profile F-Output user data (page 145)*. |
| B | Zero speed (drive parameter 21.06): Speed limit for activating the drive STO function. |
| C | Safety function response time (depends on system configuration). For more information see chapter *Technical data*. |

| Step | Description |
|---|---|
| 1 | The SS1-t request is received from the safety PLC. The module starts a counter for time A. The SS1-t indication (Off3) in the drive and safety PLC goes on. |
| 2 | After time C has elapsed, the drive starts to ramp down the motor speed. Drive para-meters define the deceleration ramp (emergency stop ramp). |
| 3 | The defined SS1-t delay time has elapsed and the module activates the drive STO function. |
| 4 | The SS1-t request is removed from the safety PLC. The STO and SS1 functions are automatically acknowledged and the indications go off. |

*SS1-t function drive modulation stopped*



A    SS1-t delay for STO: Time after which the module activates the drive STO function re-
     gardless of the motor speed. The value is received from the safety PLC in each SS1-t
     activation request, see section *ABB_PS3 profile F-Output user data (page 145)*.

B    Zero speed (drive parameter 21.06): Speed limit for activating the drive STO function.

C    Safety function response time (depends on system configuration). For more information
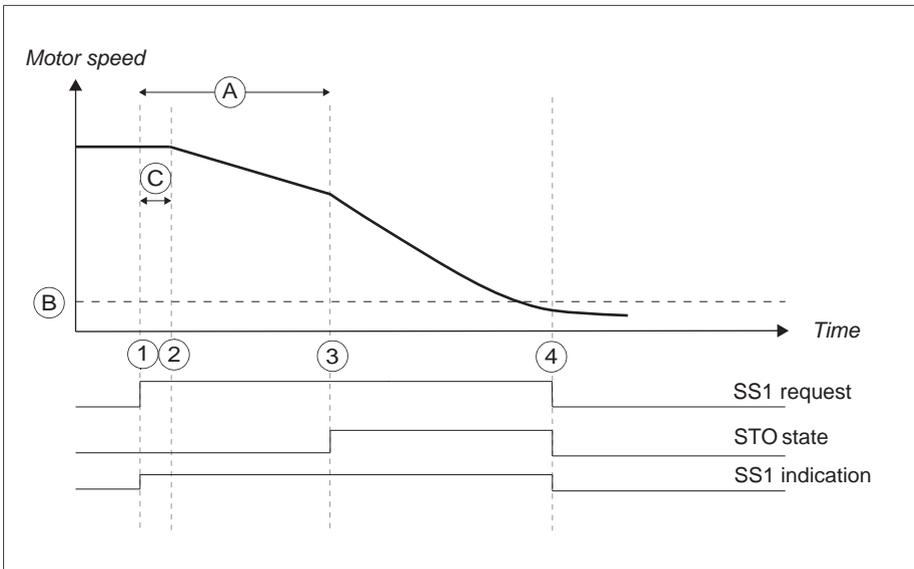     see chapter *Technical data*.

| Step | Description |
|------|-------------|
| 1 | The SS1-t request is received from the safety PLC. The module starts a counter for time A. The SS1-t indication (Off3) in the drive and safety PLC goes on. |
| 2 | After time C has elapsed, the drive starts to ramp down the motor speed. Drive para-meters define the deceleration ramp (emergency stop ramp). |
| 3 | The modulation of the drive is stopped during ramp down (Eg. Drive enable signal re-moved, stop request from panel or from ATEX module, etc.) and the module activates the drive STO function. |
| 4 | The SS1-t request is removed from the safety PLC. The STO and SS1 functions are automatically acknowledged and the indications go off. |

## ■ Priorities of safety functions

STO function will always override SS1-t function, should they occur within the same
time frame.

# Acknowledgement methods

The safety functions have one acknowledgement method for entering the Operational state (during start-up, or after a safety function request is removed):

- **Automatic**: The module grants the drive permission to restart after a safety function request is removed or the start-up is complete. If the drive is in the automatic restart mode, it starts automatically, which may cause danger.

**Note:** In addition, you can create a manual acknowledgement method in the safety PLC program.

⚠ **WARNING!**
FSPS-21 module only has the automatic acknowledgement method. Make sure that the system does not start up unexpectedly, eg, due to automatic start of the drive.

# States and modes

## ◼ States

When the FSPS-21 module is up and running, it can be in one of the following states depending on the drive STO status:

- **Safe**: STO active, that is, the drive STO circuit is open, modulation stops, and motor coasts.
- **Operational**: STO inactive.

In the Operational and Safe states, the FSPS-21 module can execute the safety functions.

## ◼ Modes

The FSPS-21 can be in one of the following modes:

- **Power down**: The power to the FSPS-21 is off. The drive STO circuit is open.
- **Start-up**: The FSPS-21 is starting up after power-up.
- **Running**: The FSPS-21 is up and running. It can be in different states (see previous section) depending on the status of safety functions and the safety fieldbus communication.
- **Failure-detected**: The FSPS-21 has detected a failure, drive STO is activated, and FSPS-21 enters the Fail-safe mode. It can be in different states (see previous section) depending on the status of safety functions and the safety fieldbus communication.
- **Fail-safe**: There is a failure in the FSPS-21 and Safe state has been reached. The drive STO is active. You have to reboot the FSPS-21 to exit the Fail-safe mode.

For more information on the FSPS-21 LEDs, see section .

For more information on the states and modes, see *FSPS-21 module modes (page 146)*.

## ■ Safety functions indications

You can see the status of safety functions from the PROFIsafe message. Only PROFIsafe information can be used for functional safety applications.

In addition, the drive indicates the drive STO status according to parameter *31.22 STO indication run/stop*. For more information, see the firmware manual.

# 6

# Hardware description

## Contents of this chapter

This chapter gives a short description of the module.

## FSPS-21 layout

| No. | Description |
|-----|-------------|
| 1 | Lock |
| 2 | Mounting and grounding screw |
| 3 | RJ-45 connector [X1] to Ethernet |
| 4 | RJ-45 connector [X2] for chaining another module |
| 5 | STO connector (under connectors [X1] and [X2]) |
| 6 | Diagnostic LEDs |
| 7 | MAC ID |

## Type designation label



| No. | Description |
|-----|-------------|
| 1 | Type |
| 2 | Serial number of format RYWWSSSSWS, where<br>R: component revision; A, B, …<br>Y: Last digit of the manufacturing year: 4, 5, … for 2014, 2015<br>WW: Manufacturing week: 01, 02, … for week 1, week 2, …<br>SSSS: Integer starting every week from 0001<br>WS: Manufacturing location |
| 3 | ABB MRP code of the FSPS-21 module |
| 4 | Combined ABB MRP code, component revision, serial number and manufacturing location |
| 5 | RoHS mark |

# 7

# Planning for installation

## Contents of this chapter

This chapter gives instructions and references to instructions in other manuals for planning the safety system installation, as well as the requirements for installation in the applicable safety standards.

## Requirements for designers and installers

- Designers and installers must be trained to understand the requirements and principles of designing and installing safety-related systems.

- Designers and maintainers must be trained to understand the causes and consequences of Common Cause Failures (CCF). See the checklist for the appropriate standard in section *Common cause failure (CCF) checklists (page 52)*.

## Installation site

The subsystem elements must always be likely to operate within the range of temperature, humidity, corrosion, dust, vibration, etc. for which they are specified, without the use of external environmental control (see section *Technical data*).

The FSPS-21 module must only be used in an environment where no conductive dust or contaminants are present. One way to ensure proper protection against contamination is to use the FSPS-21 module in at least an IP54 enclosure. For further information on environmental limits, see chapter *Planning the mechanical installation* in the drive hardware manual.

---

⚠ **WARNING!**
If you operate the drive system with a safety module in environmental conditions
that are outside of the specified ranges for the safety module, this can cause that
a safety function is lost.

---

# Electrical installation

## ▪ General requirements

Electrical installation of the safety system must be performed according to the practices
outlined in chapter *Planning the electrical installation* in the drive hardware manual.

Chapter *Installation checklists (page 51)* provides additional advice for the planning.

All wiring must be well protected, routed and clamped where practicable.

When installing cabling it must be assured that there is no pulling or pinching on the
cables.

## ▪ Ensuring the EMC compatibility

The system must only be used in the EMC environment it is designed for, or necessary
mitigations must be applied.

# 8

# Mechanical installation

## Contents of this chapter

This chapter contains a delivery checklist and instructions on installing the module.

## Necessary tools and instructions

You will need a Torx TX10 screwdriver to secure the FSPS-21 module to the drive. See also the drive hardware manual.

## Unpacking and examining the delivery

1. Open the option package.

2. Make sure that the package contains:

   • fieldbus module, type FSPS-21 (1)

   • STO cable (with a connector suitable for ACS880/DCS880 series drives) (2)

   • quick guide (not shown in the figure).

3. Make sure that there are no signs of damage.

## Installing the module

⚡ ⚠️ **WARNING!**
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

The module is installed to a free option slot on the drive control unit. Plastic pins, a lock and one screw hold the module in place. The screw also makes an electrical connection between the module and drive frame for cable shield termination.

**Note:** Drives with separate supply and inverter units:

FSPS-21 is an option module that can be installed to an inverter unit only. If PROFInet communication to the supply unit is needed, install FPNO-21 or FENA-21 to the supply unit.

**Note:** Do not install the FSPS-21 module on the FEA-03 F-series extension adapter.

When the module is installed, it makes the signal and power connection to the drive through a 20-pin connector.

To install or remove the module from the control unit:

1. Pull out the lock.
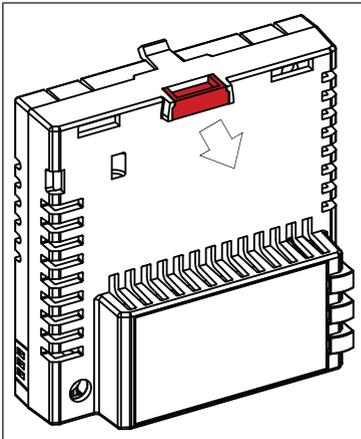


2. Install the module carefully to an option module slot of the drive. See the drive hardware manual.

3. Push in the lock.
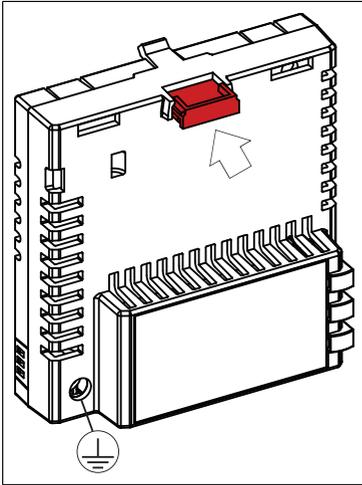


4. Tighten the screw to torque 0.8 N·m using a Torx TX10 screwdriver.

**WARNING!**
Do not use excessive force, or leave the screw too loose. Overtightening can damage the screw or module. A loose screw decreases the EMC performance, and can even cause an operation failure.

# 9

# Electrical installation

## Contents of this chapter

This chapter contains general cabling instructions and instructions on connecting the FSPS-21 module to the Ethernet network and the drive.

## Necessary tools and instructions

See the drive hardware manual.

## General cabling instructions

- Arrange the bus cables as far away from the motor cables as possible.

- Avoid parallel runs.

- Use bushings at cable entries.

- If the STO cable is too long, you can cut it shorter. Obey good engineering practices to do this.

## Connecting the FSPS-21 to the Ethernet network and to the STO of the drive

⚠⚠ **WARNING!**
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

The network cable can be CAT5 or higher, braided and foiled shield, with minimum AWG 22 / 0×32mm$^2$. Use a PROFINET-certified cable. The cable shield is connected

to the drive frame through an RC network. It is recommended to use a dedicated PROFINET-cable for PROFINET installation.

**Note:** Further information on PROFINET-wiring is available from the PROFIBUS organization publications at
https://www.profibus.com/download/profinet-installation-guidelines/

- Design guideline, Order no. 8.062

- Installation guideline for cabling and assembly, Order no. 8.072

- Commissioning guide, Order no. 8.082

### ■ Terminals



| Con-nector | Description |
|---|---|
| A | Mounting and grounding screw |
| X1 | X1 connector to Ethernet |
| X2 | X2 connector for chaining another module |
| STO | STO connector |

1. Connect the network cable to connector [X1] on the module.

2. If you want to create a daisy chain network with the modules, connect connector [X2] of the first module to connector [X1] on the next module, and so on.

3. Connect the STO cable to the module (black connector).

4. **ACS880/DCS880:** Connect the yellow connector to drive's STO connector.
   **ACS380/580:** Remove the yellow connector from the cable and connect the wires to drive's STO connectors (see figure below).

   **Note:** It is not allowed to install any devices between the FSPS-21 and the drive STO connector, unless otherwise guided. See safety related technical instructions in https://new.abb.com/drives/functional-safety.

   **Note:** It is not allowed to use external power supply for the STO circuit with the FSPS-21 module.

**ACS580 drive**

FSPS-21     Control unit

STO     STO

Red — 34 OUT1

35

Black — 36 DGND

Yellow — 37 IN1

White — 38 IN2

**ACS380 drive**

FSPS-21     Control unit

STO    Red    SGND   S1

S+   S2

Black

Yellow

White
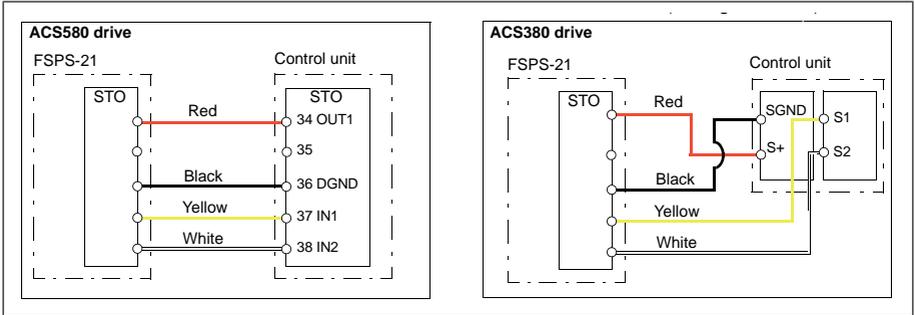
# 10

# Installation checklists

## Contents of this chapter

This chapter contains a checklist for checking the mechanical and electrical installation of the FSPS-21 module and refers to common cause failure checklists in standards.

## Checklists

Check the mechanical and electrical installation of the module before start-up. Go through the checklists below together with another person and make a memo as needed. Read chapter *Safety instructions (page 13)* before you work on the safety system.

### ■ General checklist

| Check that … | ☑ |
|---|---|
| The ambient operating conditions are within the allowed range. | ☐ |
| Transportation stops and packing material have been removed from the installation area. | ☐ |
| The module is fastened properly. | ☐ |
| The drive and the module are properly grounded to the same potential. | ☐ |
| The network cable is properly connected. | ☐ |
| The STO cable is correctly installed. | ☐ |

## ◼ Common cause failure (CCF) checklists

Check measures against common cause failures (CCF). There is one checklist in EN ISO 13849-1 and another in EN/IEC 62061. The checklists are useful for both the planning of the installation and the actual installation.

# 11

# **Commissioning**

The commissioning procedure of FSPS-21 module is as follows:

**Note:** The safety of the machine users must be ensured during the commissioning.

**Note:** FSPS-21 will keep the STO function active until the PROFIsafe communication with the drive has been established and the reintegration is requested by the safety PLC.

**Note:** It is possible to disable the communication between the FSPS-21 module and the drive with parameter '50.01 FBA A enable' by setting the value of this parameter to *0*.

1. Commission, configure and do necessary ID runs for the drive according to the drive's HW & FW manuals.

2. Install FSPS-21 according to the FSPS-21 user manual instructions (see chapter *Electrical installation*).

3. Configure the PROFINET and PROFIsafe with FSPS-21 according to the application needs through the drive's fieldbus parameter groups (50 – 56) (See chapter *Configuration*).

4. Create a safety PLC project with PROFIsafe communication to the drive (see examples from chapter *PROFIsafe*).

5. Validate safety functions (See chapter *Verification and validation*).

# 12

# Configuration

## Contents of this chapter

This chapter lists the parameters related to the safety functions and gives configuration instructions.

## Competence

The person who configures the safety functions must be a competent person as required by IEC 61508-1 clause 6. In this context, the person must have adequate expertise and knowledge of functional safety, the safety functions as well as the configuration of the module. We recommend our training courses on the FSPS-21 module in ABB MyLearning portal.

## Tools

You need a control panel or the Drive composer PC tool to configure the FSPS-21 module. For more information, see Drive composer start-up and maintenance PC tool user's manual (3AUA0000094606 [English]) or a control panel user's manual.

# Drive parameters related to FSPS-21 module configuration (ACS880, ACS580 and ACS380)

This table lists the drive parameters related to the FSPS-21 module and the safety functions for ACS880, ACS580 and ACS380 drives. For more information, see the firmware manual.

| Index | Name | Description |
|-------|------|-------------|
| 21.06 | Zero speed limit | Sets the zero speed limit for the drive. The drive will stop modulating when the zero speed limit is reached. Relevant for the SS1-t function. |
| 21.07 | Zero speed delay | Sets the delay for the zero speed delay function. The function is useful in applications where a smooth and quick restarting is essential. During the delay, the drive knows the rotor position accurately.<br>Relevant for the SS1-t function. |
| 23.23 | Emergency stop time | In speed control mode, this parameter defines the deceleration rate for emergency stop Off3 as the time it would take for the speed to decrease from the value of parameter **46.01 Speed scaling** to zero. This also applies to torque control because the drive switches to speed control on receiving an emergency stop Off3 command.<br>In frequency control mode, this parameter specifies the time it would take for the frequency to decrease from the value of **46.02 Frequency scaling** to zero.<br><br>**Note:** With SS1 commanded from FSPS-21, emergency stop mode is always set as *Ramp*.<br><br>**Note:** Parameters 21.04 Emergency stop mode and 21.05 Emergency stop source have no effect to the safety functions of the FSPS-21 module. |
| 25.15 | Proportional gain em stop | Defines the proportional gain for the speed controller when an emergency stop is active. |

| Index | Name | Description |
|-------|------|-------------|
| 31.22 | STO indication run/stop | Selects which indications are given when one or both Safe torque off (STO) signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs. The tables at each selection below show the indications generated with that particular setting. **Notes:** This parameter does not affect the operation of the STO function itself. The STO function will operate regardless of the setting of this parameter: a running drive will stop upon removal of one or both STO signals, and will not start until both STO signals are restored and all faults reset. The loss of only one STO signal always generates a fault as it is interpreted as a malfunction. For more information on the STO, see the hardware manual of the drive. |
| 51.24 | PROFIsafe destination address | Sets the PROFIsafe destination address, that is, the individual address of the FSPS-21 module in the safety communication network. **Note**: This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). |

## Drive parameters related to FSPS-21 module configuration (DCS880)

This table lists the drive parameters related to the FSPS-21 module and the safety functions for DCS880. Always verify that the recommended setting values below fit the application requirements and the risk assessment. For more information, see the firmware manual.

| Index | Name | Description |
|---|---|---|
| 21.03 | Emergency stop mode | Mode for Off3 control (emergency stop). Selects the way the motor is stopped when an Off3 (emergency stop) command is given. See 06.09.b02 Used main control word. Priority list: <br> • 06.09.b01 Off2 control (highest) <br> • 21.03 Emergency stop mode <br> • 21.02 Off1 mode <br> • 21.04 Stop mode (lowest) <br><br> **Note:** For the emergency stop request (SS1) by FSPS-21 safety module, the emergency stop mode is forced to emergency ramp stop. The information of the setting xxx MC on is retained. Thus, if any of the options 0, 1, 2, 3 or 4 is chosen, an emergency ramp stop is done with opening the mains contactor (or other load switching device) if SS1 is requested. The same holds true for options 6, 7, 8, 9 and 10 except that the load switching device remains closed. <br> **Recommended setting: 2** (Emergency ramp stop) |
| 21.08 <br> 42.21 [1] | M1 zero speed level [1] <br> M2 zero speed level [1] | Motor 1 zero speed level. <br> When a Stop command is given, the motor decelerates along a speed ramp or at torque limit until the zero-speed level is reached and **21.09 M1 zero speed delay** is elapsed. See 21.04 Stop mode Afterwards the motor will coast. At that moment, existing brakes are closed (applied). <br> When an emergency stop request (SS1) is given by FSPS-21 safety module, the motor decelerates according to **23.23 Emergency stop time** until the zero-speed level is reached and 21.09 M1 zero speed delay is elapsed. At that moment, existing brakes are closed (applied) and STO is applied by the FSPS-21 safety module. See 21.03 Emergency stop mode. While the speed feedback is in the level, Zero speed is set high. See 06.21.b00 Speed control status word. <br><br> **Note:** In case 21.01 Start mode = Start from zero and in case the restart command comes before zero speed is reached, warning A137 Start condition conflict is generated. Setting 21.08 M1 zero speed level = 30000.00 rpm disables the zero-speed supervision. <br> **Recommended setting:** Set according to application. |

| Index | Name | Description |
|-------|------|-------------|
| 21.09[1)] 42.44 | M1 zero speed delay[1)] M2 zero speed delay | Motor 1 zero speed delay. The zero-speed delay compensates for the time the motor needs to decelerate from **21.08. M1 zero speed level** to standstill. Until **21.09 M1 zero speed delay** elapses the drive remains active and the brake is kept open (lifted). Also used for SS1 function with FSPS-21 safety module, see 21.08 M1 zero speed level. **Recommended setting:** Set according to application. |
| 23.23 | Emergency stop time | Deceleration time for Off3 (emergency stop) command. The time within the drive will decelerate from **46.02 M1 speed scaling actual** to zero speed. With an Off3 (emergency stop) command and 21.03 Emergency stop mode = Ramp stop/Emergency ramp stop or as reaction to a fault of fault level 4 and 31.15 Fault stop mode fault level 4 = Ramp stop. This applies also to torque control, because the drive automatically switches to speed control with an Off3 (emergency stop) command. **Recommended setting:** Must be smaller than SS1 safety time in safety module. |
| 31.22 | STO indication run/stop | Safe torque off, type of event when safe torque off is active. Selects which events are given when one or both safe torque off signals are switched off or are lost. The events also depend on whether the drive is running or stopped, when they occur. When a fault occurs, the load switching device (mains contactor, AC-breaker or DC-breaker) is opened by the relay output XSMC:1/2. **Note:** 31.22 STO indication run/stop does not affect the operation of the safe torque off function itself. The safe torque off function will operate regardless of the setting of 31.22 STO indication run/stop. A running drive will stop when removing either one or both safe torque off signals. It will not start until both safe torque off signals are restored and all faults are reset. The loss of only one signal causes either FA81 Safe torque off 1 loss or FA82 Safe torque off 2 loss. For more information on the safe torque off, see *Safety supplement for functional safety converter DCS880* (3ADW000452). **Recommended setting: 3** (Warning/Warning is the recommended setting for E-stop, stop category 0); **1** (Fault/Warning is recommended setting for E-stop, stop category 1). |

| Index | Name | Description |
|-------|------|-------------|
| 51.24 | FBA A Par24 (F-destination address) | Sets the PROFIsafe destination address, that is, the individual address of the FSPS-21 module in the safety communication network.<br>**Note:** This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). |

[1] Depending on 42.01 Motor 1/2 selection,
  • 21.08 M1 zero speed level and 21.09 M1 zero speed delay, or
  • 42.21 M2 zero speed level and 42.22 M2 zero speed delay must be used.

For diagnosis purposes, parameter group 200 (Safety related status and control words) can be useful. For details, see *Status and control words (page 231)*.

## Configuring the FSPS-21

To configure the FSPS-21, do the steps shown below.
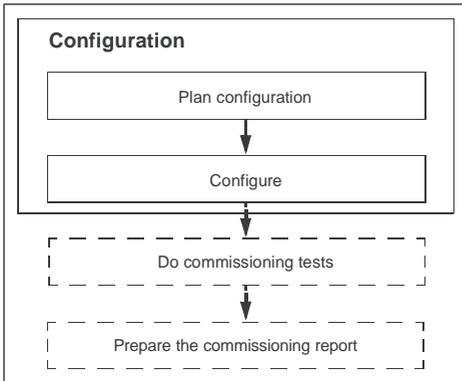


1. Plan the configuration according to the application requirements.

2. Set the drive parameters related to PROFINET IO and PROFIsafe communication, see *FSPS-21 configuration parameters – group A (group 1) (page 64)*.

3. Set the drive parameters related to safety functions: For ACS880, ACS580 and ACS380, see *Drive parameters related to FSPS-21 module configuration (ACS880, ACS580 and ACS380) (page 56)*. For DCS880, see *Drive parameters related to FSPS-21 module configuration (DCS880) (page 57)*.

4. Set up the PROFINET IO communication between the module and the safety PLC, see *Configuring the safety PLC (page 157)*.

5. Set up the PROFIsafe communication between the module and the safety PLC, see *Configuring the safety PLC (page 157)*.

6. Configure the safety PLC, see *Configuring the safety PLC (page 157)*.

7. Do commissioning tests according to *Verification and validation (page 215)*.

# 13

# PROFINET IO – Start-up

## Contents of this chapter

This chapter contains:

- information on configuring the drive for operation with the adapter module
- drive-specific instructions on starting up the drive with the adapter module
- examples of configuring the master station for communication with the adapter module.

## Warnings

**WARNING!**
Obey the safety instructions given in this manual and the drive documentation.

## Drive configuration

The information in this section applies to all drive types compatible with the FSPS-21 module, unless otherwise stated.

### ■ PROFINET IO connection configuration

After the adapter module has been mechanically and electrically installed, you must prepare the drive for communication with the module.

The detailed procedure of activating the module for PROFINET IO communication with the drive depends on the drive type. Normally, you must set the PROFINET parameters

to establish the communication. See the *Starting up fieldbus communication for drives (page 76)*.

Once communication between the drive and the adapter module has been established, several configuration parameters are shown to user. These parameters are listed in the tables below and must be checked first and adjusted where necessary. You can adjust the parameters via a drive control panel or a PC tool.

• The new parameter settings take effect only when you power up the module the next time or when you activate the fieldbus adapter refresh parameter.

**FSPS-21 configuration parameters – group A (group 1)**

**Note:** The actual parameter group number depends on the drive type. Group A (group 1) corresponds to:

• parameter group 51 in ACS380 and ACS580.

• parameter group 51 in ACS880/DCS880 if the adapter is installed as fieldbus adapter A or group 54 if the adapter is installed as fieldbus adapter B.

| No. | Name/Value | Description | Default |
|-----|-----------|-------------|---------|
| 01 | FBA type | **Read-only.** Shows the fieldbus adapter type as detected by the drive. The value cannot be adjusted by the user. If the value is 0 = None, the communication between the drive and the module has not been established. | **133** = PROFIsafe |
| 02 | Protocol.Profile | Selects the application protocol and communication profile for the network connection. The selections available for PROFINET IO communication are listed below. | **11** = PNIO ABB Pro |
| | **10** = PNIO Pdrive | PROFINET IO protocol: PROFIdrive profile | |
| | **11** = PNIO ABB Pro | PROFINET IO protocol: ABB Drives profile | |
| | **12** = PNIO T16 | PROFINET IO protocol: Transparent 16-bit profile | |
| | **13** = PNIO T32 | PROFINET IO protocol: Transparent 32-bit profile | |
| | **14** = PNIO PdriveM | PROFINET IO protocol: PROFIdrive positioning mode | |

| No. | Name/Value | Description | Default |
|-----|-----------|-------------|---------|
| 03 | Commrate | Sets the bit rate for the Ethernet interface. | **0** = Auto |
| | **0** = Auto | Auto-negotiate | |
| | **1** = 100 Mbps FD | 100 Mbps, full duplex | |
| | **2** = 100 Mbps HD | 100 Mbps, half duplex | |
| | **3** = 10 Mbps FD | 10 Mbps, full duplex | |
| | **4** = 10 Mbps HD | 10 Mbps, half duplex | |
| 04 | IP configuration | Sets the method for configuring the IP address, subnet mask and gateway address for the module.<br>In a PROFINET IO network, the master controller has a Duplicate Address Detection mechanism.<br>**Note:** It is recommended to use IP setting for PROFINET as Static IP and address 0.0.0.0. Use PLC hardware configuration to set the IP address for each device in the network. | **0** = Static IP |
| | **0** = Static IP | Configuration will be obtained from parameters *05*…*13* or from the PLC via DCP.The DCP protocol allows the master controller to find every PROFINET IO device on a subnet. When the adapter module is configured for the PROFINET IO protocol, the IP address is transferred to the PROFINET IO communication stack.<br>If there is a need to change the IP address configured via DCP, it should be done with a DCP tool, such as Siemens Step7. If some of the other methods are used to change the IP address, the module must be restarted to enable any changes. | |
| | **2** = Temp IP | IP address is set as Temporary through DCP by the controller.<br>Parameters 05...13 shows the set IP. After reboot this setting goes back to static IP and address 0.0.0.0 is taken to use. This setting is not allowed to be set by the user. | |

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 05<br>...<br>08 | IP address 1 | An IP address is assigned to each IP node on a network. An IP address is a 32-bit number that is typically represented in "dotted decimal" notation consisting of four decimal integers, on the range 0…255, separated by periods. Each integer represents the value of one octet (8-bits) in the IP address. Parameters *05…08* define the four octets of the IP address. | 0 |
| | 0...255 | IP address | |
| | ... | ... | ... |
| | IP address 4 | See parameter *05 IP address 1*. | 0 |
| | 0...255 | IP address | |
| 09 | Subnet CIDR | Subnet masks are used for splitting networks into smaller networks called subnets. A subnet mask is a 32-bit binary number that splits the IP address into a network address and host address.<br>Subnet masks are typically represented in either dotted decimal notation or the more compact CIDR notation, as shown in the table below. | 0 |

| CIDR | Dotted decimal | CIDR | Dotted decimal |
|---|---|---|---|
| 31 | 255.255.255.254 | 15 | 255.254.0.0 |
| 30 | 255.255.255.252 | 14 | 255.252.0.0 |
| 29 | 255.255.255.248 | 13 | 255.248.0.0 |
| 28 | 255.255.255.240 | 12 | 255.240.0.0 |
| 27 | 255.255.255.224 | 11 | 255.224.0.0 |
| 26 | 255.255.255.192 | 10 | 255.192.0.0 |
| 25 | 255.255.255.128 | 9 | 255.128.0.0 |
| 24 | 255.255.255.0 | 8 | 255.0.0.0 |
| 23 | 255.255.254.0 | 7 | 254.0.0.0 |
| 22 | 255.255.252.0 | 6 | 252.0.0.0 |
| 21 | 255.255.248.0 | 5 | 248.0.0.0 |
| 20 | 255.255.240.0 | 4 | 240.0.0.0 |
| 19 | 255.255.224.0 | 3 | 224.0.0.0 |
| 18 | 255.255.192.0 | 2 | 192.0.0.0 |
| 17 | 255.255.128.0 | 1 | 128.0.0.0 |
| 16 | 255.255.0.0 | | |

| | | | |
|---|---|---|---|
| 1...31 | Subnet mask in CIDR notation | | |

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 10 ... 13 | GW address 1 | IP gateways connect individual physical IP subnets into a unified IP network. When an IP node needs to communicate with an IP node on another subnet, the IP node sends the data to the IP gateway for forwarding. Parameters *10*…*13* define the four octets of the gateway address. | 0 |
| | 0...255 | GW address | |
| | ... | ... | ... |
| | GW address 4 | See parameter *10 GW address 1*. | 0 |
| | 0...255 | GW address | |
| 14 | Commrate 2 | Sets the bit rate for the Ethernet port 2. | **0** = Auto |
| | **0** = Auto | Autonegotiate | |
| | **1** = 100 Mbps FD | 100 Mbps, full duplex | |
| | **2** = 100 Mbps HD | 100 Mbps, half duplex | |
| | **3** = 10 Mbps FD | 10 Mbps, full duplex | |
| | **4** = 10 Mbps HD | 10 Mbps, half duplex | |

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 15 | Service configuration | Disable services that are not required. Each service is represented by a single bit. Bit 0, Lock configuration, can be used to prevent accidental changing of this parameter. By default, all services are enabled and configuration is unlocked. | |
| | | <table><tr><th>Bit</th><th>Name</th><th>Information</th></tr><tr><td>0</td><td>Lock configuration</td><td>Changing of this parameter are no longer possible when this bit is set. Only reset fieldbus configuration to default will unlock the parameter.</td></tr><tr><td>1</td><td>Disable IP config tool</td><td>When this bit is set, access from ABB IP Configuration tool is prevented.</td></tr><tr><td>2</td><td>Disable ETH tool network</td><td>When this bit is set, access from Ethernet tool network (eg, ABB Drive Composer tool) is prevented.</td></tr><tr><td>3</td><td>Disable ping response</td><td>When this bit is set, response to ICMP (ping) message is prevented.</td></tr></table> | |
| | 0000b … 1111b | Service configuration | |
| 16<br>...<br>18 | Reserved | These parameters are not used by the adapter module when the module is configured for PROFINET IO. | N/A |

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 19 | T16 scale | Defines the scaling for reference 1 and actual 1 with Transparent 16 profile. (Protocol.Profile = PNIO T16)<br>Scaling also depends on the selected Reference type on 50.04 FBA A Ref 1 type and 50.34 FBA B Ref 1 type and 50.07 and 50.37 for the actual 1.<br>Ref type = Transparent<br>FBA_A/B_Ref1 = Ref1_from_PLC * (T16_Scale + 1)<br>Ref type = General<br>FBA_A/B_Ref1 = Ref1_from_PLC * (T16_Scale + 1) / 100 | 99 |
|  | 0…65535 | Reference multiplier/actual value divisor |  |
| 20 | Telegram type | **Read-only.** Indicates the telegram type selected for PROFINET IO communication. The adapter module automatically detects the telegram type defined in the PLC.<br>For more information on the supported PPO message types, see section *PPO types (page 113)*. | **0** = Unknown |
|  | **0** = Unknown | Cyclical communication between the master and the module has not been established yet. |  |
|  | **3** = PPO3 | PPO3 selected |  |
|  | **4** = PPO4 | PPO4 selected |  |
|  | **6** = PPO6 | PPO6 selected |  |
|  | **7** = PPO7 | PPO7 selected |  |
|  | **8** = ST1 | ST1 selected |  |
|  | **9** = ST2 | ST2 selected |  |
| 21 | Diagnostic alarm | Disables the PROFIdrive alarm mechanism which generates alarms in case of drive faults. But the standard PROFINET alarms are still sent.<br>For more information on the diagnostics and alarm mechanism for PROFIdrive, see section *Diagnostic and alarm mechanism (page 134)*. | **0** = Enabled |
|  | **0** = Enabled | PROFIdrive alarms are enabled. |  |
|  | **1** = Disabled | PROFIdrive alarms are disabled. |  |

| No. | Name/Value | Description | Default |
|-----|-----------|-------------|---------|
| 22 | Map selection | Defines the preferred data type of mapped parameters when mapping is done through PROFIdrive parameters.<br>**Note:** Supported with ACS580, ACS880 and DCS880 drives only. | **1** = 16bit |
| | **0** = 32bit | 32 bits | |
| | **1** = 16bit | 16 bits | |
| 23 | Reserved | This parameter is not used by the adapter module when the module is configured for PROFINET IO. | N/A |
| 24 | F Destination Address | Sets the PROFIsafe destination address, that is, the address of the FB module in the safety communication network.<br>**Note:** This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add).<br>For more information, see section *Configuring the safety PLC (page 157)*. | 0 |

| No. | Name/Value | Description | Default |
|-----|-----------|-------------|---------|
| 25 | PN Name Index | Allows defining the PROFINET station name. By default this value is 0 and the station name is set from the network. When the value is set to other than 0, the PROFINET station name is overwritten in the format "abbdrive-xx", where xx is the value of the parameter name index. Example: Setting this value to 12 results in the name "abbdrive-12". | 0 |
| | | **Note:** During every boot the FSPS-21 module checks the value of PN Name Index, <br>• If the value is not Zero then the active PN Name Index overrides the PROFINET station name. <br>• If the new name is set by DCP Set command as permanent, the new name is used and stored to flash. The PN Name Index parameter value is not changed, so after next boot, the name is taken according to the PN Name Index. <br>• If the new name is set by DCP Set command as temporary, the new name is used and the empty name is stored to flash. The PN Name Index parameter value is not changed, so after next boot name is taken according to the PN Name Index. <br>• The PROFINET DCP factory reset also resets the PN Name Index value to default (0). | |
| | 0...65535 | | |
| 27 | FBA A/B par re-fresh | Validates any changed adapter module configuration parameter settings. After refreshing, the value reverts automatically to 0 = Done. <br>**Note:** This parameter cannot be changed while the drive is running. | **0** = Done |
| | **0** = Done | Refreshing done | |
| | **1** = Refresh | Refreshing | |

| No. | Name/Value | Description | Default |
|-----|-----------|-------------|---------|
| 28 | FBA A/B par table ver | **Read-only**. Displays the parameter table revision of the fieldbus adapter module mapping file stored in the memory of the drive. In format **xyz**, where<br>**x** = major revision number<br>**y** = minor revision number<br>**z** = correction number<br>OR<br>in format **axyz**, where<br>**a** = major revision number<br>**xy** = minor revision numbers<br>**z** = correction number or letter. | N/A |
| | | Parameter table revision | |
| 29 | FBA A/B drive type code | **Read-only**. Displays the drive type code of the fieldbus adapter module mapping file stored in the memory of the drive. | N/A |
| | | Drive type code of the fieldbus adapter module mapping file | |
| 30 | FBA A/B mapping file ver | **Read-only**. Displays the fieldbus adapter module mapping file revision stored in the memory of the drive in decimal format. | N/A |
| | | Mapping file revision | |
| 31 | D2FBA A/B comm status | **Read-only**. Displays the status of the fieldbus adapter module communication.<br>**Note:** The value names may vary by drive.<br>**Note:** Only active drive-controlled channel will change comm status *online*. PROFIsafe alone will not change the comm status. | **0** = Idle<br>or<br>**4** = Offline |
| | **0** = Idle | Adapter is not configured | |
| | **1** = Exec.init | Adapter is initializing. | |
| | **2** = Time out | A timeout has occurred in the communication between the adapter and the drive. | |
| | **3** = Conf.err | There is an internal error in the communication between the adapter and the drive. Contact your local ABB representative. | |
| | **4** = Off-line | Adapter is off-line | |
| | **5** = On-line | Adapter is on-line | |
| | **6** = Reset | Adapter is performing a hardware reset. | |

| No. | Name/Value | Description | Default |
|-----|------------|-------------|---------|
| 32 | FBA A/B comm SW ver | **Read-only.** Displays patch and build numbers of the adapter module's firmware version in **xxyy** format, where: **xx** = patch number **yy** = build number. Example: If the firmware version (<major>.<minor>.<patch>.<build>) is 3.10.200.13, the value C80D is displayed. If the version is 3.10.0.0, the value 0 is displayed. See also parameter 33. | N/A |
| 33 | FBA A/B appl SW ver | **Read-only.** Displays major and minor revision numbers of the adapter module's firmware version in **xxyy** format, where: **xx** = major revision number **yy** = minor revision number Example: If the firmware version (<major>.<minor>.<patch>.<build>) is 3.10.200.13 or 3.10.0.0, the value 310 is displayed. See also parameter 32. | N/A |

**FSPS-21 configuration parameters – group B (group 2)**

Note: The actual parameter group number depends on the drive type. Group B (group 2) corresponds to:

- parameter group 53 in ACS380 and ACS580

- parameter group 53 in ACS880/DCS880 if the adapter is installed as fieldbus adapter A or group 56 if the adapter is installed as fieldbus adapter B.

| No. | Name/Value | Description | Default |
|-----|------------|-------------|---------|
| 01 | FBA data out 1 (master to drive) | Selects the resolution of control word (16 bit or 32 bit) received by the drive. | 1 or 11 [1] |
| | **1** = CW 16bit | Control word (16 bits) | |
| | **11** = CW 32bit | Control word (32 bits) | |

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 02 | FBA data out 2 | Selects data word 1 received by the drive over the PROFINET network. The content is defined by a decimal number in the range of 0 to 9999 as follows: <table><tr><td>0</td><td>Not used</td></tr><tr><td>1…99</td><td>Virtual address area of drive control</td></tr><tr><td>101... 9999</td><td>Parameter area of the drive</td></tr></table> | 0 or 2 |
| | **0** = None | Not used | |
| | **1** = CW 16bit | Control word (16 bits) | |
| | **2** = Ref1 16bit | Reference REF1 (16 bits) | |
| | **3** = Ref2 16bit | Reference REF2 (16 bits) | |
| | **11** = CW 32bit | Control word (32 bits) | |
| | **12** = Ref1 32bit | Reference REF1(32 bits) | |
| | **13** = Ref2 32bit | Reference REF2 (32 bits) | |
| | **21** = CW2 16bit | Control word 2 (16 bits) | |
| | 101…9999 | Parameter index with format **xxyy**, where • **xx** is the parameter group number (1…99) • **yy** is the parameter number index within that group (01…99). | |
| | Other | Path to parameter area selection. | |
| 03 ... 10 | FBA data out 3 … FBA data out12 | See parameter *02 FBA data out 1*. | 0 |

[1]) 11 (CW 32bit) is the default setting if the Transparent32 profile is used.

### FSPS-21 configuration parameters – group C (group 3)

**Note:** The actual parameter group number depends on the drive type. Group C (group 3) corresponds to:

- parameter group 52 in ACS380 and ACS580

- parameter group 52 in ACS880/DCS880 if the adapter is installed as fieldbus adapter A or group 55 if the adapter is installed as fieldbus adapter B.

| No. | Name/Value | Description | Default |
|---|---|---|---|
| 01 | FBA data in 1 (drive to master) | Selects the resolution of status word (16 bit or 32 bit) sent by the drive. | 4 or 14 [1] |
|  | **4** = SW 16bit | Status word (16 bits) |  |
|  | **14** = SW 32bit | Status word (32 bits) |  |
| 02 | FBA data in 2 (drive to master) | Selects data word 1 sent by the drive over the PROFINET network. The content is defined by a decimal number in the range of 0 to 9999 as follows:<table><tr><td>0</td><td>Not used</td></tr><tr><td>1...99</td><td>Virtual address area of drive control</td></tr><tr><td>101...9999</td><td>Parameter area of the drive</td></tr></table> | 0 or 5 |
|  | **0** = None | Not used |  |
|  | **4** = SW 16bit | Status word (16 bits) |  |
|  | **5** = Act1 16bit | Actual value ACT1 (16 bits) |  |
|  | **6** = Act2 16bit | Actual value ACT2 (16 bits) |  |
|  | **14** = SW 32bit | Status word (32 bits) |  |
|  | **15** = Act1 32bit | Actual value ACT1 (32 bits) |  |
|  | **16** = Act2 32bit | Actual value ACT2 (32 bits) |  |
|  | **24** = SW2 16bit | Status word 2 (16 bits) |  |
|  | 101…9999 | Parameter index with format **xxyy**, where<br>• **xx** is the parameter group number (1…99)<br>• **yy** is the parameter number index within that group (01…99). |  |
|  | Other | Path to parameter area selection. |  |
| 03 ... 10 | DATA IN 3… DATA IN 12 | See parameter *01 FBA data in 1*. | 0 |

[1] 14 (SW 32bit) is the default setting if the Transparent32 profile is used.

### ■ Control locations

ABB drives can receive control information from multiple sources including digital inputs, analog inputs, the drive control panel and a fieldbus adapter module. ABB drives allow the user to separately determine the source for each type of control information (Start, Stop, Direction, Reference, Fault reset, etc.).

To give the fieldbus master the most complete control over the drive, you must select the adapter module as the source of this information. The drive-specific parameter setting examples below contain the drive control parameters relevant in the examples. For a complete parameter list, see the drive documentation.

## Starting up fieldbus communication for drives

1. Power up the drive.

2. Enable the communication between the adapter module and the drive by selecting the correct slot number in parameter **50.01 FBA A enable**.
   The selection must correspond to the slot where the adapter module is installed. For example, if the adapter module is installed in slot 2, you must select "slot 2".

3. With parameter **50.02 FBA A comm loss func**, select how the drive reacts to a fieldbus communication break.
   Note that this function monitors both communication between the fieldbus master and the adapter module and communication between the adapter module and the drive.

4. With parameter **50.03 FBA A comm loss t out**, define the time between communication break detection and the selected action.

5. Select application-specific values for the rest of the parameters in group 50, starting from **50.04.**
   Examples of appropriate values are shown in the tables below.

6. Set the module configuration parameters in group 51.
   At the minimum, select the communication protocol and profile with parameter **51.02 Protocol/Profile** and configure the network settings with parameters **51.03…51.13.**

7. Configure the parameter **51.24 F Destination Address** to be the same as in the Safety PLC F-parameters.

8. Define the process data transferred to and from the drive in parameter groups 52 and 53.
   **Note:** The adapter module automatically sets the communication profile-specific virtual address for the Status word in parameter **52.01** and for the Control word in parameter **53.01**.

9. Save the valid parameter values to permanent memory with parameter **96.07 Parameter save manually.**

10. Validate the settings made in parameter groups 51, 52 and 53 with parameter **51.27 FBA A par refresh.**

11. Set the relevant drive control parameters to control the drive according to the application.
    Examples of appropriate values are shown in the tables below.

# Parameter setting examples – ACS380 and ACS580

## ■ Frequency control using PROFIdrive communication profile with PPO Type 4

This example shows how to configure a basic frequency control application that uses the PROFIdrive profile. In addition, some application-specific data is added to the communication.

The start/stop commands and reference are according to the PROFIdrive profile, speed control mode. For more information, see the PROFIdrive state machine on page *102*.

The reference value ±16384 (4000h) corresponds to parameter **46.02 Frequency scaling** in the forward and reverse directions.

| Direction | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|-----------|------|------|------|------|------|------|
| Out | Control word | Frequency reference | Constant frequency 1[1] | | Constant frequency 2[1] | |
| In | Status word | Frequency actual value | Power[1] | | DC bus voltage[1] | |

1) Example

The table below gives an example of the drive parameter settings.

| Drive parameter | Setting for drives | Description |
|-----------------|-------------------|-------------|
| 50.01 FBA A enable | **1** = Enable | Enables communication between the drive and the fieldbus adapter module. |
| 50.04 FBA A ref1 type | **5** = Frequency | Selects the fieldbus A reference 1 type and scaling. |
| 50.07 FBA A act1 type | **5** = Frequency | Selects the actual value type and scaling according to the currently active Ref1 mode defined in parameter 50.04. |
| 51.01 FBA A type | **133** = PROFIsafe[1] | Displays the type of the fieldbus adapter module. |
| 51.02 Protocol/Profile | **10** = PNIO Pdrive | Selects the PROFINET IO protocol and the PROFIdrive profile. |
| 51.03 Commrate | **0** = Auto | Ethernet communication rate is negotiated automatically by the device. |
| 51.04 IP configuration | **0** = Static IP | Configuration will be obtained from parameters 51.05…13 or from the PLC via the DCP protocol. |

| Drive parameter | Setting for drives | Description |
|---|---|---|
| 51.24 F Destination Address | This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). | Sets the PROFIsafe destination address, that is, the address of the FSPS-21 module in the safety communication network. |
| 52.01 FBA DATA IN1 | **4** = SW 16bit | Status word |
| 52.02 FBA DATA IN2 | **5** = Act1 16bit | Actual value 1 |
| 52.03 FBA data in3 | 01.14 | Output power |
| 52.05 FBA data in5 | 01.11 | DC voltage |
| 53.01 FBA DATA out1 | **1** = CW 16bit | Control word |
| 53.02 FBA DATA out2 | **2** = Ref1 16bit | Reference 1 (frequency) |
| 53.03 FBA data out3 | 28.26 | Constant frequency 1 |
| 53.05 FBA data out5 | 28.27 | Constant frequency 2 |
| 51.27 FBA A par refresh | **1** = Refresh | Validates the configuration parameter settings. |
| 19.12 Ext1 control mode | **2** = Speed | Selects speed control as the control mode 1 for external control location 1. |
| 20.01 Ext1 commands | **12** = Fieldbus A | Selects the fieldbus A interface as the source of the start and stop commands for external control location 1. |
| 22.11 Speed ref1 source | **4** = FB A REF1 | Selects the fieldbus A reference 1 as the source for speed reference 1. |

[1] Read-only or automatically detected/set

The start sequence for the parameter example above is given below.

Control word:

- Reset the fieldbus communication fault (if active).

- Enter 47Eh (1150 decimal) → READY TO SWITCH ON.
  Enter 47Fh (1151 decimal) → OPERATING.

# Parameter setting examples – ACS880

## ■ Speed control using PROFIdrive communication profile with PPO Type 4

This example shows how to configure a basic speed control application that uses the PROFIdrive profile. In addition, some application-specific data is added to the communication.

The start/stop commands and reference are according to the PROFIdrive profile, speed control mode. For more information, see the PROFIdrive state machine on page *102*.

The reference value ±16384 (4000h) corresponds to parameter **46.01 Speed scaling** in the forward and reverse directions.

| Direction | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|-----------|------|------|------|------|------|------|
| Out | Control word | Speed reference | Constant speed 1[1] | | Constant speed 2[1] | |
| In | Status word | Speed actual value | Power[1] | | DC bus voltage[1] | |

1) Example

The table below gives an example of the drive parameter settings.

| Drive parameter | Setting for drives | Description |
|-----------------|--------------------|-------------|
| 50.01 FBA A enable | **1** = Option slot 2[2] | Enables communication between the drive and the fieldbus adapter module. |
| 50.04 FBA A ref1 type | **4** = Speed | Selects the fieldbus A reference 1 type and scaling. |
| 50.07 FBA A act1 type | **4** = Speed | Selects the actual value type and scaling according to the currently active Ref1 mode defined in parameter 50.04. |
| 51.01 FBA A type | **133** = PROFIsafe[1] | Displays the type of the fieldbus adapter module. |
| 51.02 Protocol/Profile | **10** = PNIO Pdrive | Selects the PROFINET IO protocol and the PROFIdrive profile. |
| 51.03 Commrate | **0** = Auto[2] | Ethernet communication rate is negotiated automatically by the device. |
| 51.04 IP configuration | **0** = Static IP | Configuration will be obtained from parameters 51.05…13 or from the PLC via the DCP protocol. |

| Drive parameter | Setting for drives | Description |
|---|---|---|
| 51.24 F Destination Address | This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). | Sets the PROFIsafe destination address, that is, the address of the FSPS-21 module in the safety communication network. |
| 52.01 FBA DATA IN1 | **4** = SW 16bit | Status word |
| 52.02 FBA DATA IN2 | **5** = Act1 16bit | Actual value 1 |
| 52.03 FBA data in3 | 01.14 | Output power |
| 52.05 FBA data in5 | 01.11 | DC voltage |
| 53.01 FBA DATA out1 | **1** = CW 16bit | Control word |
| 53.02 FBA DATA out2 | **2** = Ref1 16bit | Reference 1 (speed) |
| 53.03 FBA data out3 | 22.26 | Constant speed 1 |
| 53.05 FBA data out5 | 22.27 | Constant speed 2 |
| 51.27 FBA A par refresh | **1** = Refresh | Validates the configuration parameter settings. |
| 19.12 Ext1 control mode | **2** = Speed | Selects speed control as the control mode 1 for external control location 1. |
| 20.01 Ext1 commands | **12** = Fieldbus A | Selects the fieldbus A interface as the source of the start and stop commands for external control location 1. |
| 22.11 Speed ref1 source | **4** = FB A REF1 | Selects the fieldbus A reference 1 as the source for speed reference 1. |

1) Read-only or automatically detected/set

2) Example

The start sequence for the parameter example above is given below.

Control word:

- Reset the fieldbus communication fault (if active).

- Enter 47Eh (1150 decimal) → READY TO SWITCH ON.
  Enter 47Fh (1151 decimal) → OPERATING.

# Parameter setting examples – DCS880

## ■ Speed control using PROFIdrive communication profile with PPO Type 4

This example shows how to configure a basic speed control application that uses the PROFIdrive profile. In addition, some application-specific data is added to the communication.

The start/stop commands and reference are according to the PROFIdrive profile, speed control mode. For more information, see the PROFIdrive state machine on page *102*.

The reference value ±16384 (4000h) corresponds to parameter **46.01 Speed scaling** in the forward and reverse directions.

| Direction | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|-----------|------|------|------|------|------|------|
| Out | Control word | Speed reference | Constant speed 1 [1] | | Constant speed 2 [1] | |
| In | Status word | Speed actual value | Power [1] | | DC bus voltage [1] | |

[1] Example, DC bus voltage not used with DC drives.

The table below gives an example of the drive parameter settings.

| Drive parameter | Setting for drives | Description |
|-----------------|--------------------|-------------|
| 50.01 FBA A enable | **2** = Slot 2 [1] | Enables communication between the drive and the fieldbus adapter module. |
| 50.04 FBA A ref1 type | **4** = Speed | Selects the fieldbus A reference 1 type and scaling. |
| 50.07 FBA A act1 type | **4** = Speed | Selects the actual value type and scaling according to the currently active Ref1 mode defined in parameter 50.04. |
| 50.29 FBA A Profile | **10** = DCP | Selects the fieldbus adapter A profile. (10 = DCP; speed scaling actual value in parameter 46.02 is 20000 speed units. Any other parameter is scaled in 10000 units.) |
| 51.01 FBA A type | **133** = FSPS [2] | Displays the type of the fieldbus adapter module. |
| 51.02 Protocol/Profile | **10** = PNIO Pdrive | Selects the PROFINET IO protocol and the PROFIdrive profile. |
| 51.03 Commrate | **0** = Auto [1] | Ethernet communication rate is negotiated automatically by the device. |

| Drive parameter | Setting for drives | Description |
|---|---|---|
| 51.04 IP configuration | **0** = Static IP | Configuration will be obtained from parameters 51.05…13 or from the PLC via the DCP protocol. |
| 51.24 F Destination Address | This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). | Sets the PROFIsafe destination address, that is, the address of the FSPS-21 module in the safety communication network. |
| 52.01 FBA data in1 | **4** = SW 16bit | Status word |
| 52.02 FBA data in2 | **5** = Act1 16bit | Actual value 1 |
| 52.03 FBA data in3 | 01.25 | Output power |
| 53.01 FBA data out1 | **1** = CW 16bit | Control word |
| 53.02 FBA data out2 | **2** = Ref1 16bit | Reference 1 (speed) |
| 53.03 FBA data out3 | 22.26 | Constant speed 1 |
| 51.27 FBA A par refresh | **1** = Refresh | Validates the configuration parameter settings. |
| 06.08 Main control word source | **1** = FBA A | Selects the source for 06.01 Main control word. (1 = FBA A; 06.03 FBA A transparent control word) |
| 19.12 Ext1 control mode | **2** = Speed | Selects speed control as the control mode 1 for external control location 1. |
| 20.01 Command location | **1** = Main control word | Selector for 06.09 Used main control word. (1 = Main control word; drive is controlled via 06.01 Main control word) |
| 22.11 Speed reference 1 source | **4** = FB A reference 1 | Selects the fieldbus A reference 1 as the source for speed reference 1. |

[1] Example
[2] Read-only or automatically detected

The start sequence for the parameter example above is given below.

Control word:

- Reset the fieldbus communication fault (if active).

- Enter 47Eh (1150 decimal) → READY TO SWITCH ON.
  Enter 47Fh (1151 decimal) → OPERATING.
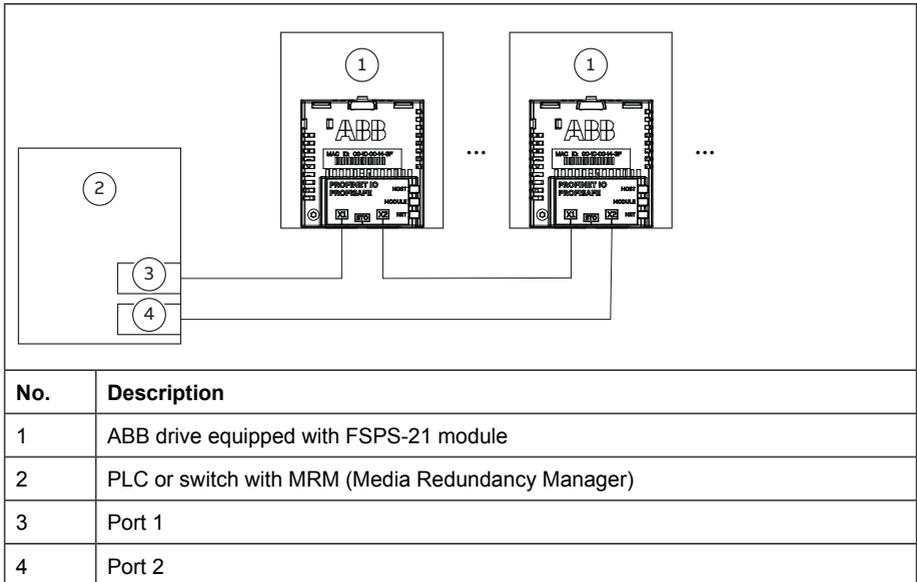
# Configuring the master station

After the adapter module has been initialized by the drive, you must prepare the master station for communication with the module. For FSPS-21, see *Configuring the safety PLC (page 157)* If you are using another master system, refer to its documentation for more information.

# Media Redundancy Protocol (MRP)

The Media Redundancy Protocol (MRP) network uses ring topology that includes multiple nodes as shown in the connection diagram below. One of the nodes has the Media Redundancy Manager (MRM) role and the nodes with FSPS-21 module(s) have the role of Media Redundancy Clients (MRC). Each node, MRM or MRC, has a pair of ports for connecting in the ring.

For FSPS-21 module, the link speed of both ports is 100 Mbit/s, full duplex.

**Note:** The number of nodes in the ring should not exceed 50 nodes.



| No. | Description |
|-----|-------------|
| 1 | ABB drive equipped with FSPS-21 module |
| 2 | PLC or switch with MRM (Media Redundancy Manager) |
| 3 | Port 1 |
| 4 | Port 2 |

### ■ Configuring Media Redundancy Protocol (MRP) with Siemens PLC

You can configure MRP for Siemens PLC with SIMATIC S7 after setting the basic configuration. For instructions on basic configuration, see section *Configuring the Siemens SIMATIC Fail-safe S7 PLC (page 185)*.

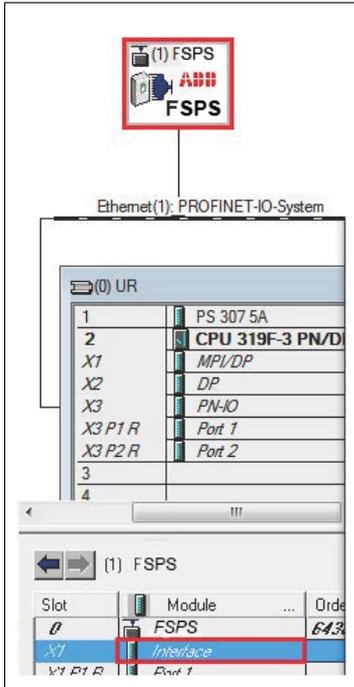1. Double-click PN-IO in the station window.
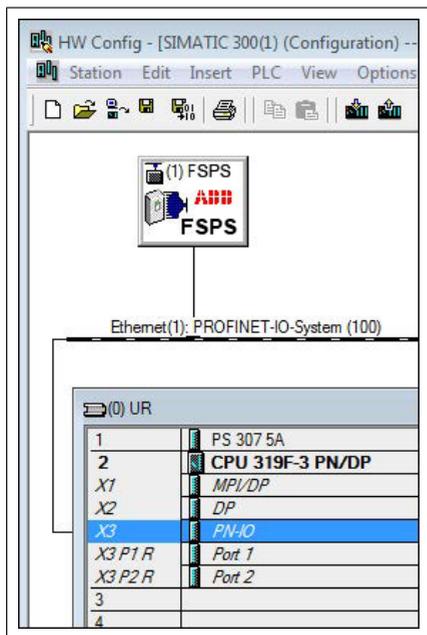
PN-IO properties window is displayed.

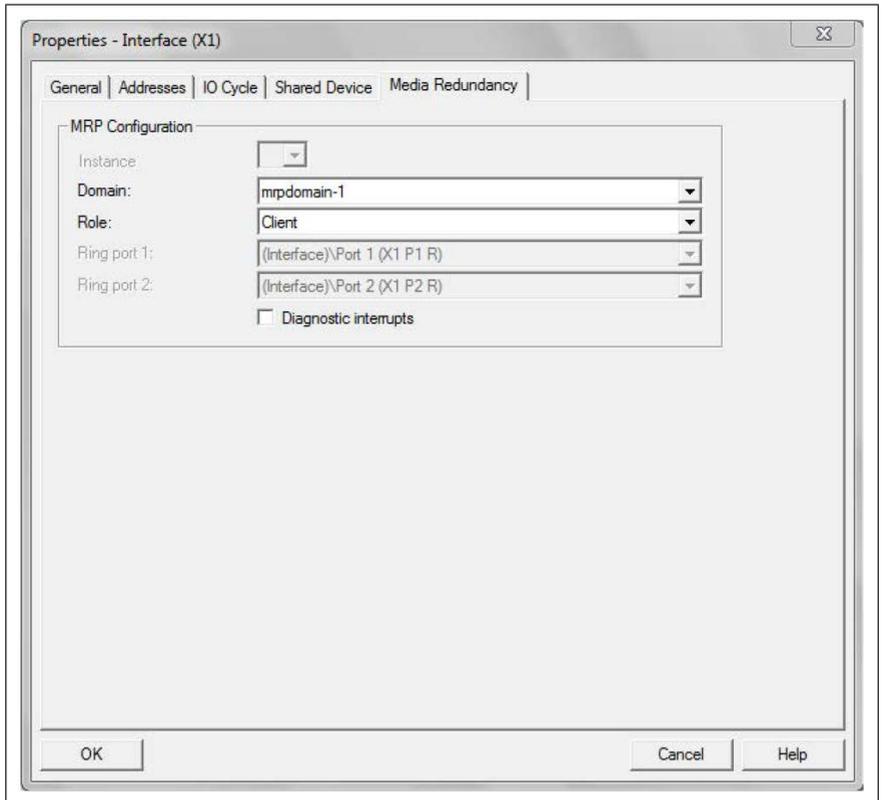2. In the Properties PN-IO window, select Media Redundancy tab.
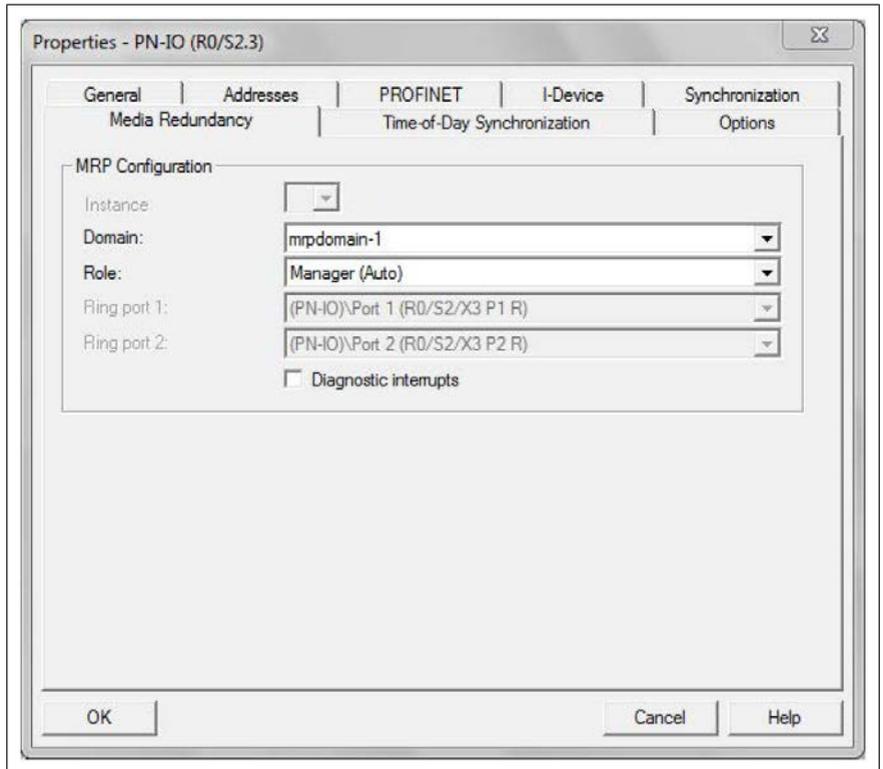
3. From the Role drop-down list, select Manager (Auto) role for the PLC and then click OK.

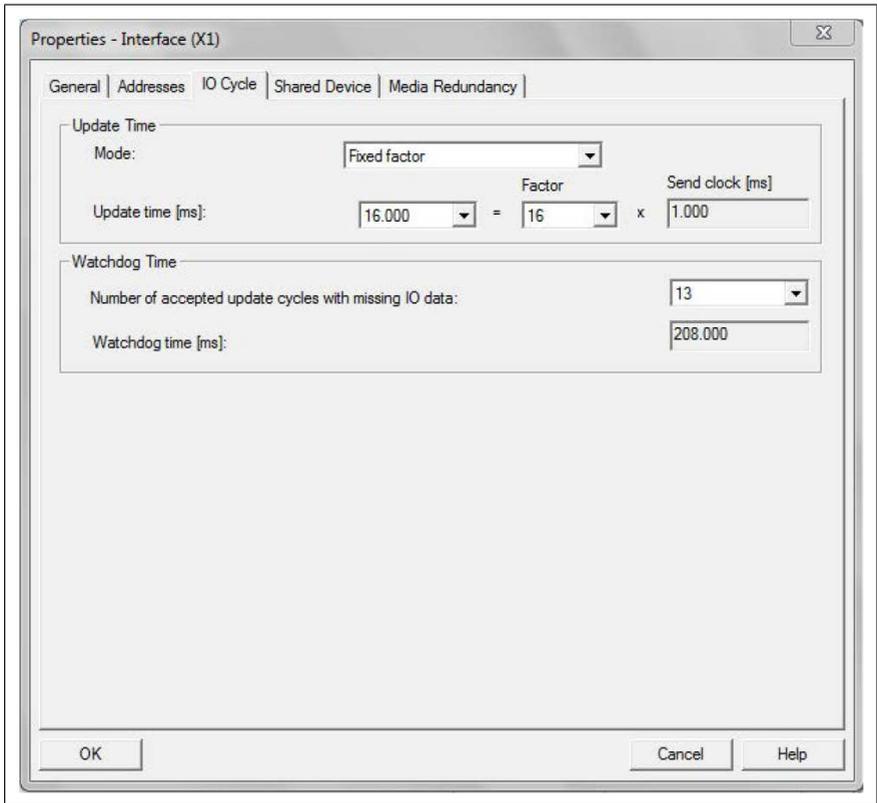4. In the master station window, click FSPS and then double-click Interface.

Properties-Interface window is displayed.

5. In the Properties-Interface window, select Media Redundancy tab.

6. From the Role drop-down list, select Client role for the FSPS module.

7. In the Properties-Interface window, select IO Cycle and set watchdog time.
   A recommended value for the watchdog time is 200 ms. Make sure that the connection is maintained during the ring break.

8. In the master station window, right-click on PROFINET IO System and select PROFINET IO Domain Management.

   The configured devices (PN-IO and FSPS) are shown in the Domain management window.
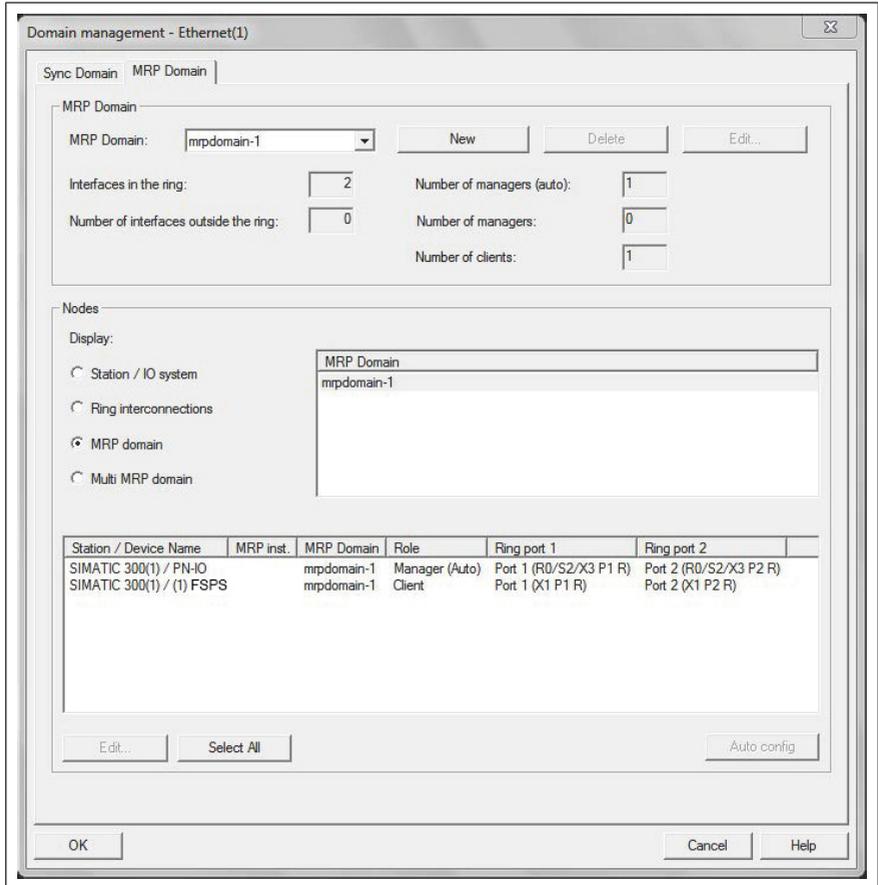
### ■ **Configuring Media Redundancy Protocol (MRP) with TIA14**

You can configure MRP for Siemens PLC with TIA14 after setting the basic configuration. For instructions of basic configuration, see section *Configuring FSPS-21 with TIA14 (page 168)*.

To configure an MRP with TIA portal, proceed as follows:

1. In TIA portal Device overview, expand PLC and select the desired PROFINET interface.
   PROFINET interface view is displayed.

2. In PROFINET interface view, click General tab and select Media Redundancy and then select Manager (auto) role for the PLC.
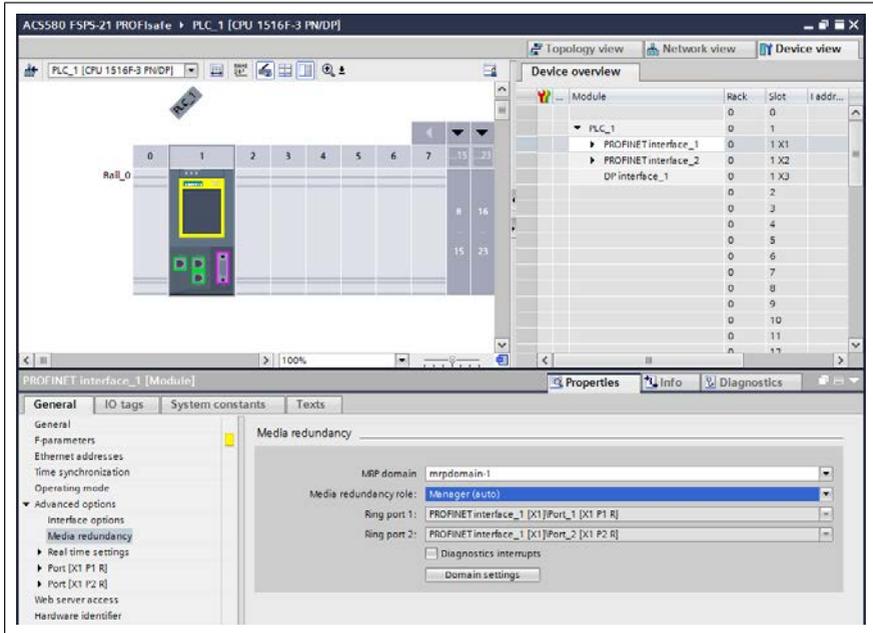
3. In the Device overview, expand FSPS-21 and select Interface.
   PROFINET interface view is displayed.

4. In PROFINET interface view, click General tab and select Media Redundancy and
   then select Client role for the FSPS-21.
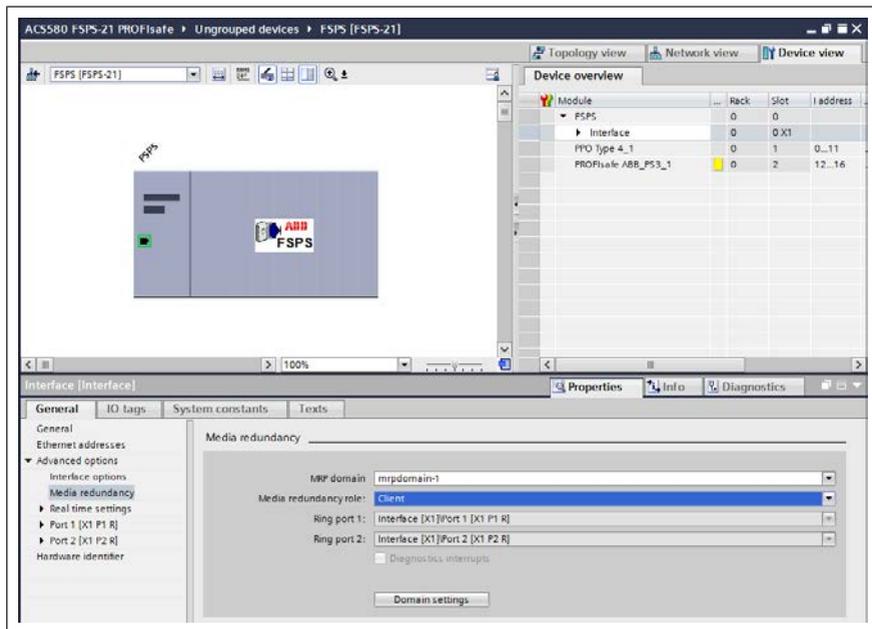
5. In the General tab, select IO cycle and set watchdog time.

   The recommended value for the watchdog time is 200 ms. Make sure that the connection is maintained during the ring break.
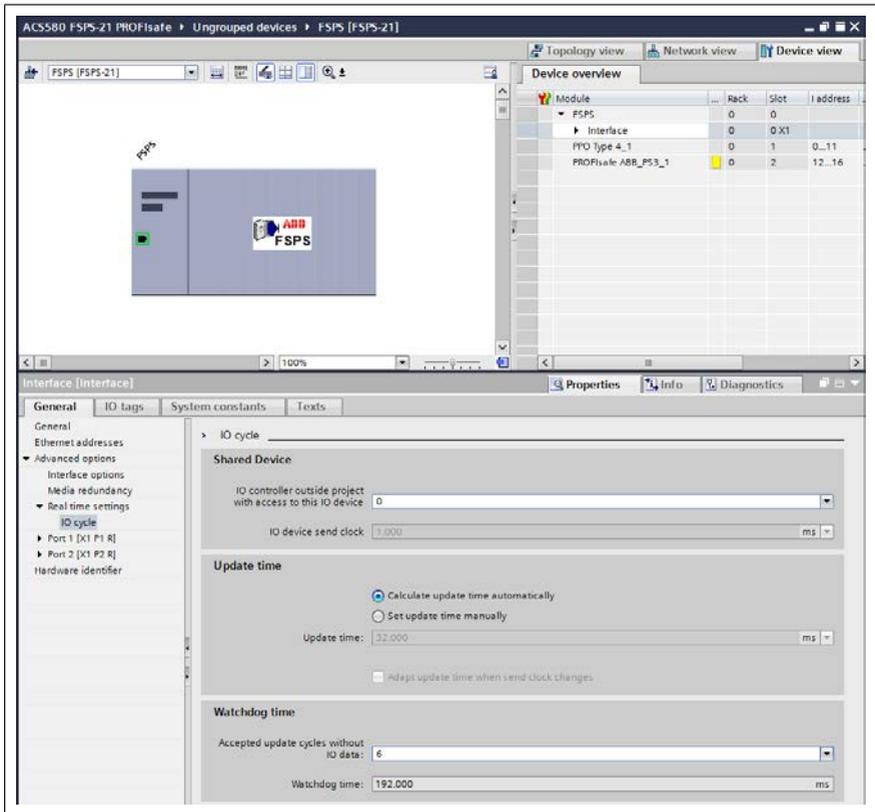
For MRP domain management, go to Media Redundancy view and click Domain settings button.

# Shared Device

Using Shared Device enable option, you can access one drive from two controllers through one FSPS-21 module.

For example, one PLC to control the drive, other Safety PLC for safety communication. The PROFINET drive control and PROFIsafe can be used by separate PLCs.

## ■ Configuring Shared Device for ABB PLC with Automation Builder
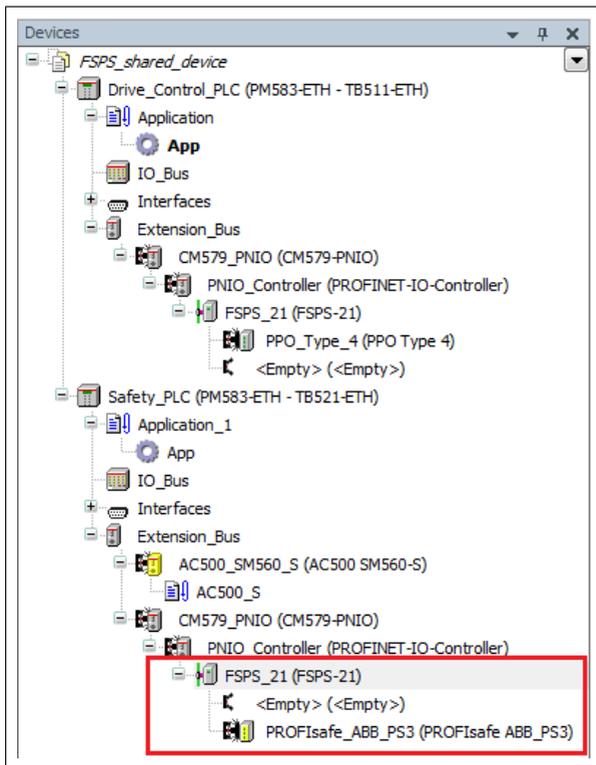
**Configuring drive control PLC**

1. Select PPO telegram to use on slot 1. Leave slot 2 empty.

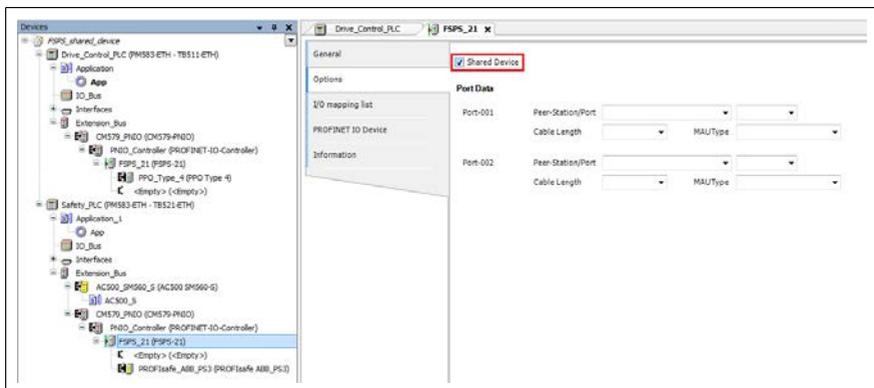2. Define PROFINET station name and IP address based on the network.
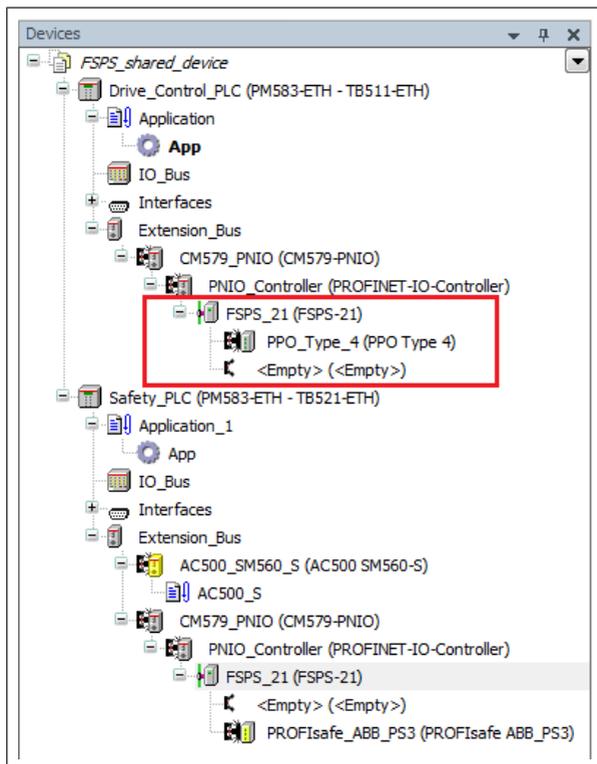
**Configuring safety PLC**

1. Select safety telegram to use on slot 2. Leave slot 1 empty.

2. Use same PROFINET station name as in drive control PLC configuration.

3. Under Option tab, tick the Shared Device check box.

■ **Configuring Shared Device for Siemens PLC with TIA portal**

**Configuring drive control PLC**

1. Select PPO telegram to use on slot 1. Leave slot 2 empty.

2. Define PROFINET station name and IP address.

**Configuring safety PLC**

1. Select FSPS-21 in the Device view.

2. Select safety telegram to use on slot 2. Leave slot 1 empty.

3. Use same PROFINET station name as in drive control PLC configuration.

4. From the Shared Device tab, select access rights to the PROFIsafe slot for the Safety PLC.
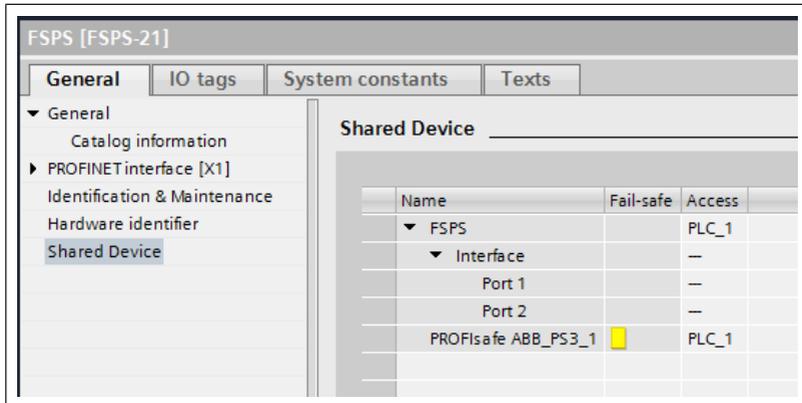


# Using MRP and Shared Device in the same network

It is possible to use Shared device together with MRP. In this case, MRP is configured into use from the switch, and the Shared Device is configured into use from one of the PLCs.

# 14
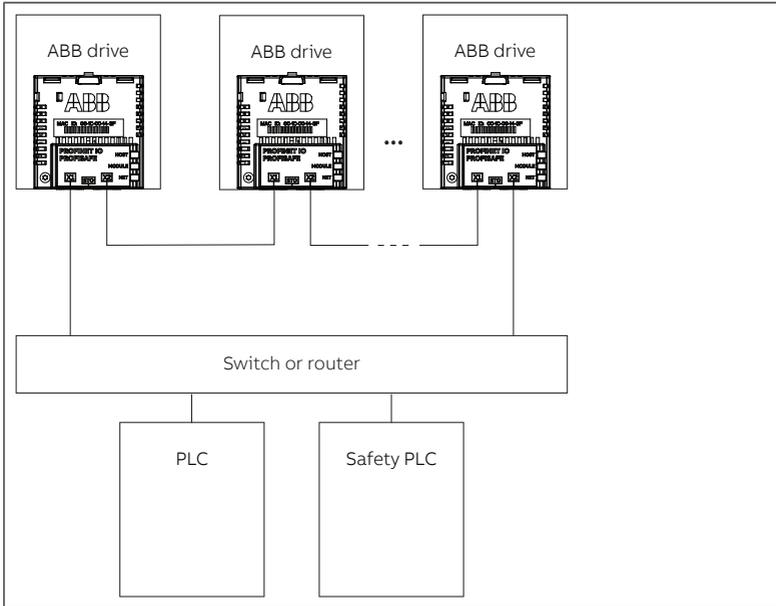
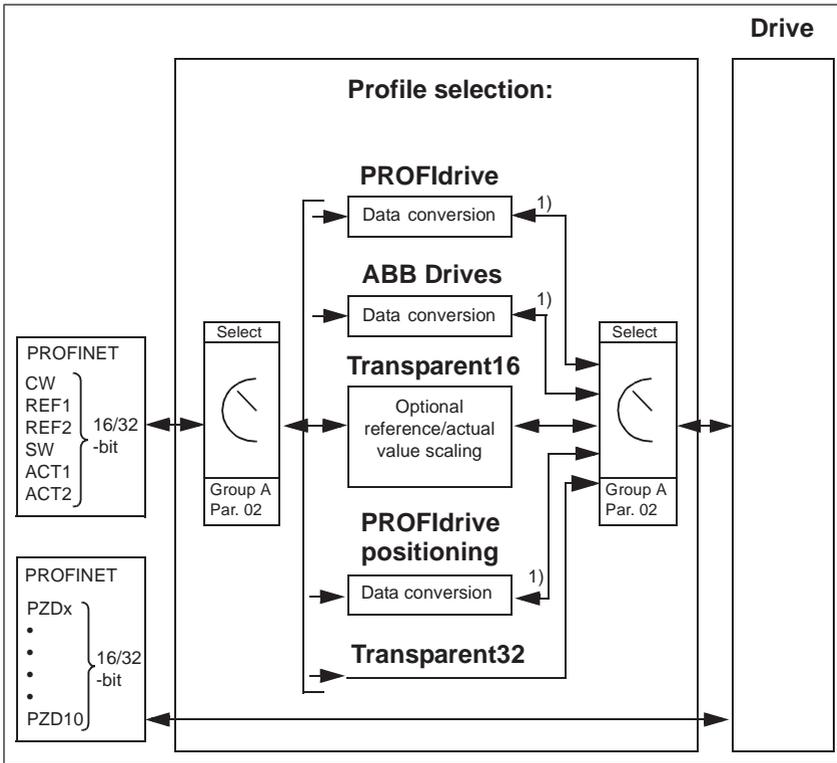# PROFINET IO – Communication profiles

## Contents of this chapter

This chapter describes the communication profiles used in the communication between the PROFINET IO master, the adapter module and the drive.

## Communication profiles

Communication profiles are ways of conveying control commands (Control word, Status word, references and actual values) between the master station and the drive.

With the FSPS-21 module, the PROFINET network may employ either the PROFIdrive profile or the ABB Drives profile. Both are converted to the native profile (eg, DCU or FBA) by the adapter module. In addition, two Transparent modes – for 16-bit and 32-bit words respectively – are available. With the Transparent modes, no data conversion takes place.

The figure below illustrates the profile selection:

**Note:** The diagram is applicable only when PPO messaging is used. If Standard Telegrams (ST) are used, the communication profile is selected automatically.

The following sections describe the Control word, the Status word, references and actual values for the PROFIdrive and ABB Drives communication profiles. Refer to the drive manuals for details on the native profiles.

# PROFIdrive communication profile

## ▄ Control word and Status word

The Control word (PROFIdrive parameter 967) is the principal means for controlling the drive from a fieldbus system. It is sent by the fieldbus master station to the drive through the adapter module. The drive switches between its states according to the bit-coded instructions in the Control word and returns status information to the master in the Status word (PROFIdrive parameter 968).

The contents of the Control word and the Status word are detailed below. See the drive documentation for information on the drive-specific bits. The drive states are presented on page *102*. The drive states for the positioning mode are presented on page *103*.

**Control word contents**

The table below shows the contents of the Control word for the PROFIdrive communication profile (PROFIdrive parameter 967). The upper case boldface text refers to the states shown in the state machine on page *102*.

| Bit | Name | Value | STATE/Description | |
|---|---|---|---|---|
| | | | **Speed control mode** | **Positioning mode** |
| 0 | ON | 1 | Proceed to **READY TO OPERATE**. | |
| | OFF1 | 0 | Emergency OFF, stop by the selected deceleration ramp. Proceed to **OFF1 ACTIVE**; proceed further to **READY TO SWITCH ON** unless other interlocks (OFF2, OFF3) are active. | |
| 1 | OFF2 | 1 | Continue operation (OFF2 inactive). | |
| | | 0 | Emergency OFF, coast to stop. Proceed to **OFF2 ACTIVE**; proceed further to **SWITCH-ON INHIBIT**. | |
| 2 | OFF3 | 1 | Continue operation (OFF3 inactive). | |
| | | 0 | Emergency stop, stop according to fastest possible deceleration mode. Proceed to **OFF3 ACTIVE**; proceed further to **SWITCH-ON INHIBIT**. **Warning:** Ensure motor and driven machine can be stopped using this stop mode. | |
| 3 | OPERATION_ENABLE | 1 | Proceed to **ENABLE OPERATION**. | |
| | | 0 | Inhibit operation. Proceed to **OPERATION INHIBIT**. | |
| 4 | ENABLE_ RAMP_ GENERATOR or TRAVERSING _TASK | 1 | Normal operation. Proceed to **RAMP FUNCTION GENERATOR: ENABLE OUTPUT**. | Normal operation. Do not reject traversing task. |
| | | 0 | Stop according to selected stop type. | Reject traversing task. |
| 5 | | 1 | Normal operation. Proceed to RAMP FUNCTION GENERATOR: ENABLE ACCELERATION. | Normal operation. No intermediate stop. |
| | | 0 | Halt ramping (Ramp Function Generator output held). | Intermediate stop |

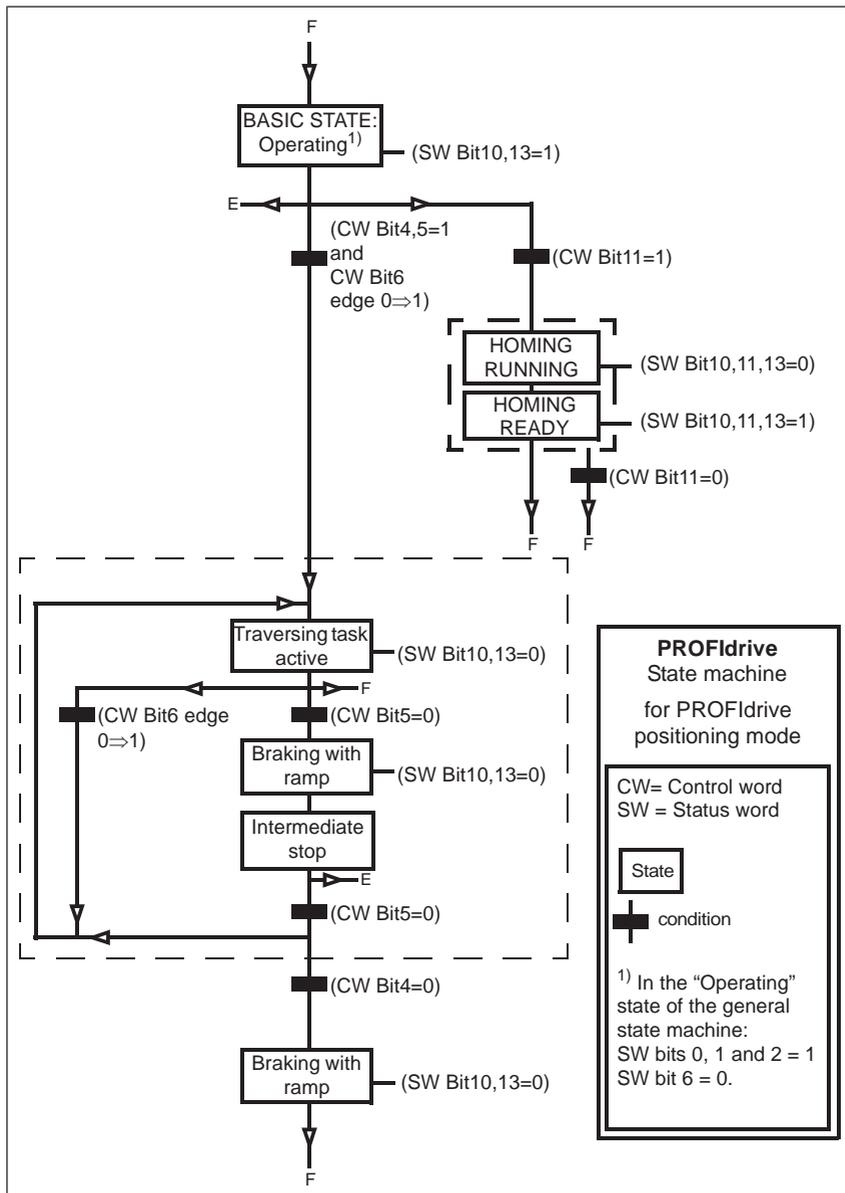| Bit | Name | Value | STATE/Description | |
|-----|------|-------|-------------------|---|
| | | | **Speed control mode** | **Positioning mode** |
| 6 | | 1 | Normal operation. Proceed to OPERATING. Note: This bit is effective only if the fieldbus interface is set as the source for this signal by drive parameters. | Activate traversing task (0 → 1). This is a toggle bit; each rising edge of signal enables a traversing task or a new set point. |
| | | 0 | Force Ramp Function Generator input to zero. | |
| 7 | RESET | 0 → 1 | Fault reset if an active fault exists. Proceed to SWITCH-ON INHIBIT. **Note:** This bit is effective only if the fieldbus interface is set as the source for this signal by drive parameters. | |
| | | 0 | (Continue normal operation) | |
| 8 | JOGGING_1 | | Jogging 1 (Not supported by all drive types) | |
| 9 | JOGGING_2 | | Jogging 2 (Not supported by all drive types) | |
| 10 | REMOTE_ CMD | 1 | Fieldbus control enabled | |
| | | 0 | Control word <> 0 or reference <> 0: Retain last Control word and reference. Control word = 0 and reference = 0: Fieldbus control enabled. | |
| 11 | | 1 | Vendor-specific bit as defined by PROFIdrive parameter 933 | Start homing procedure. |
| | | 0 | | Stop homing procedure. |
| 12 | | | Vendor-specific bit as defined by PROFIdrive parameter 934. As default mapped to Drive Main CW bit 12. | |
| 13 | | | Vendor-specific bit as defined by PROFIdrive parameter 935. As default mapped to Drive Main CW bit 13. | |
| 14 | | | Vendor-specific bit as defined by PROFIdrive parameter 936. As default mapped to Drive Main CW bit 14. | |
| 15 | | | Vendor-specific bit as defined by PROFIdrive parameter 937. As default mapped to Drive Main CW bit 15. | |

**Status word contents**

The table below shows the contents of the Status word for the PROFIdrive communication profile (PROFIdrive parameter 968). The upper case boldface text refers to the states shown in the state machine on page *102*.

| Bit | Name | Value | STATE/Description | |
|-----|------|-------|-------------------|--|
| | | | **Speed control mode** | **Positioning mode** |
| 0 | RDY_ON | 1 | **READY TO SWITCH ON** | |
| | | 0 | **NOT READY TO SWITCH ON** | |
| 1 | RDY_RUN | 1 | **READY TO OPERATE** | |
| | | 0 | **OFF1 ACTIVE** | |
| 2 | RDY_REF | 1 | **ENABLE OPERATION** | |
| | | 0 | **OPERATION INHIBIT** | |
| 3 | TRIPPED | 1 | **FAULT** | |
| | | 0 | No fault | |
| 4 | OFF_2_STA | 1 | OFF2 inactive | |
| | | 0 | **OFF2 ACTIVE** | |
| 5 | OFF_3_STA | 1 | OFF3 inactive | |
| | | 0 | **OFF3 ACTIVE** | |
| 6 | SWC_ON_ INHIB | 1 | **SWITCH-ON INHIBIT ACTIVE** | |
| | | 0 | **SWITCH-ON INHIBIT NOT ACTIVE** | |
| 7 | ALARM | 1 | Warning/Alarm | |
| | | 0 | No Warning/Alarm | |
| 8 | AT_SETPOINT | 1 | **OPERATING**. Actual value equals reference value (= is within tolerance limits). | |
| | | 0 | Actual value differs from reference value (= is outside tolerance limits). | |
| 9 | REMOTE | 1 | Automation system is requested to assume control. | |
| | | 0 | Control by automation system is not possible. Control is possible only at the device or by another interface. | |

| Bit | Name | Value | STATE/Description | |
|-----|------|-------|-------------------|---|
| | | | **Speed control mode** | **Positioning mode** |
| 10 | | 1 | Actual frequency or speed value equals or is greater than supervision limit. | Target position reached. |
| | | 0 | Actual frequency or speed value is within supervision limit. | Not at target position |
| 11 | | 1 | Mapped to PROFIdrive SW bit 11. | Homing procedure was executed and is valid. |
| | | 0 | Vendor-specific bit as defined by PROFIdrive parameter 939. As default mapped to PROFIdrive SW bit 11. | No valid home position available. |
| 12 | | 1 | Mapped to PROFIdrive SW bit 11. | Traversing task acknow-ledgement (0 → 1) |
| | | 0 | Vendor-specific bit as defined by PROFIdrive parameter 940. As default mapped to PROFIdrive SW bit 12. | |
| 13 | | 1 | Mapped to PROFIdrive SW bit 11. | Drive stopped. |
| | | 0 | Vendor-specific bit as defined by PROFIdrive parameter 941. As default mapped to PROFIdrive SW bit 13. | Drive moving. Traversing task is executed (n <> 0). |
| 14 | | | Vendor-specific bit as defined by PROFIdrive paramet-er 942. As default mapped to PROFIdrive SW bit 14. | |
| 15 | | | Vendor-specific bit as defined by PROFIdrive paramet-er 943 | |

**State machine for all operating modes**

The general PROFIdrive state machine for all operating modes is shown below.
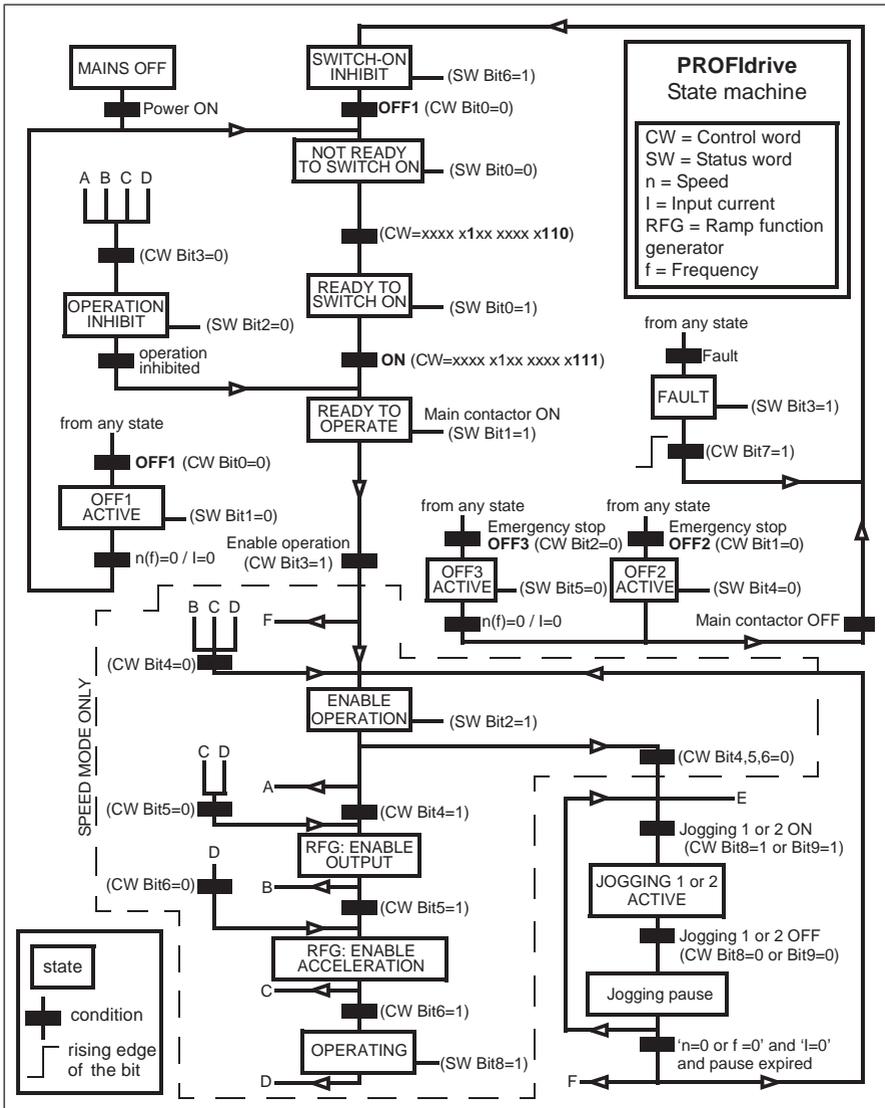
## State machine for the positioning mode

The PROFIdrive state machine for the positioning mode is shown below.

```
                              F
                              ↓
                    ┌─────────────────┐
                    │ BASIC STATE:    │
                    │ Operating¹⁾     │── (SW Bit10,13=1)
                    └─────────────────┘
              E ←───────┬──────────┐
                 (CW Bit4,5=1       █ (CW Bit11=1)
                 and                │
                 CW Bit6      ┌ ─ ─ ┴ ─ ─ ┐
                 edge 0⇒1)    │ ┌─────────────┐
                             │ │ HOMING      │── (SW Bit10,11,13=0)
                             │ │ RUNNING     │
                             │ └─────────────┘
                             │ ┌─────────────┐
                             │ │ HOMING      │── (SW Bit10,11,13=1)
                             │ │ READY       │
                             │ └─────────────┘
                             └ ─ ─█(CW Bit11=0)
                                   │
                              F    F
```

(CW Bit4,5=1 and CW Bit6 edge 0⇒1)

(CW Bit11=1)

HOMING RUNNING — (SW Bit10,11,13=0)

HOMING READY — (SW Bit10,11,13=1)

(CW Bit11=0)

┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐

Traversing task active — (SW Bit10,13=0)

(CW Bit6 edge 0⇒1)   (CW Bit5=0)

Braking with ramp — (SW Bit10,13=0)

Intermediate stop

(CW Bit5=0)

(CW Bit4=0)

Braking with ramp — (SW Bit10,13=0)

F

**PROFIdrive**
State machine

for PROFIdrive positioning mode

CW= Control word
SW = Status word

State

█ condition

¹⁾ In the "Operating" state of the general state machine:
SW bits 0, 1 and 2 = 1
SW bit 6 = 0.

## ■ References

ABB drives can receive control information from multiple sources including analog and digital inputs, the drive control panel and a fieldbus adapter module (for example,

FSPS-21). To have the drive controlled through PROFINET, you must select the module as the source for control information, for example, reference.

**References in speed control mode**

In the speed control mode, references are 16-bit or 32-bit words containing a sign bit and a 15-bit or 31-bit integer. A negative reference (indicating reversed direction of rotation) is formed by calculating the two's complement from the corresponding positive reference.

A 16-bit speed reference (REF or NSOLL_A) in hexadecimal (0…4000h) corresponds to 0…100% of Maximum Reference (as defined with a drive parameter).

A 32-bit speed reference (NSOLL_B) in hexadecimal (0…4000 0000h) corresponds to 0…100% of Maximum Reference (as defined with a drive parameter).

### ■ Actual values

Actual values are 16-bit or 32-bit words containing information on the operation of the drive. The functions to be monitored are selected with a drive parameter.

**Actual values in speed control mode**

The scaling of 16-bit actual speed values (ACT or NIST_A) in hexadecimal (0…4000h) corresponds to 0…100% of the maximum reference (as defined with a drive parameter, for example, speed scaling in ACS580, ACS880 and DCS880).

The scaling of 32-bit actual speed values (NIST_B) in hexadecimal (0…4000 0000h) corresponds to 0…100% of the maximum reference (as defined with a drive parameter, for example, speed scaling in ACS580, ACS880 and DCS880).

## ABB Drives communication profile

### ■ Control word and Status word

The Control word is the principal means for controlling the drive from a fieldbus system. It is sent by the fieldbus master station to the drive through the adapter module. The drive switches between its states according to the bit-coded instructions in the Control word and returns status information to the master in the Status word.

The contents of the Control word and the Status word are detailed below. The drive states are presented on page .

**Control word contents**

The table below shows the contents of the Control word for the ABB Drives communication profile. The upper case boldface text refers to the states shown on page .

| Bit | Name | Value | STATE/Description |
|-----|------|-------|-------------------|
| 0 | OFF1_ CONTROL | 1 | Proceed to **READY TO OPERATE**. |
| | | 0 | Stop along currently active deceleration ramp. Proceed to **OFF1 ACTIVE**; proceed to **READY TO SWITCH ON** unless other interlocks (OFF2, OFF3) are active. |
| 1 | OFF2_ CONTROL | 1 | Continue operation (OFF2 inactive). |
| | | 0 | Emergency OFF, coast to stop. Proceed to **OFF2 ACTIVE**, proceed to **SWITCH-ON INHIBITED**. |
| 2 | OFF3_ CONTROL | 1 | Continue operation (OFF3 inactive). |
| | | 0 | Emergency stop, stop within time defined by drive para-meter. Proceed to **OFF3 ACTIVE**; proceed to **SWITCH-ON INHIBITED**.<br>**Warning:** Ensure that motor and driven machine can be stopped using this stop mode. |
| 3 | INHIBIT_ OPERA-TION | 1 | Proceed to **OPERATION ENABLED.**<br>**Note:** Run enable signal must be active; see drive docu-mentation. If the drive is set to receive the Run enable signal from the fieldbus, this bit activates the signal. |
| | | 0 | Inhibit operation. Proceed to **OPERATION INHIBITED**. |
| 4 | RAMP_OUT_ ZERO | 1 | Normal operation. Proceed to **RAMP FUNCTION GEN-ERATOR: OUTPUT ENABLED.** |
| | | 0 | Force Ramp Function Generator output to zero. Drive ramps to stop (current and DC voltage limits in force). |
| 5 | RAMP_HOLD | 1 | Enable ramp function.<br>Proceed to **RAMP FUNCTION GENERATOR: ACCEL-ERATOR ENABLED.** |
| | | 0 | Halt ramping (Ramp Function Generator output held). |
| 6 | RAMP_IN_ ZERO | 1 | Normal operation. Proceed to **OPERATION.**<br>**Note:** This bit is effective only if the fieldbus interface is set as the source for this signal by drive parameters. |
| | | 0 | Force Ramp Function Generator input to zero. |
| 7 | RESET | $0 \rightarrow 1$ | Fault reset if an active fault exists. Proceed to **SWITCH-ON INHIBITED**.<br>**Note:** This bit is effective only if the fieldbus interface is set as the source for this signal by drive parameters. |
| | | 0 | Continue normal operation. |
| 8 … 9 | Reserved | | |

| Bit | Name | Value | STATE/Description |
|-----|------|-------|-------------------|
| 10 | REMOTE_ CMD | 1 | Fieldbus control enabled |
| | | 0 | Control word and reference not getting through to the drive, except for CW bits OFF1, OFF2 and OFF3. |
| 11 | EXT_CTRL_ LOC | 1 | Select External Control Location EXT2. Effective if control location parameterized to be selected from fieldbus. |
| | | 0 | Select External Control Location EXT1. Effective if control location parameterized to be selected from fieldbus. |
| 12 ... 15 | Drive-specific (For information, see the drive documentation.) | | |

## Status word contents

The table below shows the contents of the Status word for the ABB Drives communication profile. The upper case boldface text refers to the states shown on page *108*.

| Bit | Name | Value | STATE/Description |
|-----|------|-------|-------------------|
| 0 | RDY_ON | 1 | **READY TO SWITCH ON** |
| | | 0 | **NOT READY TO SWITCH ON** |
| 1 | RDY_RUN | 1 | **READY TO OPERATE** |
| | | 0 | **OFF1 ACTIVE** |
| 2 | RDY_REF | 1 | **OPERATION ENABLED** |
| | | 0 | **OPERATION INHIBITED** |
| 3 | TRIPPED | 1 | **FAULT** |
| | | 0 | No fault |
| 4 | OFF_2_STA | 1 | OFF2 inactive |
| | | 0 | **OFF2 ACTIVE** |
| 5 | OFF_3_STA | 1 | OFF3 inactive |
| | | 0 | **OFF3 ACTIVE** |
| 6 | SWC_ON_ INHIB | 1 | **SWITCH-ON INHIBITED** |
| | | 0 | – |
| 7 | ALARM | 1 | Warning/Alarm |
| | | 0 | No warning/alarm |

| Bit | Name | Value | STATE/Description |
|-----|------|-------|-------------------|
| 8 | AT_SETPOINT | 1 | **OPERATION.** Actual value equals reference (= is within tolerance limits, i.e., in speed control, speed error is 10% max. of nominal motor speed). |
| | | 0 | Actual value differs from reference (= is outside tolerance limits). |
| 9 | REMOTE | 1 | Drive control location: REMOTE (EXT1 or EXT2) |
| | | 0 | Drive control location: LOCAL |
| 10 | ABOVE_ LIMIT | 1 | Actual frequency or speed equals or exceeds supervision limit (set by drive parameter). Valid in both directions of rotation. |
| | | 0 | Actual frequency or speed within supervision limit |
| 11 | EXT_CTRL_ LOC | 1 | External Control Location EXT2 selected. **Note concerning ACS880/DCS880:** This bit is effective only if the fieldbus interface is set as the target for this signal by drive parameters. User bit 0 selection (06.33) |
| | | 0 | External Control Location EXT1 selected |
| 12 | EXT_RUN_ EN-ABLE | 1 | External Run Enable signal received. **Note concerning ACS880/DCS880:** This bit is effective only if the fieldbus interface is set as the target for this signal by drive parameters. User bit 1 selection (06.34) |
| | | 0 | No External Run Enable signal received |
| 13 ... 14 | Drive-specific (For information, see the drive documentation.) | | |
| 15 | FBA_ERROR | 1 | Communication error detected by fieldbus adapter module |
| | | 0 | Fieldbus adapter communication OK |

**State machine**

The state machine for the ABB Drives communication profile is shown below.
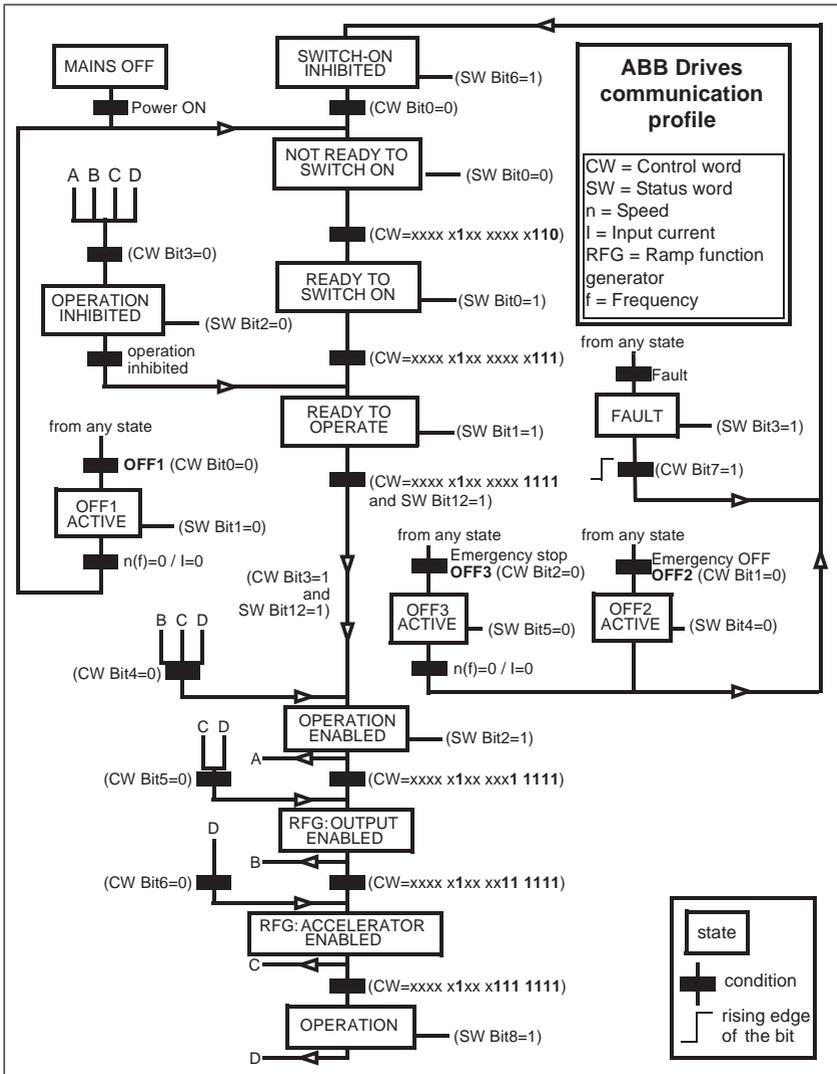
## ■ References

References are 16-bit words containing a sign bit and a 15-bit integer. A negative reference (indicating reversed direction of rotation) is formed by calculating the two's complement from the corresponding positive reference.

ABB drives can receive control information from multiple sources including analog and digital inputs, the drive control panel and a fieldbus adapter module (for example,

FSPS-21). To have the drive controlled through the fieldbus, you must select the module as the source for control information, for example, reference.

**Scaling**

References are scaled as shown below.

**Note:** The values of REF1 MAX and REF2 MAX are set with drive parameters. See the drive manuals for further information.

In ACS580, ACS880 and DCS880, the speed reference (REFx) in decimal (0…20000) corresponds to 0…100% of the speed scaling value (as defined with a drive parameter).

```
Fieldbus  ──────────▶  Drive

  REF2: 10000  ─┬─  REFx MAX / Speed scale
  REF1: 20000   │
                │
                │    ⎧REFx MIN
          0   ──┼──  ⎨
                │    ⎩-(REFx MIN)
                │
                │
  REF2: -10000 ─┴─  -(REFx MAX) / Speed scale
  REF1: -20000
```
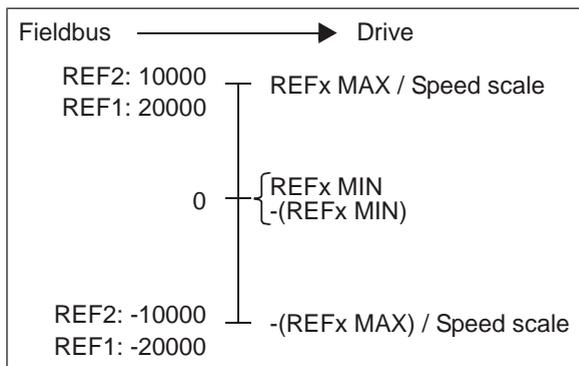
◻ **Actual values**

Actual values are 16-bit words containing information on the operation of the drive. The functions to be monitored are selected with a drive parameter.

**Scaling**

Actual values are scaled as shown below.

**Note:** The values of REF1 MAX and REF2 MAX are set with drive parameters. See the drive manuals for further information.

```
Fieldbus  ◀──────────  Drive

  ACT2: 10000  ─┬─  REFx MAX
  ACT1: 20000   │
                │
          0   ──┼──  0
                │
                │
  ACT2: -10000 ─┴─  -(REFx MAX)
  ACT1: -20000
```

# 15
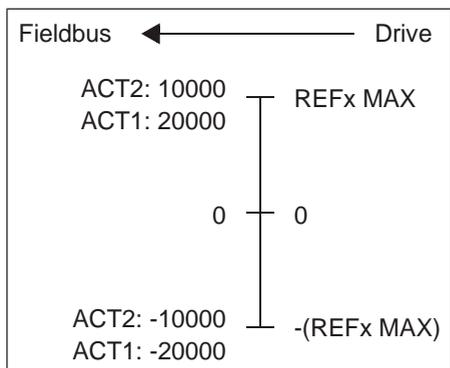
# PROFINET IO – Communication protocol

## Contents of this chapter

This chapter describes the PROFINET IO communication protocol for the adapter module. For detailed information on PROFINET IO communication, refer to *PROFINET specification Application Layer protocol for decentralized periphery and distributed automation v2.0.*

## PROFINET IO

PROFINET IO is a fieldbus protocol that enables communication between programmable controllers and distributed field devices in an Ethernet network. The protocol classifies devices into I/O controllers, I/O supervisors and I/O devices, which have a specific collection of services.

PROFINET IO uses three different communication channels to exchange data:

- The standard UDP/IP and TCP/IP channel is used for parameterization and configuration of devices and for acyclic operations.

- The real time (RT) channel is used for cyclic data transfer and alarms.

- The isochronous real time (IRT) channel is used, for example, in motion control applications (not implemented in FSPS-21).

PROFINET IO devices are structured in slots and sub-slots, which can contain modules and sub-modules correspondingly. A device can have almost any number of slots and sub-slots, and they can be virtual or real. Device-specific data is represented in slot 0; module-specific and sub-module-specific data in subsequent slots and sub-slots.

One of the benefits of PROFINET IO is the diagnostics and alarm mechanism. Every module and sub-module provide alarm data to the I/O controller using the cyclic channel. Diagnostic data can be read non-cyclically from the device by using record data.

The properties and services of a PROFINET IO device are described in a GSD file written in GSDML (General Station Description Markup Language). The GSD file describes the device-specific modules and the method of assigning modules and sub-modules to predefined slots and sub-slots. For more information, see section *Downloading the GSD file (page 157)*.

## PROFINET network settings

In PROFINET, network devices are identified with station names. The controller uses DCP (Discovery and Configuration protocol) to find devices with configured names from the network. Device with the given name responds with an Identity response which also contains the current IP address of the device.

If the current IP address differs from the address in the hardware configuration of the controller, the controller sets the device with a new IP address according to the configuration. This IP is set as temporary, which means that after reboot of the device, the IP address will be 0.0.0.0 as specified in the PROFINET standard.

The recommended IP setting for PROFINET is Static IP and address is 0.0.0.0. With this setting, there is need to configure the IP in only one place (hardware configuration) and this avoids any IP conflicts among the devices.

## PROFINET IO in FSPS-21

When PROFINET IO is selected as the communication protocol, the FSPS-21 module can employ the ABB Drives, Transparent 16 and Transparent 32 communication profiles or the PROFIdrive profile. You can select the profile via FSPS-21 configuration parameter 02 Protocol/Profile. You can select the appropriate device access point (DAP) and functional module with the tool as well.

- Slot 0 has sub-slots, and the DAP module attached to it represents the device itself. The following sub-slots are available:
    - sub-slot 0x0001 is DAP
    - sub-slot 0x8000 is interface sub-module
    - sub-slot 0x8001 is port 1
    - sub-slot 0x8002 is port 2.

- Slot 1 and its sub-slots support other functional modules and sub-modules described in the GSD file. The following sub-slots are available:
    1. For PPO types
        - sub-slot 0x0001 is the telegram

2. For Standard telegrams

- sub-slot 0x0001 is the Module Access point

- sub-slot 0x0002 is the telegram

- Slot 2 is used for PROFIsafe

 - sub-slot 0x0001 is PROFIsafe telegram

# The services provided by the FSPS-21 module

- Cyclic messaging

- Acyclic parameter access mechanism

- Identification & Maintenance functions (I&M)

- Media Redundancy Protocol (MRP)

- Shared Device

- Network Diagnostic (SNMP)

- Topology information (LLDP) with LLDP-MIB

- PROFIdrive parameters (limited in the ABB Drives and Transparent profiles)

- Diagnostic and alarm mechanism (only with the PROFIdrive profile)

- Fault buffer mechanism (limited in the ABB Drives and Transparent profiles).

# Cyclic message types

## ◼ PPO types
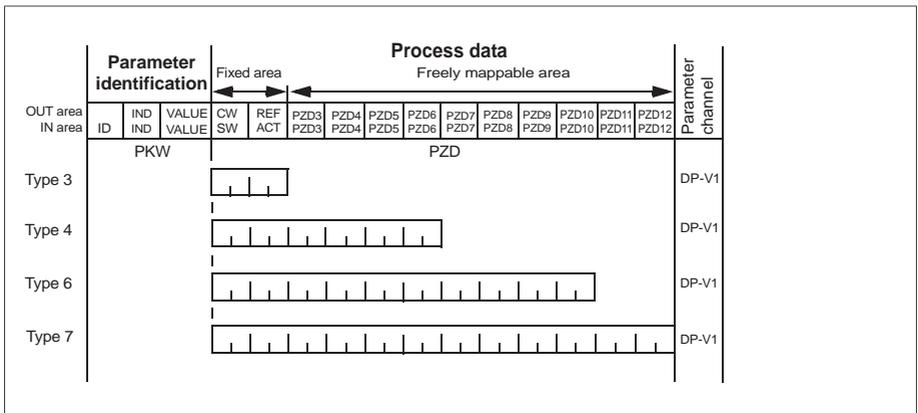


**OUT area** – Data sent from master to slave (control data)

**IN area** – Data sent from slave to master (actual data)

**Parameter identification:**

ID – Parameter identification

IND – Index for arrays

VALUE – Parameter value (Max. 4 bytes)

PKW – Parameter ID/value

**Process data:**

CW – Control word

SW – Status word

REF – Reference

ACT – Actual value

PZD – Process data (application-specific)

DW – Data word

## ■ Standard telegram (ST) types (DP-V1)

**ST1**

|  | PZD1 | PZD2 |
|---|---|---|
| OUT area | STW1<br>Control word 1 | NSOLL_A<br>Speed set point A |
| IN area | ZSW1<br>Status word 1 | NIST_A<br>Speed actual value A |

**ST2**

|  | PZD1 | PZD2...3 | PZD4 |
|---|---|---|---|
| OUT area | STW1<br>Control word 1 | NSOLL_B<br>Speed set point B | STW2<br>Control word 2 |
| IN area | ZSW1<br>Status word 1 | NIST_B<br>Speed actual value B | ZSW2<br>Status word 2 |

**Note:** For the contents of the Control word, the Status word, references and actual values, see chapter *PROFINET IO – Communication profiles*

◼ **Behavior of output data**

| If | Then |
|---|---|
| IOPS (PLC provider status)=Bad | Output data retains last values |
| Connection loss | Output data retains last values |
| After power-up | All output data is 0 |

# Parameter handling using acyclic parameter access mechanism (DP-V1)

PROFINET IO offers record read and write services for the acyclic parameter access mechanism. When the drive parameters or FSPS-21 parameters are accessed, the corresponding slot, sub-slot and index are set, and a PROFIdrive DP-V1 message is placed on the data block of the record read or write frame.

◼ **Header and frame structures**

PROFINET IO uses the DCE RPC (Distributed Computing Environment Remote Procedure Call) protocol for acyclic read and write services. I/O controllers and supervisors take care of formulating most of the request frames. However, it is possible that handling the PROFIdrive request and response headers must be performed in the application logic. The acyclic frame structure, headers and error codes are described further below.

| Frames | Dest addr. | Src addr. | Ether type | IP UDP | RPC | NDR | Read or Write | Data |
|---|---|---|---|---|---|---|---|---|
| Bytes | 6 | 6 | 2 | 28 | 80 | 20 | 64 | … |

**Dest addr.** and **Src addr.** are the destination and the source of the communication relationship. The addresses are in hexadecimal format, for example, 00-30-11-02-57-AD.

**Ether type** is 0x800 for non-real-time communication.

**IP** and **UDP** fields contain the IP address of the source and the destination as well as the communication ports and length of the message.

**RPC** contains, for example, the read or write service ID, interface description and selected objects.

**NDR** request block describes the length of the following data block. The response block also contains bytes ErrorCode, ErrorDecode, ErrorCode1 and ErrorCode2 for presenting the status of the request. The response error codes are listed in the table below.

| Byte | Value and meaning |
|---|---|
| ErrorCode | 0xDF (Error Write) |
| | 0xDE (Error Read) |
| ErrorDecode | 0x80 (PNIORW) ErrorCode1 decoded as shown in section *Error-Code1 (page 116)*. ErrorCode2 is 0. |
| | 0x81 (PNIO) ErrorCode1 and ErrorCode2 decoded as shown in section *ErrorCode1 (page 116)*. |
| ErrorCode1 | Error class and error code. See section *ErrorCode1 (page 116)*. |
| ErrorCode2 | Not described here |

**ErrorCode1**

The table below lists the ErrorCode1 with PNIORW decoding.



| Error class | Meaning | Error code |
|---|---|---|
| 0…9 | (Reserved) | |
| 10 (0x0A) | Application | 0 = Read error<br>1 = Write error<br>2 = Module failure<br>3…7 = Reserved<br>8 = Version conflict<br>9 = Feature not supported<br>10…15 = User-specific |
| 11 (0x0B) | Access | 0 = Invalid index<br>1 = Write length error<br>2 = Invalid slot<br>3 = Type conflict<br>4 = Invalid area<br>5 = State conflict<br>6 = Access denied<br>7 = Invalid range<br>8 = Invalid parameter<br>9 = Invalid type<br>10…15 = User-specific |

| 12 (0x0C) | Resource | 0 = Read constraint conflict<br>1 = Write constraint conflict<br>2 = Resource busy<br>3 = Resource unavailable<br>4…7 = Reserved<br>8…15 = User-specific |
|-----------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13…15     | User-specific |  |

### ■ DP-V1 read/write request sequence

A read/write service on a drive parameter is illustrated below.
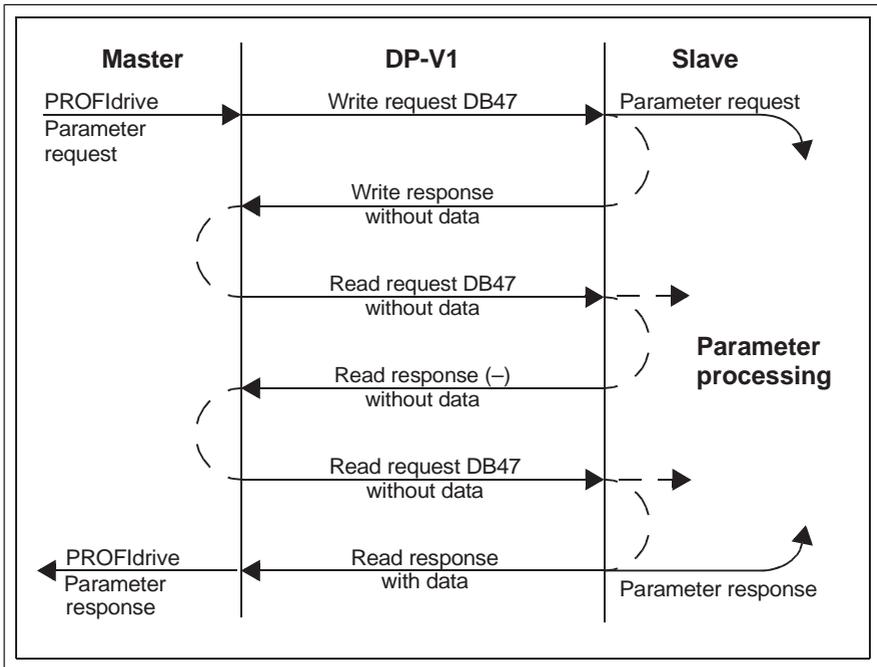


The messaging employs DP-V1 data units. The PROFIdrive parameter request is included within the DP-V1 request as data. Likewise, the DP-V1 response contains the PROFIdrive parameter response as data.

A write request is first sent containing the parameter request. If the write request is valid, the adapter module acknowledges it with a DP-V1 write response with no data. The master will then send a read request. If the adapter module is still busy performing the internal parameter request, it will return a negative response with the DP-V1 error code B5h (State conflict). In this case, the master will repeat the read request until the adapter module has the PROFIdrive response data ready.

If the write request is invalid, a negative response is returned with a DP-V1 error code (see section *ErrorCode1 (page 116)*).

**Read and write blocks**

A read block is used in read requests and responses, while a write block is used in write requests and responses. A request consists of unique identifiers for the connection, addressing information and the length of the record data. A response also contains two additional fields for transferring information.

The table below shows the structure of the read and write blocks in detail.

| Field(s) | Description | Range | Type |
|---|---|---|---|
| Service | Request or Response service | Request (0x00) Response (0x80) | UI8 |
| Operation | Read or Write operation | Write (0x08) Read (0x09) | UI8 |
| Block length | Length of the block | 0…0xFFFF | UI16 |
| ARUUID | Identifier • time low • time mid • time high and version • clock • node | | UI32 UI16 UI16 Octet[2] Octet[6] |
| API | Application process identifier | Device access point (0x0000) PROFIdrive (0x3A00) | UI32 |
| Slot | Slot of the module access point (MAP/PAP) | 0x01 | UI16 |
| Subslot | Subslot of the module access point (MAP/PAP) | 0x01 | UI16 |
| Padding | 2 bytes | | |
| Index | Index of the record data object | 0x2F 0xB02E 0xB02F | UI16 |
| Data length | Length of the data block | 0…0xFFFFFFFF | UI32 |
| Additional value 1 (response only) | Field for transferring additional data | | UI16 |
| Additional value 2 (response only) | Field for transferring additional data | | UI16 |
| Padding | 24 bytes for request, 20 bytes for response. | | |
| Data block | Used only with write request and read response. | | |

**Data block**

The data block contains a PROFIdrive-specific request or response header.

The table below shows the contents of the PROFIdrive request.

| Field(s) | Description | Range | Byte/ Word |
|---|---|---|---|
| Request Reference | Unique identification set by the master. Changed for each new request. | 1…255 | Byte |
| Request ID | Request type for the issued block | Request Parameter (01h) Change Parameter (02h) | Byte |
| Drive Object ID | To be set to 0 or 1. | 0…255 | Byte |
| No. of Parameters | Number of the parameters that are present in the request | 1…37 | Byte |
| Attribute | Type of the object being accessed. Note: "Description" and "Text" are not supported. | Value (10h) Description (20h) Text (30h) | Byte |
| No. of Elements | Number of the array elements accessed or length of the string accessed. Set to 0 if non-array parameters are used. | 0, 1…234 | Byte |
| Parameter Index | Address of the parameter that is being accessed. "0" is allowed by FSPS-21. | 1…65535 | Word |
| Subindex | Addresses<br>• the first array element of the parameter or<br>• the beginning of a string access or<br>• the text array or<br>• the description element that is being accessed | 0…65535 | Word |
| Format[1] | See the table on page *120*. | See the table on page *120*. | Byte |
| Number of Values[1] | Number of the values following | 0…234 | Byte |
| Values[1] | The values of the request. In case of an odd number of bytes, a zero byte is appended to ensure the word structure of the telegram. | – | See the Format field. |

[1] Only if Request ID is 02h (Change Parameter). The Format, Number of Values and Values fields are repeated for other parameters.

The table below shows the contents of the PROFIdrive response.

| Field(s) | Description | Range |
|---|---|---|
| Request Reference (mirrored) | Mirrored from the request. | 1…255 |
| Response ID | Response from the slave. In case any requested services fail, a "not acknowledged" (NAK) response will be indicated. | Request Param OK (01h) Request Param NAK (81h) Change Param OK (02h) Change Param NAK (82h) |
| Drive Object ID | To be set to 1. | 0…255 |
| No. of Parameters | Number of the parameters that are present in the response | 1…37 |
| Format[1] | See the table on page *120*. | See the table on page *120*. |
| Number of Values[1] | Number of the values following | 0…234 |
| Values[1] | The values of the request. In case of an odd number of bytes, a zero byte is appended to ensure the word structure of the telegram. | – |

[1] Only if Response ID is 01h (Request Parameter OK). The Format, Numberof Values and Values fields are repeated for other parameters.

The table below shows the data types for the Format field in the PROFIdrive response.

| Code | Type |
|---|---|
| 0x00 | (Reserved) |
| 0x01…0x36 | Standard data types<br>1. Boolean (not supported)<br>2. Integer8 (not supported)<br>3. Integer16<br>4. Integer32<br>5. Unsigned8 (not supported)<br>6. Unsigned16<br>7. Unsigned32<br>8. Floating point (not supported)<br>9. Visible string (not supported)<br>… |
| 0x37…0x3F | (Reserved) |
| 0x40 | Zero |
| 0x41 | Byte |

| Code | Type |
|------|------|
| 0x42 | Word |
| 0x43 | Double word |
| 0x44 | Error |
| 0x45…0xFF | (Reserved) |

The table below shows the PROFIdrive parameter request error codes.

| Error # | Meaning | Used at |
|---------|---------|---------|
| 00h | Impermissible parameter number | Access to an unavailable parameter |
| 01h | Parameter value cannot be changed | Change access to a parameter value that cannot be changed |
| 02h | Low or high limit exceeded | Change access with a value outside the limits |
| 03h | Invalid subindex | Access to an unavailable subindex |
| 04h | No array | Access with a subindex to a non-indexed parameter |
| 05h | Incorrect data type | Change access with a value that does not match the data type of the parameter |
| 06h | Setting not permitted (can only be reset) | Change access with a value unequal to 0 when this is not permitted |
| 07h | Description element cannot be changed | Change access to a description element that cannot be changed |
| 09h | No description data available | Access to an unavailable description (parameter value is available) |
| 0Bh | No operation priority | Change access rights without rights to change parameters |
| 0Fh | No text array available | Access to a text array that is not available (Parameter value is available.) |
| 11h | Request cannot be executed because of operating mode | Access is temporarily not possible for reasons that are not specified in detail. |
| 14h | Value impermissible | Change access with a value that is within limits but is not permissible for other long-term reasons (parameter with defined single values) |
| 15h | Response too long | The length of the current response exceeds the maximum transmittable length. |
| 16h | Parameter address impermissible | Illegal value or value that is not supported for the attribute, number of elements, parameter number or sub-index, or a combination |

| Error # | Meaning | Used at |
|---------|---------|---------|
| 17h | Illegal format | Write request: Illegal format or format of parameter data that is not supported |
| 18h | Number of values inconsistent | Write request: Number of values of the parameter data does not match the number of elements at the parameter address. |
| 65h … FF | Manufacturer-specific error area | – |
| 65h | Vendor-specific error | Vendor-specific error |
| 66h | Request not supported | Request not supported |
| 67h | Communication error | Request cannot be completed because of a communication error. |
| 6Eh | Non-volatile error | Failure during write to non-volatile memory |
| 6Fh | Time-out error | Request aborted because of a timeout. |
| 78h | PZD map failure | Parameter cannot be mapped to PZD (size mismatch or non-existent). |
| 79h | PZD memory failure | Parameter cannot be mapped to PZD (out of memory). |
| 7Ah | Multiple PZD map | Parameter cannot be mapped to PZD (multiple PZD write). |
| 82h | Control word bit map | Cannot map Control word bit (parameter 933…937, eg, double mapping of bits). |
| 8Ch | Set torque mode error | Cannot change mode to TORQUE (frequency is used). |
| 90h | Illegal Request ID | The request ID of the response is illegal. |
| 96h | Internal buffer | Buffer overflow |
| A0h | Internal communication | Communication error between the module and the drive |

## ■ Function blocks for sending DP-V1 messages (Siemens S7)

In IEC 61131-3 compatible systems, function blocks are available for accessing data non-cyclically. In Siemens S7, SFB 52 "RDREC" can be used for reading and SFB53 "WRREC" for writing data records as follows:

- On INDEX: Connect the value 0xB02F, 0xB02E or 0x2F.
- On Write record: Set the length of the DP-V1 write request to MLEN.
- On Read record: Set the maximum length of the DP-V1 read response.

• Connect the DP-V1 message to RECORD.

```
        RDREC
BOOL  ---REQ              VALID---  BOOL
DWORD    ID              BUSY ---  BOOL
   INT    INDEX          ERROR---  BOOL
   INT    MLEN           STATUS---  DWORD
                         LEN ---  INT
  ANY    RECORD--     --RECORD


        WRREC
BOOL  ---REQ              DONE ---  BOOL
DWORD  ---ID              BUSY ---  BOOL
   INT  ---INDEX          ERROR---  BOOL
   INT  ---LEN            STATUS---  DWORD
  ANY  ---RECORD--     --RECORD
```
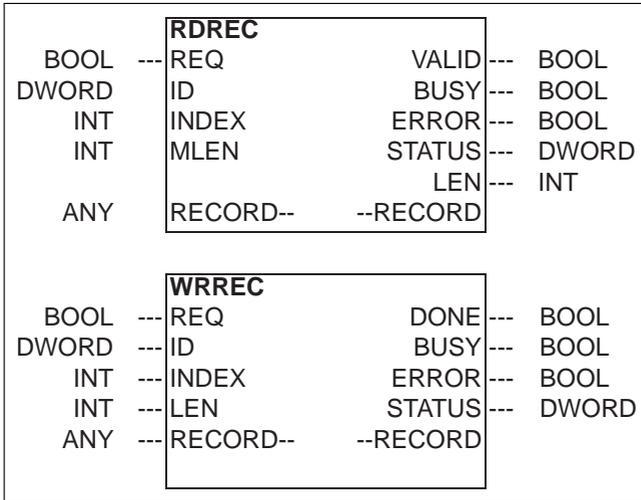
**Note:** The function block names for Siemens 12xx and 15xx series PLCs are RD_REC and WR_REC, and this naming convention is also applicable for other blocks.

For more information on the above function blocks, see document *Communication Function Blocks for PROFIBUS DP and PROFINET IO v2.0* available at www.profibus.com.

■ **Parameter data transfer examples**

The following examples show how parameter data is transferred using the DP-V1 mechanisms READ and WRITE.

Only the data block part of the request is presented in the examples. See section .

**Example 1a: Reading a drive parameter (array element)**

Drive parameters are addressed so that the drive parameter group corresponds to the Parameter index (PNU), and the drive parameter number within the group corresponds to the Subindex (IND). In the following example, a value is read from drive parameter 12.04 (0C.04h).

• DP-V1 Write request (Read parameter value):
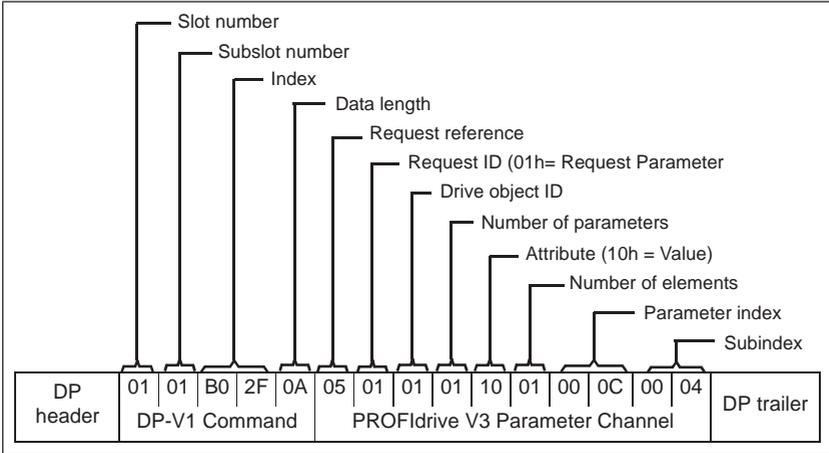
• Positive Read response to DP-V1 Read request:
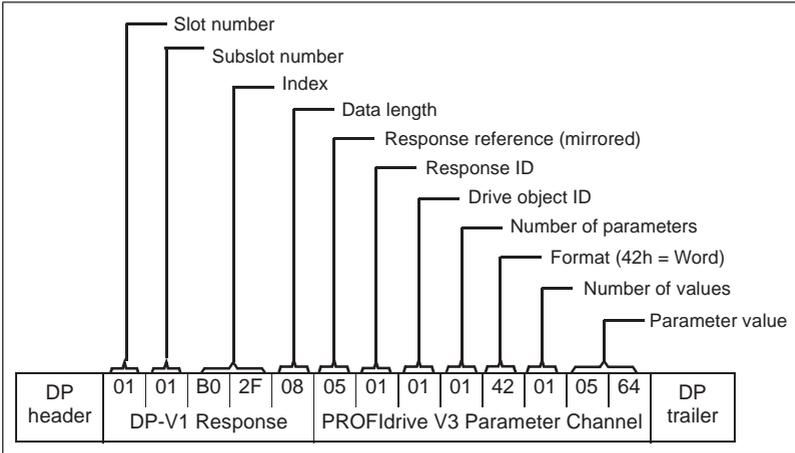


• Negative response to PROFIdrive Read request:
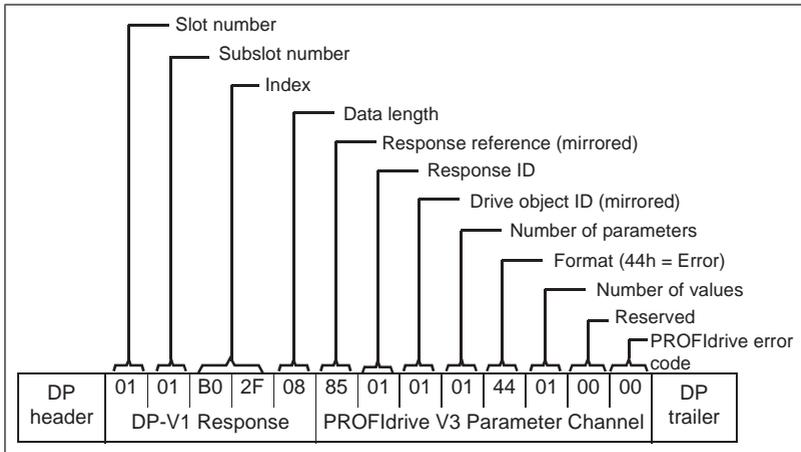
**Example 1b: Reading 3 drive parameters (multi-parameter)**

In this example, three parameters (12.04, 20.08 and 30.19) are read using one telegram.

• DP-V1 Write request (Read parameter value)

The diagram shows the structure of a DP-V1 Read request with labeled fields:
- Slot number
- Subslot number
- Index
- Data length
- Request reference
- Request ID (01h= Request Parameter
- Drive object ID
- Number of parameters
- Attribute (10h = Value)
- Number of elements
- Parameter number
- Subindex

| DP header | 01 | 01 | B0 | 2F | 16 | 06 | 01 | 01 | 03 | 10 | 01 | 00 | 0C | 00 | 04 | ••• |

DP-V1 Command | PROFIdrive V3 Parameter Channel

••• | 10 | 01 | 00 | 14 | 00 | 08 | ••• (Par. Channel continued)

••• | 10 | 01 | 00 | 1E | 00 | 13 | DP trailer (Par. Channel continued)

• Positive Read response to DP-V1 Read request:

The values 190h (400), 1F4h (500) and 1Eh (30) are returned.

**Example 2a: Writing a drive parameter (one array element)**

Drive parameters are addressed so that the drive parameter group corresponds to the Parameter index (PNU), and the drive parameter number within that group corresponds to the Subindex (IND). In the following example, a value is written to drive parameter 12.02 (0C.02h).

The first diagram (DP-V1 Command) has the following fields labeled, from top to bottom:

- Slot number — 01
- Subslot number — 01
- Index — B0
- Data length — 2F
- Request reference — 0E
- Request ID — 07
- Drive object ID — 02
- Number of parameters — 01
- Attribute (10h = Value) — 01
- Number of elements — 10
- Parameter number — 01
- Subindex — 00 0C
- Format (42h = Word) — 00 02
- Number of values — 42
- Value — 01 02 58

Byte sequence: 01 | 01 | B0 | 2F | 0E | 07 | 02 | 01 | 01 | 10 | 01 | 00 | 0C | 00 | 02 | 42 | 01 | 02 | 58

DP header | DP-V1 Command | PROFIdrive V3 Parameter Channel | DP trailer

The second diagram (DP-V1 Response) has the following fields labeled:

- Slot number — 01
- Slot number — 01
- Index — B0
- Data length — 2F
- Request reference (mirrored) — 04
- Response ID — 07
- Drive object ID (mirrored) — 02
- Number of parameters — 01 01

Byte sequence: 01 | 01 | B0 | 2F | 04 | 07 | 02 | 01 | 01

DP header | DP-V1 Response | PROFIdrive V3 Parameter Channel | DP trailer

**Example 2b: Writing 2 drive parameters (multi-parameter)**

In this example, the values 300 (12Ch) and 500 (1F4h) are written to drive parameters 12.02 (0C.02h) and 20.08 (14.08h) respectively using one telegram.
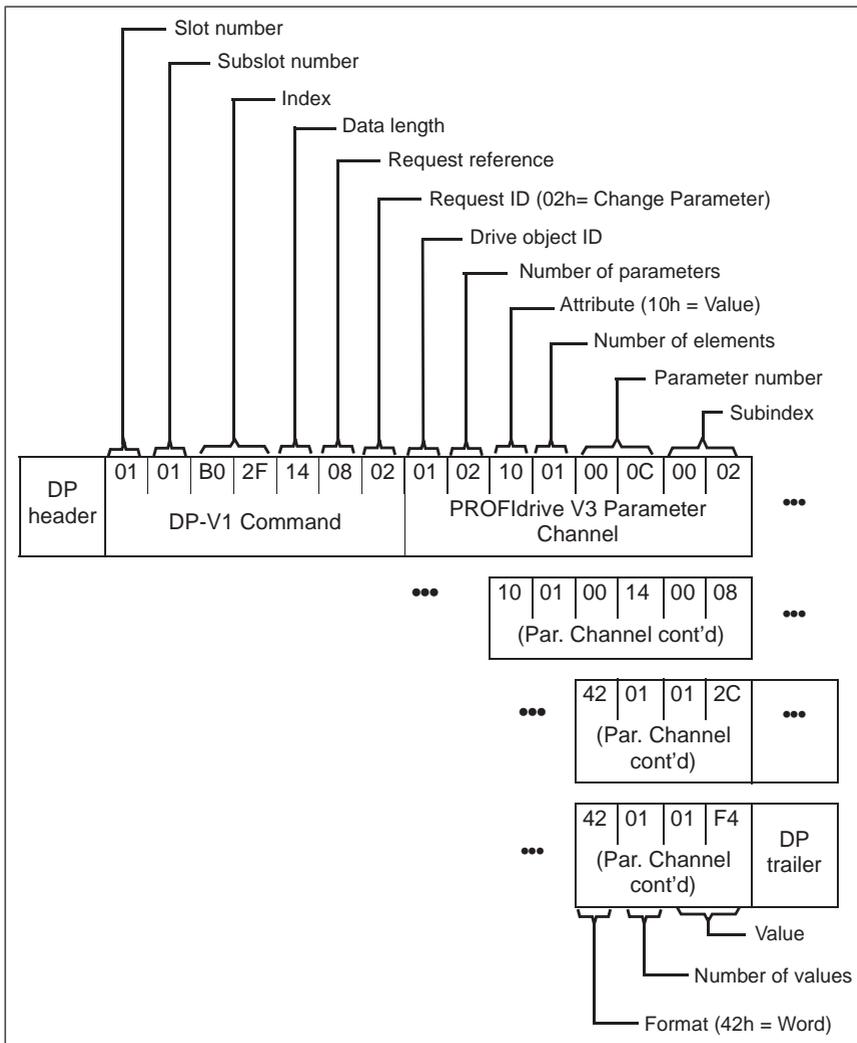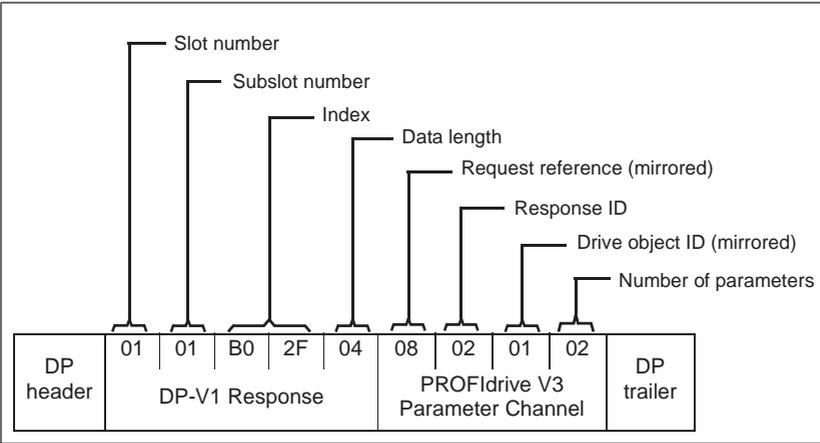
**Example 3: Reading a PROFIdrive parameter**

In this example, PROFIdrive parameter 919 (397h) is used to read the device system number of the slave, which is the product code of the drive.

• DP-V1 Write request (Reading a PROFIdrive parameter):



• DP-V1 Read response:

| DP header | 01 | 01 | B0 | 2F | 08 | 0B | 01 | 01 | 01 | 42 | 01 | 0C | 05 | DP trailer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DP-V1 Response | | | | | PROFIdrive V3 Parameter Channel | | | | | | | | |

Labels (top to bottom):
- Slot number
- Subslot number
- Index
- Data length
- Request reference (mirrored)
- Response ID
- Drive object ID (mirrored)
- Number of parameters
- Format (42h = Word)
- Number of values
- Value of error values
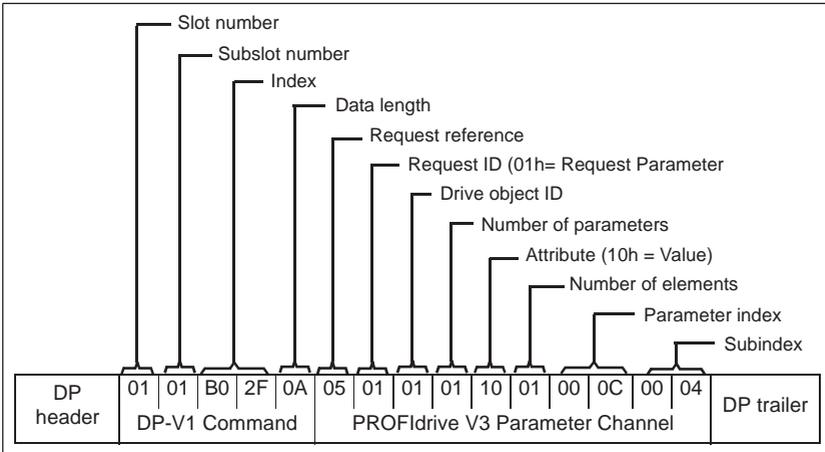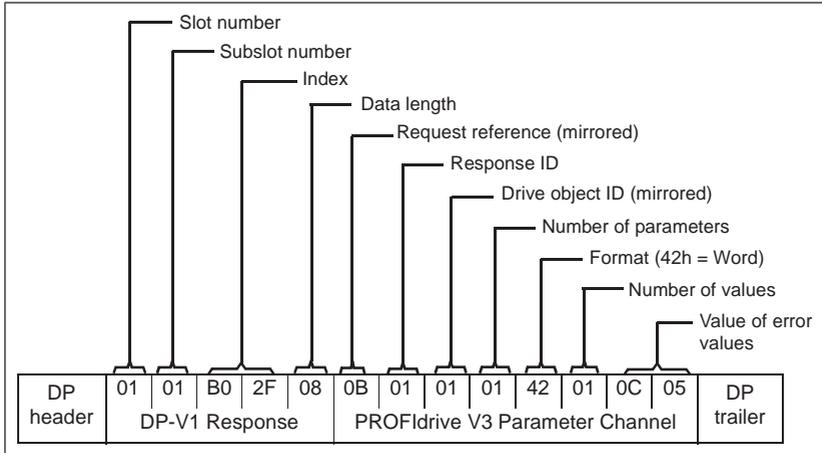
The slave returns the product code of the drive (20Bh in this example).

**Example 4: Configuring the process data written to the drive**

PROFIdrive parameter 915 (393h) can be used to define which data is written cyclically to a drive parameter as application-specific process data.

In the example below, the value of drive parameter 12.06 (0C.06h) is selected to be taken from PZD3. The parameter will continue to be updated with the contents of PZD3 in each Request frame until a different selection is made.

*Subindex* (IND) defines which process data word the required data is taken from. *Value* selects the drive parameter to which that word is mapped.

• DP-V1 Write request
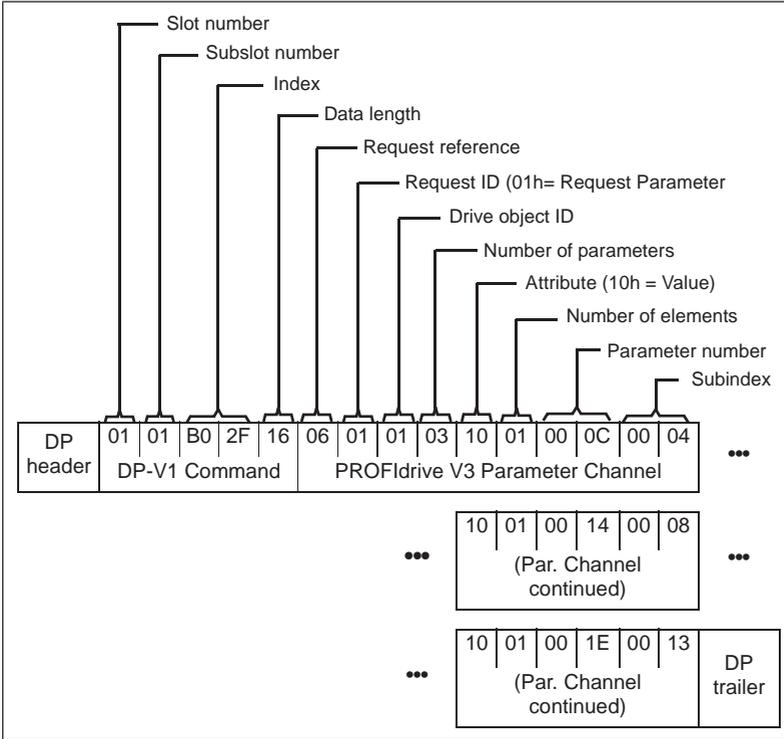
- DP-V1 Read response:
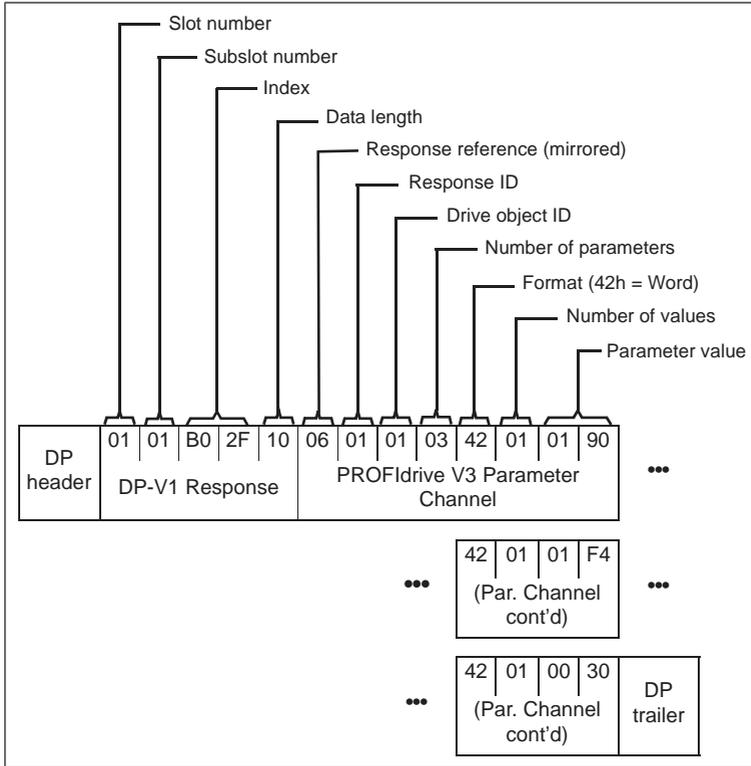
Subsequently, the contents of PZD3 in each Request frame are written to drive parameter 12.06 until a different selection is made.

**Example 5: Determining the source of the process data read from the drive**

PROFIdrive parameter 916 (394h) can be used to define which data is read cyclically from the drive as application-specific process data. In the example below, the parameter is used to determine which drive parameter the contents of PZD3 are taken from. Subindex (IND) defines which process data word the required data is transmitted in.

• DP-V1 Write request

Slot number
Subslot number
Index
Data length
Request reference
Request ID (01h = Read)
Drive object ID
Number of parameters
Attribute (10h = Value)
Number of elements
Parameter index
Subindex

| DP header | 01 | 01 | B0 | 2F | 0A | 0B | 01 | 01 | 01 | 10 | 01 | 03 | 94 | 00 | 03 | DP trailer |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | DP-V1 Response | | | | PROFIdrive V3 Parameter Channel | | | | | | | | | | | |

• DP-V1 Read response:

Slot number
Subslot number
Index
Data length
Request reference (mirrored)
Response ID
Drive object ID (mirrored)
Number of parameters
Format (42h = Word)
Number of values
Value of error values

| DP header | 01 | 01 | B0 | 2F | 08 | 0B | 01 | 01 | 01 | 42 | 01 | 0C | 05 | DP trailer |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | DP-V1 Response | | | | PROFIdrive V3 Parameter Channel | | | | | | | | |

*Value* indicates the source of PZD3 as drive parameter 12.05 (0C.05h).

# Diagnostic and alarm mechanism

The FSPS-21 module has mechanisms for sending alarms and saving diagnostics data to a fault buffer. An alarm is triggered if the host or drive has faults in communication or operation. The alarm and fault buffer mechanisms are enabled by default and can be disabled with a configuration parameter, see *FSPS-21 configuration parameters – group A (group 1) (page 64)*.

■ **Alarm mechanism**

When a fault situation occurs, the adapter module sends an alarm notification, which the master station has to acknowledge. Alarm notifications can be acknowledged, viewed and handled, for example, with Siemens S7 blocks OB82, OB83, OB86 and OB122.

- Block OB82 is used to make sure that the drive does not go to the stop mode during a diagnostic alarm.
- Block OB83 is called if a module is inserted or removed from the system or if the module is modified.
- Block OB86 indicates if there is a failure or event in the distributed periphery.
- Block OB122 is called if the CPU calls a device that is not accessible.

**Fault code mapping**

An alarm notification contains a fault code, which is called ChannelErrorType. For PROFIdrive API, the drive internal DRIVECOM fault numbers are mapped to PROFIdrive ChannelErrorTypes according to the table below. The fault numbers that are not listed are mapped to ChannelErrorType Other.

| ChannelErrorType | Description | DRIVECOM fault numbers |
|---|---|---|
| 0x9000 | Microcontroller hardware or software | 4211, 5000, 5401, 5402, 5403, 5484, 5691, 5693, 6100, 6180, 6300, 6306, 6306, 6320, 6481, 6487, 630D, 630F, 64A1, 64A2, 64A3, 64E1, 6581, 65A1, 6682, 6683, 6684, 6881, FF55 |
| 0x9001 | Mains supply | 3291 |
| 0x9002 | Low voltage supply | 3130, 3220 |
| 0x9003 | DC link overvoltage | 3210 |
| 0x9004 | Power electronics | 2211, 2281, 2310, 2312, 2340, 2381, 3180, 3181, 3182, 3183, 3184, 3185, 3186, 3187, 3381, 3385, 5400, 5482, 5682, 5692, FF56 |
| 0x9005 | Overtemperature electronic device | 4110, 4210, 4212, 4290, 4310, 4313, 4981, 7182, 42F1, 4380 |
| 0x9006 | Earth/ground fault | 2330 |
| 0x9007 | Motor overload | 7121 |
| 0x9008 | Fieldbus system | |

| ChannelErrorType | Description | DRIVECOM fault numbers |
|---|---|---|
| 0x9009 | Safety channel | 8182, 8183, 5090, 5091, FA81, FA82, FF7A, FFA0, FFA1, FFA2 |
| 0x900A | Feedback | 7301, 7310, 7380, 7381, 7389, 7391, 8480, 8584, 738A, 738B, 738C, 73A0, 73A1 |
| 0x900B | Internal communication | 5480, 5681, 5690, 7000, 7080, 7081, 7510, 7520, 7540, 7584 |
| 0x900C | Infeed | |
| 0x900D | Brake resistor | 7111, 7112, 7113, 7181, 7183, 7184, 7185, 7186, 7187, 7191, 71A2, 71A3, 71A5 |
| 0x900E | Line filter | |
| 0x900F | External | 9000, 9001, 9081, FF81, FF82, FF8E, FF90 |
| 0x9010 | Technology | 6382 |
| 0x9011 | Engineering | |
| 0x9012 | Other | 5080, 5093, 5210, 5300, 6200, 7583, 8110, 8500, 8582, 8583, FF61, FF69, FF6A, FF83, FF84, FF95 |

### ▪ Fault buffer mechanism

The PROFIdrive profile has a mechanism that can store eight fault situations to PROFIdrive parameters. Fault and diagnostic data, like fault number and fault code, can be accessed simultaneously with only one subindex. The mechanism consists of four PROFIdrive parameters:

- PNU944: Fault message counter.
  - Incremented each time the fault buffer changes.
- PNU945: PROFIdrive fault codes presented in section on page .
- PNU946: Fault code list that converts fault numbers to fault codes.
  - Read using the fault number as a subindex to get the corresponding fault code.
- PNU947: Fault numbers according to the DRIVECOM profile.

The table below illustrates the structure of a fault buffer. The fault buffer consists of two parameters: fault number (PNU 947) and fault code (PNU 945). The rows of the fault buffer are represented by the parameter subindices. Fault messages are entered into

the buffer in the sequence they are detected. Each line in the fault buffer represents a fault message, which is a part of a fault situation. A fault situation lasts from a detection of a fault to its acknowledgement.

| Fault situation | PNU947 | PNU945 | |
|---|---|---|---|
| | Fault number | Fault code | Subindex |
| | 0x4210 | 0x9005 | 0 |
| | 0 | 0 | 1 |
| | 0 | 0 | 2 |
| | 0 | 0 | 3 |
| | 0 | 0 | 4 |
| | 0 | 0 | 5 |
| | 0 | 0 | 6 |
| Actual fault situation n | 0 | 0 | 7 |
| | 0x7510 | 0x900B | 8 |
| | 0 | 0 | 9 |
| | 0 | 0 | 10 |
| | 0 | 0 | 11 |
| | 0 | 0 | 12 |
| | 0 | 0 | 13 |
| | 0 | 0 | 14 |
| Fault situation n-1 | 0 | 0 | 15 |
| ... | ... | ... | ... |

| Fault situation | PNU947 | PNU945 | |
| --- | --- | --- | --- |
| | Fault number | Fault code | Subindex |
| | 0 | 0 | 56 |
| | 0 | 0 | 57 |
| | 0 | 0 | 58 |
| | 0 | 0 | 59 |
| | 0 | 0 | 60 |
| | 0 | 0 | 61 |
| | 0 | 0 | 62 |
| Fault situation n-7 | 0 | 0 | 63 |

# 16

# PROFIsafe

## Contents of this chapter

This chapter describes the safety system when the FSPS-21 module is communicating with a safety PLC using the PROFIsafe profile of PROFINET. It describes the module states and transitions and the contents of the PROFIsafe messages. The chapter also includes installation instructions, configuration instructions for the ABB AC500-S Safety PLC and Siemens SIMATIC Fail-safe S7 PLC, as well as fault tracing tips.

## Introduction

When the drive is controlled from a safety PLC, the reliability of the fieldbus communication must be secured. This can be done with the PROFIsafe technology. The PROFIsafe technology includes several safety measures to minimize the effect of various transmission errors that can occur when messages are transferred in a complex network.

PROFIsafe is an application layer (protocol) that describes the safety communication between fail-safe devices. It is an additional layer on top of the standard PROFIBUS and PROFINET protocols.

There are two versions of the PROFIsafe protocol:

• V1 can only be used with PROFIBUS

• V2 can be used with PROFIBUS and PROFINET.

The FSPS-21 module supports version V2 with PROFINET.

The PROFIsafe protocol can be used for safety applications up to SIL 3 according to IEC 61508 / IEC 62061, Category 4 according to EN 954-1 or PL e according to ISO 13849-1.

For more information on PROFIsafe and PROFINET, and for full PROFIsafe profile (PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO), see www.profibus.com/.

## System description

### ■ Required components

- FSPS-21 module, revision A or later
- ACS880 primary control program: version 2.80 or later
- ACS580 standard control program: version 2.05 or later
- ACS380 machinery control program; version 2.05 or later
- DCS880 firmware; version 2.06 or later
- compatible safety PLC system, for example, ABB AC500-S Safety PLC or Siemens SIMATIC Fail-safe S7 PLC

### ■ Tools

- Drive composer pro: version 1.7 or later
- For ABB PLCs: Automation builder: 1.0 or later (includes PS501 Control Builder Plus version 2.3.0), safety license PS501-S
- For Siemens PLCs: SIMATIC Step 7 V5.5 + S7 Distributed Safety V5.4 and SIMATIC Step 7 (TIA Portal) + Step 7 Safety Advanced

### ■ System overview

This figure shows an overview of a safety PLC that is connected to the ACS380 drive via the PROFIsafe communication bus.
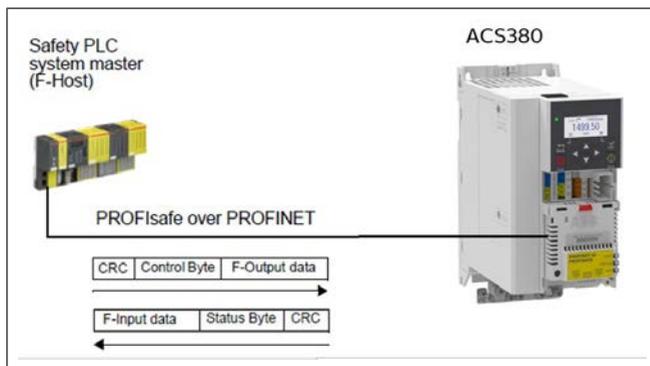
The FSPS-21 module is installed on the ACS580 drive. The safety PLC is connected to the FSPS-21 module. The safety PLC activates safety functions via the PROFIsafe communication bus.

The PROFIsafe protocol secures the whole path from the location where a safety signal originates to the location where it is processed and vice versa.

The safety PLC sends PROFIsafe messages (frames) to the FSPS-21 module extracts the frame from the PROFINET communication. The FSPS-21 module reads and interprets the PROFIsafe messages and performs the required actions. The FSPS-21 module sends PROFIsafe messages back to the safety PLC.

The term PROFIsafe F-Output data refers to the application-specific user data in the frames that are transmitted to the FSPS-21 module (F-Device) from the safety PLC (F-Host). The term PROFIsafe F-Input data refers to the application-specific user data in the frames that are transmitted from the FSPS-21 module to the safety PLC. For a detailed description of the PROFIsafe message format, see section *PROFIsafe message format (page 141)*.

F-Parameters are PROFIsafe parameters that all PROFIsafe devices support. F-Parameters are sent from the F-Host (safety PLC) to the F-Device (FSPS-21 module) when the PROFIsafe connection is created. They contain the PROFIsafe addresses and the watchdog time for the PROFIsafe connection.

**Note:** We recommend that you use only PROFINET compatible Ethernet switches and cables in the PROFIsafe communication bus.

## FSPS-21 module passivation

If the FSPS-21 module or the safety PLC detects an error in the fieldbus communication, the FSPS-21 module is passivated. The module activates the STO function, goes into Safe state and generates an FSx safety bus warning (0xA7DD).

## PROFIsafe description

### ■ PROFIsafe message format

The FSPS-21 module supports only the PROFIsafe short frame format. The short frame supports a maximum of 12 octets of user data. The frame also includes a CRC (3 octets) and one Status/Control Byte octet. Therefore, the maximum frame size of the message is 16 octets.

| Data | F-Input / F-Output user data | Status / Control Byte | CRC2 |
|---|---|---|---|
| Size (octets) | Max. 12 | 1 | 3 |

**Control Byte and CRC2 bit order**

PROFIsafe messages sent from the safety PLC to the FSPS-21 module include the F-Output user data, the Control Byte and CRC2.

This table shows the bit order of the Control Byte and CRC2. $N_o$ is the length of F-Output user data.

| Octet | Bit | Name | Description |
|---|---|---|---|
| **Control Byte** | | | |
| $N_O$ | 7 | Reserved | The value is ignored. |
| | 6 | Reserved | The value is ignored. |
| | 5 | Toggle_h | Toggle bit |
| | 4 | Activate_FV | Fail-safe values (FV) to be activated |
| | 3 | Use_TO2 | Use F_WD_Time_2 (secondary watchdog). Not in use. The value is ignored. |
| | 2 | R_cons_nr | Reset Vconsnr_d |
| | 1 | OA_Req | Operator acknowledgement requested |
| | 0 | iPar_EN | Parameter assignment deblocked. Not in use. The value is ignored. |
| **CRC2** | | | |
| $N_O$+1 | 7 | CRC bit 23 | Octet 3 (MSB) of 24 bit CRC |
| | … | | |
| | 0 | CRC bit 16 | |
| $N_O$+2 | 7 | CRC bit 15 | Octet 2 of 24 bit CRC |
| | … | | |
| | 0 | CRC bit 8 | |
| $N_O$+3 | 7 | CRC bit 7 | Octet 1 (LSB) of 24 bit CRC |
| | … | | |
| | 0 | CRC Bit 0 | |

**Status Byte and CRC2 bit order**

PROFIsafe messages sent from the FSPS-21 module to the safety PLC include the F-Input user data, the Status Byte and CRC2.

This table shows the bit order of the Status Byte and CRC2. $N_i$ is the length of F-Input user data.

| Octet | Bit | Name | Description |
|---|---|---|---|
| **Status Byte** | | | |

| Octet | Bit | Name | Description |
|---|---|---|---|
| N$_i$ | 7 | Reserved | The value is always 0. Must be ignored by the F-Host. |
| | 6 | cons_nr_R | Vconsnr_d has been reset. |
| | 5 | Toggle_d | Toggle bit |
| | 4 | FV_activated | Fail-safe values (FV) activated. |
| | 3 | WD_timeout | Communication fault: Watchdog timeout |
| | 2 | CE_CRC | Communication fault: CRC error |
| | 1 | Device_Fault | Failure exists in the F-Device. |
| | 0 | iPar_OK | F-Device has new iParameter values assigned. Not in use. The value is always 0. |
| **CRC2** | | | |
| N$_i$+1 | 7 | CRC bit 23 | Octet 3 (MSB) of 24 bit CRC |
| | … | | |
| | 0 | CRC bit 16 | |
| N$_i$+2 | 7 | CRC bit 15 | Octet 2 of 24 bit CRC |
| | … | | |
| | 0 | CRC bit 8 | |
| N$_i$+3 | 7 | CRC bit 7 | Octet 1 (LSB) of 24 bit CRC |
| | … | | |
| | 0 | CRC bit 0 | |

## ▪ FSPS-21 PROFIsafe profiles

The content of the F-Input and F-Output user data is configured with FSPS-21 specific PROFIsafe profiles. The FSPS-21 module supports the ABB_PS3 profile.

The ABB_PS3 profile provides the functionality to control and monitor the safety functions.

**ABB_PS3 profile F-Input user data**

This table shows the bit order of the F-Input user data, which is included in the PROFIsafe message sent from the FSPS-21 module to the safety PLC. For all the bits in the F-Input data, one (1) means active and zero (0) non-active.

| PROFIsafe frame from F-Device to F-Host | | |
|---|---|---|
| **F-Input data** | **Status byte** | **CRC 2** |
| 2 octets as bits | 1 octet | 3 octets |

| PROFIsafe frame from F-Device to F-Host | | | | | |
|---|---|---|---|---|---|
| **F-Input data** | | **Status byte** | **CRC 2** | | |
| Octet 0 | Octet 1 | Octet 0 | MSB Octet 0 | ... | LSB Octet n |

| **F-Input data** | | | | | | |
|---|---|---|---|---|---|---|
| **Type** | **Octet** | **Bit** | **Name** | **Description** | | |
| Unsigned8 (used as bits) | 0 | 0 | Device_state | 1=Safe state, 0=Operational state | | |
| | | 1 2 | Device_mo-de_bit_1 | *Bit 1* | *Bit 2* | *State* |
| | | | Device_mo-de_bit_2 | 0 | 0 | Run |
| | | | | 1 | 0 | Fault detected |
| | | | | 0 | 1 | Fail-safe |
| | | | | 1 | 1 | Reserved *) |
| | | 3 | STO_signals_active | 1=Both STO signals 24V, 0=otherwise | | |
| | | 4 | STO_active | 1=STO function active, 0=not active | | |
| | | 5 | SS1-t_active | 1=SS1-t function active, 0=not active | | |
| | | 6 | | Reserved *) | | |
| | | 7 | | Reserved *) | | |
| Unsigned8 (used as bits) | 1 | 0 | | Reserved *) | | |
| | | 1 | | Reserved *) | | |
| | | 2 | | Reserved *) | | |
| | | 3 | | Reserved *) | | |
| | | 4 | | Reserved *) | | |
| | | 5 | | Reserved *) | | |
| | | 6 | | Reserved *) | | |
| | | 7 | | Reserved *) | | |

*) The safety PLC shall set reserved bits to value 0. This ensures the compatibility with future versions of the PROFIsafe profile where the reserved bits may be used.

*) The safety PLC must ignore the value of the reserved bits. This ensures the compatibility with future versions of the PROFIsafe profile where the reserved bits may be used.

**ABB_PS3 profile F-Output user data**

This table shows the bit order of the F-Output data, which is included in the PROFIsafe message sent to the FSPS-21 module from the safety PLC. For all the bits in the F-Output data, one (1) means active and zero (0) non-active.

| PROFIsafe frame from F-Host to F-Device | | | | | | | |
|---|---|---|---|---|---|---|---|
| F-Output data | | | | Control byte | CRC 2 | | |
| 2 octets as bits | | 2 octets as Int16 | | 1 octet | 3 octets | | |
| Octet 0 | Octet 1 | MSB Octet 2 | LSB Octet 3 | Octet 0 | MSB Octet 0 | ... | LSB Octet n |

| F-Output data | | | | |
|---|---|---|---|---|
| Type | Octet | Bit | Name | Description |
| Unsigned8 (used as bits) | 0 | 0 | STO_request | 1=Activate STO function, 0=Deactivate STO |
| | | 1 | SS1-t_request | 1=Activate SS1-t function, 0=Deactivate SS1-t |
| | | 2 | | Reserved *) |
| | | 3 | | Reserved *) |
| | | 4 | | Reserved *) |
| | | 5 | | Reserved *) |
| | | 6 | | Reserved *) |
| | | 7 | | Reserved *) |
| Unsigned8 (used as bits) | Octet 1 | 0 | | Reserved *) |
| | | 1 | | Reserved *) |
| | | 2 | | Reserved *) |
| | | 3 | | Reserved *) |
| | | 4 | | Reserved *) |
| | | 5 | | Reserved *) |
| | | 6 | | Reserved *) |
| | | 7 | | Reserved *) |

| F-Output data | | | | |
|---|---|---|---|---|
| **Type** | **Octet** | **Bit** | **Name** | **Description** |
| Signed16 | 2<br><br>3 | 0 ...<br>15 | SS1-t_time | Safe stop 1 monitoring time limit (SS1-t) in 100 ms. Value range is 0...32767. For example, value 21 = 2.1 s. Negative values result in 0.0 s. |

\*) The safety PLC shall set reserved bits to value 0. This ensures the compatibility with future versions of the PROFIsafe profile where the reserved bits may be used.

### ■ FSPS-21 module modes

**FSPS-21 modes**

The FSPS-21 module can be in the following modes:

- Start-up mode
  **Note:** PROFIsafe communication is not used in this mode.

- Failure-detected mode

- Fail-safe mode

- RUN mode
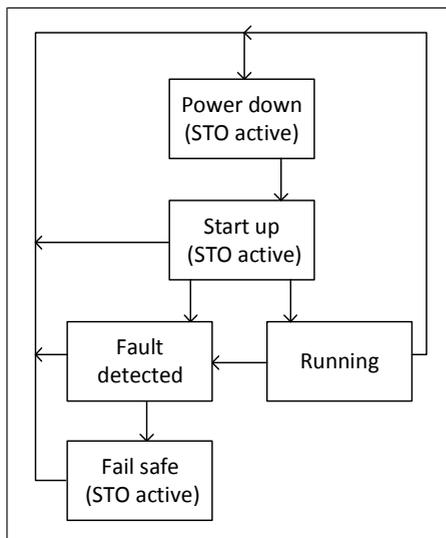
**Description of modes**

The table describes the FSPS-21 module modes and how they are shown in the PROFIsafe messages. The Status Byte and the profiles are described in detail in chapter *PROFIsafe description (page 141)*.

The table refers to several variables that are available to the programmer of an F-Host program (for example, an AC500-S program in CoDeSys).

| Mode | Description |
|---|---|
| Run | The FSPS application runs without fatal failures. ABB_PS3 profile bits in the F-Host for the FSPS-21 module:<br>• device_mode.0 = 0<br>• device_mode.1 = 0 |
| Fault-detected | This mode is reached if a fatal error (for example, CPU test, RAM test, STO channel test, etc., failed) takes place.<br>In the end, the drive STO is activated and transition to fail-safe mode is performed.<br>ABB_PS3 profile bits from the module to the F-Host:<br>• device_mode.0 = 1<br>• device_mode.1 = 0<br>**Note:** Time spent in this mode may be so short that device_mode-bits may not be updated to Safety PLC. |
| Fail-safe | The application keeps the system in the safe state. PROFIsafe communication is up and running.<br>This mode is reached after safe stopping function has been completed in fault-detected mode. The drive STO is kept permanently active.<br>PROFIsafe Status Byte bits from the module to the F-Host:<br>• Device_fault = 1<br>ABB_PS3 profile bits from the module to the F-Host:<br>• device_mode.0 = 0<br>• device_mode.1 = 1<br>• device_state = 1<br>**Note:** To exit the fail-safe mode, reboot the FSPS-21 module. |

**Transitions between modes**

| Transition | Description |
|---|---|
| Start-up - Running | Initial tests performed ok. |

| Transition | Description |
|---|---|
| Start-up - Failure_detected | Fatal failure detected during start-up. |
| Running - Failure_detected | Fatal failure detected during run. |
| Failure_detected - Fail_safe | FSPS reached Safe-state. See section *States (page 37)*. |

## ■ FSPS-21 module states

### FSPS-21 states

The FSPS-21 module can be in the following states:

- Operational
- Safe (with the following sub-states based on the PROFIsafe communication status)
    - Module passivation
    - Module passivation & reintegration
    - Module passivation with a command.

**Note:** The FSPS-21 module stays in Safe state until it has received valid F-Parameters from the safety PLC.
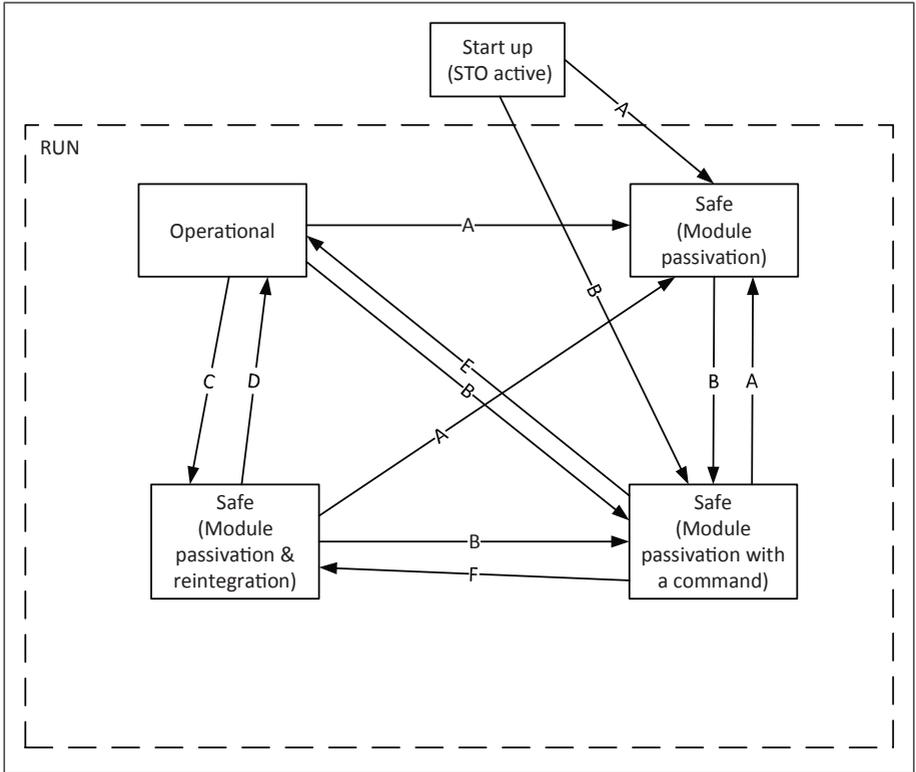
**Description of states**

The table describes the FSPS-21 module states and how they are shown in the PROFIsafe messages. The Status Byte and the profiles are described in detail in chapter *PROFIsafe description (page 141)*.

The table refers to several variables that are available to the programmer of an F-Host program (for example, an AC500-S program in CoDeSys).

**Note:** States and modes are not directly linked together. The table shows the states in RUN mode for simplicity. In fail-safe mode, for example, the PROFIsafe communication may also have an error and appropriate PROFIsafe status bytes are set.

| State | Description |
|-------|-------------|
| Operational | PROFIsafe communication is up and running. Safe stopping function (eg. SS1) is not requested or it is not yet performed to the end. <br> PROFIsafe Control Byte bits in the F-Host to the FSPS-21 module: <br> • "Active_FV" = 0 (PROFIsafe control byte) ***) <br> PROFIsafe Status Byte bits from the FSPS-21 module to the F-Host: <br> • "WD_Timeout" and "CE_CRC" and "FV_activated" = 0 ***) <br> ABB_PS3 profile bits from the module to the F-Host: <br> • device_state = 0 <br> ***) Bits may/will be active during transition period from operational state to safe state. |
| Safe (Module passivation & rein-tegration) | PROFIsafe communication is up and running. <br> Safe stopping function (eg. SS1) has been performed to the end. This may have been caused due to safe stopping request. <br> As soon as the associated safe stopping function has been completed and possible requests for it removed, reintegration of the module is possible. <br> PROFIsafe Control Byte bits in the F-Host to the FSPS-21 module: <br> • "activate_FV" = 0 <br> PROFIsafe Status Byte bits from the module to the F-Host: <br> • "WD_Timeout" and "CE_CRC" = 0 <br> ABB_PS3 profile bits from the module to the F-Host: <br> • device_state = 1 <br><br> **Note:** Reintegration may be so fast that the device_state-bit may not be up-dated to Safety PLC. |
| Safe (Module passivation) | The application is running and there has been an error in the PROFIsafe communication. STO is activated. <br> Possible reasons for module passivation are: <br> PROFIsafe communication failure (CRC error) or PROFIsafe watchdog timeout exceeded. <br> If the PROFIsafe communication is broken, the safety application continuously attempts to establish a communication to the safety PLC. <br> A state transition to another state is possible only if the detected error has been solved. <br> PROFIsafe Status Byte bits in the F-Host for the FSPS-21 module <br> • "WD_timeout" or "CE_CRC" = 1 <br> ABB_PS3 profile bits from the module to the F-Host: <br> • device_state = 1 |
| Safe (Module passivation with a command) | PROFIsafe communication is up and running. <br> The module is passivated because the safety application on the safety PLC requested a module passivation (activate_FV_C = 1 was set). Safe stopping function has been performed to the end. <br> PROFIsafe Control Byte bits in the F-Host for the module: <br> • "activate_FV" = 1 <br> PROFIsafe Status Byte bits from the module to the F-Host: <br> • "WD_Timeout" and "CE_CRC" = 0 <br> • Device_fault = 0 <br> ABB_PS3 profile bits from the module to the F-Host: <br> • device_state = 1 |

**Transitions between states**

This table describes the transitions between the FSPS-21 module states. The ID refers to the transitions shown in the *FSPS-21 states (page 148)*.

| ID | Description |
|----|-------------|
| A | PROFIsafe error and safe state reached |
| B | No PROFIsafe errors, command bit "activate_FV = 1" from PLC, and safe state reached |
| C | No PROFIsafe errors and safe state reached |
| D | No PROFIsafe errors, all stopping-related safety function requests removed, and safety functions acknowledged |
| E | No PROFIsafe errors, "activate_FV = 0" from PLC, and no stopping-related safety function requests active |
| F | No PROFIsafe errors, "activate_FV = 0" from PLC, and stopping-related safety function requests active |

PROFIsafe error: Cyclic PROFIsafe error was detected (watchdog time or communication error [PROFIsafe status bits "WD_Timeout" or "CE_CRC"] will result in "FV_activated" to be active also, as according to PROFIsafe standard).

No PROFIsafe errors: Cyclic PROFIsafe communication is error-free.

Safe state, see *States (page 37)*.

■ **PROFIsafe response time**

The safety function response time (SFRT) is the time within which the safety system must react after an error has occurred in the system.

SFRT is also the maximum time within which the safety system must respond to a change in the input signals.

According to *PROFIsafe System Description, Version November 2010*, SFRT for PROFIsafe devices can be defined as:

SFRT = TWCDT + Longest ΔT_WD

where

- TWCDT (total worst case delay time) is the maximum time for input signal transfer in the safety system until the output reaction under worst-case conditions (all components require the maximum time)
- Longest ΔT_WD is the longest time difference between the watchdog time for a given entity and the worst case delay time.

In safety systems, to define SFRT you must take into account a potential single fault in one of the components during the signal transfer. It is enough to consider a single fault only (see *PROFIsafe System Description, Version November 2010*).

The worst case delay time (WCDT) and watchdog (WD) values for the FSPS-21 module is listed in the table below.

| Device | WCDT | Device WD |
|---|---|---|
| FSPS-21 | 10 ms | 10 ms |

The documentation of the safety PLC defines how you can calculate the processing time and transmission time of the PROFIsafe connection.

For example, *AC500-S Safety User Manual* (3ADR025091M0202 [English]) proposes that SFRT is calculated using the following formula:

SFRT = Device_WD1 + 0.5 x F_WD_Time1 + F_Host_WD + 0.5 x F_WD_Time2 + Device_WD2 + Longest ΔT_WD

where

- Device_WD1 is an internal input device watchdog time

- F_WD_Time1 is the watchdog time for receipt of the new valid telegram (from the input device to the safety PLC)

- F_Host_WD is the watchdog time of the safety PLC

- F_WD_Time2 is the watchdog time for receipt of the new valid telegram (from the safety PLC to the output)

- Device_WD2 is an internal output device watchdog time.

Instead of WCDT values, the calculation uses watchdog times. See *AC500-S Safety User Manual* (3ADR025091M0202 [English]) for details.

For example, when using the ABB AI581-S as the input device, the SM560-S safety PLC and the FSPS module as the output device, SFRT can be calculated as follows:

SFRT = Device_WD1 + 0.5 x F_WD_Time1 + F_Host_WD + 0.5 x F_WD_Time2 + Device_WD2 + Longest ΔT_WD

= 76.5 + 15 + 6 + 25 + 10 + 25 = 159.5 ms

where

- Device_WD1 = 76.5 ms

- F_WD_Time1 = 30 ms

- F_Host_WD = 6 ms

- F_WD_Time2 = 50 ms

- Device_WD2 = 10 ms

- Longest ΔT_WD = Max (0.5 x F_WD_Time1; 0.5 x F_WD_Time2) = 25 ms (all other used WCDT values are equal to their corresponding watchdog times).

■ **PROFIsafe watchdog time**

F-Parameter F_WD_Time determines the watchdog time for the PROFIsafe connection. The minimum watchdog time is composed of four timing sections as shown in this figure.
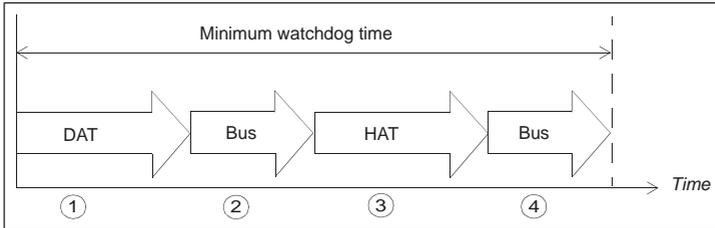


1. Device acknowledgement time (DAT) is the time it takes for the F-Device (such as the FSPS-21 module) to process an incoming PROFIsafe frame. DAT starts when the F-Device receives the PROFIsafe frame and ends when the F-Device has prepared a new PROFIsafe frame using the currently available process values.

2. Bus time is the time it takes when the PROFIsafe frame is transmitted from the F-Device (FSPS-21 module) to the F-Host (such as the ABB SM560-S safety controller station) through the "black channel".

3. Host acknowledgement time (HAT) is the time it takes for the F-Host to process an incoming PROFIsafe frame.

4. Another Bus time elapses when the new PROFIsafe frame is transmitted from the F-Host back to the F-Device.

F_WD_Time assigned to the FSPS-21 module must be higher than the minimum watchdog time. The worst case delay time of the FSPS-21 module also depends on the safety functions that are used simultaneously and on the PROFIsafe cycle time. The longest worst case delay time of the FSPS-21 module is 10 ms.

**Calculating the watchdog time**

It is not always easy to calculate the worst case delay time of "black channel" components. See *AC500-S Safety User Manual* (3ADR025091M0202 [English]) for a proposed method of tracing the actual PROFIsafe cycle times in a real system.

You must then set F_WD_Time about 30% higher than the worst case value in variable tResponseTimeMS (in the AC500-S safety program) for the given safety device.

If you use this approach for the FSPS-21 module, you can set the PROFIsafe cycle time and the corresponding watchdog time F_WD_Time as short as possible for the given system.

If the longest recorded PROFIsafe cycle time (minimum F_WD_Time) is, for example, 40 ms, a suitable value for F_WD_Time is:

F_WD_Time = 40 ms x 1.3 = 52 ms.

## Installation

Installation procedure:

1. Install the FSPS-21 safety functions fieldbus module to the drive, see chapters
   Planning for installation and Installation and the drive hardware manual.

2. Connect the FSPS-21 module to the safety PLC through a PROFINET network.

## Configuration

### ◼ Configuring the FSPS-21 module

You can use either the drive control panel or the Drive composer pro PC tool to modify
the settings of the FSPS-21 module.

**Parameters for the PROFINET and PROFIsafe communication**

1. Depending on the drive, you can configure the FSPS-21 module as fieldbus channel
   A or B. Enable the communication between the drive and the FSPS-21 module for
   the option slot in which the FSPS-21 module is installed into (parameter *50.01 FBA
   A enable* or *50.31 FBA B enable*).

2. Set the FSPS-21 parameters that correspond to the selected fieldbus channel.
   Parameter groups 51, 52 and 53 include the settings for FBA A and groups 54, 55
   and 56 for FBA B.

   Groups 52, 53, 55 and 56 configure the contents of the normal PROFINET cyclic
   communication by mapping the words in the PROFINET frame to the desired drive
   parameters.

   Groups 51 and 54 configure the PROFINET and PROFIsafe connection.

| Index | Name/Value | Description | Example value |
|-------|-----------|-------------|---------------|
| 50.01 | FBA A enable | Enables/disables communication between the drive and fieldbus adapter A and specifies the slot the adapter is installed into. | |
| | Option slot 1 | Communication between drive and fieldbus adapter A enabled. The adapter is in slot 1. | 1 |
| 50.31 | FBA B enable | Enables/disables communication between the drive and fieldbus adapter B, and specifies the slot the adapter is installed into. | |
| | Disable | Communication between drive and fieldbus adapter B disabled. | 0 |
| 51/54.01 | FBA A/B type | Shows the type of the connected fieldbus adapter module A/B. This parameter is read-only. | PROFI-safe |

| Index | Name/Value | Description | Example value |
|---|---|---|---|
| 51/54.02 | FBA A/B PAR2 (PROTOCOL/ PROFILE) | Selects one of the PNIO profiles. | |
| | PNIO ABB Pro | Profile PNIO ABB Pro is selected | 11 |
| 51/54.03 | FBA A/B PAR2 (COMMRATE ) | Sets the Ethernet communication rate. | |
| | Auto | Ethernet communication rate is negotiated automatically by the device. | 0 |
| 51/54.04 ... 13 | IP CONFIGURA-TION | The user can set the IP configuration for the network in these parameters or in the PLC project. | Static IP 0 |
| 51/54.20 | Telegram type | Shows the telegram type for the selected I/O communication.<br>This parameter is read-only. | |
| | PPO4 | PPO Type 4 | 4 |
| 51/54.21 | Diagnostic alarm | Enables/disables the sending of diagnostic messages to the PROFINET network. | |
| | Enabled | Diagnostic messages are sent. | 0 |
| 51/54.24 | F Destination Ad-dress | Sets the PROFIsafe destination address, that is, the address of the FSPS-21 module in the safety communication network.<br>This address must be the same as is set in the F-Parameters for the PROFIsafe module properties (F_Dest_Add). | 1 |

| Index | Name/Value | Description | Example value |
|-------|-----------|-------------|---------------|
| 51/54.25 | PN Name Index | Allows defining the PROFINET station name. By default this value is 0 and the station name is set in PLC project. When the value is set to other than 0, the PROFINET station name is overwritten in the format "abbdrive-xx", where xx is the value of the parameter name index.<br>Example: Setting this value to 12 results in the name "abbdrive-12".<br>**Note:**<br>During every boot the FSPS-21 module checks the value of PN Name Index:<br>• If the value is not Zero then the active PN Name Index overrides the PROFINET station name.<br>• If the new name is set by DCP Set command as permanent, the new name is used and stored to flash. The PN Name Index parameter value is not changed, so after next boot, the name is taken according to the PN Name Index.<br>• If the new name is set by DCP Set command as temporary, the new name is used and the empty name is stored to flash. The PN Name Index parameter value is not changed, so after next boot, the name is taken according to the PN Name Index.<br>• The PROFINET DCP factory reset also resets the PN Name Index value to default (0). | 12 |
| 51/54.27 | FBA A/B PAR REFRESH | Validates any changed FSPS-21 module configuration settings and reboots the module taking all the changes to the drive parameters in use. After refreshing, the value reverts automatically to Done (0).<br><br>**Note:** This parameter cannot be changed while the drive is running. | |
| | REFRESH | Refreshing. | 1 |

**Note:** When the FSPS-21 module is installed to the drive for the first time, you must set the value of parameter 51/54.02 to one of the PROFINET profiles (value 11 if a drop-down list is unavailable) and reboot the FSPS-21 module with parameter 51/54.27. Only after this, the rest of the parameters in group 51/54 get the correct texts and options. If required, you must reconnect Drive composer pro to the drive to get the parameters show up correctly (select **Refresh** from the **New** menu).

### ◼ Configuring the safety PLC

After the drive has initialized the FSPS-21 module, you must prepare the safety PLC for communication with the adapter module. Examples of ABB AC500-S Safety PLC and Siemens SIMATIC Fail-safe S7 PLC are given below. The examples include the minimum required steps for starting the PROFINET and PROFIsafe communication with the FSPS-21 module. For detailed information, see the documentation of your safety PLC.

The examples apply to all drive types that are compatible with the FSPS-21 module.

**Note:** Any safety PLC that supports PROFIsafe can be used with the FSPS-21 module.

### ◼ Downloading the GSD file

To configure the controller station, you need a type definition (GSD) file. In PROFINET IO, the GSD file is written in an XML-based language called GSDML.

Download the FSPS-21 GSD file from the ABB Document library (www.abb.com/drives/documents). The file name format is:
**GSDML-Vx.x-ABB-FSPS-yyyymmdd.xml**.

The GSD file describes the vendor-specific, PROFIdrive-specific and PROFIsafe-specific features of the adapter module. You can use the vendor-specific features, for example, in the ABB Drives communication profile. The PROFIdrive profile supports a set of services described in the PROFIdrive specification.

The actual PROFIsafe messages are processed in the FSPS-21 module. The GSD file and the instructions in this chapter refer to the FSPS-21 module which is the device that is connected to PROFINET.

### ◼ Configuring the ABB AC500-S Safety PLC

This example shows how to configure the communication between the ABB AC500-S Safety PLC and the FSPS-21 module using Automation Builder 2.0.

> ⚠ **WARNING!**
> Do not use this configuration example in real applications. This configuration is only an example.

Before you use the safety configuration and programming tools in Automation Builder, you must study the AC500-S Safety PLC user manual (AC500-S Safety User Manual (3ADR025091M0202 [English]). Only qualified persons are allowed to work with the AC500-S Safety PLC.

You need a password to configure the safety parts of a Automation Builder project. In all new projects, there is a default user "Owner" with an empty password. This is a project administrator who can, for example, access the safety controller station. For detailed information on the passwords and access permissions in Automation Builder, see the AC500-S Safety PLC user manual.

You can find the complete documentation of ABB PLCs and the Automation Builder application in www.abb.com/PLC.

Before you start, make sure that you have downloaded the FSPS-21 GSD file from the ABB Document library. See section *Downloading the GSD file*.

1. Start the ABB Automation Builder application.

2. On the **Tools** menu, select **Device Repository**.

3. In the window that opens, click **Install...** and browse for the GSD file.
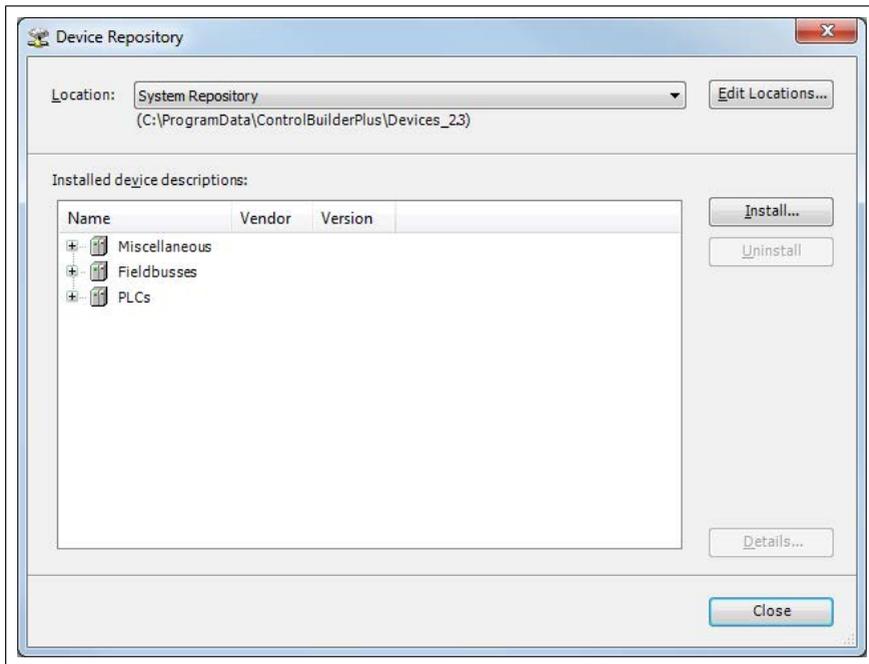


4. Open or create the PLC project that is used to control the drive.
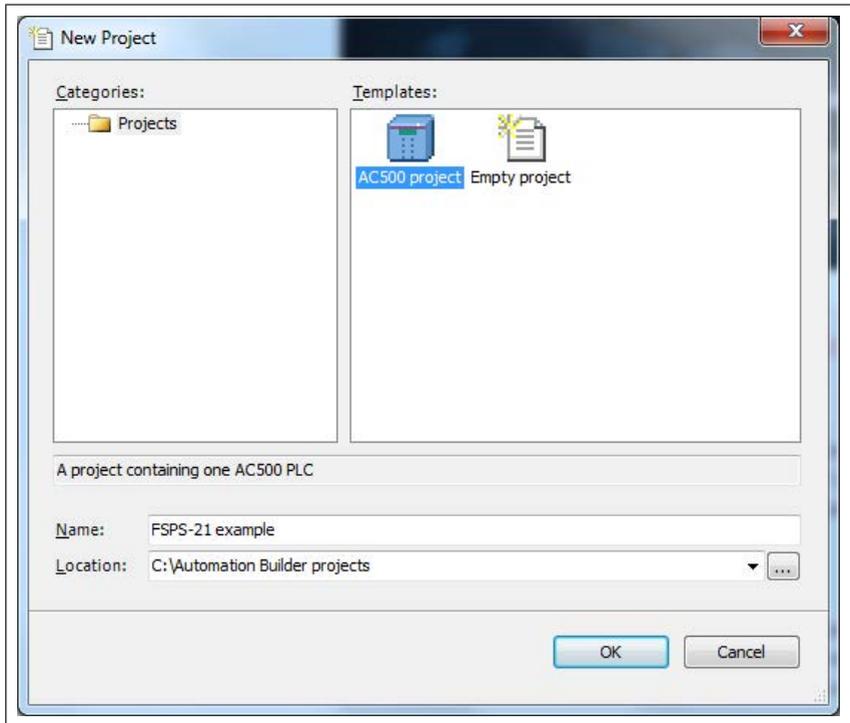
5. Add the necessary controller devices to the PLC project.
   In the project below, these controller stations have been added:

   - controller station AC500 PM583-ETH,

   - safety controller station AC500 SM560-S and

   - PROFINET controller CM579-PNIO.
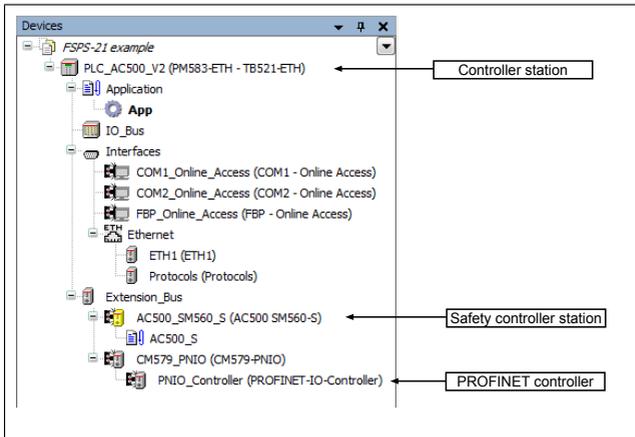
**Note:** Make sure that the "Enable debug" setting is On for the safety controller station, if you want to view or debug the PLC program after the download.

6. Right-click on the PROFINET controller **CM579-PNIO-Master** and add the FSPS-21 module to the PROFINET IO network.

7. Add the desired IO module, for example, "PPO Type 4" to the first slot of the FSPS-21 module to define cyclic communication between the module and the PLC.
   For additional information about PPO Type 4, see *FSPS-21 PROFIsafe profiles (page 143)*.

8. Add the PROFIsafe module "PROFIsafe ABB_PS3" to the second slot of the FSPS-21 module to define cyclic safety communication between the module and the PLC.
   For additional information about PS3 telegrams, see *FSPS-21 PROFIsafe profiles (page 143)*.
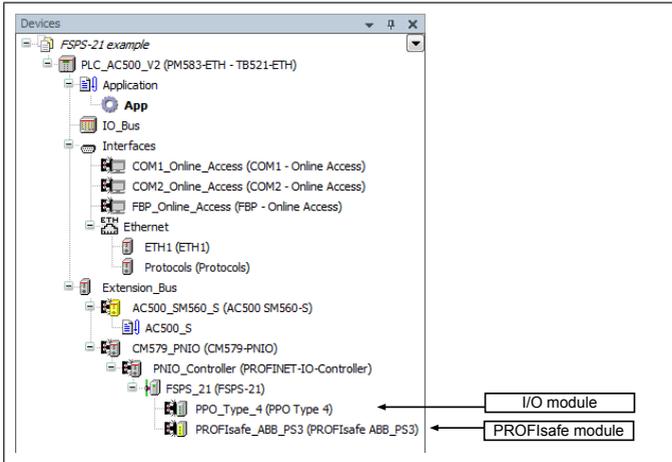
9. Download the safety and "non-safety" PLC programs.

10. Define the PROFINET controller (CM579-PNIO) properties, such as the IP address and IP address settings for devices:

   • Select CM579_Master.

   • On the PROFINET IO Controller tab, define the necessary IP addresses.
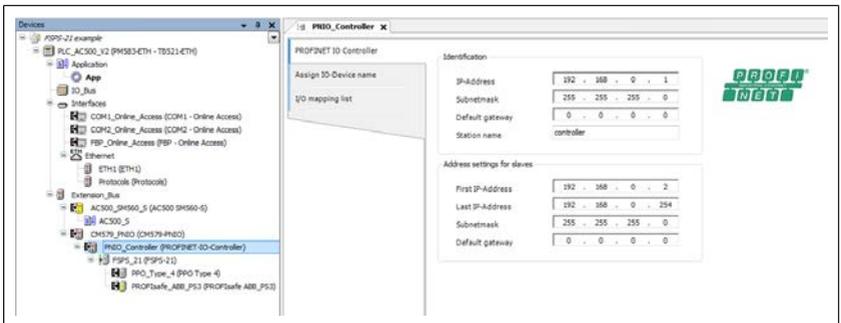


11. Define the FSPS-21 properties:

   • Select **FSPS_21**.

   • On the **General** tab, define the IP address and Subnet mask, and type the Station name (in this example, drive1).

   **Note:** Use only lower case letters for the Station name.
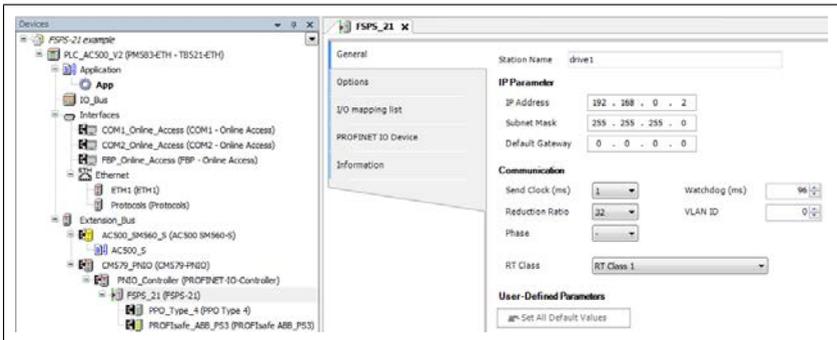
12. Return to the PROFINET controller (CM579-PNIO) properties. On the **Assign IO-Device name** tab:

- Click **Connect to PLC (Login)** and select the communication link used between Automation Builder and the PLC.

- Click **Scan** to find all PROFINET devices connected to the network.

- In the **Configure station name** box, select the station name defined for the module in step 10 (in this example, drive1), and click **Assign IO-Device name**.

- In the **IP address** and **Network mask** boxes, type the IP address and subnet mask defined in step 11, and click **Assign IP configuration**.
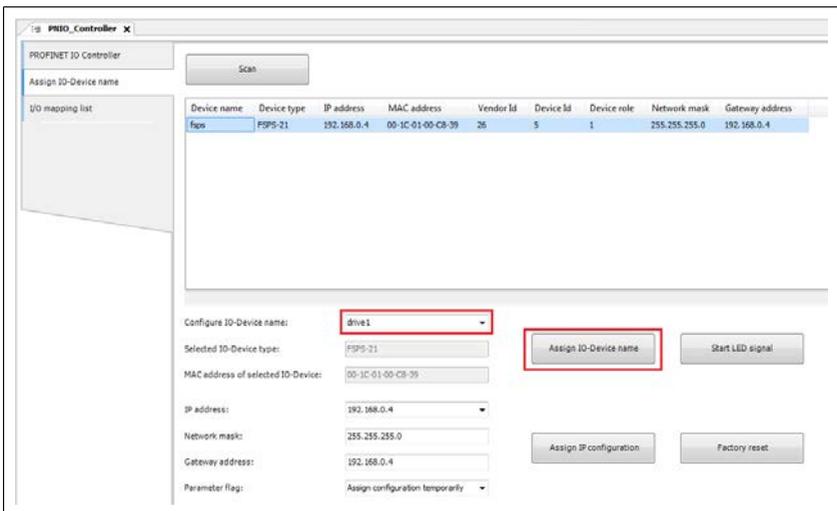


13. Define the IO module properties:

- Select the IO module **PPO_Type_4**.

- On the **PNIO parameters** tab, configure the Stop Mode Action and Control-zero mode functions, and define Fail-safe values for the PLC output process data (PZDs).
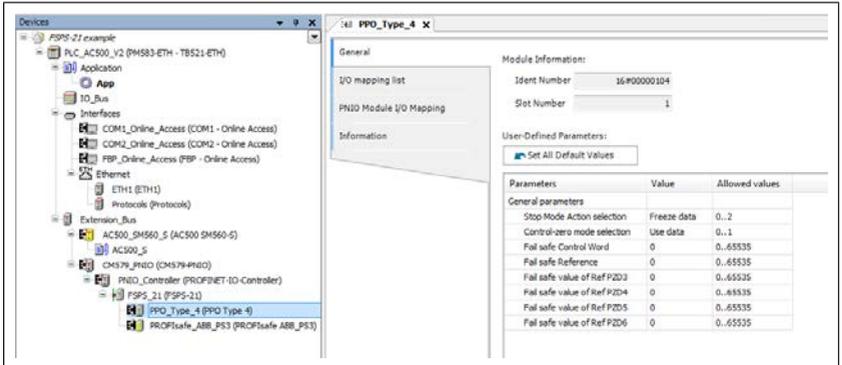


- Rename the IO modules, for example, drive1_PPO4 and drive1_ABB_PS3.

- On the **PNIO Module I/O Mapping** tab, type names for the variables that refer to the drive's signals in the PLC program. (See section *ABB_PS3 profile F-Output user data*.)
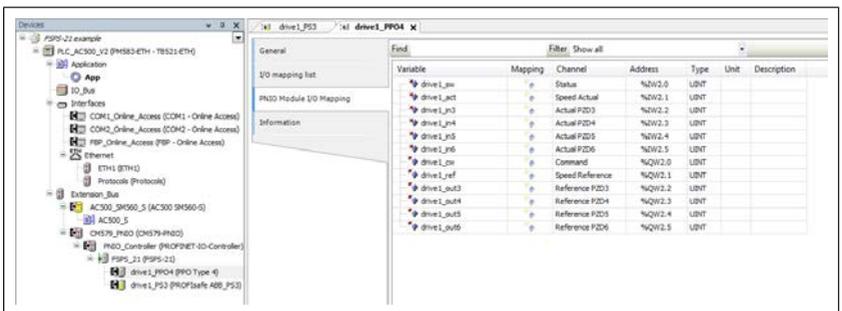


14. Define the PROFIsafe module properties:

   - Select the PROFIsafe module **PROFIsafe_ABB_PS3**.

   - On the **F-Parameter** tab, modify the PROFIsafe safety parameters. Three of the listed parameters can be modified for FSPS-21:

   - F_Source_Add is the address of the safety controller station (in this example, AC500 SM560-S).

- F_Dest_Add is the address of the FSPS-21 module. This must match the control unit parameter 51.24, see section *Drive parameters related to FSPS-21 module configuration (ACS880, ACS580 and ACS380) (page 56)*. For DCS880, see section *Drive parameters related to FSPS-21 module configuration (DCS880) (page 57)*. These two define the codename for the PROFIsafe relationship of this particular FSPS-21 module and the safety controller station.

- F_WD_Time is the PROFIsafe watchdog time. See section *Calculating the watchdog time (page 153)* for instructions on how to calculate the correct watchdog time.

- On the **PNIO Module Safety IO Mapping** tab, type names for the variables that refer to the PROFIsafe message data in the safety PLC program. (See section *ABB_PS3 profile F-Output user data*.)
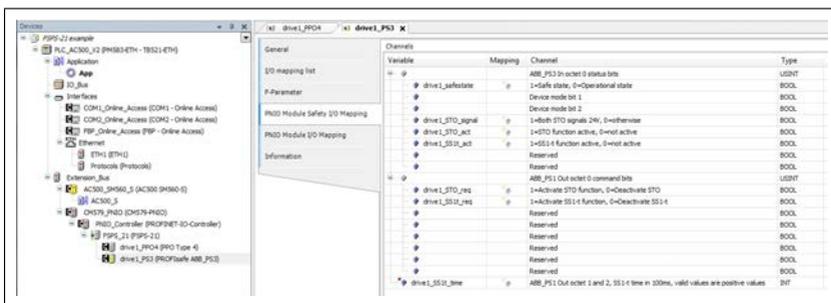


15. Create the configuration data for the controller station:

    - Right-click on the **AC500** and select **Create Configuration Data**.

16. Create the safety configuration data for the controller station:

    - Right-click on the **AC500_S** and select **Create Safety Configuration Data**.

17. Create a program that controls the drive:

    - Double-click the **AC500**. This opens the PLC program in the CoDeSys programming tool.

18. Create a safety program that controls the FSPS-21 via PROFIsafe:

    - Double-click the **AC500_S**. This opens the safety PLC program in the CoDeSys programming tool.
      **Note:** If you do not have a complete safety program, you must at least implement watchdog toggling and operator acknowledgement according to application requirements to be able to acknowledge the STO.
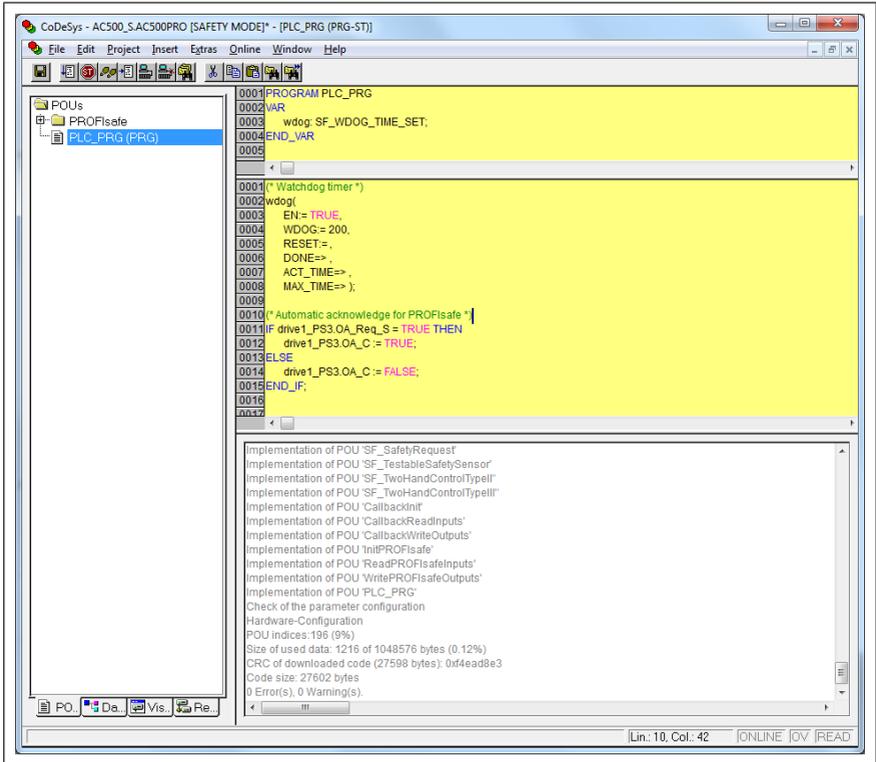
Watchdog toggling for safety controller program can be implemented in the following way:
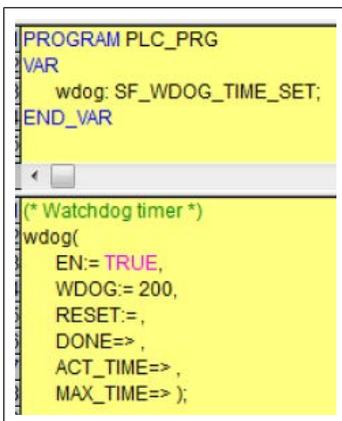
As an example, automatic operator acknowledgement can be implemented in the following way:

> ⚠️ **WARNING!**
> Activate automatic acknowledgement only when its use has been approved in the risk assessment of the application.

```
(* Automatic acknowledge for PROFIsafe *)
IF drive1_PS3.OA_Req_S = TRUE THEN
    drive1_PS3.OA_C := TRUE;
ELSE
    drive1_PS3.OA_C := FALSE;
END_IF;
```

**Note:** In this example, the name of the IO module is "drive1_PS3"; see step 13.

**Note:** Make sure the safety communication parameters are the following:
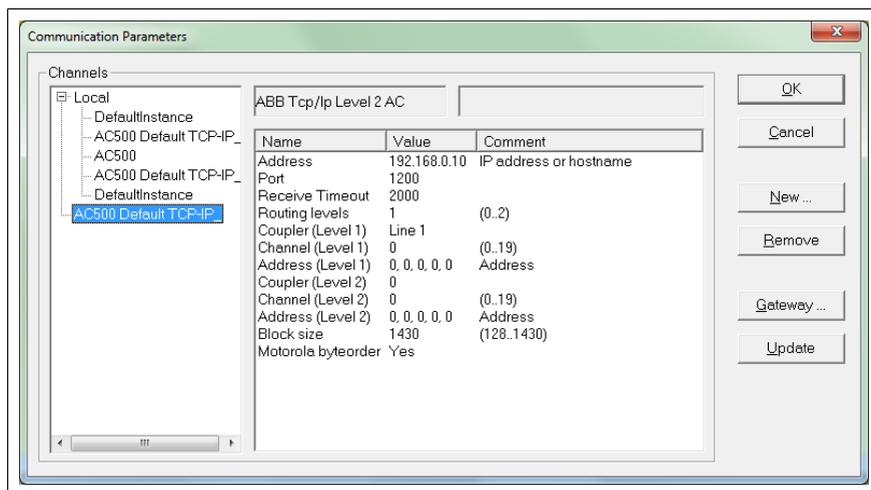


19. For the "non-safety" program:

   - In the **Project** menu, select **Build.**

   - In the **Online** menu, select **Login.**

     **Note:** If there are communication problems at this point, select **Communication parameters...** from the **Online** menu.

**Note:** To make sure that the program is downloaded to the PLC (even when no changes have been made), select **Clean all** and then **Rebuild all** from the **Project** menu.

- In the window that opens, click **Yes**. This downloads the program to the PLC.

- In the **Online** menu, select **Create boot project**. This saves the program permanently to the PLC.

- In the **Online** menu, select **Logout.**

20. Repeat step 19 for the safety program.

21. Switch the power of both PLCs off and on.

22. For the "non-safety" program:

- In the **Online** menu, select **Login.**

23. In the **Online** menu of the "non-safety program", select **Run**. This starts both programs.

**Monitoring the PROFIsafe message**

It is possible to monitor the contents of the PROFIsafe message. For example:

• Check the variable values in the **Current Value** column on the **PNIO Module IO Mapping** tab.



■ **Configuring FSPS-21 with TIA14**

1. Open TIA and create a new project.



2. Select your CPU from the list.
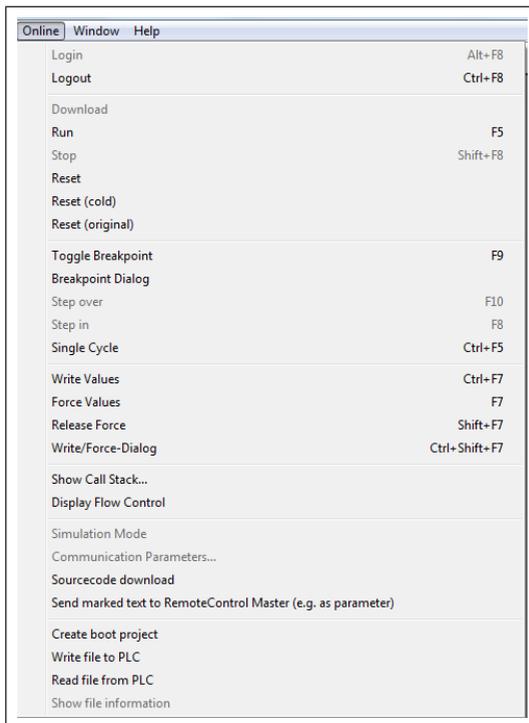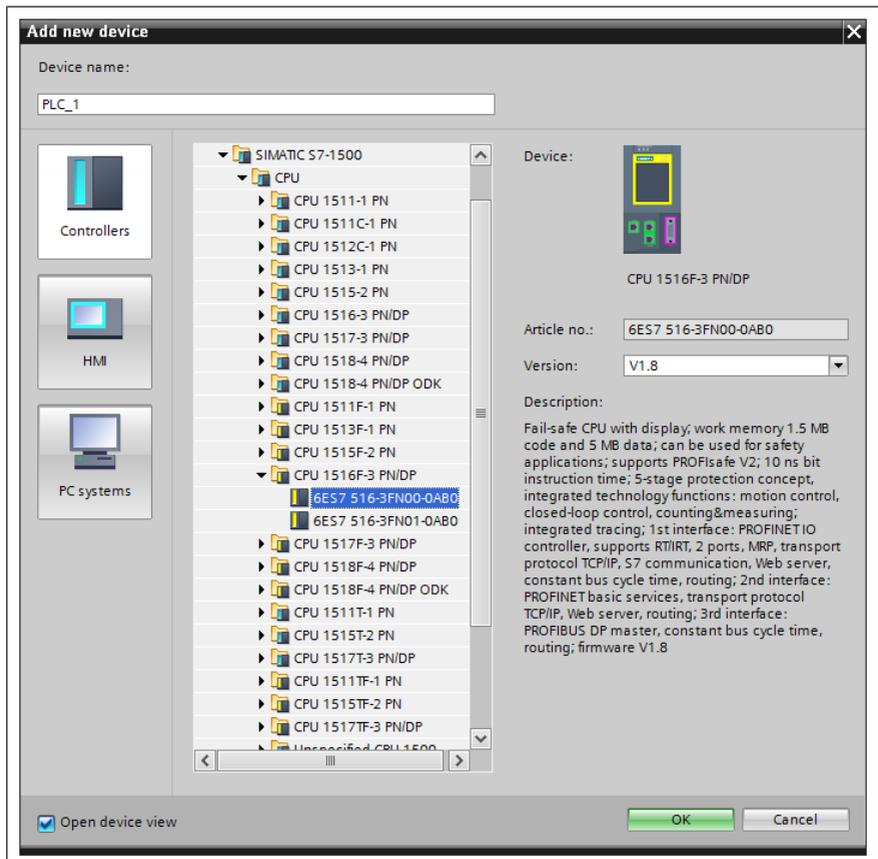
3. Install FSPS-21 GSDML file.
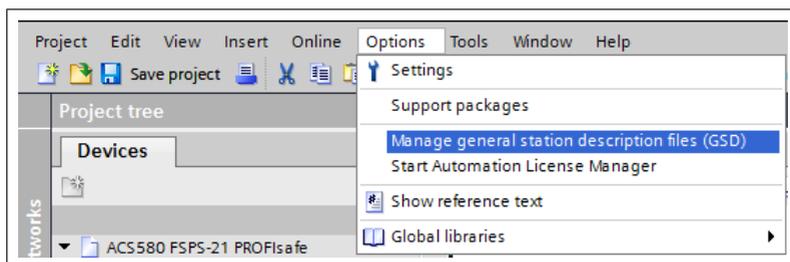


4. Add FSPS-21 to the device configuration by dragging it from the hardware catalog.
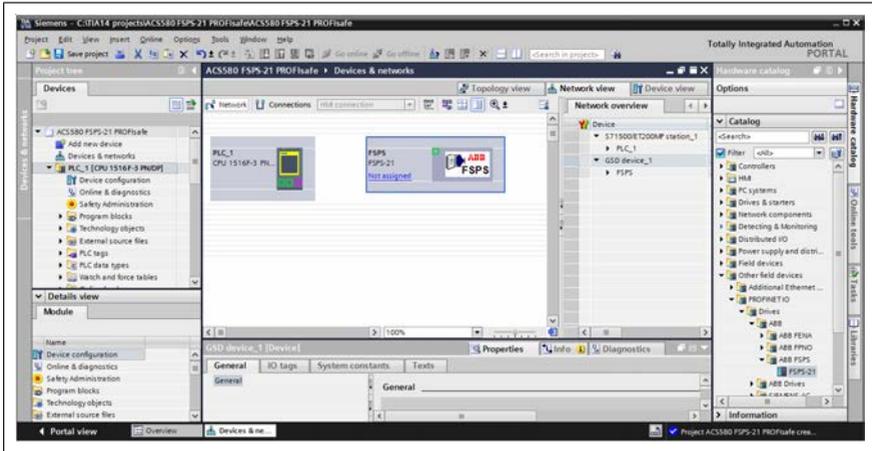
5. Open the FSPS-21 device view and add (by dragging and dropping) the desired
   PPO and PS telegrams to slot 1 and 2. In this example we use PPO4 and PS3.
   For additional information about PPO and PS telegrams, see or *FSPS-21 PROFIsafe
   profiles (page 143)*.
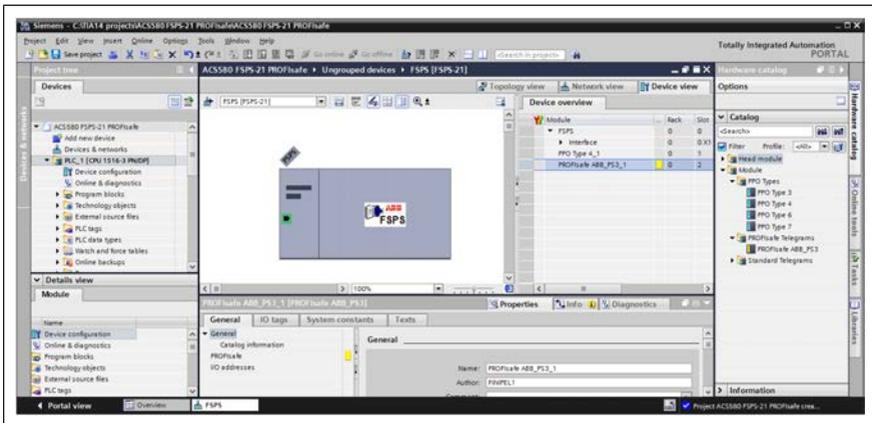


6. Network view shows E-stop icon on FSPS device to indicate that device is an
   F-device with safety capability.
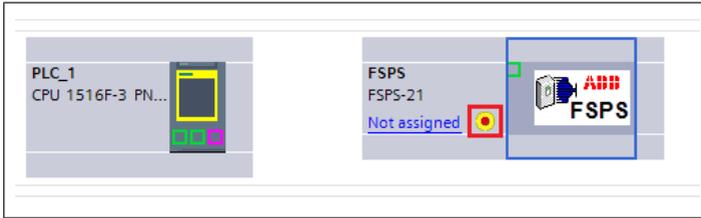
7. Assign FSPS-21 to PROFINET controller:
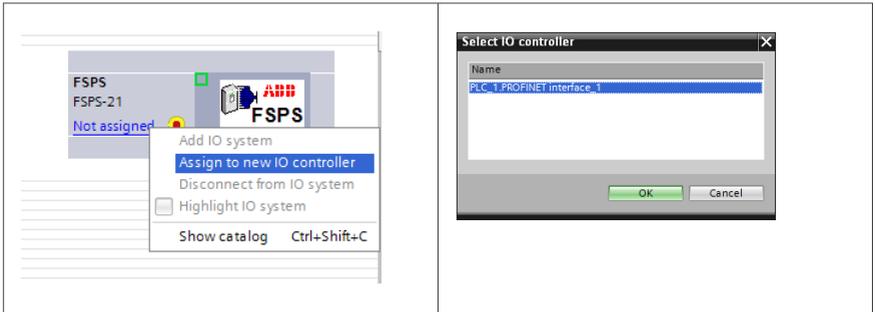


Network configuration is updated:
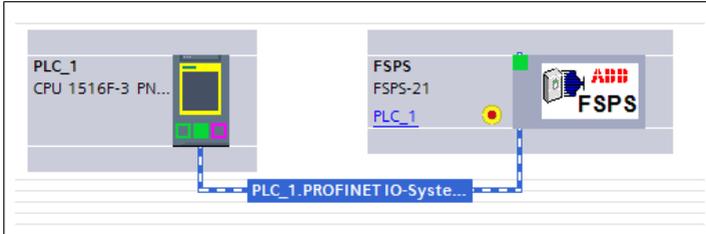


IO addressing is assigned automatically to FSPS. This can be seen in Device view (highlighted red box).
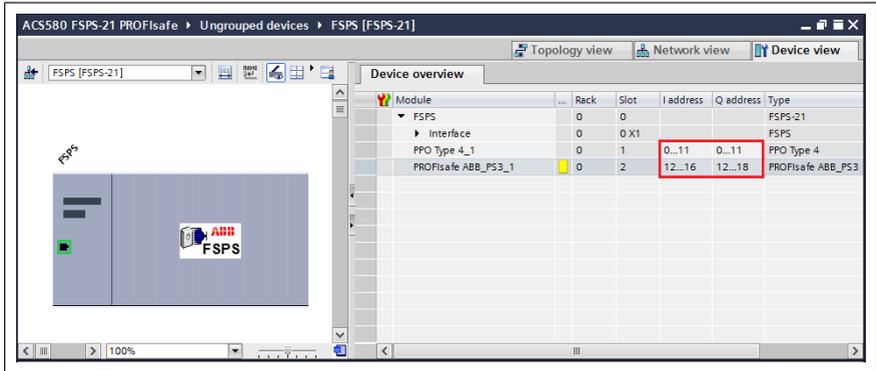
8. Select PLC from network view and Properties will show on the bottom of the screen. In PLC properties, enable F-capability under the Fail-safe submenu.
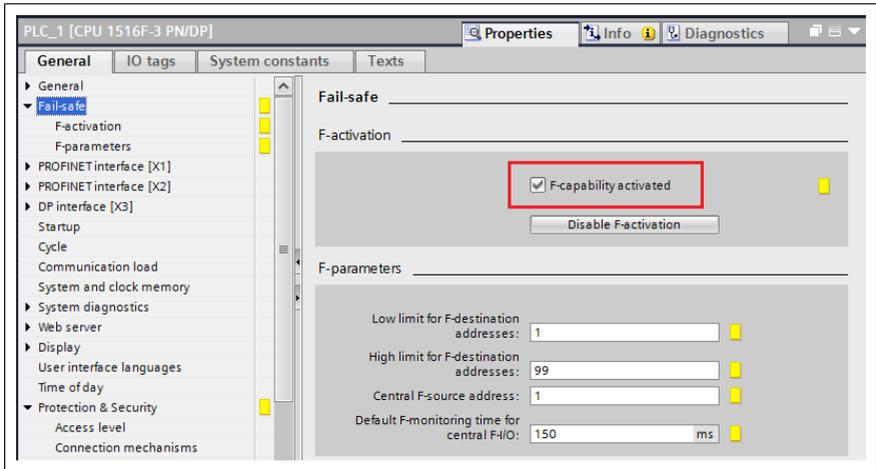


9. In the F-parameters submenu, define the maximum allowed safety program execution interval. If this value is exceeded, PROFIsafe goes to safe state (watchdog).
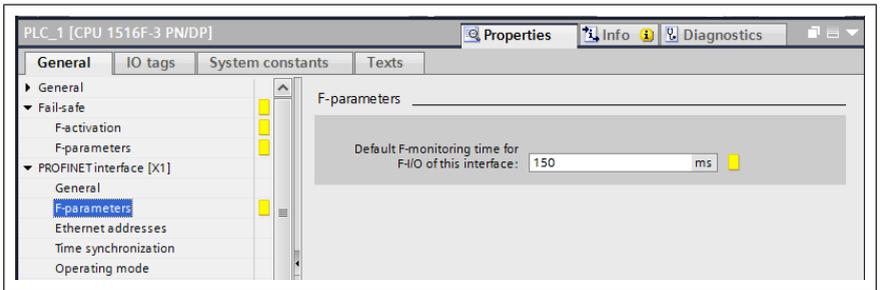
10. In Ethernet addresses submenu, set PLC IP address.
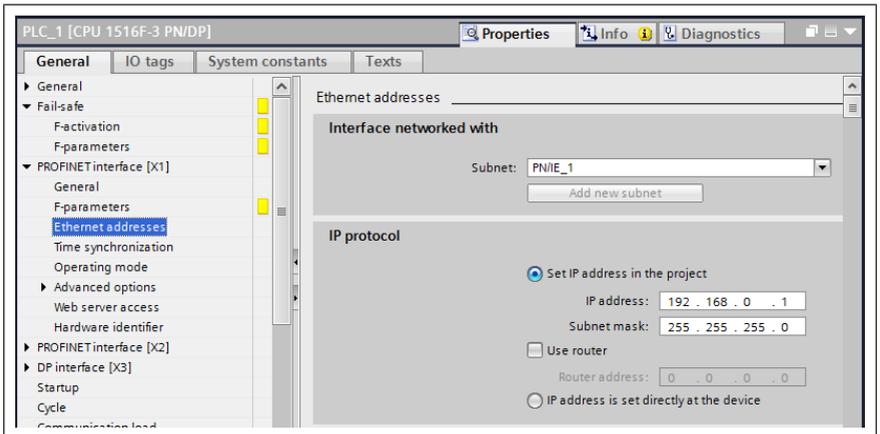


11. In advanced options, set PLC minimum cycle time for IO and PROFINET communication (PROFINET cycle time).
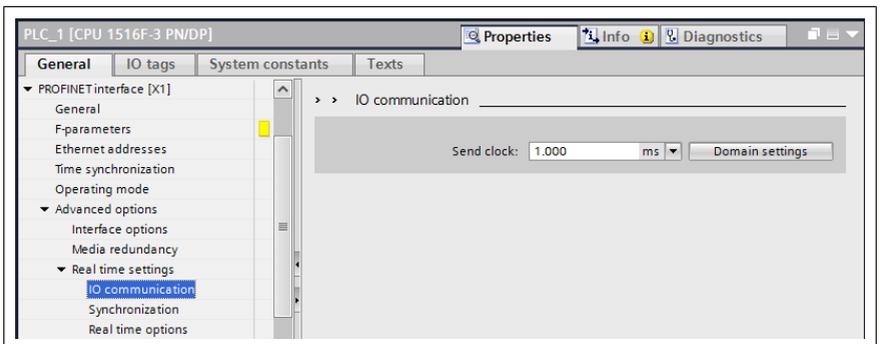
12. In FSPS properties, set FSPS-21 IP address and PROFINET device name. Device name will be used as identification. After successful identification, PLC will assign IP address to FSPS.

    **Note:** FB module parameters (51.04 onwards) should be static 0.0.0.0 in drive.
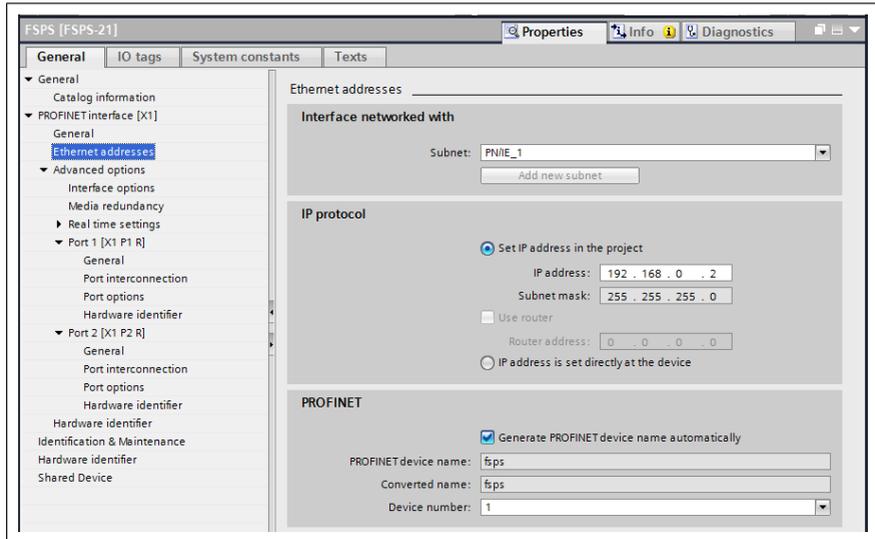


13. Configure FSPS PROFIsafe settings:

    - F_Source_Add = PLC PROFIsafe address

    - F_Dest_Add = FSPS PROFIsafe address

    - F_WD_Time = Maximum allowed PROFIsafe message cycle time. In this example we use 200 ms. Calculate your own value according to section *Calculating the watchdog time (page 153)*.

14. Add OB86 (Rack and station failure) program block to prevent PLC from stopping due to an error, eg, in a drive fault situation when it sends an alarm to the PLC.
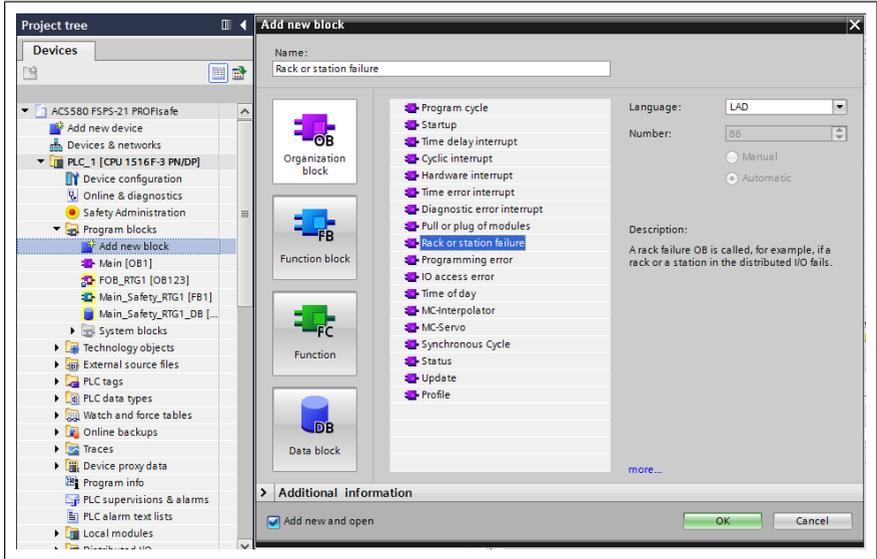
15. Add new Function Block "ABB Drive".
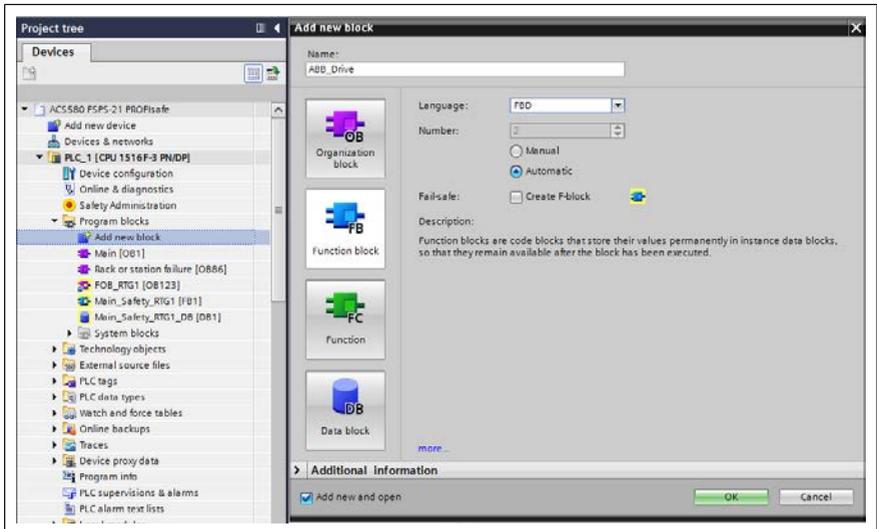


16. Add variables to ABB_Drive FB.

17. Add ABB_Drive FB to OB1 (drag&drop to network). Assign new instance Data Block for ABB_Drive FB (pop-up when FB is added to OB). When using multiple drives, create one DB for each drive.

18. Select the corresponding FSPS PPO address for the drive HW input.
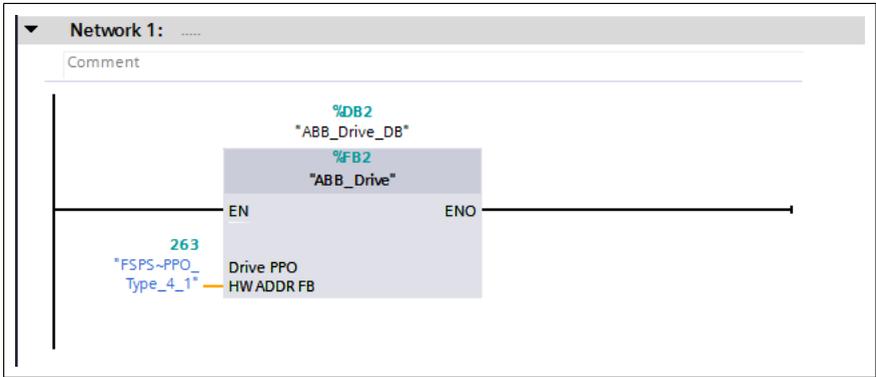


Value can be verified from the HW configuration, in the FSPS PPO type properties, under the Hardware Identifier tab.
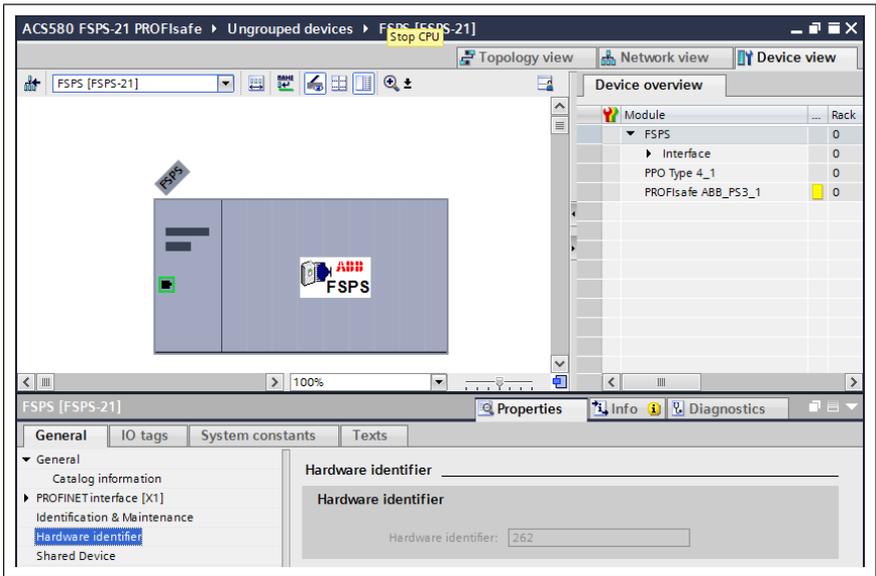


19. In ABB_Drive FB, add blocks DPRD_DAT and DPWR_DAT.
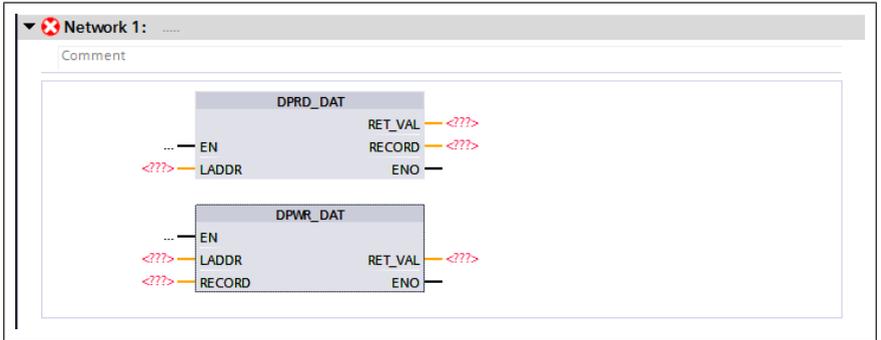
20. Insert values to blocks.
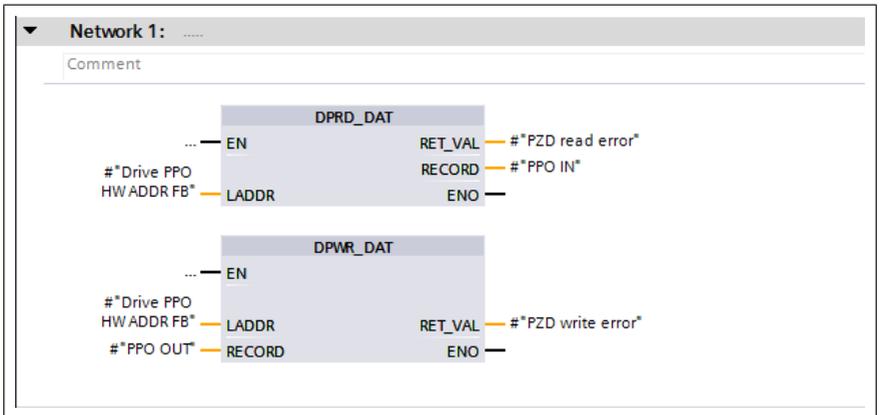


Later the PPO message data can be found in ABB_Drive_DB.

21. In PLC Safety Administration, configure F-runtime group cycle time, warn and maximum cycle time limits. If maximum limit is exceeded, PLC will go to safe state.
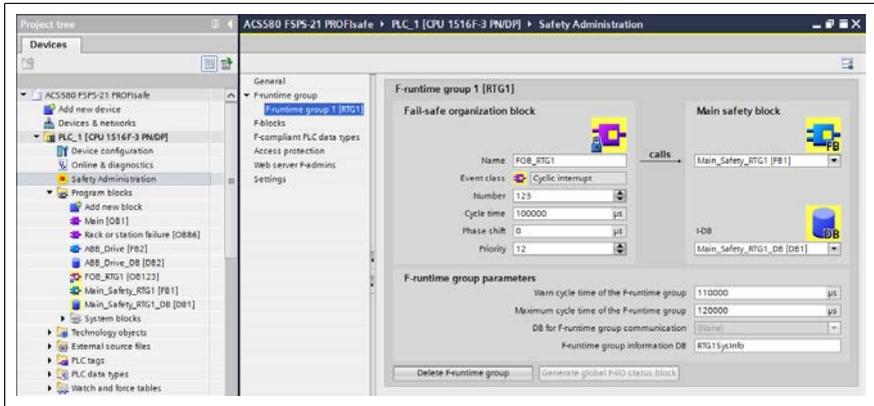


22. If you do not have a complete safety program, you must at least implement acknowledgement for reintegration according to application requirements to be able to acknowledge the STO.

As an example, automatic acknowledgement for reintegration can be implemented in the following way:

---

⚠ **WARNING!**
Activate automatic acknowledgement only when its use has been approved in the risk assessment of the application.

---
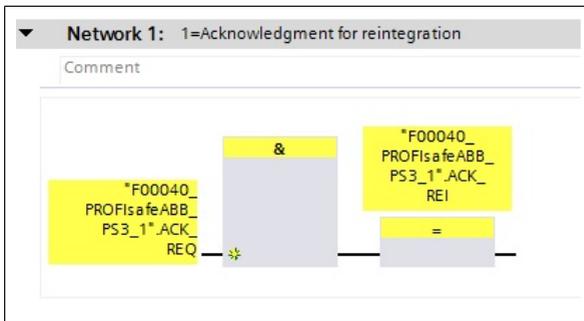


23. Create tag table for ABB_PS3 safety functions. See bit descriptions in section *FSPS-21 PROFIsafe profiles (page 143)*.
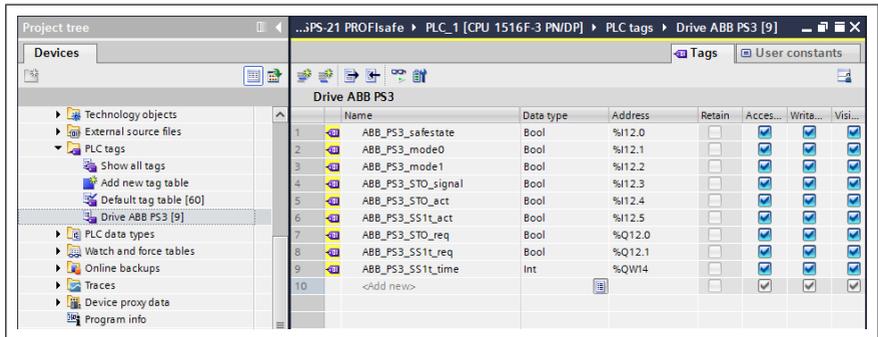
See correct IO addresses from HW configuration.



24. Save, compile, and download HW and SW to the PLC.
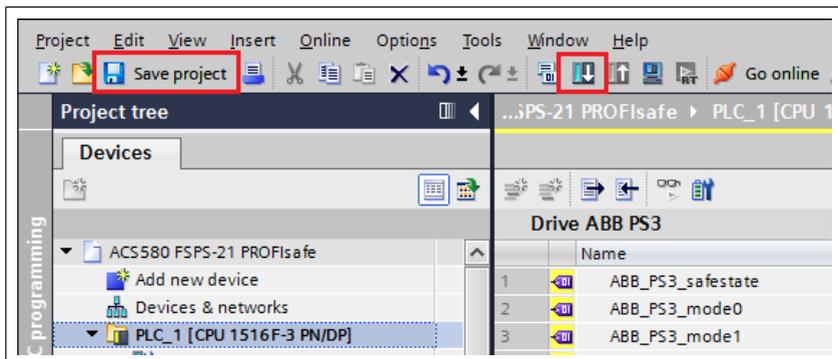


25. Scan for accessible devices (start search). Note that firewall may block traffic. Load configuration to target device.
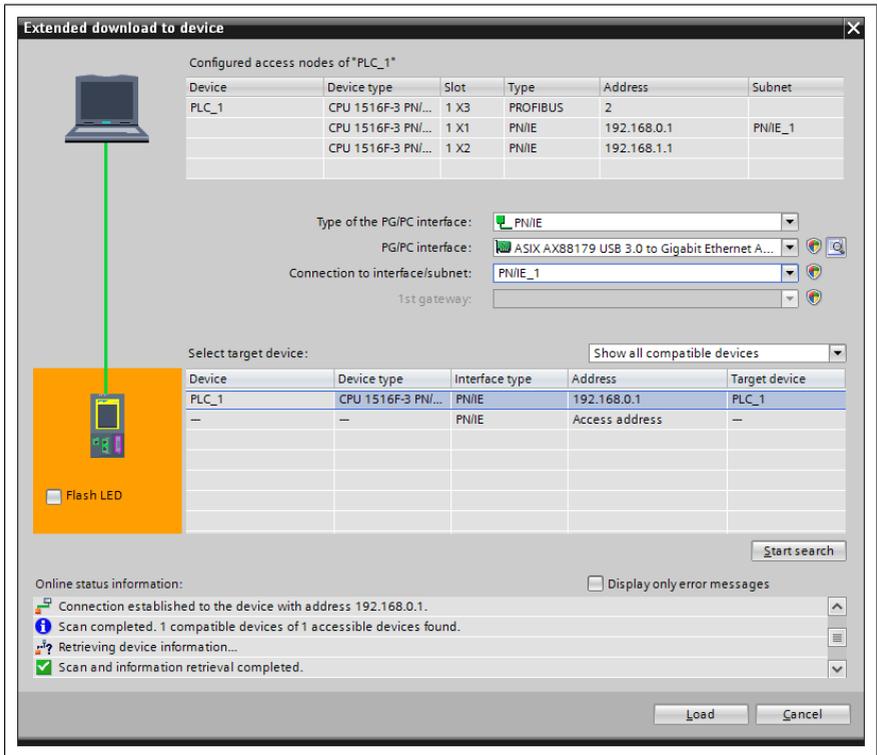
26. In device configuration, right-click FSPS icon and select Assign device name.
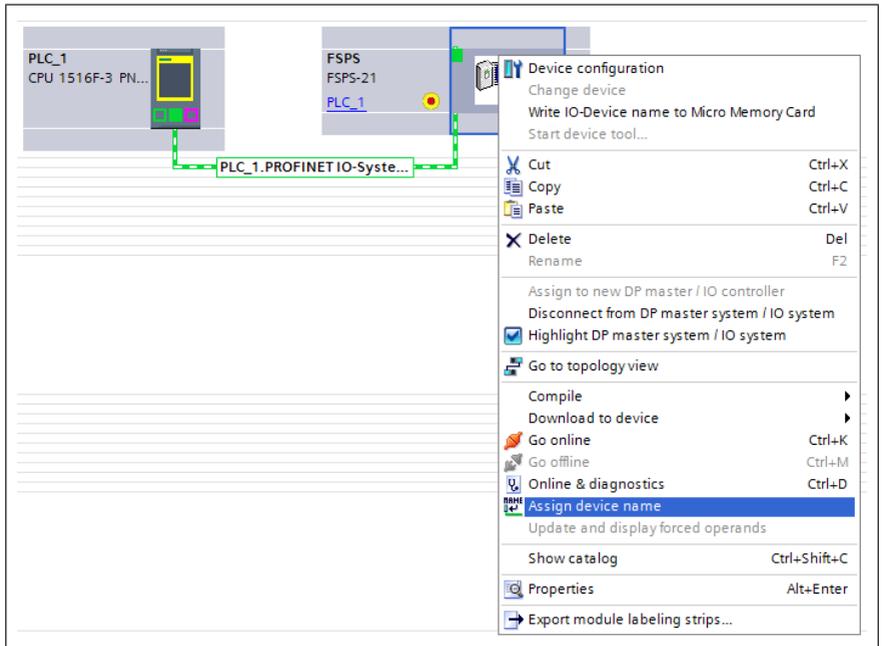
27. Select update list and identify the correct FSPS-based on MAC ID label. Select device from list and click Assign name.

    **Note:** MAC ID can be found on the cover of the FB module.
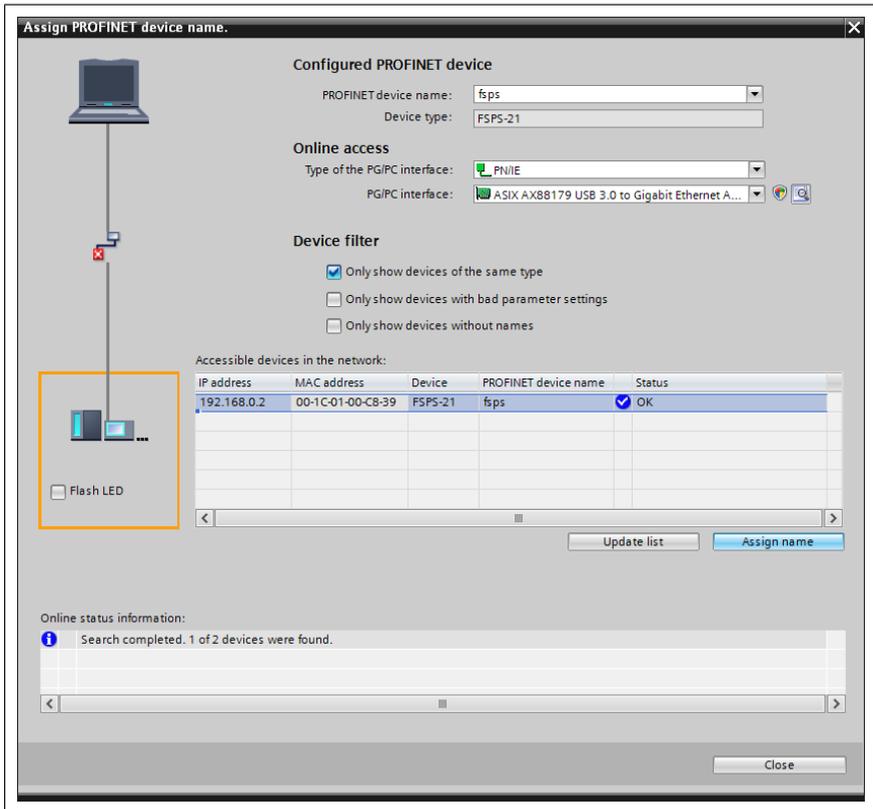
28. After PLC identifies the device on the network by its name, the PLC will assign the IP address to it automatically. Drive parameter group 51 values will update accordingly.

| 51. FBA A settings | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | FBA A type | PROFIsafe | NoUnit | | | | None |
| 2 | Protocol/Profile | PNIO ABB Pro | NoUnit | | | | MB/TCP ABB C |
| 3 | Commrate | Auto | NoUnit | | | | Auto |
| 4 | IP configuration | Temp IP | NoUnit | | | | Static IP |
| 5 | IP address 1 | 192 | NoUnit | 0 | 255 | | 0 |
| 6 | IP address 2 | 168 | NoUnit | 0 | 255 | | 0 |
| 7 | IP address 3 | 0 | NoUnit | 0 | 255 | | 0 |
| 8 | IP address 4 | 2 | NoUnit | 0 | 255 | | 0 |
| 9 | Subnet CIDR | 24 | NoUnit | 0 | 32 | | 0 |
| 10 | GW address 1 | 192 | NoUnit | 0 | 255 | | 0 |
| 11 | GW address 2 | 168 | NoUnit | 0 | 255 | | 0 |
| 12 | GW address 3 | 0 | NoUnit | 0 | 255 | | 0 |
| 13 | GW address 4 | 2 | NoUnit | 0 | 255 | | 0 |
| 14 | Commrate Port 2 | Auto | NoUnit | | | | Auto |
| 15 | - | 0 | NoUnit | 0 | 65535 | | 0 |
| 16 | - | 0 | NoUnit | 0 | 65535 | | 0 |
| 17 | - | 0 | NoUnit | 0 | 65535 | | 0 |
| 18 | - | 0 | NoUnit | 0 | 65535 | | 0 |
| 19 | T16 scale | 99 | NoUnit | 0 | 65535 | | 0 |
| 20 | Telegram type | PPO4 | NoUnit | | | | Unknown |

■ **Configuring the Siemens SIMATIC Fail-safe S7 PLC**

⚠ **WARNING!**
This safety program is only an example which you can use only for trial purposes to get the system up and running.

This example shows how to configure the communication between the Siemens SIMATIC Fail-safe S7 PLC and the FSPS-21 module using SIMATIC Manager Step 7 (version V5.5+SP4) and S7 Distributed Safety Programming (version V5.4+SP5).

For detailed configuration instructions, see the documentation of the safety PLC (*S7 Distributed Safety - configuring and programming, Programming and Operating Manual, 07/2013, A5E00109537-05*).

Before you start, make sure that you have downloaded the FSPS-21 GSD file from the ABB Document library. See section *Downloading the GSD file*.

1. Start SIMATIC Manager and open/create a SIMATIC project.

2. Add the necessary objects to the project. In this example, a SIMATIC 300 Station and an Industrial Ethernet object have been added.

3. Open the hardware configuration of the project.
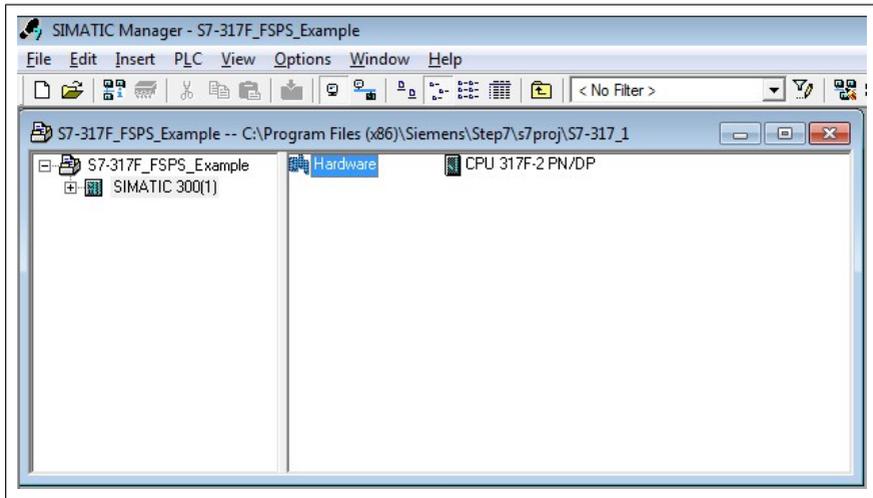
4. Select the controller station and rail from the catalog and drag them to the project. This example project uses a CPU 317F-2 controller station (V3.2) that is installed in a RACK-300 Rail.
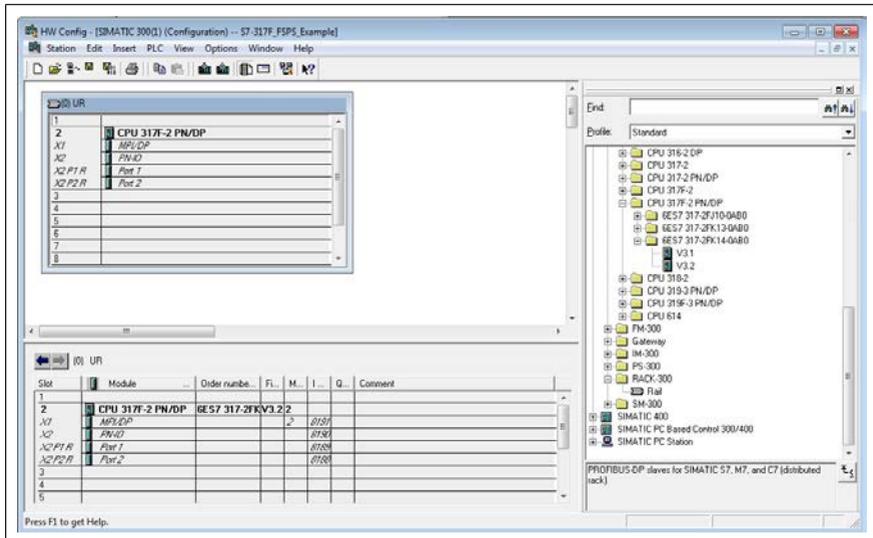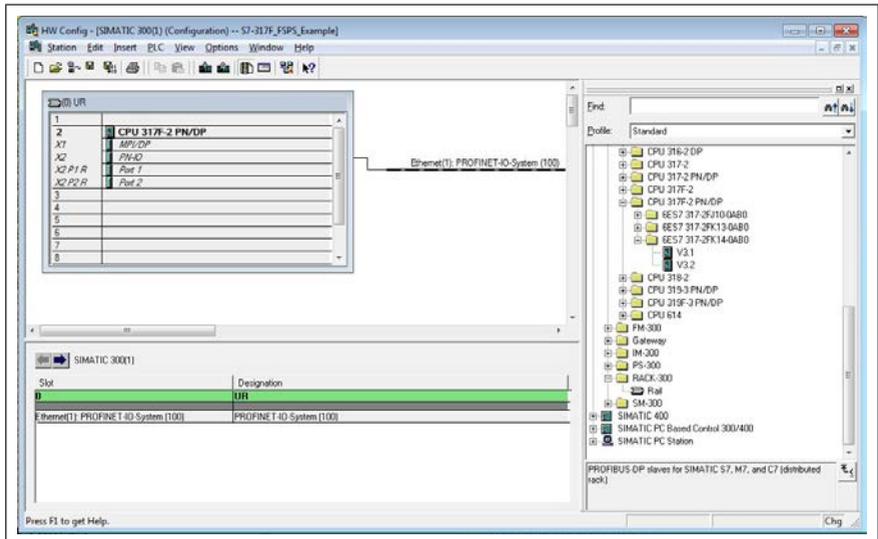
5. When you install the controller station to the rail, select Industrial Ethernet as the subnet for the controller station.
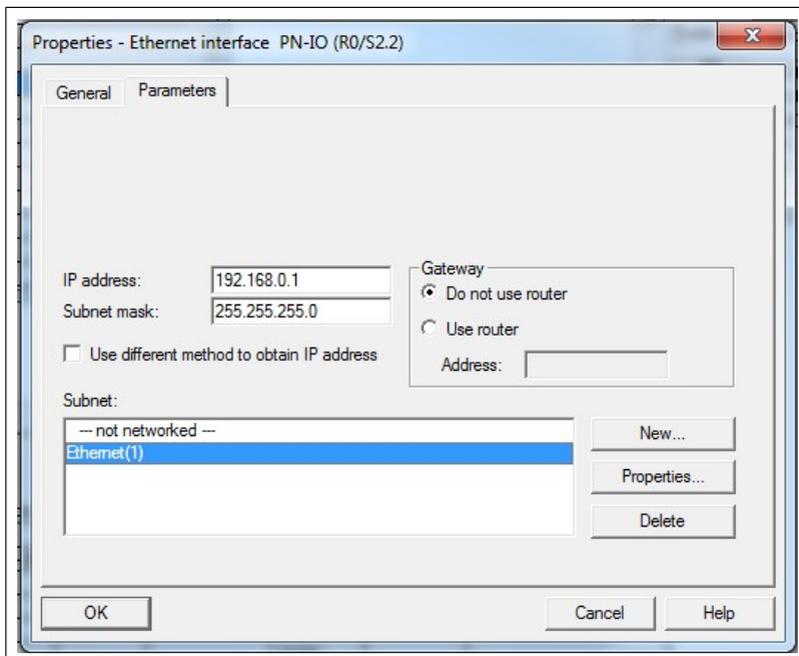
6. Install the FSPS-21 GSD file:

- In the **Options** menu, select **Install GSD Files**.

- Browse for the GSD file that you downloaded from the ABB Document library.

- Click **Install.**

• **Note:** In some versions of the SIMATIC environment, you have to close the whole SIMATIC program and open it again to make the new GSD file visible in the object catalogue.
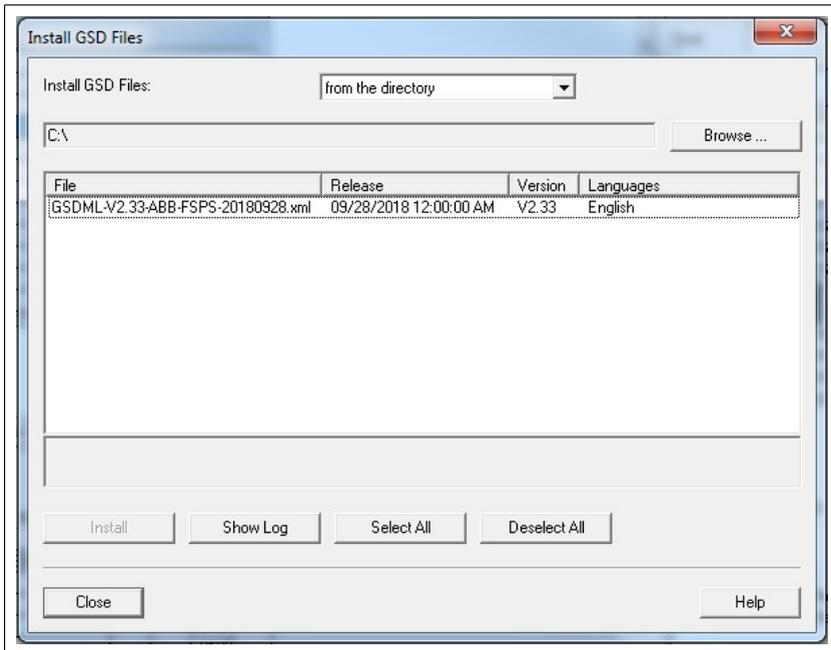
7. Click and drag the FSPS object from the device catalog to the Ethernet (1): PROFINET-IO-System.

8. Click and drag the desired IO object, for example PPO Type 7, to the first slot of the FSPS-21 module to define cyclic standard communication between the module and the PLC.

9. Click and drag the PROFIsafe object PROFIsafe ABB_PS3 to the second slot of the FSPS-21 module to define cyclic safety communication between the module and the PLC.
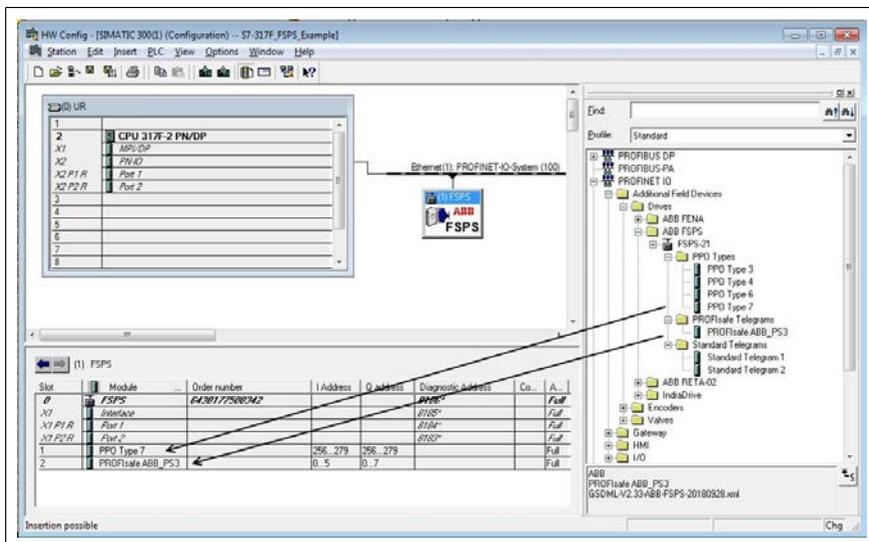


10. Double-click **FSPS-21** to open the **Properties** window.

11. On the **General** tab, type the Device name for the adapter module (in this example, drive1).
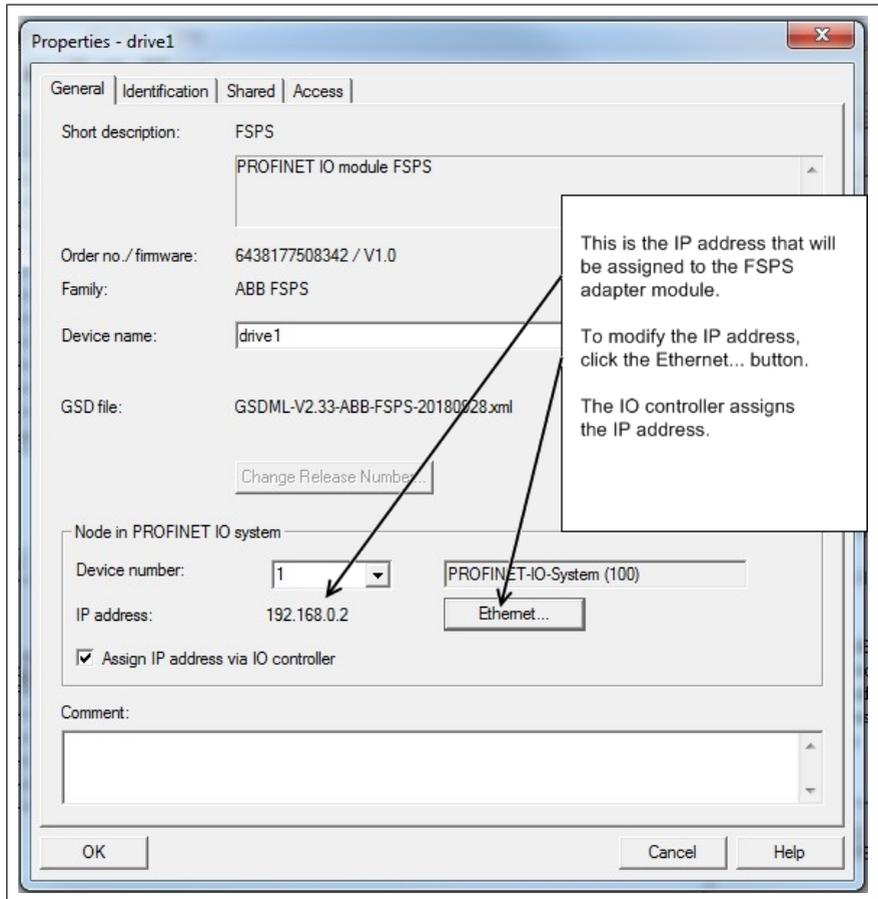
**Note:** Do not change the IP address assigned here. Use the same IP address for the FSPS-21 module also in other tools (eg, the Drive composer pro PC tool) which you use to connect to the drive.

12. Click **OK**.

13. In the hardware configuration, double-click the IO object (PPO Type 7) in Slot 1 to open the **Properties** window.

14. Type a name for the IO object (in this example, PROFIsafe ABB_PS3).
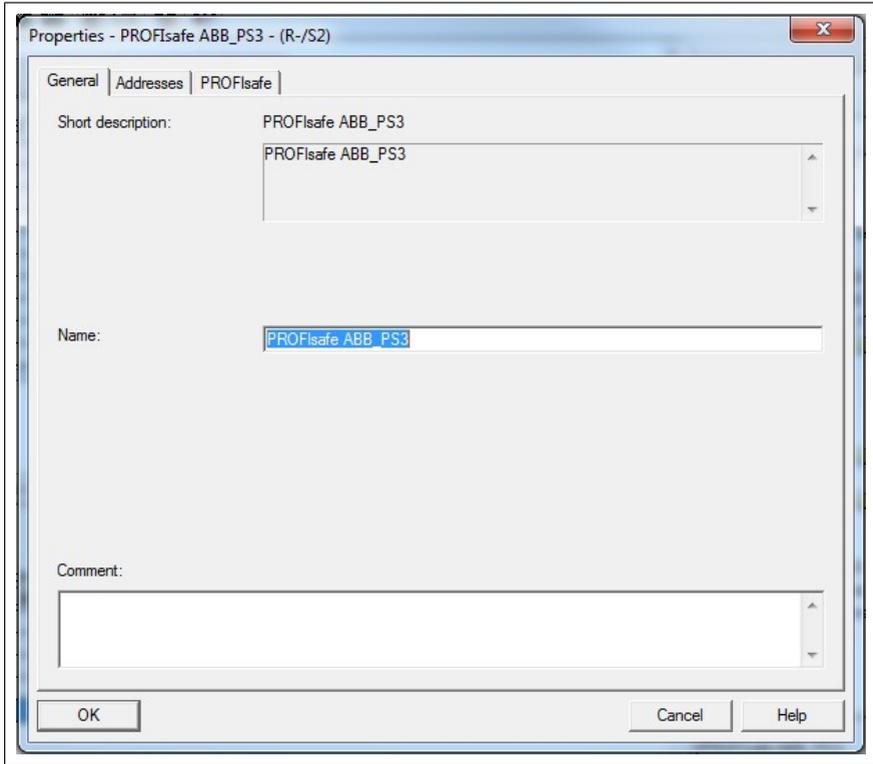
Select Addresses tab to see the correct IO addresses.
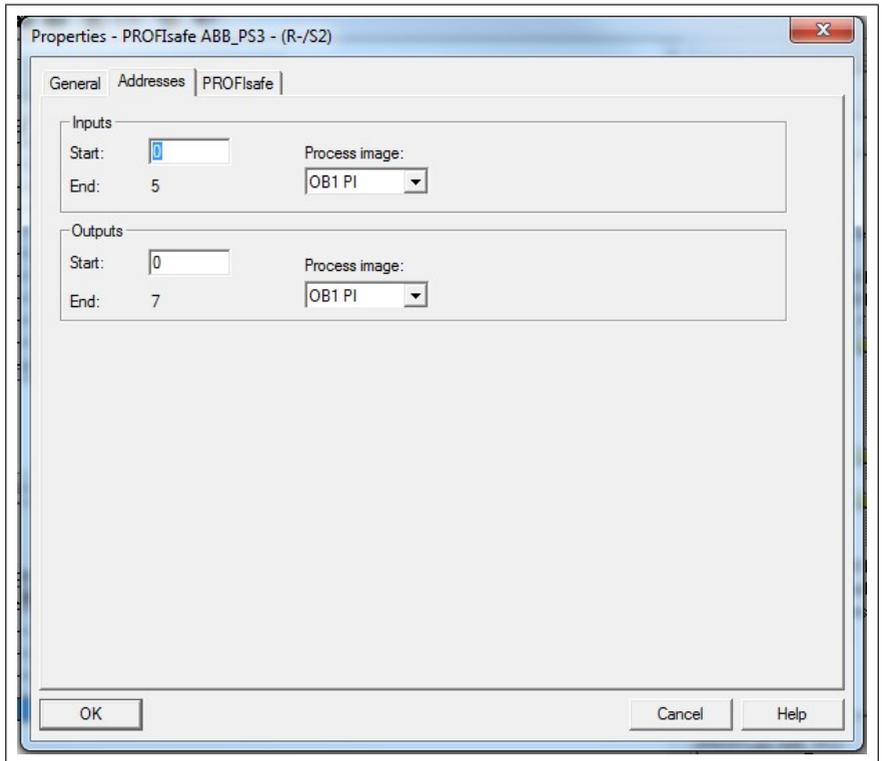
15. On the **Parameters** tab, configure the Stop mode and Control-zero mode functions, and define Fail safe values for the PLC output process data (PZDs).
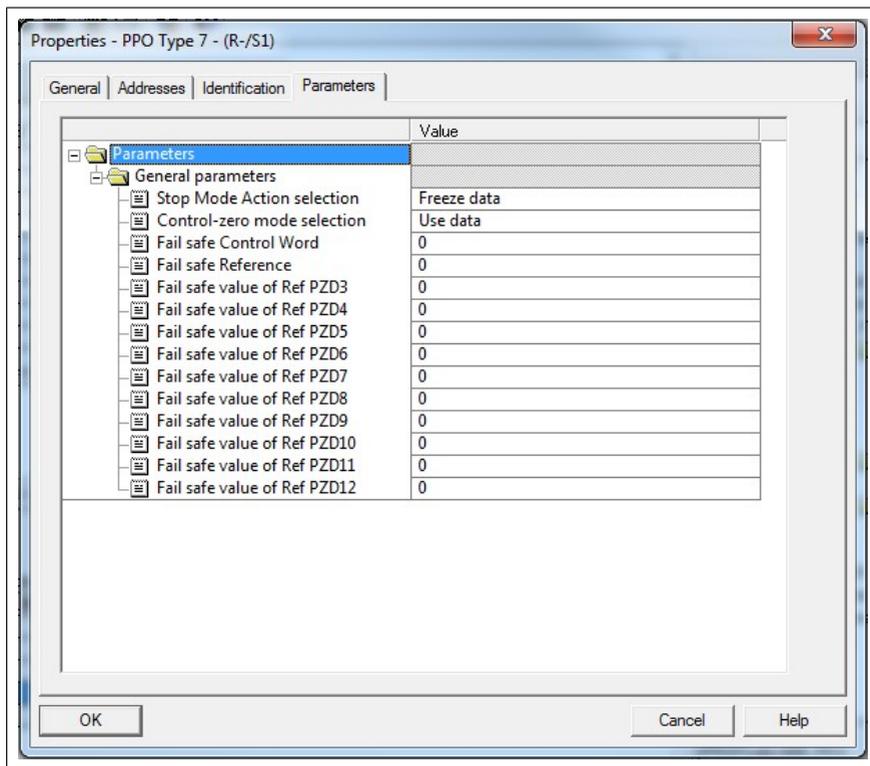
16. Assign the device name (defined in step 11) to the adapter module:

   - In the hardware configuration, click **FSPS**.

   - In the **PLC** menu, select **Ethernet**, and select **Assign Device Name**.

   - Click the **Update** button.

   - Click the available device with the correct MAC address to which the device name will be assigned.

   - Click **Assign name**. This assigns the name to the FSPS-21 module.

   - Click **Close**.
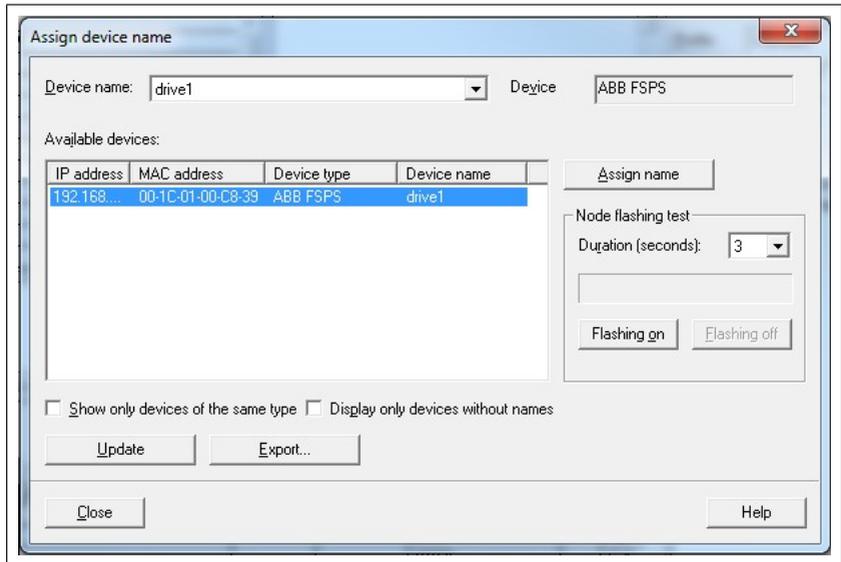
17. Check F-Parameters for the controller:

- In the hardware configuration, double-click the controller station (for example, CPU 317F-2).

- Select the **F Parameters** tab.

- When prompted, give the password for the Safety Program. See the documentation of the SIMATIC system for details.



- Make the necessary changes and click **OK**.
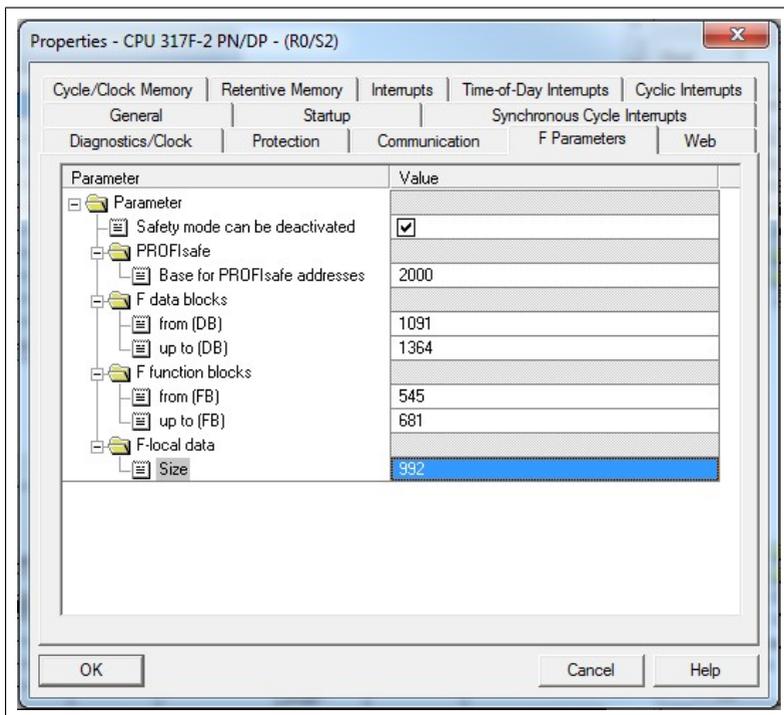
18. Set F-Parameters of the FSPS-21 module:

   • In the hardware configuration, double-click **PROFIsafe ABB_PS3** to open the Properties window.

   • On the **PROFIsafe** tab, modify the F_Dest_Add and F_WD_Time values as needed.

   • F_Source_Add is the address of the safety controller station. You can modify this in the **Host** F Parameters tab.

   • F_Dest_Add is the address of the FSPS-21 module. This is a control unit parameter 51.24, see section *Drive parameters related to FSPS-21 module configuration (ACS880, ACS580 and ACS380) (page 56)*.For DCS880, see section *Drive parameters related to FSPS-21 module configuration (DCS880) (page 57)*. These two define the codename for the PROFIsafe relationship of this particular FSPS-21 module and the safety controller station.

   • F_WD_Time is the PROFIsafe watchdog time. See section *Calculating the watchdog time (page 153)* for instructions on how to calculate the correct watchdog time.
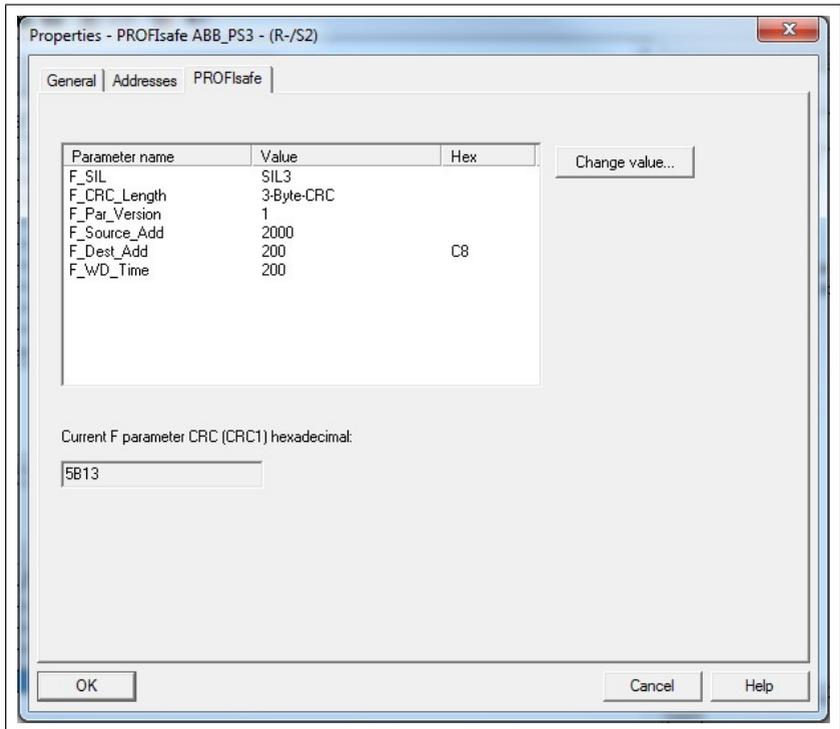
19. If necessary, you can give proper symbol names to the cyclic data:

   • Right-click the IO object (PPO Type 7) in Slot 1 and select **Edit Symbols…**

   • Add names for the symbols.

   • Repeat the same for the PROFIsafe object (PROFIsafe ABB_PS3) in Slot 2.
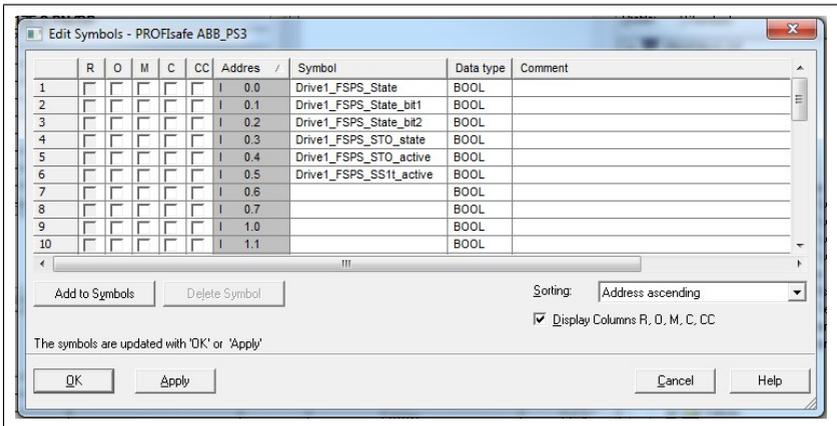
**Note:** In PROFINET communication, the bits of each octet are sent with the most significant bit first. Therefore, the bits of every octet in the PROFINET message are in reversed order compared to the bits shown in the figure. For example, the first bit that is sent in the PROFINET message is the 7th bit of the first octet (I 0.7).

20. Check the protection of the controller station:

   • In the hardware configuration, double-click the controller station (for example, CPU 317F-2).

   • Select **Protection** tab.

   • Select **1: Access protect. for F CPU**.

   • Check **Can be bypassed with password**.

   • Enter the password twice to the edit boxes.

   • Check **CPU contains safety program**.
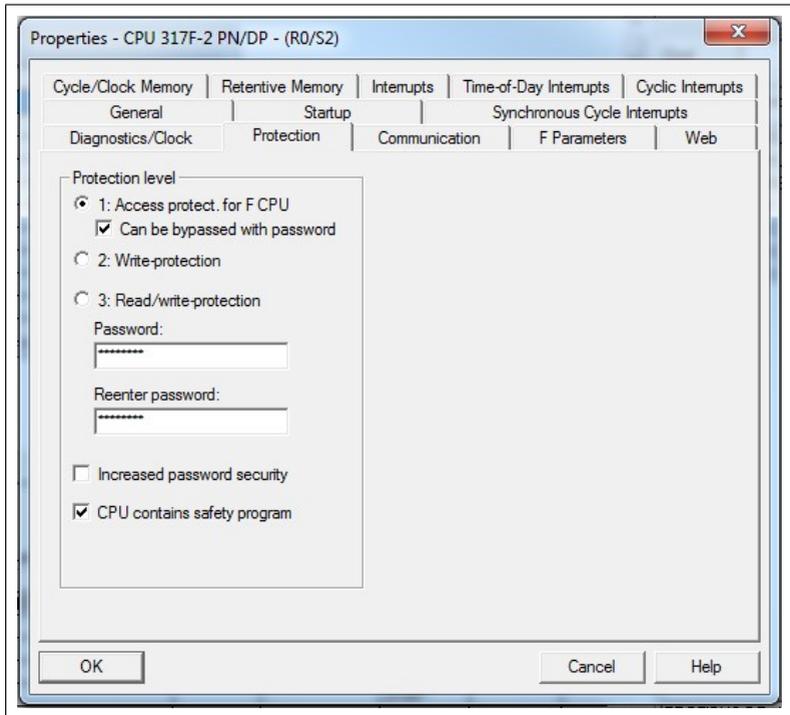
21. Save, compile and download the hardware configuration to the PLC.
The PLC is now ready for communication with the FSPS-21 module.

22. In SIMATIC Manager, right-click on the **Blocks** folder of the S7 Program of the project.

23. Select **Insert New Object**, and add the following blocks to the program:

   - Organization Block OB35 to call the safety program cyclically.

   - Function Block FB1 using F-FBD language.

   - Function FC1 using F-CALL language.
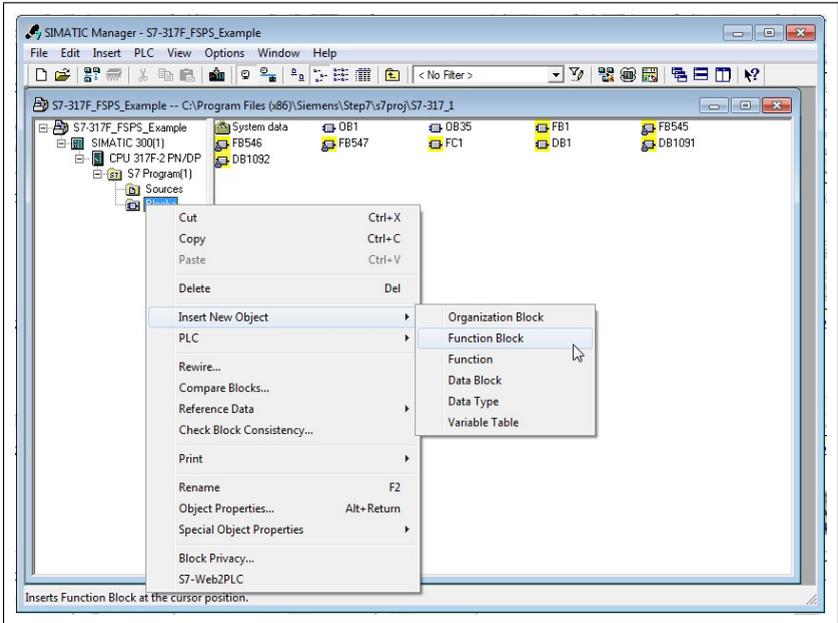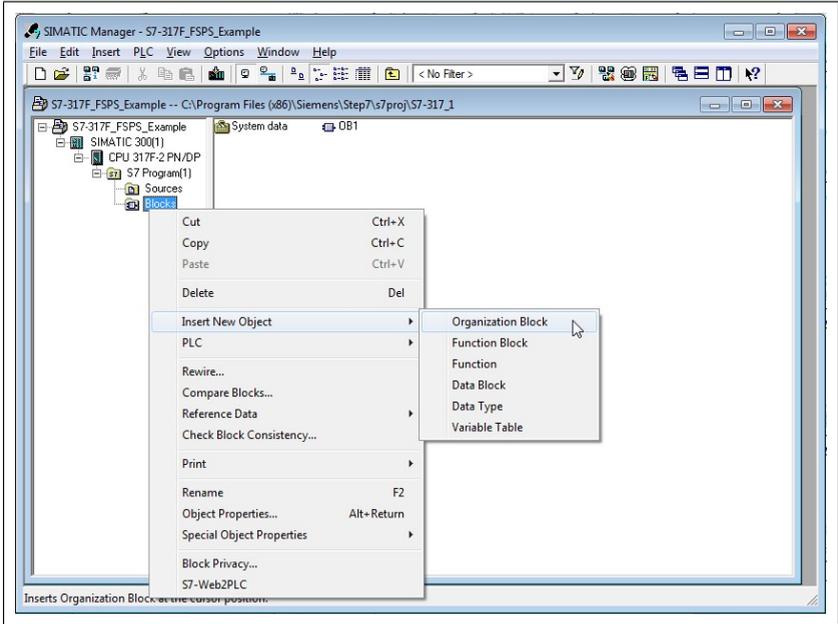
24. Double-click on the **FC1** block.

25. Set DB1 as the I-DB for the F-program block and FB1 as the F-program block.

26. Click **OK** and close the dialog windows.
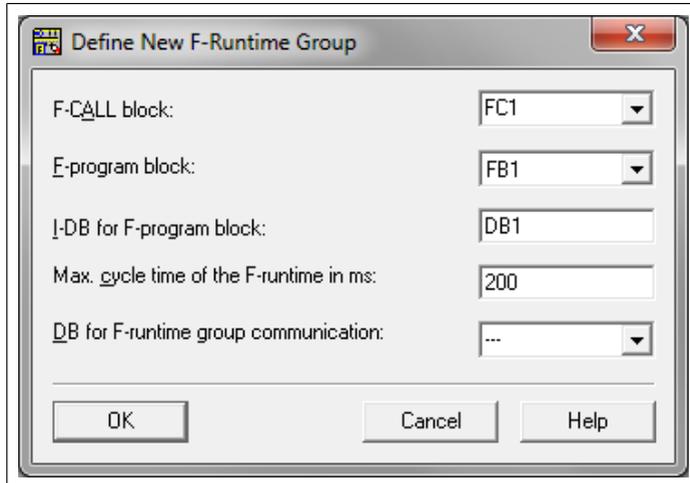


27. In SIMATIC manager, double-click on **OB35**.

28. Add call to FC1 by dragging the FC1 block from the FC blocks folder.

29. Save the block and close the editor.
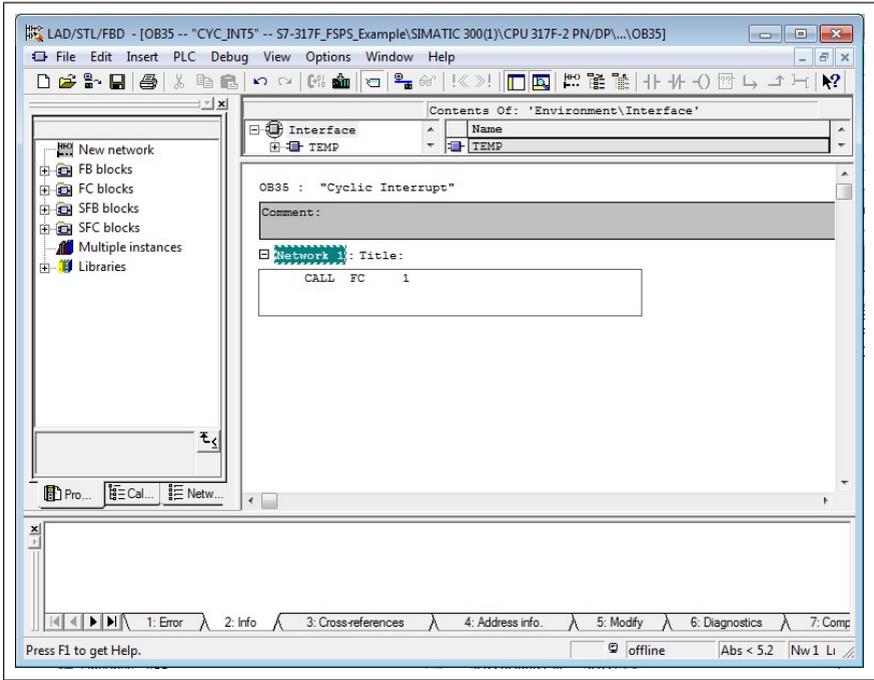
30. In SIMATIC manager, double-click on **FB1**.

31. If you do not have a complete safety program, you must at least implement acknowledgement for reintegration according to application requirements to be able to acknowledge the STO.

    Add acknowledgement for reintegration by assigning the value of ACK_REQ to ACK_REI in DB1092. (In this example, DB1092. Check the correct data block from your HW configuration.)

    ⚠️ **WARNING!**
    Activate automatic acknowledgement only when its use has been approved in the risk assessment of the application.

32. Save the block and close the editor.

33. In SIMATIC Manager, select **Edit safety program** from the **Options** menu.

34. Select **Compile**.

35. Select **Download**. If prompted, accept the inclusion of standard blocks.

36. Switch the controller station to run mode.

**Monitoring the PROFIsafe message**

It is possible to monitor the contents of the PROFIsafe message. For example:

In HW Configuration, select **Monitor/Modify** for the PROFIsafe telegram in Slot 2 of the FSPS-21 module.



## Fault tracing

### ■ Reading diagnostic messages

You can read the PROFIsafe diagnostics messages from:

1. the Event logger of the Drive composer pro PC tool,

2. the Event log of the ACS-AP-x assistant control panel and

3. the error buffers of the PLC system. In this case, make sure that drive parameter *51.21* is set to Enabled (see the drive firmware manual).

## ABB AC500-S

In the ABB AC500-S system, you can read PROFINET diagnostics messages from Automation Builder or with a separate PNIO_DEV_DIAG function block in the "non-safety" PLC program.
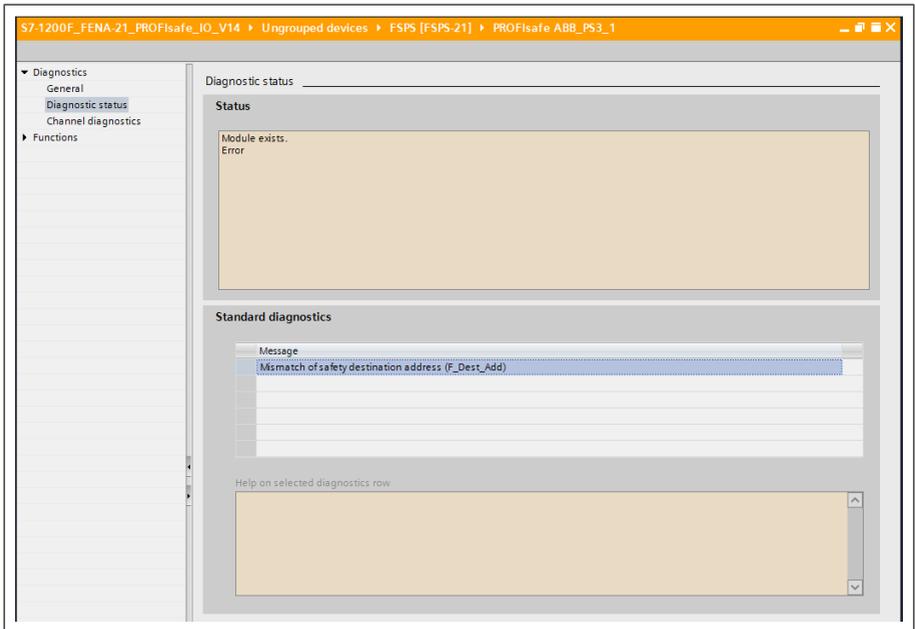
To read the alarm data of the last active alarm from Automation Builder:

1. Select **FSPS_21**.

2. On the **Diagnostics for Profinet slave** tab, select **Refresh** to read diagnostics messages.

## Siemens TIA14

To view diagnostics messages in TIA, right-click on the device you wish to diagnose and choose "Online & diagnostics".
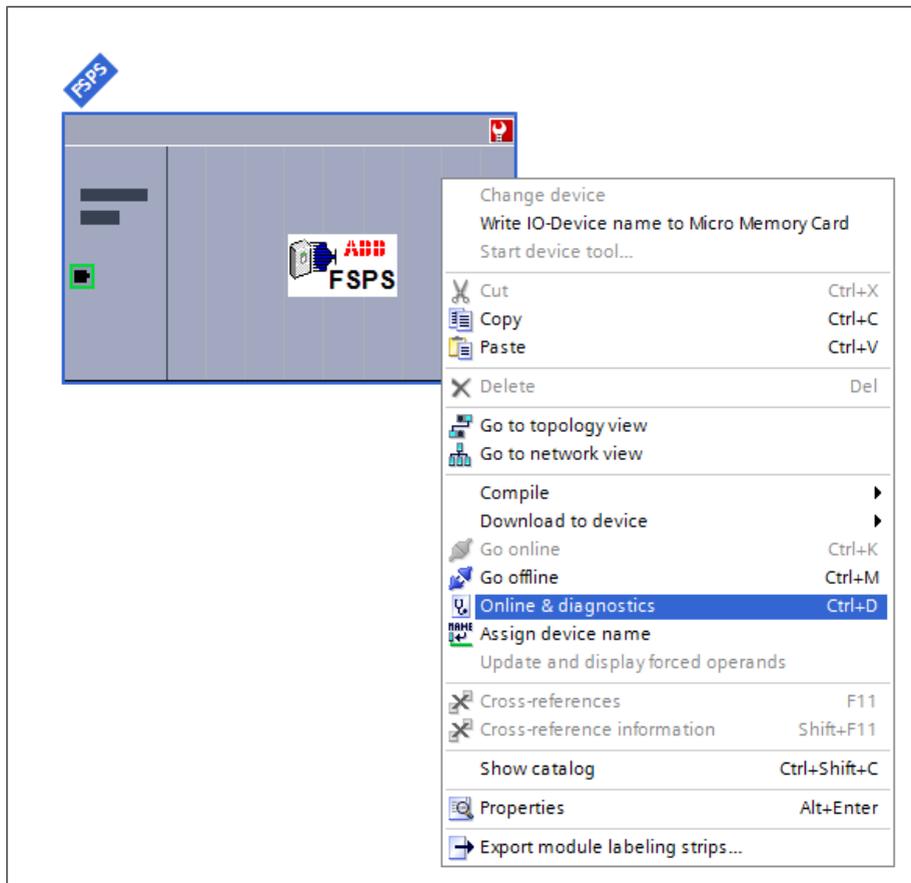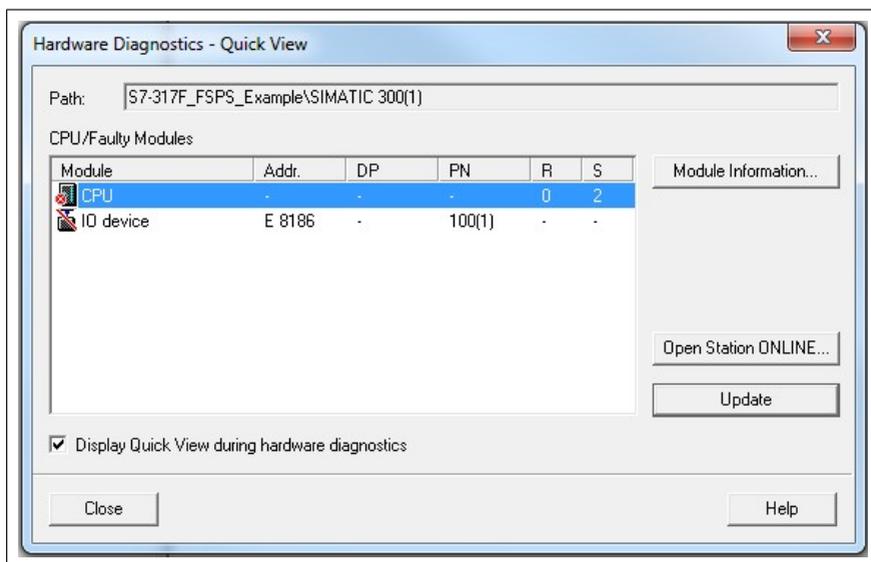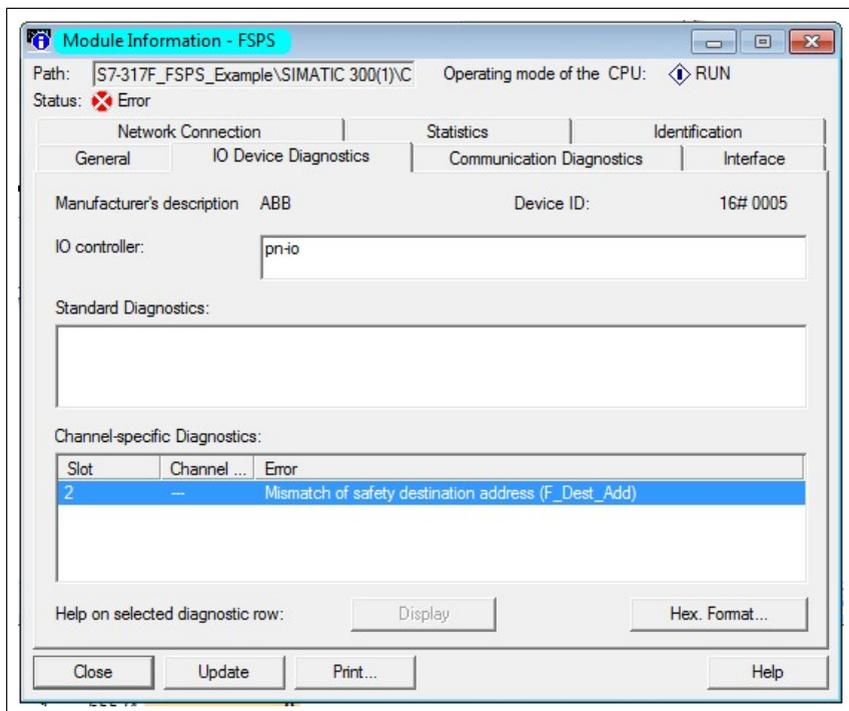
**SIMATIC Manager**

To read diagnostics messages:

1. In the **PLC** menu, select **Diagnostic/Setting**.

2. Select **Hardware diagnostics**.

3. In the window that opens, select the FSPS-21 module of your system.

4. Click the **Module Information** button.

5. To read the diagnostic messages, select the **IO Device Diagnostics** tab.

6. To check the Device number of the FSPS-21 module, select the **General** tab.
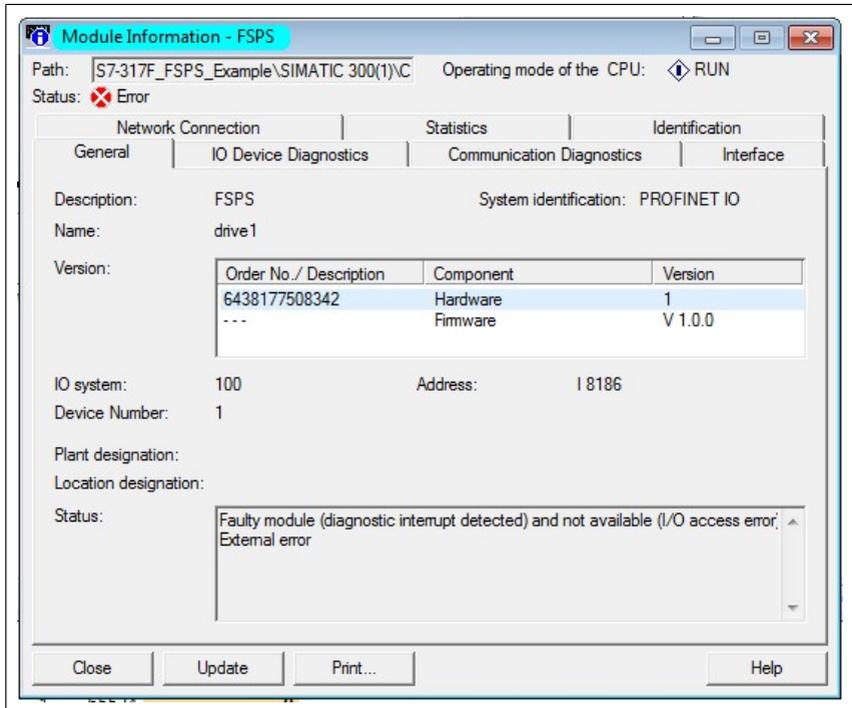


■ **Fault tracing tips for FSPS module passivation**

In this example fault tracing tips are given for FSPS module passivation caused by STO cable disconnection.

When STO cable between FSPS module and drive control unit is disconnected, FSPS module goes to fail-safe state, STO function is activated and the FSPS module is passivated in PROFIsafe.

In drive event log, *7A9C FSx STO diagnostics fault* is given due to missing STO connection and *A7DD FSx safety bus warning* due to module passivation. STO connection must be repaired and drive rebooted in order to continue the normal operation.

The data in PROFIsafe profile cannot be used for fault tracing when the FSPS module is passivated. In passivated state all the PROFIsafe profile status bits show value 0. If the status must be read, it can be read via PROFIsafe profile standard bits (possible e.g. with ABB AC500-S PLC) or QBAD bits (Siemens SIMATIC PLC).

Reading PROFIsafe profile status bits, Siemens SIMATIC PLC

| | | | | |
|---|---|---|---|---|
| | "ABB_PS3_safestate" | %I40.0 | Bool | ☐ FALSE |
| | "ABB_PS3_mode0" | %I40.1 | Bool | ☐ FALSE |
| | "ABB_PS3_mode1" | %I40.2 | Bool | ☐ FALSE |
| | "ABB_PS3_SS1t_act" | %I40.5 | Bool | ☐ FALSE |
| | "ABB_PS3_STO_act" | %I40.4 | Bool | ☐ FALSE |
| | "ABB_PS3_STO_signal" | %I40.3 | Bool | ☐ FALSE |
| | "ABB_PS3_SS1t_req" | %Q40.1 | Bool | ☐ FALSE |
| | "ABB_PS3_STO_req" | %Q40.0 | Bool | ☐ FALSE |
| | "F00040_PROFIsafeABB_PS3_1".QBAD | | Bool | ▼ ■ TRUE |
| | "F00040_PROFIsafeABB_PS3_1".PASS_ON | | Bool | ☐ FALSE |
| | "F00040_PROFIsafeABB_PS3_1".PASS_OUT | | Bool | ■ TRUE |

Reading PROFIsafe profile status bits, ABB AC500-S PLC



■ **Diagnostic messages related to F-Parameters**

If the FSPS-21 module encounters problems in processing the F-Parameters received from the controller station (PLC), a diagnostic message is displayed. This may occur, for example, when starting up the PROFINET communication between the controller station and the module.

The table below includes a list of the diagnostic messages.

| Value (hex) | Description | Notes |
|---|---|---|
| 64 (0x0040) | Mismatch of safety destination address (F_Dest_Add). | F_Dest_Add did not match the value configured in the safety parameters (PROFIsafe. 11 PROFIsafe F_Dest_Add). |
| 65 (0x0041) | Safety destination address is not valid (F_Dest_Add). | F_Dest_Add of 0 or FFFFh is not allowed. A valid F_Dest_Add is within range 1...65534. |
| 66 (0x0042) | Safety source address is not valid (F_Source_Add). | F_Source_Add of 0 or FFFFh is not allowed. A valid F_Source_Add is within range 1...65534. |
| 67 (0x0043) | Safety watchdog time value is 0 ms (F_WD_Time). | Watchdog time 0 ms is not allowed. A valid F_WD_Time is within range 1...65535. |
| 68 (0x0044) | Parameter "F_SIL" exceeds SIL from specific device application. | F_SIL defined for this device at F-Host is not correct. This device supports up to F_SIL = 3. |
| 69 (0x0045) | Parameter "F_CRC_Length" does not match the generated values. | F-Parameter checksum length different from 3 octets. This device supports only three (3) octet CRC2. |
| 70 (0x0046) | Parameter "F_Par_Version" set incorrectly. | Version of F-Parameter defined for this device at F-Host is not correct. This device supports only V2. |
| 71 (0x0047) | CRC1 Fault | Checksum CRC1 calculated over the F-Parameters does not match the checksum value in the F-Parameters. |
| 72 (0x0048) | Device-specific diagnosis information | Unsupported PROFINET submodule identification number received from the controller station upon PROFINET connection, or general error in the F-Parameters. |
| 73...75 | - | Not in use for FSPS-21 |
| 76 0x004C | F_Block_ID not supported | Reserved F_Block_ID bit combination used in F_Prm_Flag2 in F-Parameters. |
| 77 0x004D | Transmission error: data inconsistent (CRC2 error) | CRC2 checksum is calculated over F-Parameters, sequence number and transmitted/received data. If CRC2 is wrong, then transmitted/received data might be corrupted or from wrong device. |

| Value (hex) | Description | Notes |
|---|---|---|
| 78 0x004E | Transmission error: timeout (F_WD_Time or F_WD_Time_2 elapsed) | PROFIsafe device did not receive new data within the configured watchdog period. A possible solution is to increase watchdog time (if safety calculation allows) or decrease PROFINET cycle time. |

## ■ Typical communication errors

This table lists some typical error situations in the PROFINET and PROFIsafe communication.

| Fault | Cause | What to do |
|---|---|---|
| You cannot start the PROFINET communication. | The FSPS-21 station name saved in the drive parameter settings does not match the station name of the FSPS-21 in the PLC configuration. | Check the station name in drive parameter 51.25 PN Name Index and in the PLC configuration. |
| | The FSPS-21 IP address saved in the drive parameter settings does not match the IP address of the FSPS-21 in the PLC configuration. | Check the IP address in drive parameter settings and in the PLC configuration. |
| | The FSPS-21 is not configured for the PROFINET communication. | Check drive parameter *51.01* or *54.01*. |
| You cannot start the PROFIsafe communication. | The PROFIsafe destination address of the FSPS-21 in the drive parameter settings does not match the PROFIsafe destination address of the FSPS-21 in the PLC configuration. | Check the value of parameter 51.24 F-destination address. |
| PROFIsafe communication watchdog time exceeds often. | The watchdog time is too short. | Calculate a new watchdog time. See section *PROFIsafe response time (page 151)*. |

| Fault | Cause | What to do |
|---|---|---|
| All errors solved but you still cannot start the PROFIsafe communication. | After you have modified the configuration of the safety devices, you may have to reboot of the whole system before the changes take effect. | Reboot the safety PLC. If this does not help, reboot also the FSPS-21 module and the drive. To reboot the FSPS-21 module: <br>• switch the power off and on, or <br>• use drive parameter FBA A/B PAR REFRESH (parameter 51.27/54.27, see the drive firmware manual). <br>To reboot the drive: <br>• switch the power off and on, or <br>• use drive parameter Control board boot (parameter 96.08, see the drive firmware manual). |

# 17

# Verification and validation

## Contents of this chapter

This chapter describes verification and validation of the implemented safety functionality.

Verification and validation produce documented proof of the compliance of the implementation with specified safety requirements.

For more information, see *Technical guide No. 10 - Functional safety* (3AUA0000048753 [English]).

## Verifying the achieved SIL/PL level

Verification of the functional safety system demonstrates and ensures that the implemented safety system meets the requirements specified for the system in the safety requirements specification phase.

The most convenient way to verify the required SIL/PL level reached with the implemented system is to use a specific safety calculator software.

## Safety validation

### ■ Validation procedure

It is always the responsibility of the machine builder to ensure that the functionality of all the required safety functions has been appropriately verified and validated.

⚠ **WARNING!**
Until all the safety functionality is validated, the system must not be considered safe.

The acceptance test must be performed to each safety function.

The acceptance test using the start-up checklists described below (see Validation checklists for start-up) must be performed:

- at initial start-up of the safety function
- after any changes related to the safety function (wiring, components, settings, etc.)
- after any maintenance work related to the safety function.

The acceptance test must include at least these steps:

- having an acceptance test plan
- testing all commissioned functions for proper operation
- testing all used inputs for proper operation
- testing all used outputs for proper operation
- documenting all acceptance tests performed
- testing person signing and archiving the acceptance test report for further reference

## ◻ **Acceptance test reports**

You must store the signed acceptance test reports in the logbook of the machine. The report must include, as required by the referred standards:

- a description of the safety application (including a figure)
- a description and revisions of safety components that are used in the safety application
- a list of all safety functions that are used in the safety application
- a list of all safety related parameters and their values (the drive STO has no safety-related parameters, but listing the non-safety related parameter *31.22 STO indication run/stop* and its setting is recommended)
- documentation of start-up activities, references to failure reports and resolution of failures
- the test results for each safety function, checksums, date of the tests and confirmation by the test personnel.

You must store any new acceptance test reports performed due to changes or maintenance in the logbook of the machine.

## ◻ **Competence**

The acceptance test of the safety function must be carried out by a competent person with expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

■ **Tools**

You need the Drive composer pro PC tool or a control panel to perform the validation procedures.

## Validation checklists for start-up

■ **Validation of the PROFIsafe connection**

Follow these steps to validate the PROFIsafe connection:

1. Make sure that the FSPS-21 module is enabled in drive parameter *50.01* (FBA A enable) or *50.31* (FBA B enable).

    **Note:** FBA B applies only to ACS880/DCS880 drives.

2. Make sure that the module is configured correctly in drive parameter group 51 or 54 (depends on which FBA channel of the module [FBA A or FBA B] is used). Most importantly,

    • parameter 51.02/54.02 Protocol/Profile must be set to configure one of the PROFINET profiles

    • parameter 51.21 or 54.21 must be set to Enabled (0) to enable sending of the PROFIsafe diagnosis messages.

3. Make sure that the PROFIsafe watchdog time for the module that is configured in the controller station is calculated as specified in section *Calculating the watchdog time (page 153)*.

4. Make sure that the PROFIsafe address (F_Dest_Add) of the F-device (FSPS-21 module) is unique in the network and the same value is set in **parameter 51.24** and in the safety PLC.

5. Make sure that the PROFIsafe address (F_Source_Add) of the F-host (safety PLC) is unique in the network.

6. Make sure that the safety controller station is commissioned according to its instructions. See, for example, *AC500-S Safety User Manual* (3ADR025091M0202 [English]) for details.

7. Make sure that the functionality used in the project works correctly via PROFIsafe.

8. Make sure that the drive event log does not contain any unexpected entries. See chapter *Fault tracing* for details.

9. If possible, make sure that the LEDs do not indicate any unexpected conditions. See chapter *Fault tracing* for details.

10. Make sure that the diagnostic messages at the safety controller station do not contain any unexpected entries.

## ■ Validation of the STO function

Follow these steps to validate the STO function:

1. Make sure that the STO function is configured correctly.

2. Make sure that you can run and stop the motor freely.

3. Start the drive and set it to a typical motor speed for the application.

4. Activate the STO function from the safety PLC.

5. Make sure that the motor speed starts to decelerate.

6. Make sure that the drive STO is activated.

7. Make sure that the drive cannot be restarted as long as STO function request is on.

8. Remove STO function request/activation from the safety PLC.

9. If safety function acknowledgement is configured to be manual in safety PLC, make sure that the drive cannot be restarted.

10. Acknowledge safety function from the PLC.

11. If drive parameter 31.22 is set to fault/fault, make sure that the drive cannot be restarted.

12. If drive parameter 31.22 is set to fault/fault, reset the drive fault.

13. Check that there are no unwanted errors in the drive.

14. Restart the drive and make sure that the motor runs normally.

## ■ Validation of the SS1-t time limit hit

Follow these steps to validate the SS1-t function:

1. Make sure that the SS1-t function is configured correctly.

2. Check that parameter 25.15 Proportional gain em stop has been set according to application needs.

3. Make sure that you can run and stop the motor freely.

4. Start the drive and set it to a motor speed typical for the application.

5. Activate the SS1-t function from the safety PLC.

6. Set drive emergency ramp time to be longer than SS1-t time (drive parameter groups 23 and 46 depending on operation mode - see drive firmware manuals).

7. After SS1-t time runs out and the drive STO is activated, make sure that the system behaves in a safe way.

8. Restore drive emergency ramp time value to match your application requirement.

9. Remove SS1-t request/activation from the safety PLC.

10. Reset safety ramp fault from the drive.

11. If drive parameter 31.22 is set to fault/fault, reset the fault.

12. Proceed to the SS1-t validation.

■ **Validation of the SS1-t function**

1. Make sure that the SS1-t function is configured correctly.

2. Make sure that you can run and stop the motor freely.

3. Check that parameter 25.15 Proportional gain em stop has been set according to application needs.

4. Start the drive and set it to a motor speed typical for the application.

5. Activate the SS1-t function from the safety PLC.

6. Make sure that the motor speed ramps down properly and the time monitoring delay is set correctly.

7. Make sure that the drive STO is activated when the drive reaches zero speed.

8. Make sure that the drive cannot be restarted as long as SS1-t function request is on.

9. Remove SS1-t function request/activation from the safety PLC.

10. If safety function acknowledgement is configured to be manual in safety PLC, make sure that the drive cannot be restarted.

11. Acknowledge the safety function from the safety PLC.

12. If drive parameter 31.22 is set to fault/fault, make sure that the drive cannot be restarted.

13. Reset Drive fault.

14. Check that there are no unwanted errors in the drive.

15. Restart the drive and make sure that the motor runs normally.

# 18

# Start-up

## Contents of this chapter

This chapter describes the general precautions to be taken before starting up the safety system for the first time.

## Safety

The start-up may only be carried out by a qualified electrician who has appropriate knowledge on functional, machine and process safety. The safety instructions must be followed during the start-up. See the drive and the safety component specific safety instructions in the individual product manuals.

**WARNING!**
Until all the safety functionality is validated, the system must not be considered safe. See chapter *Verification and validation (page 215)*

**WARNING!**
FSPS-21 module has automatic acknowledgement method. Make sure that the system is designed so that this does not cause unacceptable risk.

## Checks

Before starting the system for the first time, make sure that:

• the installation has been checked according to individual product checklists (drive, safety component) and the checklists provided in this document
See chapter *Installation checklists (page 51)*.

- all necessary configuration steps have been completed
- all tools are cleared from the installation area
- starting the system does not cause any danger.

◇

# 19

# Fault tracing

## Contents of this chapter

This chapter describes the status LEDs and provides generic diagnostics and troubleshooting tips.

## Event types

The module generates three types of events to the drive: pure events, warnings, and faults. Only faults will cause the drive to stop. All event types are shown in the Event logger.

## Fault messages

| Code | Fault | Description | AUX code(s) | What to do |
|------|-------|-------------|-------------|------------|
| 0x7A9A | FSx undefined fault | The fault is not recognized by the drive FW. | | Gather the AUX codes from this fault and contact ABB. |
| 0x7A9B | FSx internal fault | FSX internal faults, like CPU or memory or peripherals | | Hardware can be faulty. Contact ABB. |

| Code | Fault | Description | AUX code(s) | What to do |
|------|-------|-------------|-------------|------------|
| 0x7A9C | FSx STO diagnostics fault | FSX STO fault; there is a fault in STO circuit (eg, in cabling) or inside the drive. | **0000 0001** Boot time STO test failed. | Check STO cable. If fault persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0002** Run time STO pulsing test failed. | Check STO cable. If fault persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0003** STO hi line is in 0v. | Check STO cable. If fault persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0004** STO hi line went down to 0v. | Check STO cable. If fault persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0005** STO feedback does not match the hi and ctrl state. | Check STO cable. If fault persists, gather the AUX codes from this fault and contact ABB. |
| 0x7A9D | FSx temperature fault | FSX temperature fault (eg, overtemperature). | **0000 0003** Overtemperature, sensor 1 | Check that the temperature of installation is according to the ambient conditions requirements. Gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0004** Overtemperature, sensor 2 | Check that the temperature of installation is according to the ambient conditions requirements. Gather the AUX codes from this fault and contact ABB. |
| 0x7A9F | FSx communication fault | FSX communication fault: Internal error in safety communication. | | Gather the AUX codes from this fault and contact ABB. |

| Code | Fault | Description | AUX code(s) | What to do |
|------|-------|-------------|-------------|------------|
| 0x7AA0 | FSx safety ramp fault | FS safety ramp fault: The drive did not stop in the monitoring time limit of SS1-t function. | | Check if the drive can decelerate the load using the ramp time. |

**Note:** The descriptions for AUX codes can be seen in Drive composer event log.

## Warning messages

| Code | Warning | Description | AUX code(s) | What to do |
|------|---------|-------------|-------------|------------|
| 0xA7DC | FSx undefined warning | The fault is not recognized by the drive FW. | | Gather the AUX codes from this warning and contact ABB. |

| Code | Warning | Description | AUX code(s) | What to do |
|------|---------|-------------|-------------|------------|
| 0xA7DD | FSx safety bus warning | PROFIsafe configuration problem. Gather the AUX codes from this warning and contact ABB. | **0000 0001** F_dest address does not match to configured value | Check that the value of parameter 51.24 F-destination address is the same in the PLC program and in the drive parameters. Check that PROFINET station names match. |
| | | | **0000 0002** PLC gave illegal f_dest address | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0003** F_source address does not match to configured value | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0004** PLC gave illegal f_source address | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0005** PLC gave illegal wd-time value | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0006** PLC requested sil is higher than we are capable | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0007** PLC gave config which has conflict with f_crc_length | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |

| Code | Warning | Description | AUX code(s) | What to do |
|------|---------|-------------|-------------|------------|
| | | | **0000 0008** PLC gave config which has conflict with f_par_version | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0009** PLC gave config which has conflict with f_block_id | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 000A** PLC gave config where fpar_crc does not match to calculated one | Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0010** Received new f-parameters | If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0011** Waiting for initial PROFIsafe connection | This warning is always shown after drive or module reboot. If warning persists, PLC is not able to establish a PROFIsafe connection to the drive. Check PLC program status (eg, PLC program has been configured correctly, it is in RUN state, etc.). |
| | | | **0000 0012** Crc failure in cyclic communication | Check the cabling and the external network devices. Check PLC program status. If warning persists, gather the AUX codes from this fault and contact ABB. |
| | | | **0000 0013** | |

| Code | Warning | Description | AUX code(s) | What to do |
|------|---------|-------------|-------------|-----------|
| | | | Watchdog timeout in PROFIsafe communication | Check PROFINET cabling to FSPS-21. Check that PLC safety program cycle time and PROFINET cycle time are fast enough for the watchdog. If necessary, calculate a new watchdog time. See section *PROFIsafe response time (page 151)*. |
| | | | **0000 0014** PLC set bit4 (activate_fv) in cyclic communication | This warning is shown during startup and when passivation is requested and does not require any actions. See *Safe (Module passivation with a command)*. In case passivation is not requested by the Safety PLC program and the warning persists, gather the AUX codes from this fault and contact ABB. |

# Event messages

| Code | Event | Description |
|------|-------|-------------|
| 0xB795 | FSx undefined event | FSX undefined event. |
| 0xB796 | FSx diagnostics | If AUX = 0000 0000, no errors exist. In any other case, gather the AUX codes from this event and contact ABB. |

# LEDs

The adapter module is equipped with three bicolor diagnostic LEDs. The LEDs are described below.

| Name | Color | Function |
|------|-------|----------|
| HOST | Flashing green | Establishing communication to drive control unit |
| | Green | Connection to drive control unit OK |
| | Flashing red | Communication to drive control unit lost temporarily |
| | Red, with MODULE red | Fail-safe, see *FSPS-21 module modes (page 146)* |
| | Flashing orange, alternating with the MODULE flashing orange | Internal file system error. The error may be cleared by cycling drive power. If the error persists, contact your local ABB representative. |
| | Orange | STO is active; eg. STO signal is 0V (Shown when connection to drive control unit is OK and no fail-safe is indicated.) |

| Name | Color | Function |
|------|-------|----------|
| MODULE | Off | There is no power applied to the device. |
| | Flashing orange | Device is attempting to obtain IP configuration from DHCP server if network LED is off. |
| | | Used for identification. The flashing is started by the PROFINET master and also the network LED is flashing green. |
| | Flashing green | Device needs commissioning due to configuration missing, incomplete or incorrect. The device may be in the Standby state. This may be caused by the adapter waiting for a response from a DHCP server. This may also be caused by the adapter waiting for Duplicate Address Detection to complete. If Duplicate Address Detection has detected an IP conflict, the IP is configured to 0.0.0.0 and can be reconfigured by PLC. |
| | Green | Device is operating in a normal condition. |
| | Flashing red | Ethernet link is down. |
| | Red | Ethernet interface is disabled. Duplicate Address Detection may have detected a duplicate address. Check the IP configuration and either initiate a Fieldbus Adapter parameter refresh or cycle power to the drive. |
| | Red, with HOST red | Fail-safe, see *FSPS-21 module modes (page 146)* |
| | Flashing red-green | Device is in Self Test. |
| | Flashing orange, alternating with the HOST flashing orange | Internal file system error. The error may be cleared by cycling drive power. If the error persists, contact your local ABB representative. |

| Name | Color | Function |
|---|---|---|
| NET | Off | Device is not on-line.<br>• The device has not completed the Duplicate Address Detection yet.<br>• The device may not be powered; look at the MODULE status LED. |
| | Flashing green | Device is receiving/transmitting on the Ethernet. |
| | | Used for identification. The flashing is started by the PROFINET master and also the module LED is flashing orange. |
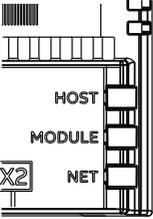
## Status and control words

This table lists the FSPS-21 module and drive status and control words with the ACS380, ACS580, ACS880 and DCS880 drives. You can view these in the parameter window of Drive composer pro.

**Note:** The status and control words in group 200 are non-safety critical information. Use these for fault tracing and status information only.

| Index | Name/ value | Description |
|---|---|---|
| 200.05 | FS control word 1 | Shows the states of the FS commands.<br><br>| Bit | Name | Values |<br>\|---\|---\|---\|<br>\| 0 \| STO request \| 0 = Off,<br>1 = On \|<br>\| 2 \| SS1 request \| 0 = Off,<br>1 = On \| |
| 200.06 | FS control word 2 | Shows the states of the FS commands.<br><br>| Bit | Name | Values |<br>\|---\|---\|---\|<br>\| 6 \| SS1 ramp selection \| 0 = Off,<br>1 = On \| |

| Index | Name/ value | Description |
|---|---|---|
| 200.07 | FS status word 1 | Shows the FS status word 1. |
| | | <table><thead><tr><th>Bit</th><th>Name</th><th>Values</th></tr></thead><tbody><tr><td>0</td><td>FSx mode bit 1</td><td rowspan="3">0=Boot, 1=Running, 2=Failure detected, 3=Fail-safe, 5=Undefined</td></tr><tr><td>1</td><td>FSx mode bit 2</td></tr><tr><td>2</td><td>FSx mode bit 3</td></tr><tr><td>3</td><td>FSx state bit 1</td><td rowspan="2">0=Safe state, 1=Operational</td></tr><tr><td>4</td><td>FSx state bit 2</td></tr><tr><td>5</td><td>FSx STO active</td><td>1= STO function active, 0 = STO not active</td></tr><tr><td>9</td><td>SS1 monitoring</td><td>1 = SS1-x finished (the finishing STO has been performed), 0=not finished</td></tr></tbody></table> |
| 200.08 | FS status word 2 | Shows the FS status word 2. |
| | | <table><thead><tr><th>Bit</th><th>Name</th><th>Values</th></tr></thead><tbody><tr><td>15</td><td>STO completed</td><td>1 = STO completed ; 0 = STO not completed</td></tr></tbody></table> |

| Index | Name/ value | Description | | | | |
|---|---|---|---|---|---|---|
| 200.09 | Drive status word 1 | Shows the drive status word 1. | | | | |

| Bit | Name | Description | Values |
|---|---|---|---|
| 0 | Drive status bit 1 | | 0 = Disabled<br>1 = Ready-on<br>2 = Readyr-un<br>3 = Starting<br>4 = Readyref<br>5 = Stopping<br>6 = Faulted |
| 1 | Drive status bit 2 | | |
| 2 | Drive status bit 3 | | |
| 3 | Drive status bit 4 | | |
| 6 | Modula-tion | Drive modulation on or off.<br><br>**Note:** This bit only signifies the status of drive modulation, not the Safe state of the drive. Safe state of the drive is achieved only when STO is activated. | 0 = Off,<br>1 = On |
| 7 | STO cir-cuit 1 | State of drive STO circuit 1. | 0 = Off,<br>1 = On |
| 8 | STO cir-cuit 2 | State of drive STO circuit 2. | 0 = Off,<br>1 = On |
| 9 | SS1 act-ive | State on the drive side | 0 = Off,<br>1 = On |

## Reporting problems and failures

If you detect any failure in the safety module or safety functions, always contact your local ABB representative.

# 20

# Maintenance

## Contents of this chapter

This chapter explains replacement of the FSPS-21 module in case of a module failure, reinstalling the FSPS-21 module to another drive, updating the firmware of the drive where the FSPS-21 module is installed, FSPS-21 module update and decommissioning as well as proof tests.

**WARNING!**
Read and obey the instructions in chapter *Safety instructions (page 13)* and chapter *Safety instructions* in the drive hardware manual. If you ignore them, injury or death, or damage to the equipment can occur.

## Planning

All maintenance and the repair actions on a safety critical system are safety critical. You must plan and perform them accordingly.

Before making any changes, make sure to back-up drive parameters.

## Tools

You need the Drive composer PC tool or a control panel to perform the maintenance procedures.

# FSPS-21 configuration back-up

## ■ Contents of this chapter

This chapter presents the settings for FSPS-21 configuration backup.

## ■ Description

FSPS-21 settings are stored in the drive parameters and also in the configuration files. FSPS-21 configuration parameters are included in the backup of the drive parameters.

## ■ Settings for backup

Consider the following points:

- Backup is not slot-specific. For example, backup in FBA A, slot 1 of the control unit can be restored to FBA A, slot 2.
- Backup depends on the fieldbus channel. For example, backup of FSPS-21 in FBA A is not restored to FSPS-21 in FBA B.

### Configuration backup for FSPS-21

Backup includes the following configuration for PROFINET IO in FSPS-21:

| Configuration | |
|---|---|
| Station name | Sets the station name using DCP. See *PROFINET network settings (page 112)*. When set, backup will automatically include this configuration. |
| I&M 1-3 | Writable strings for identification and maintenance. See *I&M records (page 254)*. When set, backup will automatically include this configuration. |
| PROFIdrive parameters 934-943 | PROFIdrive CW and SW user bit mapping. See *PROFIdrive parameters (page 249)*. **Note:** Backup will include this configuration only when it is stored with PROFIdrive parameter 971. |
| System location | Writable SNMP MIB-2 string. When set, backup will automatically include this configuration. |
| System name | |
| System contact | |

The settings are saved to the drive after 10 seconds. If a Refresh command is given to FSPS-21 using parameter 51.27, the pending backup is transferred to drive immediately and FSPS-21 is rebooted after the transfer is completed.

**Note:** The new setting is not saved to drive if the drive was powered off or the adapter was disconnected from the drive within 10 seconds of changing a setting.

# FSPS-21 module replacement

If the FSPS-21 module fails to operate, you have to replace it with a new one; you cannot repair the module.

## ■ Replacing the FSPS-21 module

1. Stop the driven machinery and prevent an unexpected start-up.
   Module parameters are automatically saved in the drive, there is no need to make a manual back-up.

2. Disconnect the supply with the supply disconnecting device.

   **WARNING!**
   Read and obey the instructions in chapter *Safety instructions (page 13)* and chapter *Safety instructions* in the drive hardware manual. If you ignore them, injury or death, or damage to the equipment can occur.

3. Remove the wiring and the FSPS-21 module.

4. Mark clearly on the FSPS-21 module that it is decommissioned.

5. Install the new FSPS-21 module and wiring according to chapter *Installation*.

6. Re-configure the HW configuration in the PLC project.

7. Perform the start-up procedure according to chapter Start-up.

8. Perform the validation procedure for each safety function according to chapter Verification and validation.

9. Update the revision of the new FSPS-21 module to the logbook of the driven machine.

# Drive replacement

If you have to replace the drive where the FSPS-21 module is installed, for example, because of a serious drive failure, follow the procedure below.

## ■ Reinstalling the FSPS-21 module to another drive

1. Stop the driven machinery and prevent an unexpected start-up.

2. Make a backup file of the drive parameters before drive replacement.
   You can make a backup of the drive configuration using the control panel or the Drive composer PC tool. See applicable drive FW manual, Control panel manual, or Drive composer manual.

3. Disconnect the supply with the supply disconnecting device.

---

⚠ **WARNING!**
Read and obey the instructions in chapter *Safety instructions (page 13)* and chapter *Safety instructions* in the drive hardware manual. If you ignore them, injury or death, or damage to the equipment can occur.

---

4. Remove the wiring and the FSPS-21 module.

5. Install the new drive. See the drive hardware manual.

6. Install the FSPS-21 module and wiring to the new drive according to chapters *Mechanical installation* and *Electrical installation*.

7. Make the necessary parameter settings according to chapter *Configuration*, or restore the parameters from the backup file. See applicable drive FW manual, Control panel manual, or Drive composer manual.

8. Perform the start-up procedure according to chapter *Start-up*.

9. Perform the validation procedure for each safety function according to chapter *Verification and validation*.

   **Note:** The STO function is the basic safety function and it has to be validated first.

10. Update hardware and firmware versions of the new drive to the logbook of the driven machine.

## Drive firmware update

If you have to update the firmware of the drive where the FSPS-21 module is installed, follow the procedure below.

### ◼ Updating the firmware of the drive where the FSPS-21 module is installed

1. Stop the driven machinery and prevent an unexpected start-up.

2. Make a back-up of the drive parameters.
   You can make a backup of the drive configuration using the control panel or the Drive composer PC tool. See applicable drive FW manual, Control panel manual, or Drive composer manual.

3. Update the firmware of the drive.

4. Make the necessary parameter settings according to chapter *Configuration*, or restore the parameters from the backup file. See applicable drive FW manual, Control panel manual, or Drive composer manual.

5. Boot the FSPS-21 module with parameter 51.27 FBA A par refresh.

6. Perform the start-up procedure according to chapter *Start-up*.

7. Perform the validation procedure for each safety function according to chapter *Verification and validation*.

   **Note:** The STO function is the basic safety function and it has to be validated first.

8. Update hardware and firmware versions of the new drive to the logbook of the driven machine.

**Note:** You can restore default fieldbus configuration to the drive and module with parameter **96.06 Parameter restore** using the selection Reset all fieldbus settings. This clears also other parameters from the drive, see the drive FW manual for additional information.

# Updates

After any changes in the safety application or the safety system configuration, you must perform the acceptance tests to verify that the safety functionality is maintained. See chapter *Verification and validation (page 215)*.

# Proof tests

If periodic proof testing is necessary based on the safety calculations, you must include proof tests in the maintenance plan and perform them periodically.

After the operation of the circuits is validated at start-up, safety functions shall be maintained by periodic proof testing. In high demand mode of operation, proof testing is not needed. The module must be replaced after 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years - see section *Safety data (page 245)*. The proof test is done by rebooting the module.

# Decommissioning

⚠ **WARNING!**
Read and obey the instructions in chapter *Safety instructions (page 13)* and chapter *Safety instructions* in the drive hardware manual. If you ignore them, injury or death, or damage to the equipment can occur.

When you decommission the FSPS-21 module, make sure that the safety of the machine is maintained until the decommissioning is complete. Mark clearly on the module that it is decommissioned.

# 21

# Technical data

## Contents of this chapter

This chapter contains the technical specifications of the FSPS-21 module.

## Dimension drawing
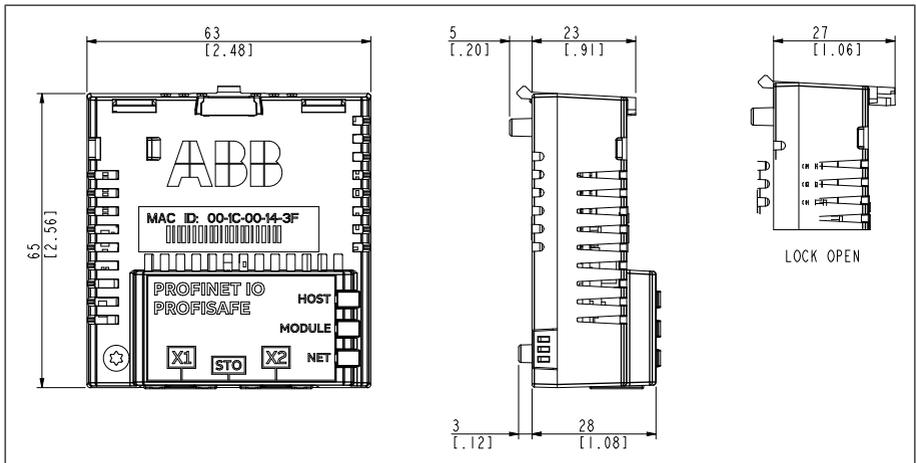


## General data

| Installation | Into an option slot on the drive control unit |
|---|---|
| Degree of protection | IP20 |

| | |
|---|---|
| **Package** | Cardboard. Plastic wrapping: Antistatic air bubble sheet (PE). |
| **Indicators** | Three bicolor LEDs (HOST, MODULE, NETWORK/NET) |
| **General** | Printed circuit board conformal coated |
| **Weight** | 72 g |
| **EMC** | Complies with EMC standards EN 61800-3:2004 and IEC 61000-6-7:2014<br>Max. STO cable length: 3m |
| **Disposal** | For the end-of-life recycling instructions, see the drive hardware manual. |

## Connection data

| | |
|---|---|
| **Connectors** | A 20-pin connector to the drive<br>RJ-45 connector to Ethernet (X1)<br>RJ-45 connector for chaining another adapter module (X2)<br>STO connector |

## Ambient conditions

| | Operation installed for stationary use | Storage in the protective package | Transportation in the protective package |
|---|---|---|---|
| **Altitude (installation site)** | 0…1000 m (0…3300 ft) above sea level, no derating required 1000…2000 m (3300…6600 ft) above sea level, air outside the module derated to -15…+49 °C (+5…+120 °F) 2000…4000 m (6600…13200 ft) above sea level, air outside the module derated to -15…+40 °C (+5…+104 °F) | same | same |
| **Air temperature** | -15…+70 °C (+5…+158 °F) | -40…+70 °C (-40…+158 °F) | -40…+70 °C (-40…+158 °F) |
| **Relative humidity** | 5...95% | same | same |
| | No condensation allowed. | | |
| | If corrosive gases are present, the maximum allowed humidity is 60%. | | |

| Contamination levels IEC 60721-3-x | No contaminants, conductive dust or corrosive dust allowed. Use at least IP54 enclosure in an environment where conductive dust or corrosive dust exists. | same | same |
|---|---|---|---|
| **Chemical gases** | Class 3C2 | Class 1C2 | Class 2C2 |
| **Solid particles** | Class 3S2 No conductive dust allowed. | Class 1S3 | Class 2S2 |
| **Vibration** IEC 60068-2-6, Test Fc (2007-12) | Frequency range 10...150 Hz Amplitude ±0,075 mm, 10...57,56 Hz Constant peak acceleration 10 m/s$^2$ (1 $g_n$), 57,76...150 Hz | same | same |
| **Shock** IEC 60068-2-27 Test Ea (2008-02) | Peak acceleration 50 m/s$^2$ (5 $g_n$) Pulse duration 30 ms 3 pulses in each direction with STO and SS1 functions activated | same | same |
| **Atmospheric pressure** | 70 to 106 kPa 0.7 to 1.05 atmospheres | same | same |

## Response times

| **Response times** | 10 ms (for both safety functions and associated fault reaction function) This is the time from the moment the module has received the STO function request until it has opened the drive STO circuit. |
|---|---|

## Ethernet link

| **Compatible devices** | Ethernet Standard IEEE 802.3 and IEEE 802.3u devices. All network devices used in conjunction with this device shall meet the requirements of IEC 61010-1 or IEC 61131-2. |
|---|---|
| **Medium** | 10BASE-TX or 100Base-TX with Auto-negotiation and Auto-MDIX (Auto-crossover) • Wiring: CAT5e/6 S/FTP, CAT5e/6 S/STP, CAT5e/6 SF/FTP • Connector: RJ-45 • Termination: Internal • Maximum segment length: 100 m / 328 ft |

| Topology | Bus, star or ring.<br>Max. 50 nodes allowed for FSPS-21 module in a ring topology.<br>In a chain maximum recommended amount of nodes is 50.<br>More can be used but PROFINET cycle time should be adjusted because of the delays in the network. Each FSPS-21 has an integrated switch which adds 19 µs forwarding delay for the minimum Ethernet frame. Length of PROFINET cyclic frame FSPS-21 uses is minimum Ethernet frame so 50 nodes will add 1 ms delay for the PROFINET frame. |
|---|---|
| **Transfer rate** | 10 Mbps or 100 Mbps |
| **Serial communication type** | Half or full duplex |
| **Protocol** | PROFINET IO (PROFIsafe) |

# TCP and UDP service ports

There are multiple in-bound and out-bound network services running on the module. Some ports are protocol-specific and are not used when other protocols are selected.

| Port | Service | Purpose |
|---|---|---|
| 34962<br>(TCP/UDP) | PROFINET | PROFINET RT Unicast.<br>**Note:** Used only when PROFINET IO protocol is selected. |
| 34963<br>(TCP/UDP) | PROFINET | PROFINET RT Multicast.<br>**Note:** Used only when PROFINET IO protocol is selected. |
| 34964<br>(TCP/UDP) | PROFINET | PROFINET Context Manager.<br>**Note:** Used only when PROFINET IO protocol is selected. |
| 80 (TCP) | HTTP | Used for Ethernet tool communication.<br>To disable, go to Service Configuration parameter 51.15. |
| 68 (UDP) | DHCP | DHCP client<br>**Note:** Used only when IP configuration method is selected as "Dyn IP DHCP". |
| 24576 (UDP) | ABB Netconfig | • Auto discovery protocol<br>• Used by ControlBuilder plus (IP Configuration tool) and Drive composer pro tools<br>• Discovers ABB-specific Ethernet devices in a local network segment, by listening to and responding to UDP broadcasts.<br>To disable, go to Service Configuration parameter 51.15. |
| 161 (UDP) | SNMP | Simple Network Management Protocol (SNMP).<br>**Note:** Used only when PROFINET IO protocol is selected. |

## Safety functions

| Stopping functions | |
|---|---|
| STO | Safe torque off |
| SS1-t | Safe stop 1, time-controlled |

## Safety data

### ■ General

To determine the SIL/PL capability of the whole safety function where the FSPS-21 is included, the failure rates (PFDavg/PFH) of all components implementing the safety function (see the figure below) must be added.



| **FSPS-21 subsystem** | The FSPS-21 acts as the logic part in the safety function. The safety data for the safety function where FSPS-21 and drive are used is composed of the safety data of the subsystems. Safety data for different subsystems is shown in section *Basic safety data (page 245)*. |
|---|---|
| **PROFIsafe** | PROFIsafe is a subsystem for the reliability of PROFIsafe connection. FSPS-21 module takes care of the reliability and safety of this connection. |
| **Drive STO** | Drive STO is the actuator for the STO of the drive. |
| **Input devices, PLCs, and other subsystems** | For the safety data, see the drive HW manual. |

After calculating the total PFDavg/PFH for the safety function, it must be verified that the PFDavg/PFH of the safety function fulfills the requirement for the targeted SIL/PL. For additional information on safety calculations, see standards EN ISO 13849-1, EN/IEC 62061, IEC 61508, IEC 61511, or ABB Drives Technical guide No. 10, Functional safety (3AUA0000048753 [English]).

### ■ Basic safety data

The FSPS-21 module is a type B safety component as defined in IEC 61508-2.

The FSPS-21 data related to safety standards IEC 61508, EN/IEC 61800-5-2, EN ISO 13849-1, IEC 61511 and EN/IEC 62061 is listed below for the subsystem of the FSPS-21 module.

Maximum useful mission time ($T_m$) for the FSPS-21 is 20 years. After 20 years, the module has to be replaced.

The given safety data applies with proof test interval T1 = 20 years (high demand and continuous mode of operation) and T1 = 2 years or T1 = 5 years (low demand mode of operation). Make sure that the proof test is performed within this time (see also section *Proof tests (page 239)*).

This safety data applies to both safety functions, STO and SS1-t.

| EN 61508 | | | EN ISO 13849-1 | | | EN/IEC 62061 | |
|---|---|---|---|---|---|---|---|
| SIL | up to 3 | | PL | up to e | | SILCL | 3 |
| SC | 3 | | Cat. | 3 | | | |

3AXD10000702254 rev E

| | PROFIsafe | FSPS-21 |
|---|---|---|
| **SIL/SILCL** | 3 | 3 |
| **PL** | e | e |
| **PFH (1/h)** (T1 = 20 a) | 1,00E-09 | 1,10E-08 |
| **PFD$_{avg}$** T1 = 2 a) | 8,76E-05 | 1,57E-04 |
| **PFD$_{avg}$** T1 = 5 a) | 8,76E-05 | 3,01E-04 |
| **MTTF$_D$ (a)** | 114155 | 82,74 |
| **HFT** | N/A | 0 |
| **Cat.** | 4 | 3 |
| **SFF (%)** | 99,00 % | 99,62 % |
| **DC (%)** | 99,00 % | 99,13 % |

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**Note:** For drive-specific STO safety data, see drive HW manual.

## Relevant failure modes

Following failure modes have been considered in the design of FSPS-21.

The only relevant dangerous failure mode due to internal random hardware failure of FSPS-21 is that the STO output is not activated on command.

The average frequency for such failure (PFH) is 1.1 * 10$^{-8}$ (1/h).

FSPS-21 implements many different diagnostics to detect internal random hardware failures. The cycle time of those diagnostics is 10 ms or less, with the exception of monitoring of the internal temperature of the device, for which the cycle time is 1 s or less.

The relevant failure mode of the diagnostics is that, due to a random hardware fault in the diagnostic system, the fault reaction is not performed while a detectable fault in the safety function is present.

The estimated failure rate of the diagnostics for the FSPS-21 module:

- 492.95 $\lambda_s$ [FIT] the safe failure rate
- 492.95 $\lambda_d$ [FIT] the dangerous failure rate
- 231.6 MTTFD [a].

For the FSPS-21 module, there are no dangerous failures that are not detected by the diagnostics.

# Related standards and directives

### ■ Related standards

| Standard | Name |
|---|---|
| EN ISO 12100:2010 | Safety of machinery – General principles for design – Risk assessment and risk reduction |
| EN ISO 13849-1:2015 | Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design |
| EN ISO 13849-2:2012 | Safety of machinery – Safety-related parts of control systems – Part 2: Validation |
| EN 60204-1:2006 + AC:2010 IEC 60204-1:2016 | Safety of machinery – Electrical equipment of machines – Part 1: General requirements |
| IEC 61000-6-7:2014 | Generic standards - Immunity requirements for equipment intended to perform functions in safety-related system (functional safety) in industrial locations |
| IEC 61010-1:2010+A1:2016 | Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements |
| IEC 61508 Parts 1-3, Ed. 2.0:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems |
| IEC 61511-1:2016 | Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements |

| Standard | Name |
|---|---|
| IEC 61784-3-3:2016 | Industrial communication networks - Profiles - Part 3-3: Functional safety fieldbuses - Additional specifications for CPF 3 |
| IEC 61784-5-3:2018 | Industrial communication networks - Profiles - Part 5-3: Installation of field-buses - Installation profiles for CPF 3 |
| EN 61800-3:2004 + A1:2012 | Adjustable Speed Electrical Power Drive Systems - Part 3: EMC requirements and specific test methods |
| IEC 61800-5-1:2007 | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy |
| IEC 61800-5-2:2016<br>EN 61800-5-2:2007 | Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional |
| IEC 61918 4th ed. 2018 | Industrial communication networks – Installation of communication networks in industrial premises |
| IEC 62061:2015 Ed. 1.2<br>EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 | Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems |

### ■ Related directives

| Directive | Name |
|---|---|
| 2006/42/EC | European Machinery Directive |

### ■ Other technical specifications

| Specification name | Version |
|---|---|
| PROFIsafe System Description – Safety Technology and Application. | Version April 2016. Order Number 4.342. |
| PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO | V2.6.1 |

# 22

# Appendix A – PROFIdrive parameters and I&M records of PROFINET IO

## Contents of this chapter

This chapter contains:

- PROFIdrive parameters of the PROFINET IO communication protocol
- telegram and response structures for the I&M (Identification & Maintenance) records of the PROFINET IO communication protocol.

## PROFIdrive parameters

| Par. no. | R/W[1) | Data type | Description |
|----------|--------|-----------|-------------|
| 915 | R/W | Array [12] Un-signed16 | Assignment PZD1 to PZD12 in PPO-write |
| 916 | R/W | Array [12] Un-signed16 | Assignment PZD1 to PZD12 in PPO-read |
| 919 | R | Octet String4 | Device system number |
| 922 | R | Unsigned16 | Telegram selection |

| Par. no. | R/W[1] | Data type | Description |
|---|---|---|---|
| 923 | R | Array [n] Unsigned16 | List of all parameters for signals. Mandatory if process data normalization is used and/or parameters *915* and *916* are implemented. |

| Signal no. and name | Type |
|---|---|
| 1 – Control word 1 (STW1) | Unsigned16 |
| 2 – Status word 1 (ZSW1) | Unsigned16 |
| 3 – Control word 2 (STW2) | Unsigned16 |
| 4 – Status word 2 (ZSW2) | Unsigned16 |
| 5 – Speed set point A (NSOLL_A) | Signed16 |
| 6 – Speed actual value A (NIST_A) | Signed16 |
| 7 – Speed set point B (NSOLL_B) | Signed32 |
| 8 – Speed actual value B (NIST_B) | Signed32 |
| 27 – Position set point A (XSOLL_A) | Signed32 |
| 28 – Position actual value A (XIST_A) | Signed32 |
| 32 – Traversing block selection (SATZANW) (not supported) | Unsigned16 |
| 33 – Actual traversing block (AKTSATZ) (not supported) | Unsigned16 |
| 34 – Target position (TARPOS_A) (not supported) | Signed32 |
| 35 – Velocity (VELOCITY_A) | Unsigned32 |
| 101…9999 – Drive-specific | – |

| Par. no. | R/W | Data type | Description |
|---|---|---|---|
| 927 | R/W | Unsigned16 | Operator control rights (parameter identification, PKW) |

| Value | Mode |
|---|---|
| 0 | Parameters cannot be written, only read (*927* can be written). |
| 1 | Parameters can be written and read (default). |

| Par. no. | R/W | Data type | Description |
|---|---|---|---|
| 928 | R/W | Unsigned16 | Control rights (process data, PZD). |

| Value | Mode |
|---|---|
| 0 | PZD part is disabled, i.e., Receipt of new PZD data is ignored. |
| 1 | PZD part is enabled (default). |

| Par. no. | R/W[1] | Data type | Description |
|---|---|---|---|
| 929 | R | Unsigned16 | Selected PPO type |

| Value | PPO type |
|---|---|
| 1 | PPO1 |
| 2 | PPO2 |
| 3 | PPO3 |
| 4 | PPO4 |
| 5 | PPO5 |
| 6 | PPO6 |
| 7 | PPO7 |

**Note:** This parameter is not available if Standard telegram ST1 or ST2 is selected.

| Par. no. | R/W | Data type | Description |
|---|---|---|---|
| 930 | R/W | Unsigned16 | Selection switch for communication profile. |

| Value | Mode |
|---|---|
| 1 | PROFIdrive |
| 8001h | ABB Drives |
| 8002h | Transparent 16 |
| 8003h | Transparent 32 |
| 8004h | PROFIdrive positioning mode |

| Par. no. | R/W | Data type | Description |
|---|---|---|---|
| 933 | R/W | Unsigned16 | Selection switch for Control word, bit 11. |

| Value | Module Control with bit |
|---|---|
| 0 | None |
| 1 to 5 | Vendor-specific 1 to 5[2] |

| Par. no. | R/W | Data type | Description |
|---|---|---|---|
| 934 | R/W | Unsigned16 | Selection switch for Control word, bit 12. (See parameter *933* for coding.) |
| 935 | R/W | Unsigned16 | Selection switch for Control word, bit 13. (See parameter *933* for coding.) |
| 936 | R/W | Unsigned16 | Selection switch for Control word, bit 14. (See parameter *933* for coding.) |
| 937 | R/W | Unsigned16 | Selection switch for Control word, bit 15. (See parameter *933* for coding.) |
| 939 | R/W | Unsigned16 | Selection switch for Status word, bit 11. |

| Value | Module Status word bit |
|---|---|
| 0 | None |
| 1 to 4 | Vendor-specific 1 to 4[2] |

| Par. no. | R/W[1] | Data type | Description |
|---|---|---|---|
| 940 | R/W | Unsigned16 | Selection switch for Status word, bit 12. (See parameter *939* for coding.) |
| 941 | R/W | Unsigned16 | Selection switch for Status word, bit 13. (See parameter *939* for coding.) |
| 942 | R/W | Unsigned16 | Selection switch for Status word, bit 14. (See parameter *939* for coding) |
| 943 | R/W | Unsigned16 | Selection switch for Status word, bit 15. (See parameter *939* for coding.) |
| 944 | R | Unsigned16 | Fault message counter |
| 945 | R | Array[64] Unsigned16 | Fault code (Channel Error Type) <table><tr><td>Sub-index</td><td>Contents</td></tr><tr><td>0</td><td>Last fault</td></tr><tr><td>8</td><td>Second last ackn. fault</td></tr><tr><td>16</td><td>Third last ackn. fault</td></tr><tr><td>24</td><td>Fourth last ackn. fault</td></tr><tr><td>32</td><td>Fifth last ackn. fault</td></tr><tr><td>40</td><td>Sixth last ackn. fault</td></tr><tr><td>48</td><td>Seventh last ackn. fault</td></tr><tr><td>56</td><td>Eighth last ackn. fault</td></tr></table> |
| 946 | R | Array [n] Unsigned16 | Fault code list. Contains the mapping between DRIVECOM fault codes and Channel Error Types. If you use a DRIVECOM fault code as an index when reading PNU946, the corresponding Channel Error Type is returned. |
| 947 | R | Array [64] Unsigned16 | Fault number (coded according to the DRIVECOM profile). <table><tr><td>Subindex</td><td>Contents</td></tr><tr><td colspan="2">See parameter *945*.</td></tr></table> |
| 953 | R | Unsigned16 | Last alarm[3] |
| 954 | R | Unsigned16 | Second last alarm[3] |
| 955 | R | Unsigned16 | Third last alarm[3] |
| 956 | R | Unsigned16 | Fourth last alarm[3] |
| 957 | R | Unsigned16 | Fifth last alarm[3] |

| Par. no. | R/W[1) | Data type | Description | | |
|---|---|---|---|---|---|
| 964 | R | Array [7] Unsigned16 | **Sub-index** | **Contents** | |
| | | | 0 | Manufacturer | |
| | | | 1 | Device type | |
| | | | 2 | Version | |
| | | | 3 | Firmware date (year) | |
| | | | 4 | Firmware date (day/month) | |
| | | | 5 | Number of Axes | |
| 965 | R | Octet String2 | Profile number of this device.<br>Eg: 0302h = Profile 3, Version 2 | | |
| 967 | R | Unsigned16 | Control word (CW) | | |
| 968 | R | Unsigned16 | Status word (SW) | | |
| 970 | R/W | Unsigned16 | Load parameter record | | |
| | | | **Value** | **Description** | |
| | | | 0 | No action | |
| | | | 1 | Restore factory settings | |
| | | | The parameter must do a zero-to-one transition and the motor must be stopped. | | |
| 971 | R/W | Unsigned16 | Save parameter record | | |
| | | | **Value** | **Description** | |
| | | | 0 | No action | |
| | | | 1 | Save the drive parameters to non-volatile memory | |
| | | | The parameter must do a zero-to-one transition and the motor must be stopped. | | |
| 972 | R/W | Unsigned16 | Software reset | | |
| | | | **Value** | **Description** | |
| | | | 0 | No action | |
| | | | 1 | Re-boot PROFIBUS module | |
| | | | The parameter must do a zero-to-one transition and the motor must be stopped. | | |

| Par. no. | R/W[1] | Data type | Description |
|---|---|---|---|
| 975 | R | Array[n] Unsigned16 | DO identification. For subindexes 0…4, see parameter *964*. |
| | | | Sub-index \| Meaning<br>5 \| Value 2 = Axis |
| 980<br>981 | R | Array[n] Unsigned16 | Number list of defined parameters. If the subindex is 0, the end of the list has been reached. If the subindex is the number of the next list parameter, the list is continued there. |
| 1000 | R/W | Unsigned16 | Map 16-bit selection[3]. Used to request the data type for mapped parameters if mapping is done with parameter 915 or 916.<br>Value \| Description<br>1 \| User 16-bit mapping, if available. |
| 50000 | R/W | Unsigned16 | Disable alarms.<br>Value \| Description<br>0 \| PNIO alarms enabled<br>1 \| PNIO alarms disabled |
| 61000 | R | VisibleString24 | Name of station |
| 61001 | R | Unsigned32 | IP of station |
| 61002 | R | OctetString[6] | MAC address of station |
| 61003 | R | Unsigned32 | Default gateway of station |
| 61004 | R | Unsigned32 | Subnet mask of station |

[1] Read and/or Write

[2] The meaning of vendor-specific bits is defined by the drive control program.

[3] Support depends on the drive type.

## I&M records

I&M (Identification & Maintenance) records can be read, for example, with the DTM tool. The FSPS-21 module supports the mandatory I&M0 record as well as the optional I&M1, I&M2, I&M3 and I&M4 records.

### ■ Call-REQ-PDU telegram for read/write access to I&M records

| Function | Record Data Index |
|----------|-------------------|
| I&M0 | 0xAFF0 |
| I&M1 | 0xAFF1 |
| I&M2 | 0xAFF2 |
| I&M3 | 0xAFF3 |
| I&M4 | 0xAFF4 |

### ■ Response structure for I&M0 (Read-only)

| | Contents | Size | Coding |
|---|----------|------|--------|
| Header | | 10 Octets | – |
| I&M block | MANUFACTURER_ID | 2 Octets | 0x1A = ABB Automation |
| | ORDER_ID | 20 Octets | 6438177508335 = EAN code for FSPS-21 kit |
| | SERIAL_NUMBER | 16 Octets | Serial number of FSPS-21 module |
| | HARDWARE_REVISION | 2 Octets | Hardware version of FSPS-21 module |
| | SOFTWARE_REVISION | 4 Octets | Format: V255.255.255 Eg, V1.0.0 = software version 100 |
| | REVISION_COUNTER | 2 Octets | (Marks a change of hardware or its parameters) |
| | PROFILE_ID | 2 Octets | 3A00 (…3AFF) PROFIdrive |
| | PROFILE_SPECIFIC_ TYPE | 2 Octets | 0 = no specific type |
| | IM_VERSION | 2 Octets | 0x0101 = version 1.1 |
| | IM_SUPPORTED | 2 Octets | 30 = I&M0, I&M1, I&M2, I&M3 and I&M4 supported |

■ **Response structure for I&M1 (Read/Write)**

|  | Contents | Size | Coding |
|---|---|---|---|
| Header |  | 10 Octets | – |
| I&M block | TAG_FUNCTION | 32 Octets | Device function or task |
|  | TAG_LOCATION | 22 Octets | Device location |

■ **Response structure for I&M2 (Read/Write)**

|  | Contents | Size | Coding |
|---|---|---|---|
| Header |  | 10 Octets | – |
| I&M block | INSTALLATION_DATE | 16 Octets | Installation date. **Eg, 2011-01-01 16:23** |
|  | RESERVED | 38 Octets | Reserved |

**Note:** I&M1, I&M2 and I&M3 are blank (0x20) by default.

■ **Response structure for I&M3 (Read/Write)**

|  | Contents | Size | Coding |
|---|---|---|---|
| Header |  | 10 Octets | – |
| I&M block | DESCRIPTOR | 54 Octets | Description of the device set by the user |

■ **Response structure for I&M4 (Read/Write)**

I&M4 is read-only and shows the PROFIsafe configuration CRC.

|  | Contents | Size | Coding |
|---|---|---|---|
| Header |  | 10 Octets | – |
| I&M block | SIGNATURE | 54 Octets | Security code for identifying sessions and changes |

**Note:** I&M4 is filled with zeros (0x0) by default.

# 23

# Appendix B – ABB IP configuration tool

## Contents of this chapter

This chapter shows how to use the ABB IP configuration tool to:

- find configured and unconfigured **FSPS-21** adapter modules in the network
- rewrite the IP configuration of the adapter modules.

## Installation

The ABB IP configuration tool is part of the ABB Automation Builder software. No separate installation is needed.

## Finding adapter modules in the network

1. Open the ABB IP configuration tool.

2. Click the **Scan** button.
   The FSPS-21 adapter modules present in the network appear on the results list.
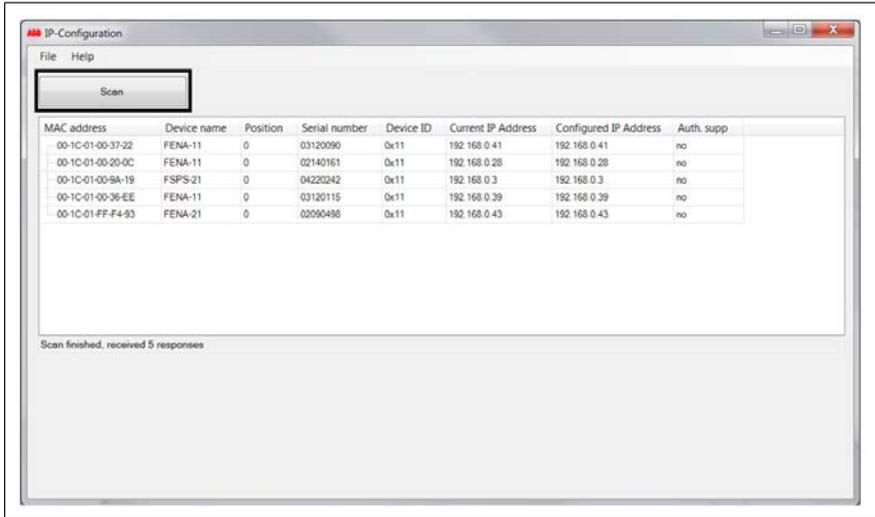
## Rewriting the IP configuration of adapter modules

1. Scan the network for adapter modules.
   For instructions, see section *Finding adapter modules in the network (page 257)*.

2. On the results list, click to select the adapter module whose IP configuration you want to modify.
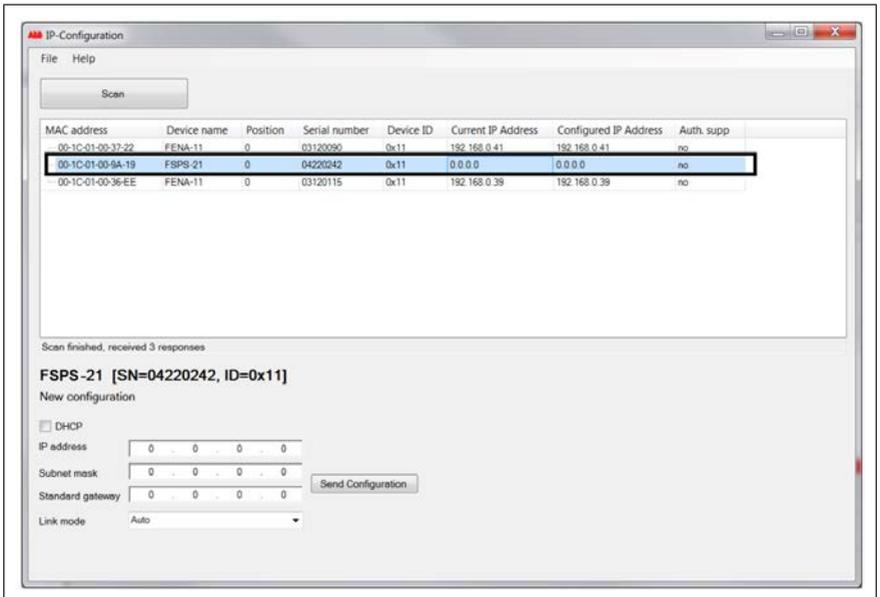
3. Below **New configuration**, define the IP configuration settings according to your network configuration.

4. If you want the adapter module to use a static IP address instead of **DHCP**, clear the DHCP check box.

5. To apply the new settings, click the **Send Configuration** button.
The new current IP address and configured IP address appear on the results list.
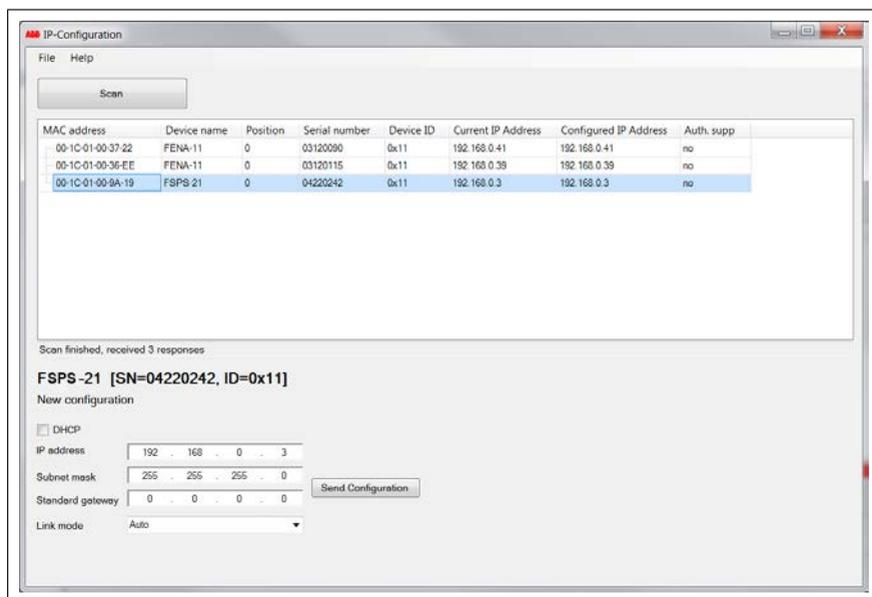
# — Further information

## Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

## Product training

For information on ABB product training, navigate to new.abb.com/service/training.

## Providing feedback on ABB manuals

Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.

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