



Operation Manual

PRODUCT NAME

SI Unit

MODEL / Series

EX245-FPS1

EX245-FPS2

EX245-FPS3

PRODUCT NAME

Digital Input Module

MODEL / Series

EX245-DX1

PRODUCT NAME

Digital Output Module

MODEL / Series

EX245-DY1

SMC Corporation

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1. Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution", "Warning" or "Danger". They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)*1), and other safety regulations.

*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines. (Part 1: General requirements)

ISO 10218: Manipulating industrial robots -Safety.

etc.



Caution

Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.



Warning

Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.



Danger

Danger indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Warning

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



1. Safety Instructions

Caution

1. The product is provided for use in manufacturing industries.

The product herein described is basically provided for peaceful use in manufacturing industries. If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.
If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer/Compliance Requirements

The product used is subject to the following "Limited warranty and Disclaimer" and "Compliance Requirements".

Read and accept them before using the product.

Limited warranty and Disclaimer

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.*2)
Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

*2) Vacuum pads are excluded from this 1 year warranty.

A vacuum pad is a consumable part, so it is warranted for a year after it is delivered. Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

Compliance Requirements

1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.
2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulation of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.

Operator

- ◆ This operation manual has been written for those who have knowledge of machinery and apparatus that use pneumatic equipment and have full knowledge of assembly, operation and maintenance of such equipment.
- ◆ Please read this operation manual carefully and understand it before assembling, operating or providing maintenance to the product.

■ Precautions

Danger

- After maintenance is complete, perform appropriate functional inspections.
Stop operation if the equipment does not function properly.
Safety cannot be assured in the case of unexpected malfunction.

Warning

- Do not operate the product outside of the specifications.
Do not use for flammable or harmful fluids.
Fire, malfunction, or damage to the product can result.
Verify the specifications before use.
- Do not operate in an atmosphere containing flammable or explosive gases.
Fire or an explosion can result.
This product is not designed to be explosion proof.
- If using the product in an interlocking circuit:
 - Provide a double interlocking system, for example a mechanical system.
 - Check the product regularly for proper operation.
Otherwise malfunction can result, causing an accident.
- The following instructions must be followed during maintenance:
 - Turn off the power supply.
 - Stop the air supply, exhaust the residual pressure and verify that the air is released before performing maintenance.
Otherwise an injury can result.

Caution

- Provide grounding to assure the safety and noise resistance of the Serial System.
Individual grounding should be provided close to the product with a short cable.

■NOTE

○Follow the instructions given below when designing, selecting and handling the product.

- The instructions on design and selection (installation, wiring, environment, adjustment, operation, maintenance, etc.) described below must also be followed.

*Product specifications

- Use the specified voltage.

Otherwise failure or malfunction can result.

- Reserve a space for maintenance.

Allow sufficient space for maintenance when designing the system.

- Do not remove any nameplates or labels.

This can lead to incorrect maintenance, or misreading of the operation manual, which could cause damage or malfunction to the product.

It may also result in non-conformity to safety standards.

●Product handling

*Installation

- Do not drop, hit or apply excessive shock to the fieldbus system.

Otherwise damage to the product can result, causing malfunction.

- Tighten to the specified tightening torque.

If the tightening torque is exceeded the mounting screws may be broken.

IP65 protection cannot be guaranteed if the screws are not tightened to the specified torque.

- Never mount a product in a location that will be used as a foothold.

The product may be damaged if excessive force is applied by stepping or climbing onto it.

*Wiring

- Avoid repeatedly bending or stretching the cables, or placing heavy load on them.

Repetitive bending stress or tensile stress can cause breakage of the cable.

- Wire correctly.

Incorrect wiring can break the product.

- Do not perform wiring while the power is on.

Otherwise damage to the fieldbus system and/or I/O device can result, causing malfunction.

- Do not route wires and cables together with power or high voltage cables.

Otherwise the fieldbus system and/or I/O device can malfunction due to interference of noise and surge voltage from power and high voltage cables to the signal line.

Route the wires (piping) of the fieldbus system and/or I/O device separately from power or high voltage cables.

- Confirm proper insulation of wiring.

Poor insulation (interference from another circuit, poor insulation between terminals, etc.) can lead to excess voltage or current being applied to the product, causing damage.

- Take appropriate measures against noise, such as using a noise filter, when the fieldbus system is incorporated into equipment.

Otherwise noise can cause malfunction.

*Environment

- Select the proper type of protection according to the environment of operation.
IP65 protection is achieved when the following conditions are met.
 - (1) Connectors that are not used must be closed with covering caps.
 - (2) All covering caps must be screwed down correctly after wiring and setting has been completed.
 - (3) Apply the recommended tightening torque and all manifold parts must be installed correctly.If using in an environment that is exposed to water splashes, please take measures such as using a cover.
If the product is to be used in an environment containing oils or chemicals such as coolant or cleaning solvent, even for a short time, it may be adversely affected (damage, malfunction etc.).
- Do not use in a place where the product could be splashed by oil or chemicals.
If the product is to be used in an environment containing oils or chemicals such as coolant or cleaning solvent, even for a short time, it may be adversely affected (damage, malfunction etc.).
- Do not use the product in an environment where corrosive gases or fluids could be splashed.
Otherwise damage to the product and malfunction can result.
- Do not use in an area where surges are generated.
If there is equipment which generates a large amount of surge (solenoid type lifter, high frequency induction furnace, motor, etc.) close to the fieldbus system, this may cause deterioration or breakage of the internal circuit of the fieldbus system. Avoid sources of surge generation and crossed lines.
- When a surge-generating load such as a relay or solenoid is driven directly, use an fieldbus system with a built-in surge absorbing element.
Direct drive of a load generating surge voltage can damage the fieldbus system.
- The product is CE marked, but not immune to lightning strikes. Take measures against lightning strikes in the system.
- Prevent foreign matter such as remnant of wires from entering the fieldbus system to avoid failure and malfunction.
- Mount the product in a place that is not exposed to excessive vibration or impact.
Otherwise failure or malfunction can result.
- Do not use the product in an environment that is exposed to temperature cycle.
Heat cycles other than ordinary changes in temperature can adversely affect the inside of the product.
- Do not expose the product to direct sunlight.
If using in a location directly exposed to sunlight, shade the product from the sunlight.
Otherwise failure or malfunction can result.
- Keep within the specified ambient temperature range.
Otherwise malfunction can result.
- Do not operate close to a heat source, or in a location exposed to radiant heat.
Otherwise malfunction can result.

*Adjustment and Operation

- Set the switches by using a sharp-pointed screwdriver etc.
Caution: Ensure the tool does not damage the switches during this process.
- Perform settings suitable for the operating conditions.
Caution: Incorrect settings can cause operation failure and unexpected actuator behaviour
- Please refer to the PLC manufacturer's manual etc. for details of programming and addresses.
For the PLC protocol and programming refer to the relevant manufacturer's documentation.

*Maintenance

- Turn off the power supply, stop the supplied air, exhaust the residual pressure and verify the release of air before performing maintenance.
There is a risk of unexpected malfunction.
- Perform regular maintenance and inspections.
There is a risk of unexpected malfunction.
- After maintenance is complete, perform appropriate functional inspections.
Stop operation if the equipment does not function properly.
Otherwise safety is not assured due to an unexpected malfunction or incorrect operation.
- Do not use solvents such as benzene, thinner etc. to clean the SI unit and individual modules
They could damage the surface of the body and erase the markings on the body.
Use a soft cloth to remove stains.
For heavy stains, use a cloth soaked with diluted neutral detergent and fully squeezed, then wipe up the stains again with a dry cloth.

2. For your safety

Purpose of this manual

This user manual provides information about how the module works, its operating and connection elements, and its parameter settings.

Validity of the user manual

This user manual is valid for the EX245-FPS1/2/3 module in the version indicated on the inner cover page, as well as for the same or later versions if replaced with the devices of the same type.

2.1. General safety notes

WARNING: Risk of injury

Depending on the application, inappropriate use of the module may result in serious injury.

- Observe all the safety notes and warning instructions provided in this section and elsewhere in this user manual

2.1.1. Qualified personnel

Within the context of this user manual, qualified personnel are persons who, because of their education, experience and instruction, and their knowledge of relevant standards, regulations, accident prevention, and service conditions, have been authorized to carry out any required operations, and who are able to recognize and avoid any possible dangers.

Furthermore, knowledge of the following topics and products is required:

- Non-safety-related target system (e.g. PROFINET)
- PROFIsafe
- Components used
- EX245-FPS1/2/3 product range
- Operation of the software tools
- Safety regulations in the field of application

In the context of the use of the PROFIsafe system, the following operations must only be carried out by qualified personnel:

- Planning
- Configuration, parameterization, programming
- Installation, start-up, servicing
- Maintenance, decommissioning

2.1.2. Documentation

Observe all information in this user manual and the accompanying documents: see [Section 2.5. Documentation](#)

2.1.3. Safety of personnel and equipment

The safety of personnel and equipment can only be assured if the module is used correctly: see [Section 2.4.1. Intended use](#)

2.1.4. Error detection

Depending on the wiring and the parameterization, the module detects errors within the safety equipment.

2.1.5. Do not carry out any repairs or modifications

It is prohibited for the user to carry out repair work or make modifications to the module. The housing must not be opened. The module is protected against tampering by means of security labels. The security label is damaged in the event of unauthorized repairs or opening of the housing. In this case, the correct operation of the safety module can no longer be ensured.

In the event of an unrecoverable error, send the module to SMC or contact SMC immediately.

2.1.6. Mismatching and polarity reversal of connections

Take care to avoid the mismatching, polarity reversal or tampering of connections. For increased protection against mismatching, connectors and slot markings are colour coded

2.2. Electrical safety

WARNING: Loss of safety function/hazardous shock currents

Incorrect installation can result in the loss of the safety function as well as hazardous shock currents.

- Observe the notes on electrical safety.
- Plan the modules used and their installation in the system according to the specific requirements.
- Recheck plants and systems retrofitted with PROFIsafe.

2.2.1. Direct/indirect contact

Protection against direct and indirect contact according to VDE 0100 Part 410 / EN 61010-2-201 must be ensured for all components connected to the system. In the event of an error, parasitic voltages must not occur (single-fault tolerance).

Measures required:

- Using power supply units with safe isolation (PELV).
- Decoupling circuits, which are not PELV systems, using optocouplers, relays, and other components which meet the requirements of safe isolation.

2.2.2. Power supply units for 24 V supply

Only use power supply units with safe isolation and PELV according to EN 61010-2-201. These power supply units prevent short circuits between the primary and secondary side.

Make sure that the output voltage of the power supply does not exceed 30 V even in the event of an error.

Note if an SELV supply is used then the supply 0 V should be connected to protective bonding circuit in accordance with the basic safety principle referred to in table D.1 of EN ISO 13849-2

2.2.3. Insulation rating

When selecting the equipment, please take into consideration the pollution degree and surge voltages which may occur during operation.

The module is designed for surge voltage category II (according to DIN EN 60664-1). If you expect surge voltages in the system, which exceed the values defined in surge voltage category II, implement additional measures for voltage limitation.

2.3. Safety of the machine or system

The machine/system manufacturer and the operator are responsible for the safety of the machine or system and the application in which the machine or system is used.

2.3.1. Draw up and implement a safety concept

In order to use the module, a safety concept is required for your machine or system. This includes a hazard and risk analysis as well as a test report (checklist) for validating the safety function: see [Section 2.4 “Directive and standards”](#) and see [“Appendix E: Checklists”](#).

The target safety integrity level (SIL according to IEC 61508, SILCL according to EN 62061 or performance level and category according to EN ISO 13849-1) is ascertained on the basis of the risk analysis. The safety integrity level ascertained determines how to connect and parameterize the module within the safety function.

2.3.2. Validate hardware and parameterization

Carry out a validation every time you make a safety-related modification to your overall system. Use your test report to ensure that:

- The safe modules are connected to the correct sensors and actuators.
- The safe input and output channels have been parameterized correctly.
- The variables have been linked to the safe sensors and actuators correctly (single-channel or two-channel).

2.4. Directive and standards

The standards to which the module conforms are listed in the certificate issued by the approval body and in the EC declaration of conformity

2.4.1. Intended use

The EX245-FPS1/2/3 module is designed exclusively for use in a PROFIsafe system and fulfils the PROFINET guidelines as defined by PI (PNO). It can only perform its tasks in the system if it is used according to the specifications in this document.

Only use the module according to the defined technical data and ambient conditions: see [Section 4 “General Specifications”](#).

The module is designed for connecting single-channel or two-channel sensors, which can be used in association with safety technology.

Examples of use for the module:

- Single or two-channel emergency stop or safety door equipment
- Applications with enable button
- Applications with two-hand control devices
- Applications with mode selector switches
- As secondary switchgear for safety-related photoelectric barriers
- Safety circuits according to EN 60204, Part 1

2.5. Documentation

2.5.1. Correctness and availability of documentation

Always use the latest documentation for this product. Changes or additions to documentation can be found on the Internet (see: www.smcworld.com)

2.5.2. PROFIsafe user manuals:

- For the safe controller used
- For the failsafe PROFIsafe I/O modules used
- For PROFIsafe system function blocks

Observe the information on PROFINET, and PROFIsafe which is available on the Internet (see: www.profisafe.net).

2.6. Abbreviations used

Table 2-1 Abbreviations for safety requirements

Abbreviation	Meaning	Standard	Example
SIL	Safety integrity level	IEC 61508	SIL 2, SIL 3
SILCL	SIL claim limit	EN 62061	SIL CL 3
Cat.	Category	EN ISO 13849-1	Cat. 2, Cat. 4
PL	Performance level	EN ISO 13849-1	PL e, PL d

Table 2-2 General Abbreviations

Abbreviation	Meaning
PELV	Protective extra-low voltage according to EN 50178/VDE 0160

Explanations of terms and abbreviations used in the context of PROFIsafe: see "[Appendix A: glossary for PROFIsafe](#)".

3. Product Summary

3.1. Features

SI Unit

The SI (Serial Interface) Unit represents a PROFIsafe on PROFINET IO-device for SMC pneumatic valves. It is designed for digital data control by connecting compatible EX245 modules and for use within rugged industrial environments, especially automotive plants. The SI Unit can be used to implement a safety function for the directly connected valves and has the following properties:

- IP65 protection
- Two connectors for PROFINET IO and two connectors (24 Volt) for supply voltages
EX245-FPS1: 2 x Push Pull connectors and 2 x Push Pull connectors (SCRJ)
EX245-FPS2: 2 x Push Pull connectors and 2 x Push Pull connectors (RJ45)
EX245-FPS3: 2 x 7/8 inch 5pins connectors and 2 x M12 4 pins socket D-coded connectors
- Four separately controlled safe power supplies (3 for valve zones & one for I/O modules)
- Up to 24 solenoid valves outputs (arranged in 3 separate safety zones of 8 valves each). See [Section 6](#) "[Valve Manifold](#)".
- Up to 128 digital inputs plus 8 safe digital inputs (or 4 safe dual channel digital inputs)
- Up to 64 digital outputs independent of solenoid valves
- Up to 8 non-safe I/O modules (limited by the total current consumption)
- Integrated diagnostic and protection function
- Galvanically isolated power supplies
- Free module configuration
- Flexible power supply combination
- Designed for use in safety systems up to SIL 3 according to EN 61508
- Designed for use in safety systems up to Category 4, Performance level (PL) e according to EN ISO 13849
- Choice of user selectable fail-safe operating modes (Channel Passivation or Module Passivation)

Corresponding solenoid valve manifolds

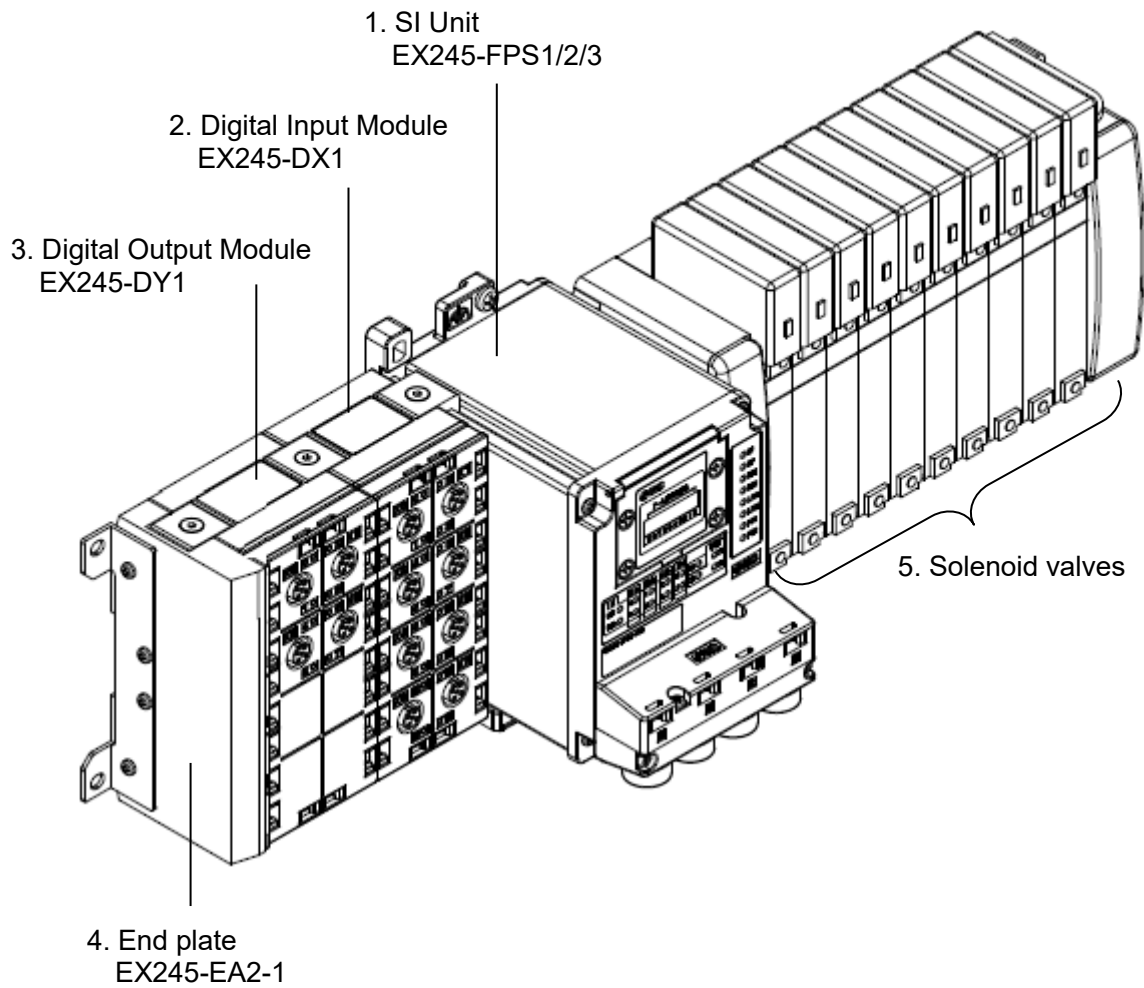
- JSY3000/5000
- SY3000/5000
- VQC2000/4000

Compatible EX245 modules

The following non-safe I/O modules can be used with the EX245 PROFIsafe SI unit

- Digital Input Module : EX245-DX1(16 digital inputs)
- Digital Output Module : EX245-DY1 (8 digital outputs)

3.2. Structure



No.	Components	Function
1	SI Unit	Fieldbus, Safety Digital Input, Safe power supply for valve interface and supply voltage to modules
2	Digital Input Module	Supply voltage to sensors and input digital data
3	Digital Output Module	Output to electric loads
4	End plate	End plate of module
5	Solenoid valves	Operate pneumatic devices

Fig. 3-1 System structure

3.3. Safe digital inputs and clock outputs UT1 and UT2

3.3.1. Safe digital inputs

The module has safe digital inputs, which can be used as follows:

- For two-channel assignment: four two-channel inputs
- For single-channel assignment: eight single-channel inputs

Or a combination of two and single channel inputs.

Technical data for the safe inputs: see [Section 10.4 "Safe digital inputs"](#). The supply voltage for the inputs can be provided externally (non-safe operation) or via the clock outputs.

3.3.2. Parameterization

The safe digital inputs of the module can be parameterized in pairs. This means that the inputs can be adapted to various operating conditions and different safety integrity levels can be implemented (SIL, SILCL, Cat., PL).

"The clock outputs are also switched on and monitored when the module is not parameterized. If a short circuit occurs between UT1/2 outputs and 0V(US1), the clock output is switched off. This state is indicated by the local diagnostics LED. UT1/UT2 LED switched on."

Information on the parameterization of the inputs: see [Section 8 "Commisioning"](#).

3.3.3. Diagnostics

Diagnostics are provided via both the local diagnostics indicators and the diagnostic messages which are transmitted to the controller.

Information on the diagnostic messages of the inputs: see [Section 16 "Error codes"](#).

⚠WARNING: Loss of safety function
Using diagnostic data for safety-related functions can result in the loss of the safety function as diagnostic data is not safety-related.

- Do not use the diagnostic data for safety-related functions or actions.

3.3.4. Requirements for sensors/controlling devices

Functional safety places requirements on the design of sensors/controlling devices.

- Use suitable sensors/controlling devices which are described in the applicable safety standards, for example.

The module's ability to detect errors depends on the parameterization.

- Adapt the module parameterization to the relevant sensor/controlling device: see [Section 8.2. "Parameterization"](#).

3.3.5. Clock outputs UT1 and UT2

The module has two independent clock outputs. These clock outputs provide the supply voltage for the safe inputs. Both clock outputs provide a pulse pattern to detect cross circuits in the external wiring of the inputs if Cross circuit detection has been activated for at least one input pair.

3.3.6. Typical pulse pattern

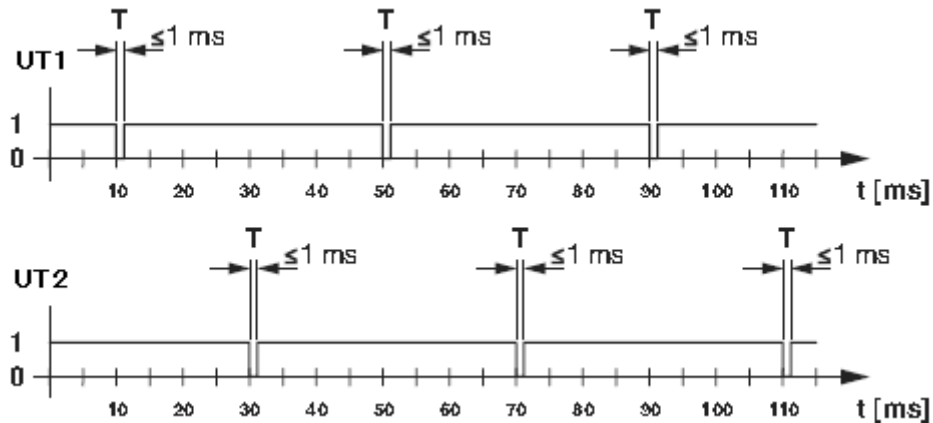


Fig. 3-2 Typical pulse pattern

Key:

- T Test pulse
- Pulse width ≤ 1 ms
- Period length ≤ 40 ms

The clock outputs are also switched on and monitored when the module is not parameterized. If a short circuit occurs between UT1 (or UT2) and 0V (US1), the relevant clock output is switched off. The fault state is indicated by the illumination of the UT1 (or UT2) LED. Note a cross circuit fault on either UT1 (and/or UT2) will not affect the state of the relevant clock output

Technical data for the clock outputs: see [Section 10.2 “Specifications”](#).

Behaviour in the event of an error

In the event of short circuit to GND or overload of the clock outputs, the clock outputs are switched off. At the same time, the error is indicated at the UT1/UT2 LEDs and a diagnostic message is generated at the controller. This error must be acknowledged so that the system can be started up again following error removal, see [Section 16.3 “Acknowledging an error for PROFIsafe”](#).

As there are two clock outputs for eight inputs, there may be reciprocal effects between the inputs.

Diagnostics

⚠ WARNING: Loss of safety function
Using diagnostic data for safety-related functions can result in the loss of the safety function as diagnostic data is not safety-related.

- Do not use the diagnostic data for safety-related functions or actions.

Diagnostics are provided via both the local diagnostics indicator and the diagnostic messages which are transmitted to the controller.

Information on the diagnostic messages of the clock outputs: see [Section 20 “Appendix D”](#).

Cross circuit detection

If all inputs are parameterized without cross circuit detection, a DC voltage can be sourced at the clock outputs without clock pulses. As soon as cross –circuit detection has been parameterized for at least one input pair, pulses are output at clock outputs UT1 and UT2.

For inputs that are parameterized with cross –circuit detection, the default assignment is as follows:

- Inputs for channel 1 (IN0 - IN3) are assigned to clock output UT1.
- Inputs for channel 2 (IN4 - IN7) are assigned to clock output UT2.

Other assignments are also possible.

Information on error detection according to clocking: see [Section 3.3.5 “Clock outputs UT1 and UT2”](#).

3.3.7. Connection options for sensors depending on the parameterization

Sensors that meet various safety requirements depending on the parameterization can be connected to the inputs.

The maximum achievable SIL/SILCL/Cat./PL is specified in the table.

In order to meet the safety requirements:

- Observe the information in the connection examples: see [Section 7.2 “Wiring”](#).
- Observe the requirements of the standards with regard to the external wiring and the sensors to be used to achieve a SIL/SILCL/Cat./PL.

Table 3-1 Maximum achievable SIL/SILCL/Cat./PL

Connection to the F connectors		Input							
		Single-channel sensor or redundant sensor			Two-channel redundant controlling device/sensor				
Input signal		-	-	-	Equivalent			Non-equivalent	
Cross-circuit detection		With	Without		With	Without		With	Without
Sensor: Contact type		Yes	Yes	-	Yes	Yes	-	Yes	Yes
Sensor: OSSD output type		No	-	Yes	No	-	Yes	No	No
Achievable safety requirement	SIL	2	2	2	3	3	3	3	3
	SIL CL	2	2	2	3	3	3	3	3
	Cat.	3*	2	2	4	3	4**	4	3
	PL	d	d	d	e	d	e	e	d

* : Cat. 3 can only be achieved with a redundant sensor (2 series NO contacts) and a connecting cable that meets the fault exclusion requirement of EN13849-2.

** : The category that can be achieved depends on the sensor used.

3.3.8. Safe state

The safe state for the module is the transmission of the value “0” in the image of the inputs to the safe controller.

The safe state for the F-Input data is “0”.
Passivation results in a change to the safe state: see [“Passivation” in Appendix A: glossary](#).

The safe state can be entered in the following cases:

1. Operating state
2. Error detection in I/O devices
3. Device errors
4. Parameterization errors
5. Error detection during safe communication

Operating state

In the operating state, the inputs can enter states “1” or “0”. State “0” is the safe state.

Error detection in I/O devices

Inputs

If an error is detected at an input, the safe state is set at this input and a “0” is represented in the process image of the input (“0” = safe state).

Operating time in the error state:

If an error state is entered on the modules, this error must be assessed, acknowledged or removed by the user within 72 hours. This action ensures the safe operating state of the module. Exceeding this time limit is not recommended and may adversely affect the future safety performance of the unit. In the error operating state, internal module tests are no longer run and it is possible that the safe state may be exited due to an accumulation of errors.

Depending on the parameterization, the following errors can be detected at inputs:

- Short circuit
- Cross circuit

The diagnostic message is transmitted to the controller: see [Section 16 “Error codes”](#).

Device errors

Device errors can stop safe communication.

Outputs

If an internal hardware error is detected all module outputs are disabled i.e. safe state is output

Inputs

If a hardware fault in the internal circuit is detected at an input, all module inputs enter the safe state. The value “0” is represented in the process image of the inputs (“0” = safe state).

The diagnostic message is transmitted to the controller: see [Section 16 “Error codes”](#).

Serious errors

All serious errors that can result in the loss of or adversely affect the safety function cause the entire module to enter the failure state.

The following serious errors result in the safe state:

- Serious hardware faults in the internal circuit
- User errors
- Module overload
- Module overheating
- Incorrect supply

The diagnostic message is transmitted to the controller: see [Section 16 “Error codes for Diagnostic Messages”](#).

⚠WARNING: Loss of safety function

Sequential errors can result in the loss of the safety function

- In the event of a device error, the module should be disconnected completely from the power supply and replaced so as to prevent sequential errors.

Parameterization errors

Parameterization errors are indicated in the following states:

- Faulty parameterization

The module switches to the safe state following parameterization errors.

In the event of faulty parameterization, a diagnostic message is transmitted to the controller: see [Section 20 “Appendix D”](#).

3.3.9. Programming data/configuration data

SMC provides device description files for various control systems.

The programming data/configuration data is defined in the device description (GSDML, FDCML, etc.) according to the bus or network used.

3.4. Safe power supply (outputs)

The module has 4 digital outputs which can be used as follows.

- Three outputs for each of the valve zones: Z1, Z2 & Z3
- One output for the supply to the output modules: M.

Note this power supply switches the 24V and 0V voltage rails to the DY1 modules

Users must take all necessary precautions to avoid any external short circuits to the outputs.

Refer to EN ISO 13849-2:2012 Table D.4 Faults and fault exclusion – conductors/cables for guidance.

⚠Caution:

Connection of the 0V to another 0V supply will bridge the safe output switch and cause a detected error.

⚠Caution:

Connection of any output to another voltage supply will bridge the safe output switch and cause an undetected error.

4. General Specifications

Table 4-1 EX245 series general specifications

Item	Specification
Rated voltage	24 V DC +20% -15%
Supply interruption for no loss of function	1 ms maximum
Protection class	IP65 (when fully installed or fitted with protective cover) (complies with IEC 60529)
Insulation resistance	10 Mohm @ 500 VAC between FE and all accessible terminals to IEC 61131-2.
Withstand voltage	500 VAC for 1 min. between FE and all accessible terminals to IEC 61131-2
Ambient temperature	Operation: -10 °C to 50 °C Storage: -20 °C to 60 °C
Ambient humidity	35% to 85% RH (non-condensing)
Atmospheric pressure	Operation: 80 kPa to 108 kPa (under 2000 m) Storage: 66 kPa to 108 kPa (under 3500 m)
Vibration resistance	10 Hz to 57 Hz (constant amplitude) 0.75 mm 57 Hz to 150 Hz (constant acceleration) 49 m/s ² 2 hours in each direction X, Y and Z
Impact resistance	147 m/s ² is applied 3 times in each direction X, Y and Z EN 60068-2-27/29
Operating environment	No corrosive gas
Certifications	
EMC directive	Yes, 2014/30/EU, IEC61326-3-1
Machinery directive	Yes, 2006/42/EC, EN 62061, EN ISO 13849
TUV Certification	Yes, EN 61508, EN 62061, EN ISO 13849
PROFINET & PROFIsafe	Yes
UL	Yes, for used materials (UL508)

5. Power Supply Concept

5.1. Power distribution

In the EX245 PROFIsafe product series, the supply for the logic input modules and hence sensors is designated “US1”. The supply for the valves and logic output modules and hence loads is designated “US2”. To provide the safety function, the “US2” supply is switched by separate high-side switches to each of the three valve zones (zone 1, zone 2 and zone 3) to the manifold and to any directly connected output modules as a fourth zone. The return supply from the module zone (zone M) is switched by a low side switch and the return supply from all the three valve zones is switched by another low side switch.

Example

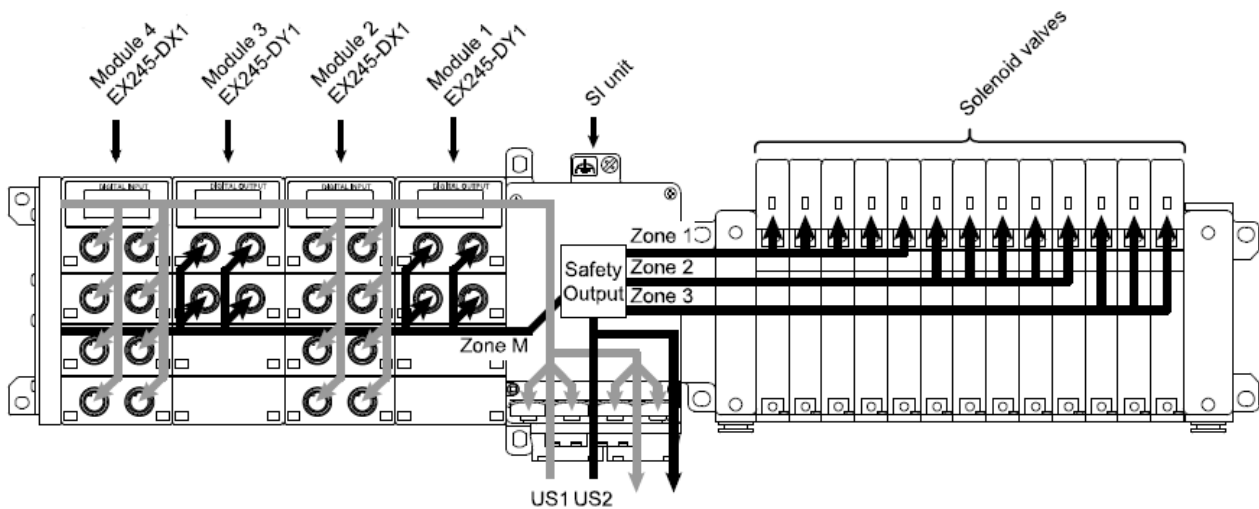


Fig. 5-1 Diagram of power supply concept (example)

- SI unit provides US1 and safely switched supply to the valves and module 1 and 3.
- All digital input modules (Module 2 and Module 4 in this case) are operated by US1.
- US1: 6 A max.
- US2: 4 A max.
- Galvanically isolated supplies (US1 to US2).

5.2. Under-voltage detection

5.2.1. LED indicator

US1 indicator shows the status of the supply for the logic/sensors. US2 indicator shows the status of the supply (US2) for the valves/loads.

The status of the load supply is reflected in the diagnostic data.

5.2.2. Diagnostic data

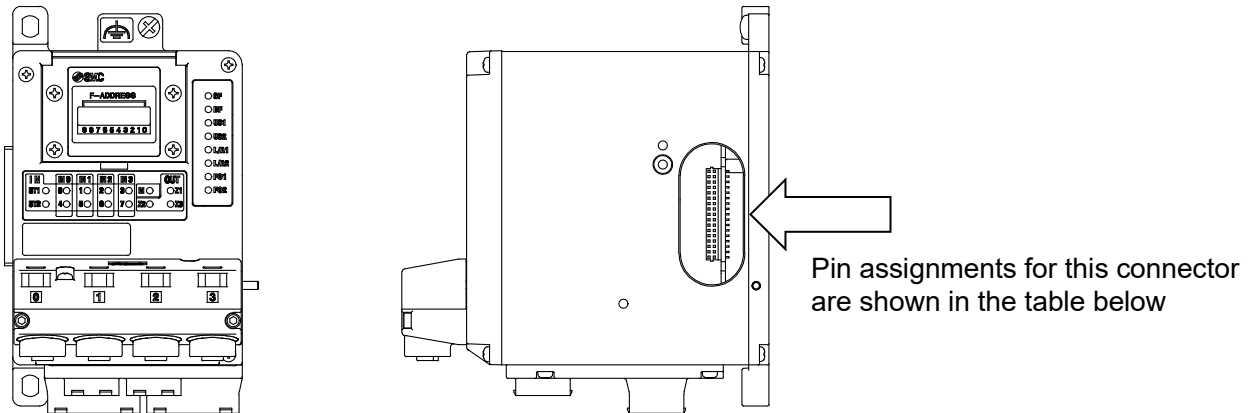
“General diagnostics 1” byte shows under-voltage detection.

“US1 Diagnostics” bit shows under-voltage detection of the supply for the logic/sensors.

“US2 Diagnostics” bit shows under-voltage detection of the supply for the valves/loads.

6. Valve Manifold

The EX245 PROFIsafe product series can be used with various valve manifolds.
For full details refer to the respective product documentation.



Pin No.	Valve Zone	Signal Name	Function
1	Common	M OUT 1	Common 0 V when non-error
2			
3	Zone 1	P OUT 1	Power when zone 1 active
4		SOL 0	Power when zone 1 active and output 0
...	
11		SOL 7	Power when zone 1 active and output 7
12	Zone 2	P OUT 2	Power when zone 2 active
13		SOL 8	Power when zone 2 active and output 8
...	
20		SOL 15	Power when zone 2 active and output 15
21	Zone 3	P OUT 3	Power when zone 3 active
22		SOL 16	Power when zone 3 active and output 16
...	
29		SOL 23	Power when zone 3 active and output 23
30		N. C.	N. C.
...			
34			

Fig. 6-1 Connector pin assignment for Valve manifold

7. Installation

7.1. Mounting

⚠ Caution

To prevent manifold components being damaged, apply the recommended tightening torque.

Mount the manifold using the 8 mounting positions on the base with screws.

Required screws are as follows:

- ① 2 x M5 (End plate: torque = 1.5 N·m)
- ② 2 x M5 (SI Unit : torque = 1.5 N·m)
- ③ 4 x M* (Valve manifold: refer to valve manifold catalogue)

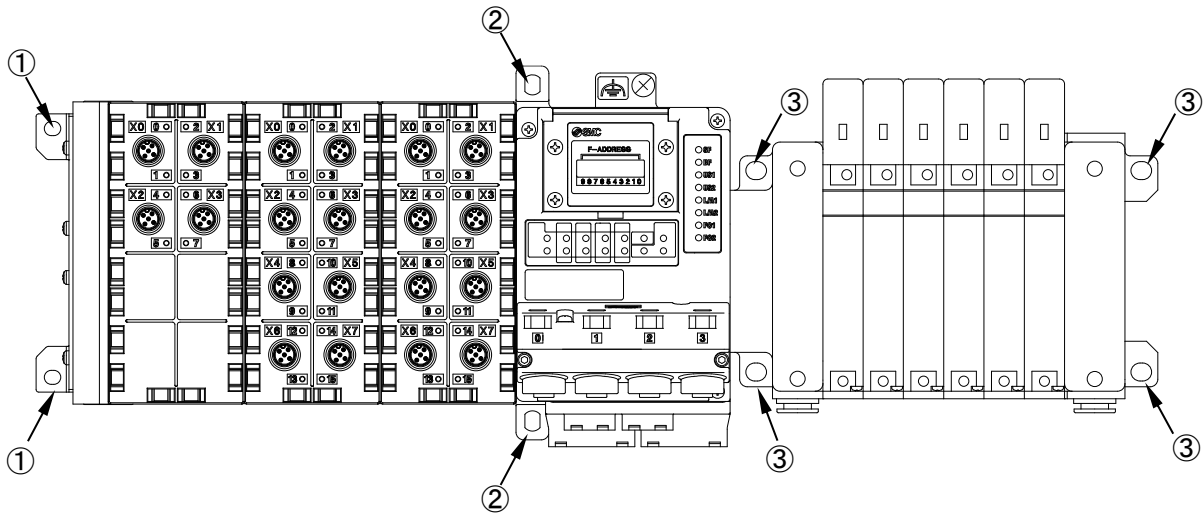


Fig. 7-1 Required screws

All manifolds are mounted using 8 screws (except VQC4000 which uses 7 screws).

7.1.1. Valve manifold connection

Connect the valve manifold with the 2 screws on the SI Unit. (hexagonal socket wrench size 2.5)

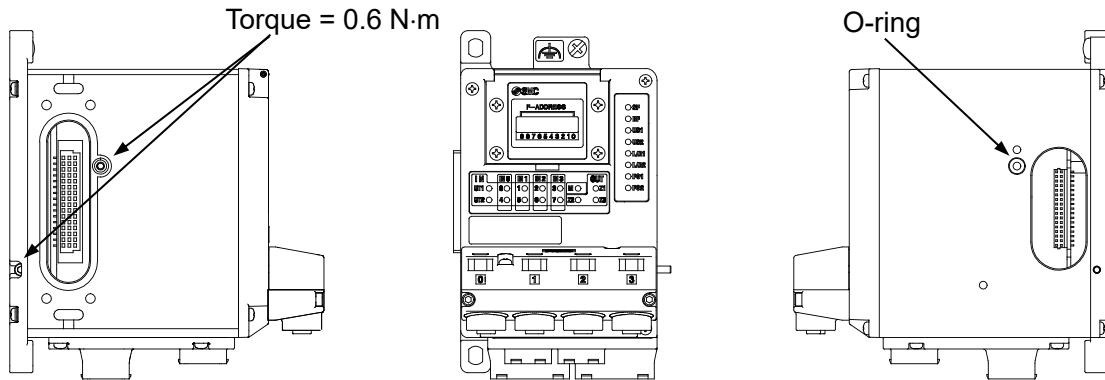


Fig. 7-2 Valve manifold connection

⚠ Caution

For a protection rating of IP65 to be ensured, apply the recommended tightening torque and make sure that the O-ring is positioned correctly on the screw.

7.1.2. Module connection

Connect the modules with the 2 modular adaptor assemblies and a joint assembly.

- ① 1 x Joint assembly
- ② 2 x Modular adaptor assembly (hexagonal socket wrench size 2.5, torque = 1.3 N·m)

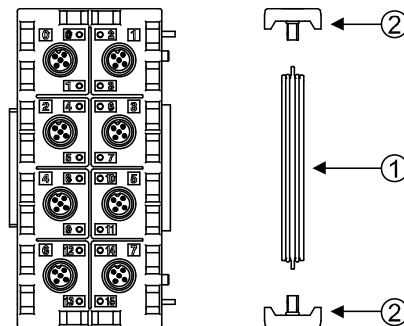


Fig. 7-3 Module connection

⚠ Caution

- For a protection rating of IP65 to be ensured, modular adaptor assemblies and joint assembly must be installed between each module correctly.
- To prevent the modules and assemblies being damaged, apply the recommended tightening torque.

7.2. Wiring

⚠ Caution

To prevent damage, all voltages to the SI Unit must be turned off (i.e. de-energized) before the modules are installed or removed.

Wire the grounding cable, the PROFINET cables and the power cable.

EX245-FPS1

- ① M5, FE terminal screw (torque = 1.5 N·m)
- ② Push Pull connector (SCRJ), PROFINET connection Port1 (XF1)
- ③ Push Pull connector (SCRJ), PROFINET connection Port2 (XF2)
- ④ Push Pull connector (24 Volt), Power connection (XD1)
- ⑤ Push Pull connector (24 Volt), Power connection (XD2)
- ⑥ M12 Connector, Safe Inputs

EX245-FPS2

- ① M5, FE terminal screw (torque = 1.5 N·m)
- ② Push Pull connector (RJ45), PROFINET connection Port1 (XF1)
- ③ Push Pull connector (RJ45), PROFINET connection Port2 (XF2)
- ④ Push Pull connector (24 Volt), Power connection (XD1)
- ⑤ Push Pull connector (24 Volt), Power connection (XD2)
- ⑥ M12 Connector, Safe Inputs

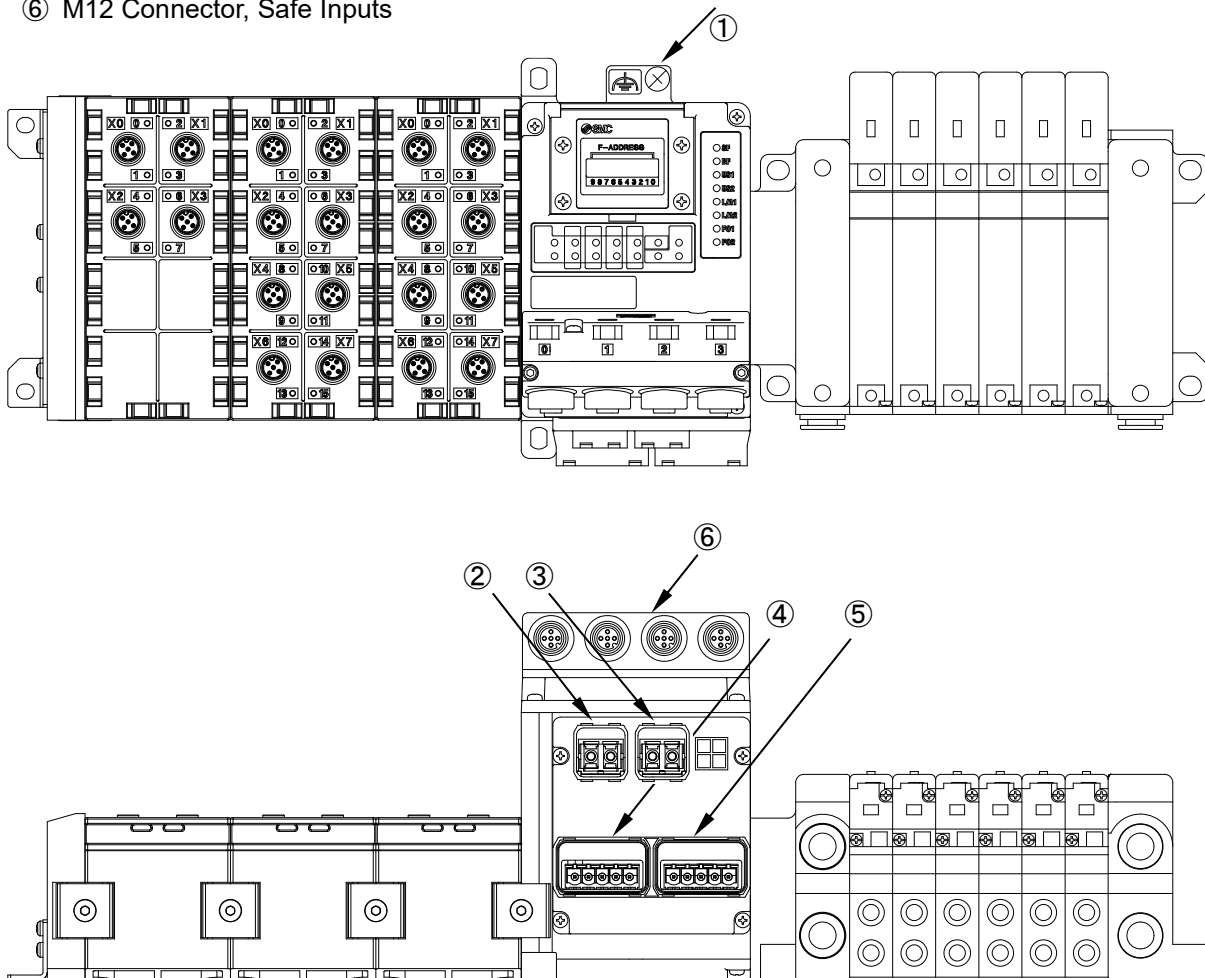


Fig. 7-4 Screw and connector allocation (EX245-FPS1/2)

- ① M5, FE terminal screw (torque = 1.5 N·m)
- ② M12 connector, PROFINET connection Port1 (XF1), Port type: MDI
- ③ M12 connector, PROFINET connection Port2 (XF2), Port type: MDI-X
- ④ 7/8 inch connector, Power connection (XD1)
- ⑤ 7/8 inch connector, Power connection (XD2)
- ⑥ M12 Connector, Safe Inputs

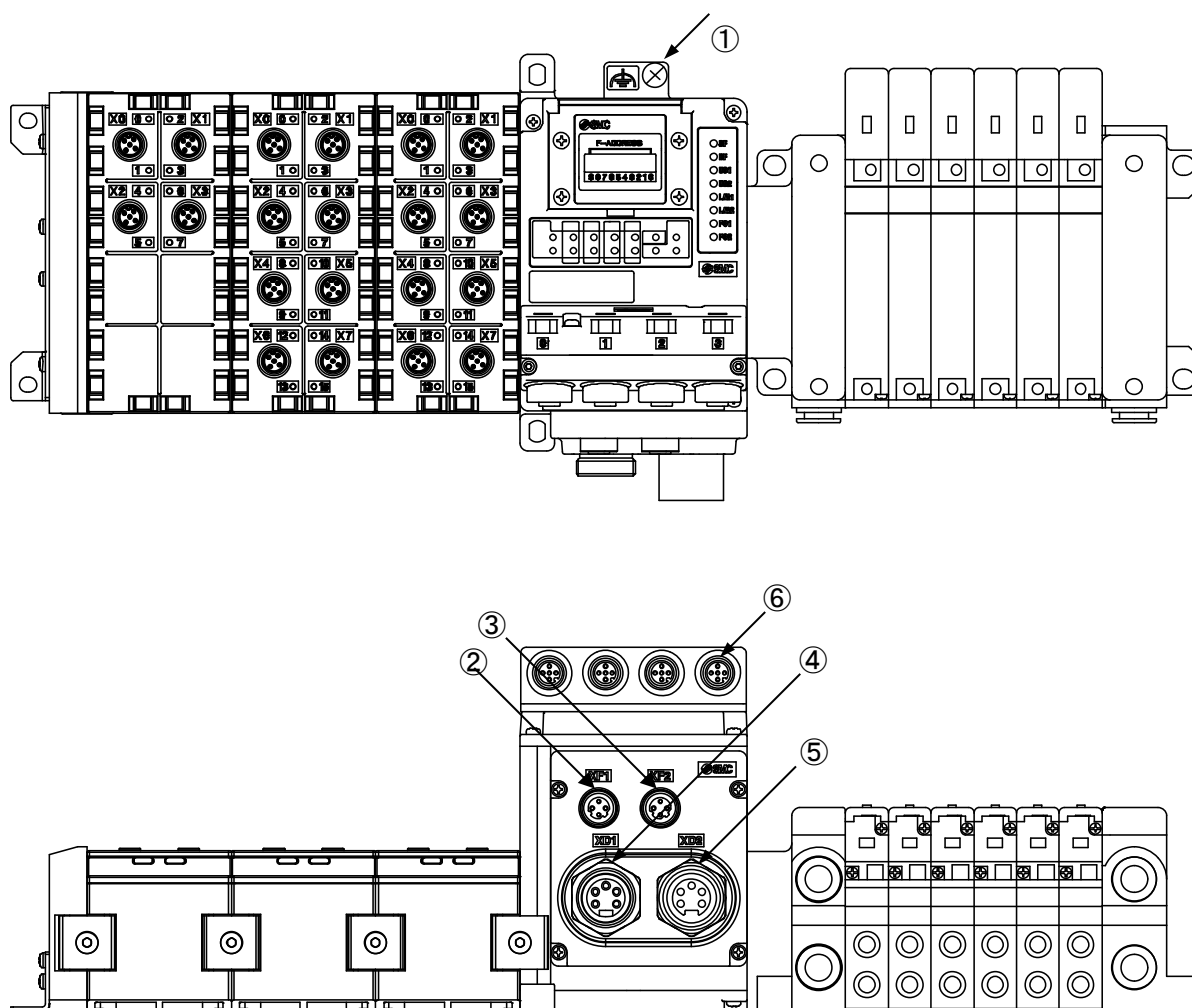


Fig. 7-5 Screw and connector allocation (EX245-FPS3)

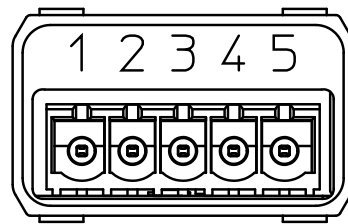
7.2.1. Bus/Power connection

The EX245-FPS1/2/3 has two Power connectors (XD1/2) and two PROFINET communication connectors (XF1/2). If only one connector is used, cover the unused connector with a blanking cap so that the protection rating of IP65 is maintained.

⚠ Caution

- "Blanking caps must be fitted to all unused bus & power connector ports to ensure an IP65 rating and to prevent eye exposure to the light beam from the SCRJ connectors."
- This rating must be maintained to guarantee PROFI-safe functionality.
- For reasons of EMC a secure connection to the cable shield must be established on the PROFINET (XF1/2) and Power (XD1/2).
- Power and bus lines must be installed correctly.
- To prevent manifold components of the EX245 from being damaged the supply lines for the electronics and for the load voltage must be protected externally with a fuse.
- All external supplies must meet the requirements of [Section 2.2.2](#) of this manual.
- Maximum loop through current between connectors must not be exceeded. Refer to EX245-FPS1/2/3 specifications table for details
- The SI unit makes use of a CLASS 1 LASER product. Do not stare into beam visible at XF1 and XF2

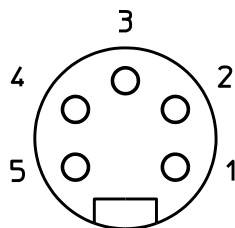
Power Connectors



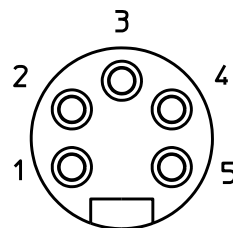
(View of the 24 Volt Socket)

Pin	Remarks
1	24V (US1)
2	0V (US1)
3	24V(US2)
4	0V(US2)
5	FE

Fig. 7-6 Pin allocation of Power connector for EX245-FPS1/2



7/8 inch plug
Connector (XD1)

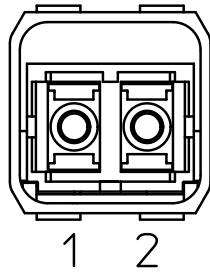


7/8 inch socket
Connector (XD2)

Pin	Remarks
1	0V (US2)
2	0V (US1)
3	FE
4	24V(US1)
5	24V(US2)

Fig. 7-7 Pin allocations of Power connectors for EX245-FPS3

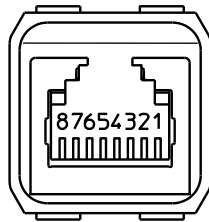
PROFINET communication



(View of the SCRJ Socket)

Pin	Remarks
1	TX Transmit Data
2	RX Receive Data

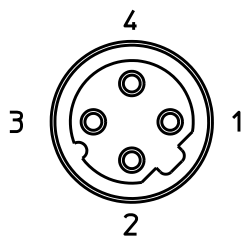
Fig. 7-8 Pin allocation of PROFINET SCRJ communication connectors for EX245-FPS1



(View of the RJ45 Socket)

Pin	Port1 (XF1) Port type: MDI	Port2 (XF2) Port type: MDI-X
1	TD+ Transmit Data	RD+ Receive Data
2	TD- Transmit Data	RD- Receive Data
3	RD+ Receive Data	TD+ Transmit Data
4	-	-
5	-	-
6	RD- Receive Data	TD- Transmit Data
7	-	-
8	-	-

Fig. 7-9 Pin allocation of PROFINET RJ45 communication connectors for EX245-FPS2



M12 4pins socket D-coded connector

Pin	Port1 (XF1) Port type: MDI	Port2 (XF2) Port type: MDI-X
1	TD+ Transmit data+	RD+ Receive data+
2	RD+ Receive data+	TD+ Transmit data+
3	TD- Transmit data-	RD- Receive data-
4	RD- Receive data-	TD- Transmit data-

Fig. 7-10 Pin allocations of PROFINET communication connectors for EX245-FPS3

Note

- If a copper communications cable is used and the “Disable autonegotiation” option is selected, you must select the correct network cable, refer to Fig 7-11, 7-12, 7-13.
- Auto crossover function is not available when the ‘Disable autonegotiation’ option is selected.
- Auto crossover function shall be capable of switching over their twisted pair ports automatically between MDI and MDI-X pin assignment.

Port Connection	Usable Cable
Port 1 (XF1) to Port 2 (XF2)	Patch cable
Port 1 (XF1) to Port 1 (XF1)	Crossover cable
Port 2 (XF2) to Port 2 (XF2)	Crossover cable

Fig. 7-11 Usable cable types when “Disable autonegotiation” is selected

The following figure Fig.7-12 shows two different cable wiring.

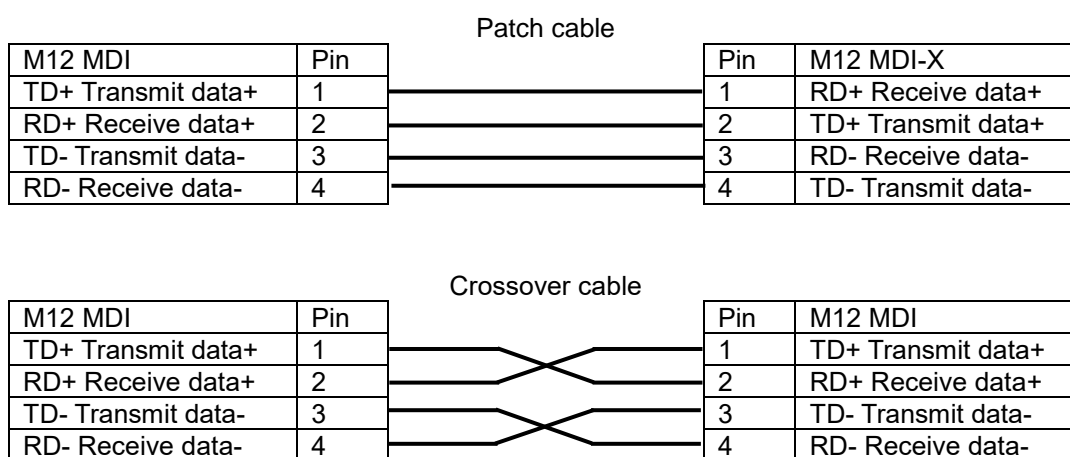
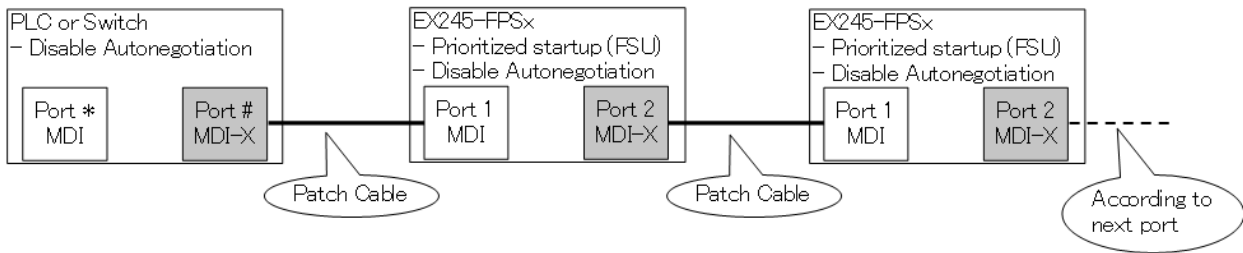


Fig. 7-12 Patch and Crossover Cable details

Connection example

Case 1



Case 2

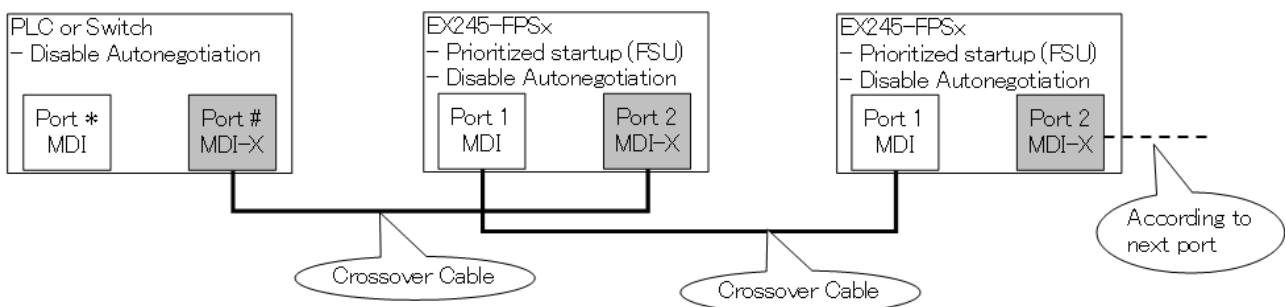


Fig. 7-13 Connection examples when “Disable autonegotiation” is selected

7.2.2. FE terminal

The SI Unit must be connected to FE (Functional Earth) to divert electromagnetic interference. Connect the grounding cable using the FE terminal screw on the SI Unit. The other end of the grounding cable should be terminated to ground potential. For maximum protection the grounding cable should be as thick and short as reasonably possible.

7.2.3. Sensor/Load/Power connection

Regarding the wiring of each module, refer to following section:

- Safe input: [Section 10.3](#)
- EX245-DX1: [Section 11.3](#)
- EX245-DY1: [Section 12.3](#)

8. Commissioning

8.1. Configuration

The EX245-FPS1/2/3 is a modular device that can consist of several modules. Setup your PROFIsafe master's software to reflect the configuration of your system.

8.1.1. File and symbol files

In order to configure the EX245-FPS1/2/3 with your PROFIsafe master's software the appropriate GSD file is required. The GSD file contains all of the necessary information to configure the EX245-FPS1/2/3 on your PROFIsafe master's software.

In order to represent the EX245-FPS1/2/3 in your PROFIsafe master's software the appropriate symbol files are required.

Current GSD file and symbol files name are as follows.

- GSD file : GSDML-V2.3-SMC-EX245-FPS-V*.*-*****.xml
- Symbol file : GSDML_0083_0006_EX2454N.bmp

Note:

The GSD file installs 4 separate module definitions for the EX245-FPS1/2/3

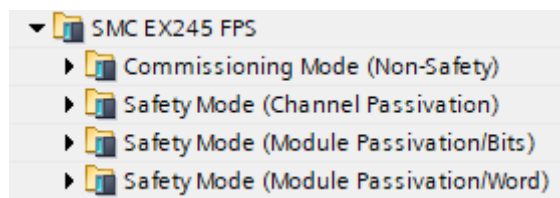


Fig. 8-1 Module definitions for EX245-FPS1/2/3

One entry (Commissioning Mode (Non-Safety)) contains module definitions when the EX245-FPS1/2/3 is used in Commissioning Mode.

The remaining entries (Safety Mode (xxx)) contain definitions when the EX245-FPS1/2/3 is used in Safety Mode.

Commissioning Mode is intended for use in product commissioning and must not be used for safety applications.

The choice of operating mode (Commissioning Mode or Safety Mode) is user selectable and must match the setting of the 2-bit DIP switch. [Refer to 10.11.2](#)

When used in Safety Mode the EX245-FPS1/2/3 can be configured how to react when a safety related fault is detected.

- Safety Mode (Channel Passivation):

In the event of a fault the affected channel(s) are passivated and "0" substitute values are used in place of the normal channel value(s) within the process image. All other channels remain operational. To resume normal channel functionality, remove the fault(s) and reintegrate the affected channel(s) using the Function Block FB60¹ (available from SMC on request)

¹TIA Portal PLC program: PNDD_IL_Diag_V1_10 (FB60)

- Safety Mode (Module Passivation/xxx):

In the event of a fault all channels are passivated and "0" substitute values are used for all channel values within the process image. To resume normal functionality all faults must be removed, and the SI unit reintegrated using the standard PROFIsafe acknowledgement process.

Note: Safety Mode (Module Passivation/xxx) can refer to either of these module types: - Safety Mode (Module Passivation/Word) or Safety Mode (Module Passivation/Bit)

8.1.2. Modules

EX245-FPS1/2/3 consists of the following modules.

Table 8-1 Overview of modules for EX245-FPS1/2/3

Module name	Occupied bytes		Allowable slot	Note
	Inputs	Outputs		
Fixed Modules				
Safe digital I/O (CM) (*)	1 byte	1 byte	1	Refer to Section 10.11.2.2
Safe digital I/O (SM) (*), (**)	6 bytes	5 bytes	1	Safety Mode (Channel Passivation) Refer to Section 10.4, 10.5
Safe digital I/O (SM/M) (*), (**)	6 bytes	12 bytes	1	Safety Mode (Module Passivation/xxx) Refer to Section 10.4, 10.5
Valve zone 1	0 bytes	1 byte	2	Refer to Section 10.7
Valve zone 2	0 bytes	1 byte	3	
Valve zone 3	0 bytes	1 byte	4	
IO Modules				
Diagnostics type 1	5 bytes	0 bytes	5	Refer to Section 9.1.1
Diagnostics type 2	4 bytes	0 bytes	5	Refer to Section 9.1.2
Output Status Unit	3 bytes	0 bytes	5...6	Refer to Section 10.8
EX245-DX1	2 bytes	0 bytes	5...14	Refer to Section 11
EX245-DY1	0 bytes	1 byte	5...14	Refer to Section 12

(*) – Only one type of ‘Safe digital I/O’ module is permitted for each individual SI unit hardware configuration. The modules must be selected from the hardware catalogue entry which matches the 2-bit DIP switch setting. [Refer to 10.11.2](#)

(**) – In a production environment one of these modules must be selected to ensure all safety functions are enabled

8.1.3. Setting the PROFIsafe Parameters

The setting method is determined by the fixed module type residing in slot 1. [Refer to 8.1.2](#)

8.1.3.1. Safety Mode (Channel Passivation) - Safe digital I/O (SM)

Parameter settings are transferred by the engineering tool (e.g. Siemens TIA Portal) when the project is downloaded from the programming station to the EX245-FPS1/2/3

8.1.3.2. Safety Mode (Module Passivation/xxx) - Safe digital I/O (SM/M)

Parameter settings are contained within the process image and occupy 8 bytes of user settable output data. The application program must ensure the process image contains valid parameter settings otherwise a PROFIsafe error will be generated. [Refer to 8.2 and 10.6](#)

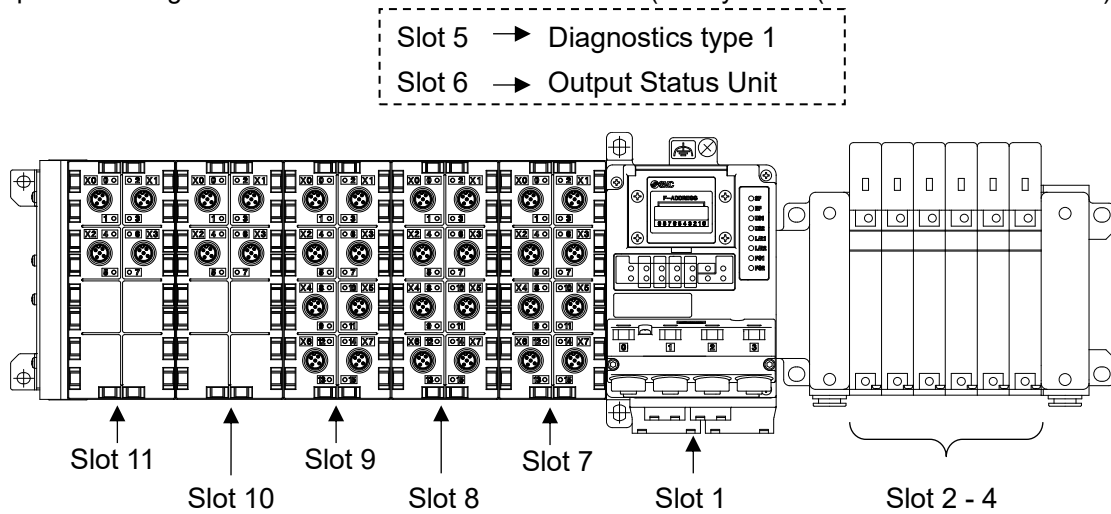
8.1.4. Configuration steps

Enter the modules in your configuration program corresponding to the actual module layout and a "Diagnostics type" module if required. If the configuration does not match the actual layout, the connection to the IO Controller will not be established and the EX245-FPS1/2/3 error LEDs will flash.

Configuration steps:

- Enter one of the "Diagnostics type" modules in Slot 5 if required.
- Enter one of the "Output Status Unit" module in Slot 5 when without any of "Diagnostics type", or in Slot 6 if Slot 5 has one of "Diagnostic type" module.
- Enter all other modules that are connected on the left hand side of the SI Unit (max. 8 modules).

Example of a configuration which uses Module Passivation (Safety Mode (Module Passivation/xxx))



Slot number	Model	Input bytes	Output bytes
Slot 1	Safe digital I/O (SM/M)	6	12
Slot 2	Valve zone 1	-	1
Slot 3	Valve zone 2	-	1
Slot 4	Valve zone 3	-	1
Slot 5	Diagnostics type 2 (Logical Modules)	4	-
Slot 6	Output Status Unit (Logical Modules)	3	-
Slot 7	EX245-DX1 (Physical Modules)	2	-
Slot 8	EX245-DX1 (Physical Modules)	2	-
Slot 9	EX245-DX1 (Physical Modules)	2	-
Slot 10	EX245-DY1 (Physical Modules)	-	1
Slot 11	EX245-DY1 (Physical Modules)	-	1

Fig. 8-1 Example of assignment of modules

NOTE

- In this example slot 1 is occupied by either of these modules: Safety Mode (Module Passivation/Words) or Safety Mode (Module Passivation/Bits)

When you change the module configuration in your configuration program, you need to turn off the supply for the logic/sensors "US1" and turn it on again.

- When you use Logical Module (Output Status Unit), it must be added before any of the Physical Modules i.e. it must occupy a lower slot address than any Physical Modules. Do not add the logical module after any Physical Modules

8.2. Parameterisation

8.2.1. PROFIsafe Parameters (F-Parameters)

Table 8-3 F-Parameter details

Parameter	Range	Default	Type of parameter
F_SIL	SIL3	SIL3	Static
F_Block_ID	0 to 7	1	Static
F_Par_Version	1	1	Static
F_Source_address	Automatic	1	Static
F_Destination_address	1 to 1023	1 (factory default setting)	Static
F_WD_Time	10 to 10,000 ms	150 ms	Static
F_iPar_CRC (*)	More than 0	81F1628F	Static

(*) – F_iPar_CRC is present only in mode: Safety Mode (Channel Passivation)

[Refer to Section 18 for details of all F-parameters.](#)

8.2.2. Module parameters

8.2.2.1. Module parameters for Valve zone 1 - 3

The Valve zone 1 - 3 has no module parameters that you can set.

8.2.2.2. Module parameters for EX245-DX1

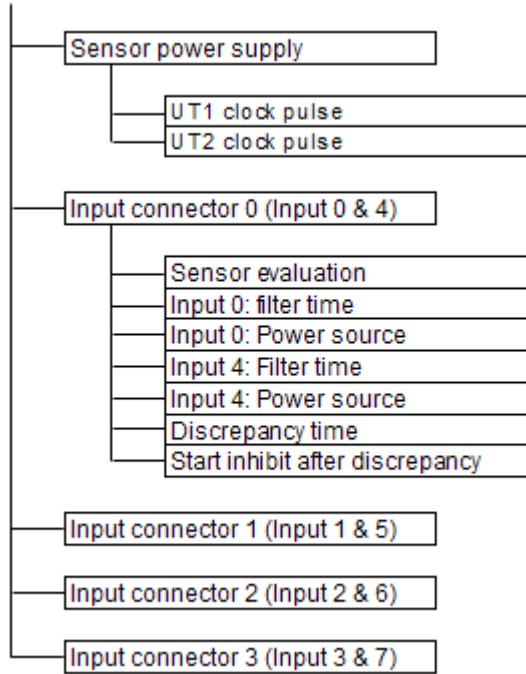
The EX245-DX1 has no module parameters that you can set.

8.2.2.3. Module parameters for EX245-DY1

The EX245-DY1 has no module parameters that you can set.

8.2.2.4. Module parameters for safe inputs in Safety Mode (Channel Passivation)

Parameter tree (overview)



Note: Parameters for 'Input Connector 1..3' are identical to parameters for Input Connector 0

For Safety Mode (Module Passivation/xxx), please refer to [section 10.6](#) for details on how configure the parameters.

Module parameters for Safe inputs parameter details in Safety Mode (Channel Passivation)

Table 8-4 Safe inputs parameter details in Safety Mode (Channel Passivation)

Parameter	Range	Default	Type of parameter
Sensor power supply (Clock configuration)			
UT1 clock pulse	Disable, Enable	Enable	Static
UT2 clock pulse	Disable, Enable	Enable	Static
Input connector			
Sensor evaluation	Disable 1-out-of-2 evaluation (2-channel equivalent) 1-out-of-2 evaluation (2-channel non-equivalent) 1-out-of-1 evaluation (Input N) 1-out-of-1 evaluation (Input N+4) 1-out-of-1 evaluation (Input N, N+4)	1-out-of-2 evaluation (2-channel equivalent)	Static
Filter time	3 ms, 5 ms, 15 ms	3 ms	Static
Power source for cross-circuit detection	Disable, UT1, UT2	UT1 (Input N) UT2 (Input N+4)	Static
Discrepancy time	Disable, 10 ms, 50 ms, 100 ms, 1 s, 5 s	10 ms	Static
Start inhibit after discrepancy	Disable, Enable	Enable	Static

- Note:
- Parameter "Filter time" and "Power source for cross-circuit detection" are valid when "Sensor evaluation" is other than "Disable"
 - Parameter "Discrepancy time" and "Start inhibit after discrepancy" are evaluated only if the "Sensor evaluation" is one of the "1oo2 2-channel" evaluation.
 - For Safety Mode (Module Passivation/xxx), please refer to [section 10.6](#) for details on how to configure the parameters.

The following gives some additional explanation for the parameters for the safe inputs.

Sensor power supply (Clock configuration)

This parameter is for activation of the clock pulse of the sensor power supply UT1 and UT2. A cross-circuit of a sensor can only be detected when the clock pulse is set to "enable."

Power source for cross-circuit detection

This parameter specifies which power supply (UT1 or UT2) is used for the sensor. A cross-circuit of a sensor can only be detected if the clock pulse is enabled for the specified power supply. The device can perform a cross-circuit test simple sensors, for example, a 2-wire sensor with reed contact switch. It is not suitable for sensors with internal electrical logic circuit, for example a 3-wire sensor with a transistor output.

Parameters for connected sensors (Sensor evaluation)

The EX245 can evaluate input signals of several types of sensors, for example, one channel sensor, two channel equivalent or non-equivalent sensor.

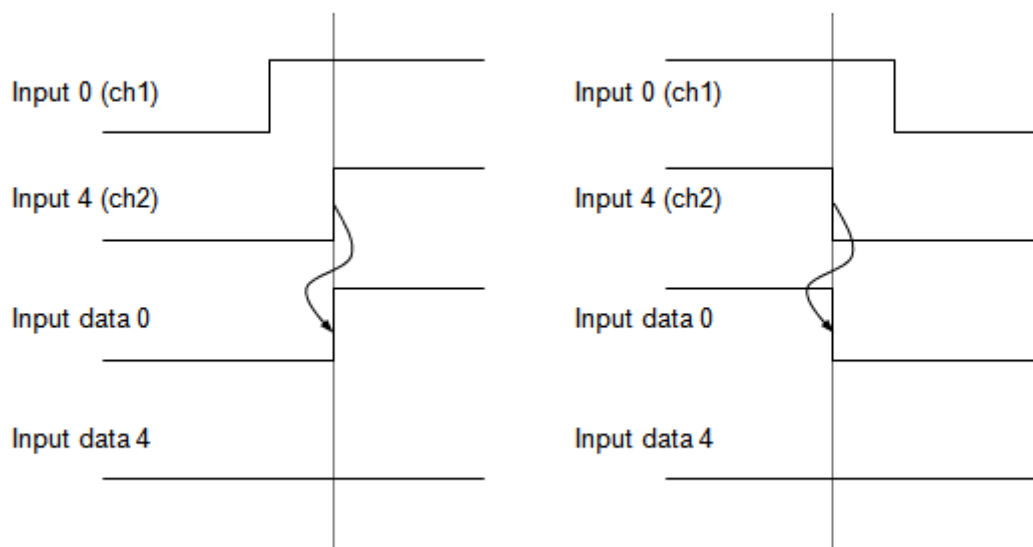
Parameters must be assigned according to the connected sensor.

The parameter specifies how to evaluate the sensor input signal in EX245.

When it is "1oo1" (i.e., one out of one), an input signal of an input N (N = 0...7) is directly copied to input data N.

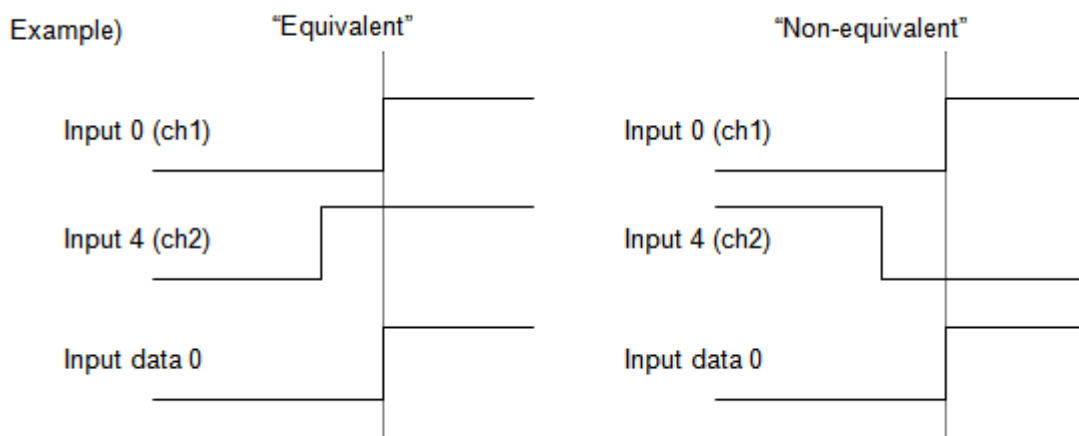
When it is "1oo2" (i.e., one out of two), two input signals from input N and N+4 are compared and input data N is determined.

Example for 1oo2)



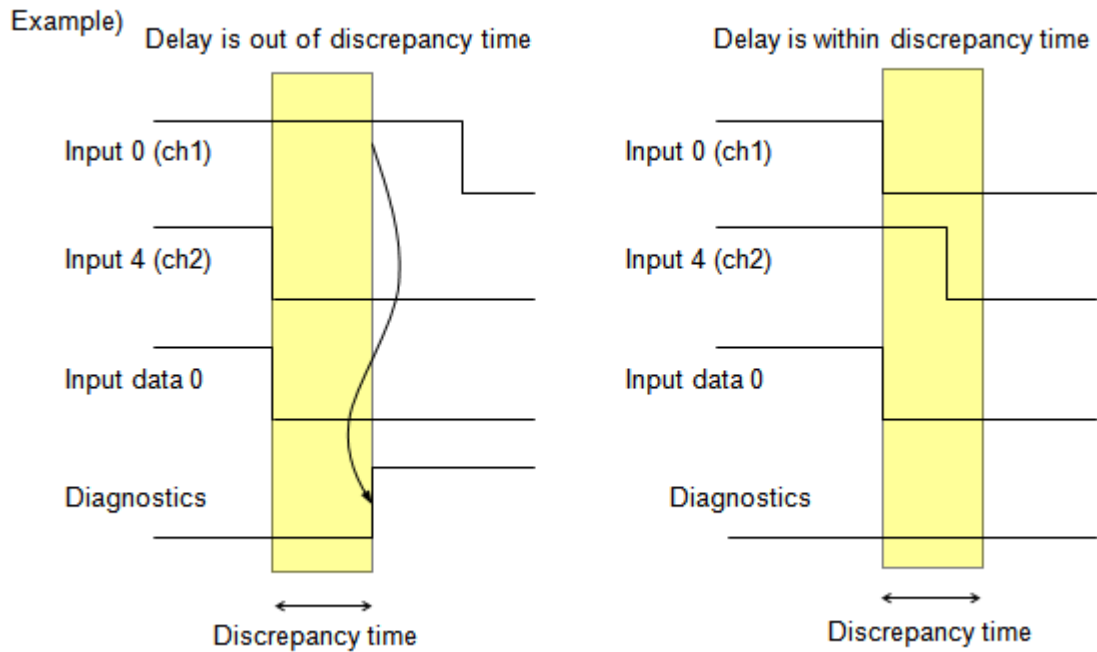
The parameter specifies "equivalent" or "non-equivalent" type of input signal when "1oo2" is specified in the sensor evaluation parameter.

In case of "1oo2 2-channel non-equivalent", logic of an input data from ch2 is inverted and then evaluated with the inverted value.



Parameters for discrepancy between two channel input signals

Discrepancy between two input signals is evaluated in the EX245 when "1oo2" is specified. Diagnostics information is sent when the time difference between a change of state in the two input signals exceeds the specified discrepancy time.



The parameter specifies the maximum amount of time that should elapse between a change of state in two inputs.

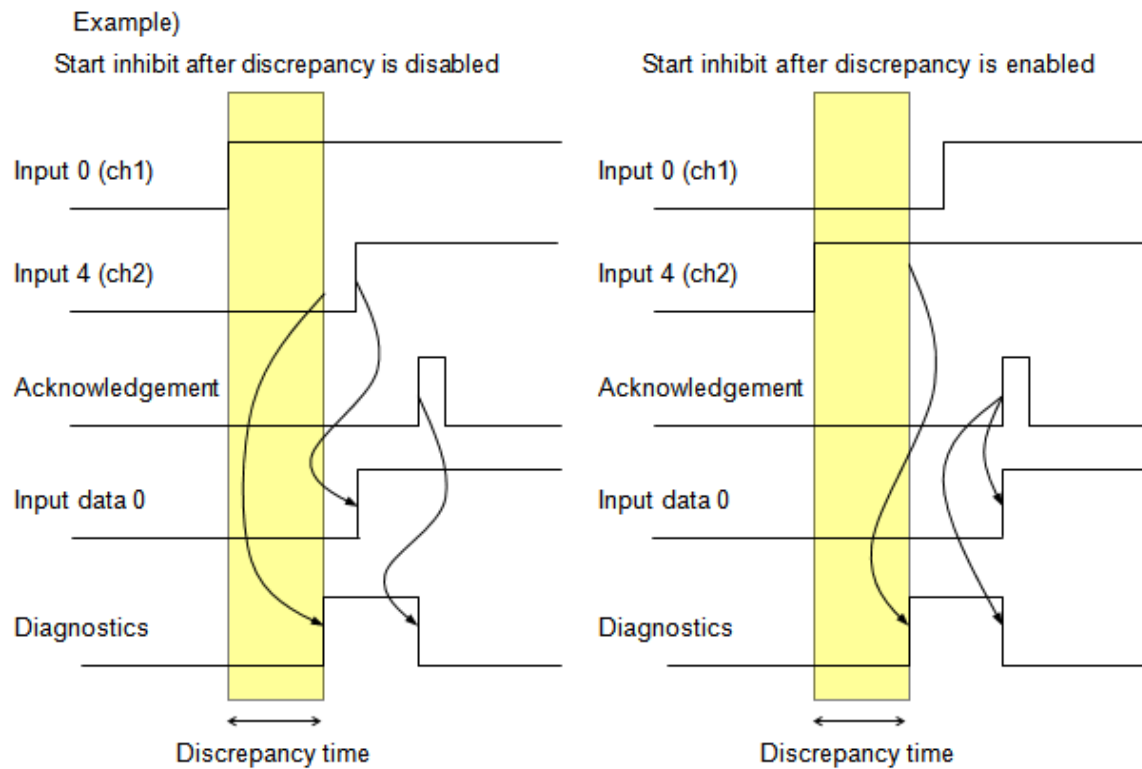
The EX245 will send a diagnostic alarm if the change of state between the two inputs does not occur within the specified time.

Start inhibit after discrepancy

The parameter specifies behaviour of an input bit after detecting a discrepancy between input ch1 and ch2. When set to “Disable”, the input bit will still change after a discrepancy is detected. When set to “Enable”, the input bit retains the last value (i.e., “0”). Until an acknowledgement is received from the controller.

In Safety Mode (Channel Passivation) the parameter setting can be either ‘Enable’ or ‘Disable’

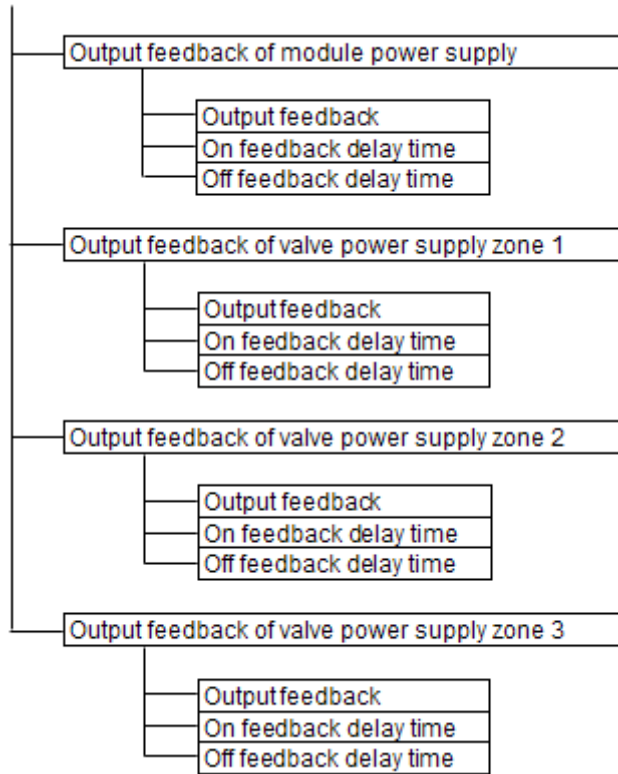
In Safety Mode (Module Passivation/xxx) the parameter setting is permanently set to ‘Enable’



8.2.2.5. Module parameter for power supplies for zones and modules in Safety Mode (Channel Passivation)

The status of the pilot pressure related to the respective safe power supply for the valve zone or IO modules can be checked.

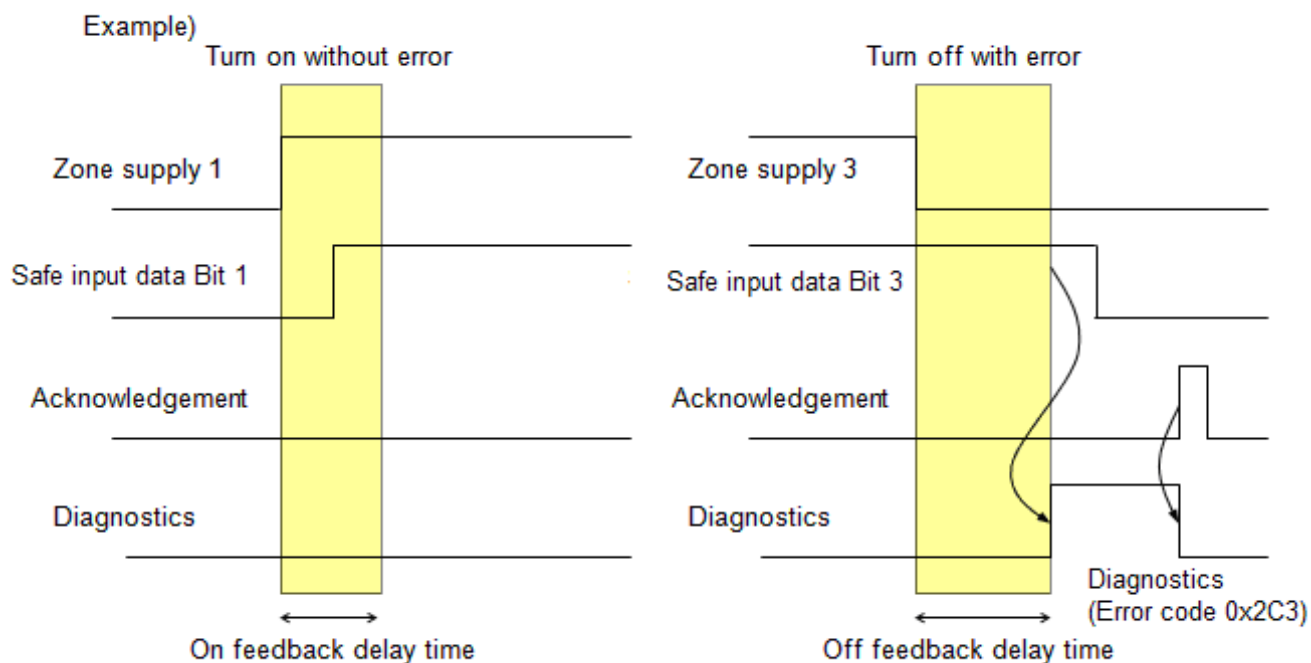
Parameter tree (overview)



For Safety Mode (Module Passivation/xxx), please refer to [section 10.6](#) for details on how to configure the parameters.

Output feedback parameter

If the parameter is enabled, the EX245 evaluates the bit status of a safe input according to the status of the safe power supply.



Relationship between safe power supplies and safe inputs

If the parameter is enabled, the relationship in the following table between the safe power supply and safe input is applied.

Table 8-5 Relationship between safe power supplies and safe inputs

No.	Safe power supply			Safe input		
	Bit	Description	Label (*)	Bit	Description	Label (*)
1	0	For I/O modules	M	0	Safe input 0	IN0 [0 and 4]
2	1	For valve zone1	Z1	1	Safe input 1	IN1 [1 and 5]
3	2	For valve zone2	Z2	2	Safe input 2	IN2 [2 and 6]
4	3	For valve zone3	Z3	3	Safe input 3	IN3 [3 and 7]

(*) Signal identities as described on product label. Refer to Section [10.9.2 LED Indicators 2](#)

9. Diagnosis

9.1. Diagnostics data on I/O mapping

The EX245-FPS1/2/3 can be allocated diagnostics data as digital input data on I/O mapping, if one of the modules, "Diagnostics type 1" or "Diagnostics type 2", is used. Use the PROFIsafe master's software to select a diagnostics module type to allocate the diagnostics data on I/O mapping.

9.1.1. Diagnostics type 1

Table 9-1 Overview of Diagnostics type 1

Byte	Description
0	General diagnostics 1
1	General diagnostics 2
2	Valve diagnostics 1
3	Valve diagnostics 2
4	Valve diagnostics 3

9.1.1.1. General diagnostics 1

Table 9-2 General diagnostics 1

Bit	Description	Explanation
0	System fault	0: No error 1: At least one error has occurred
1	Valve-coil(s) short circuit	0: No valve coil(s) have a short circuit 1: At least one valve coil has a short circuit
2	Module error	0: No module has an error 1: At least one connected module has an error
3	Changed module layout	0: Module layout has not changed 1: Module layout has changed or is different from Configuration setting
4	US1 Diagnostics	0: US1 present (> approx. 21.6 VDC) 1: US1 has dropped (< approx. 17.0 VDC)
5	US2 Diagnostics	0: US2 present (> approx. 22.8 VDC) 1: US2 has dropped (< approx. 17.0 VDC)
6	Unused	-
7	Unused	-

9.1.1.2. General diagnostics 2

Table 9-3 General diagnostics 2

Bit	Description	Explanation
0	Module 1 error	0: No error or not connected, 1: Module 1 has an error
1	Module 2 error	0: No error or not connected, 1: Module 2 has an error
2	Module 3 error	0: No error or not connected, 1: Module 3 has an error
3	Module 4 error	0: No error or not connected, 1: Module 4 has an error
4	Module 5 error	0: No error or not connected, 1: Module 5 has an error
5	Module 6 error	0: No error or not connected, 1: Module 6 has an error
6	Module 7 error	0: No error or not connected, 1: Module 7 has an error
7	Module 8 error	0: No error or not connected, 1: Module 8 has an error

9.1.1.3. Valve diagnostics 1

Table 9-4 Valve diagnostics 1

Bit	Description	Explanation
0	Valve Zone 1, coil 1 diagnostic	0: No error, 1: Fault *
1	Valve Zone 1, coil 2 diagnostic	0: No error, 1: Fault *
2	Valve Zone 1, coil 3 diagnostic	0: No error, 1: Fault *
3	Valve Zone 1, coil 4 diagnostic	0: No error, 1: Fault *
4	Valve Zone 1, coil 5 diagnostic	0: No error, 1: Fault *
5	Valve Zone 1, coil 6 diagnostic	0: No error, 1: Fault *
6	Valve Zone 1, coil 7 diagnostic	0: No error, 1: Fault *
7	Valve Zone 1, coil 8 diagnostic	0: No error, 1: Fault *

*: Fault – short circuit

9.1.1.4. Valve diagnostics 2

Table 9-5 Valve diagnostics 2

Bit	Description	Explanation
0	Valve Zone 2, coil 1 diagnostic	0: No error, 1: Fault *
1	Valve Zone 2, coil 2 diagnostic	0: No error, 1: Fault *
2	Valve Zone 2, coil 3 diagnostic	0: No error, 1: Fault *
3	Valve Zone 2, coil 4 diagnostic	0: No error, 1: Fault *
4	Valve Zone 2, coil 5 diagnostic	0: No error, 1: Fault *
5	Valve Zone 2, coil 6 diagnostic	0: No error, 1: Fault *
6	Valve Zone 2, coil 7 diagnostic	0: No error, 1: Fault *
7	Valve Zone 2, coil 8 diagnostic	0: No error, 1: Fault *

*: Fault – short circuit

9.1.1.5. Valve diagnostics 3

Table 9-6 Valve diagnostics 3

Bit	Description	Explanation
0	Valve Zone 3, coil 1 diagnostic	0: No error, 1: Fault *
1	Valve Zone 3, coil 2 diagnostic	0: No error, 1: Fault *
2	Valve Zone 3, coil 3 diagnostic	0: No error, 1: Fault *
3	Valve Zone 3, coil 4 diagnostic	0: No error, 1: Fault *
4	Valve Zone 3, coil 5 diagnostic	0: No error, 1: Fault *
5	Valve Zone 3, coil 6 diagnostic	0: No error, 1: Fault *
6	Valve Zone 3, coil 7 diagnostic	0: No error, 1: Fault *
7	Valve Zone 3, coil 8 diagnostic	0: No error, 1: Fault *

*: Fault – short circuit

9.1.2. Diagnostics type 2

Table 9-7 Overview of Diagnostics type 2

Byte	Description
0	General diagnostics 1
1	Valve diagnostics 1
2	General diagnostics 2
3	Valve diagnostics 2

9.1.2.1. General diagnostics 1

Table 9-8 General Diagnostics 1

Bit	Description	Explanation
0	Unused	Fixed at 1
1	Valve coil(s) short circuit	0: No valve coils have short circuit 1: At least one valve coil has a short circuit
2	US1 diagnostics 1	0: US1 present (> approx. 21.6 VDC) 1: US1 has dropped (< approx. 20.4 VDC)
3	Unused	Fixed at 0
4	US2 diagnostics 1	0: US2 present (> approx. 22.8 VDC) 1: US2 has dropped (< approx. 21.6 VDC)
5	US2 diagnostics 2	0: US2 present (> approx. 17.0 VDC) 1: US2 has dropped (< approx. 17 VDC)
6	Unused	Fixed at 0
7	US1 diagnostics 2	0: US1 present (> approx. 17.0 VDC) 1: US1 has dropped (< approx. 17 VDC)

9.1.2.2. Valve diagnostics 1

Table 9-9 Valve diagnostics 1

Bit	Description	Explanation
0	Valve 0, 1 diagnostics	0: Short circuit, 1: No error
1	Valve 2, 3 diagnostics	0: Short circuit, 1: No error
2	Valve 4, 5 diagnostics	0: Short circuit, 1: No error
3	Valve 6, 7 diagnostics	0: Short circuit, 1: No error
4	Valve 8, 9 diagnostics	0: Short circuit, 1: No error
5	Valve 10, 11 diagnostics	0: Short circuit, 1: No error
6	Valve 12, 13 diagnostics	0: Short circuit, 1: No error
7	Valve 14, 15 diagnostics	0: Short circuit, 1: No error

9.1.2.3. General diagnostics 2

Table 9-10 General diagnostics 2

Bit	Description	Explanation
0	Module 1 diagnostics	0: No error or not connected, 1: Short circuit
1	Module 2 diagnostics	0: No error or not connected, 1: Short circuit
2	Module 3 diagnostics	0: No error or not connected, 1: Short circuit
3	Module 4 diagnostics	0: No error or not connected, 1: Short circuit
4	Module 5 diagnostics	0: No error or not connected, 1: Short circuit
5	Module 6 diagnostics	0: No error or not connected, 1: Short circuit
6	Module 7 diagnostics	0: No error or not connected, 1: Short circuit
7	Module 8 diagnostics	0: No error or not connected, 1: Short circuit

9.1.2.4. Valve diagnostics 2

Table 9-11 Valve diagnostics 2

Bit	Description	Explanation
0	Valve 16, 17 diagnostics	0: Short circuit, 1: No error
1	Valve 18, 19 diagnostics	0: Short circuit, 1: No error
2	Valve 20, 21 diagnostics	0: Short circuit, 1: No error
3	Valve 22, 23 diagnostics	0: Short circuit, 1: No error
4	Unused	Fixed at 1 *
5	Unused	Fixed at 1 *
6	Unused	Fixed at 1 *
7	Unused	Fixed at 1 *

*: Value fixed at 1, any other value is a fault. Contact SMC if this occurs

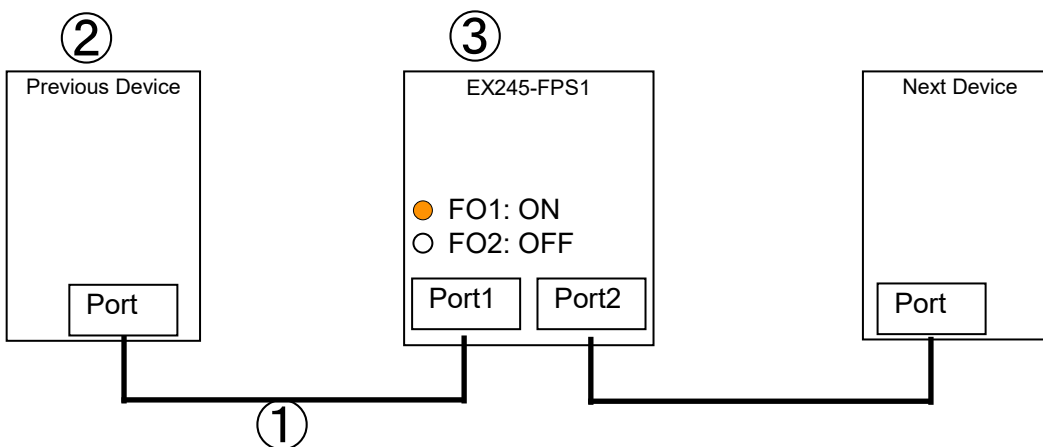
9.2. Maintenance alarm for the Fibre-optic cables

When the signal strength margin of the Fibre-optic communication is not enough, the EX245-FPS1 issues a "Maintenance alarm" for the Fibre-optic cable, if monitor setting of communication port is enabled.

If the FO LED of the EX245-FPS1 is flashing (more than 0 dB but less than 2 dB) or ON (the margin is 0 dB), refer to the Section 10.8.1.5.

In order to recover from this alarm, please check in the following order.

Example



Step 1: Check/exchange ① the Fibre-optic cable.

Step 2: Check/exchange ② the previous device.

Step 3: Check/exchange ③ the EX245-FPS1.

10. SI Unit

10.1. Parts and description

EX245-FPS1

EX245-FPS2

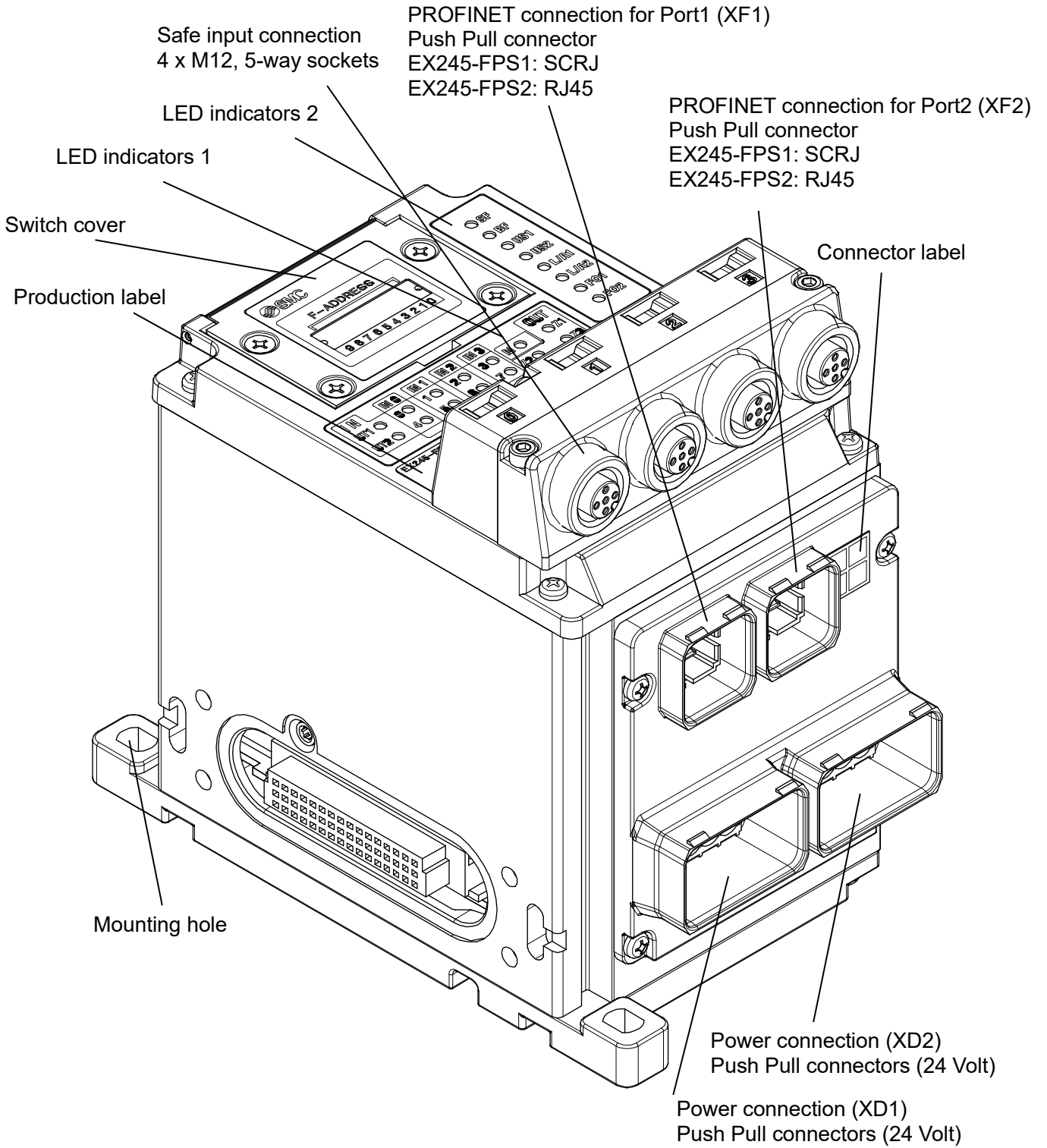


Fig. 10-1 Allocation of parts on the EX245-FPS1/2

EX245-FPS3

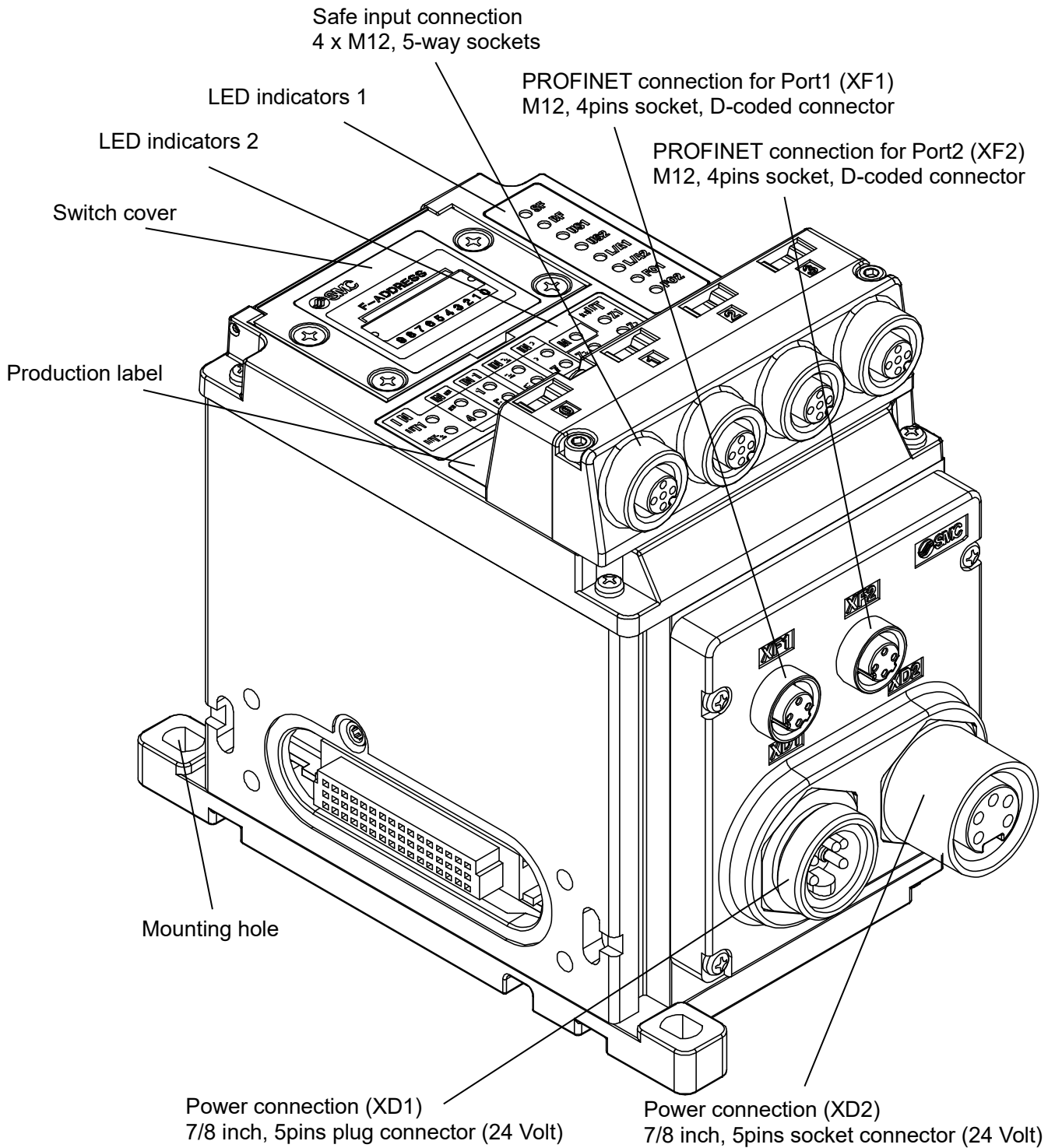


Fig. 10-2 Allocation of parts on the EX245-FPS3

10.2. Specifications

Table 10-1 specifications

Item	Description		
	EX245-FPS1	EX245-FPS2	EX245-FPS3
General			
Dimensions (W x L x H) mm	85 x 148.5 x 136		
Weight	1,100 g or less	1,200 g or less	
Housing material	Aluminium		
Max. number of modules	8		
Max. number of digital inputs	128 (independent of safe inputs)		
Max. number of analogue inputs	8		
Max. number of digital outputs	64 (independent of solenoid valves)		
Electrical			
Internal current consumption at 24 VDC	350 mA or less (via US1)	300 mA or less (via US1)	
Protection against polarity reversal	Yes (US1 and US2)		
Loop through current between power connectors	16 A (for US1 and US2)	10 A (for US1 and US2)	
US1	Operating voltage	24 VDC +20%/-15%	
	Under-voltage detection	Detected: < approx. 20.4 VDC Cancelled: > approx. 21.6 VDC	
	Dropout voltage (sensors)	< approx. 17 VDC	
	Max. current	6 A total	
US2	Operating voltage	24 VDC +20%/-15%	
	Under-voltage detection	Detected: < approx. 21.6 VDC Cancelled: > approx. 22.8 VDC	
	Dropout voltage (valves/loads)	< approx. 17 VDC	
	Max. current	4 A (independent of valves)	
	Voltage drop to valve supply	Max. 1.2 V at 24 VDC	
Galvanic isolation	Yes (between US1 and US2)		
Maintenance alarm for the Fibre-optic cable	Yes	-	
Safe input			
Number of inputs	4 two-channel or 8 single-channel		
Power supply voltages	Via UT1 or UT2 from US1		
Permissible supply voltage for external supply	24 VDC +20%/-15%		
Power supply max current	2 A per power supply UT1 1 A per power supply UT2 3 A in total		
Cross-circuit detection	Yes		
Overload and short circuit protection for UT1/UT2	Yes		
Input type	PNP		
Signal 1	11 to 30 V		
Signal 0	-3 to 5 V		
Input current signal 1	Typ. 3.8 mA at 24 VDC		
Input characteristic	Complies with IEC 61131, type 3		

Item		Description
Safe power supply		
For valve	Number of outputs	3 zones 0 VDC switch is common for all 3 zones
	Number of valve coils per zone	Fixed 8 valve coils
	Short circuit protection	Yes
	Max current	1.5 A in total
	Power source	From US2
For modules	Number of outputs	1
	Short circuit protection	Yes
	Max current	4 A
	Power source	From US2
Solenoid valve		
Applicable series	JSY3000/5000 SY3000/5000 VQC2000/4000	
Max. number of solenoid valves	24 valve coils (3 zones of 8 valve coils)	
Output type of solenoid	PNP	
Over current protection	Yes	
Over current detection	Yes	
Fieldbus		
Bus protocol	PROFIsafe on PROFINET	
Fast Start Up	No	
Media Redundancy Protocol	Yes	
IRT	Yes (Only for IRT switch function)	
Vendor ID	0083h	
Device ID	0006h	
GSD file	GSDML-V2.3-SMC-EX245-FPS-V*.*-*****.xml	
Parameterisation file	EX245-FPS*_*v**_*.**.xml	
Device Description file for PxC	SMC-EX245-FPS_FX_*****-***_****.****.****.zip	

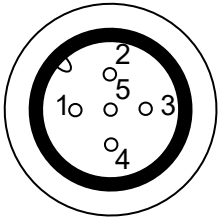
10.3. Wiring

⚠ Caution

- To prevent damage, all power for the SI Unit and modules must be turned off (i.e. de-energized) before the modules are installed or removed.
- For a protection rating of IP65 to be ensured, sockets that are not used must be closed with M12 covering caps.
- For a protection rating of IP65 to be ensured, all covering caps must be screwed down correctly after wiring and setting have been performed.

Pin allocation of the M12, 5-way socket connector as shown in the following table:

Table 10-2 Safe input connectors

Pin	Allocation	View of connector (Module side)
1	UT1	
2	DI (Input signal "n+4")	
3	0V (US1)	
4	DI (input signal "n")	
5	UT2	
Outer shell	FE (functional earth)	

⚠ WARNING: Loss of safety function

Parasitic voltages can result in the loss of the safety function.

- Connect the sensor ground directly to Pin 3 0V (US1) of the safety module. An external ground may not be used.

10.4. Safe digital I/O - Safe digital inputs

Table 10-3 Byte 0 Safe digital inputs

Bit	Description	Connector No.	Pin No.	Explanation
0	Input status of safe input 0	1	4	0: OFF, 1: ON
1	Input status of safe input 1	2	4	0: OFF, 1: ON
2	Input status of safe input 2	3	4	0: OFF, 1: ON
3	Input status of safe input 3	4	4	0: OFF, 1: ON
4	Input status of safe input 4	1	2	0: OFF, 1: ON
5	Input status of safe input 5	2	2	0: OFF, 1: ON
6	Input status of safe input 6	3	2	0: OFF, 1: ON
7	Input status of safe input 7	4	2	0: OFF, 1: ON

Note: In case of "1oo2 evaluation", input status of safe input 4-7 (Byte 0, bits 4 – 7) is fixed to 0: OFF

Table 10-4 Byte 1 Status bits (only applies to Safety Mode (Module Passivation/xxx))

Bit	Description	Explanation
0	Status bit for parameterization using Safety Mode (Module Passivation/xxx)	0: NOK (Fault state). SI unit has not received a process image for the PROFIsafe parameters or the received process image is invalid 1: OK. Process image for PROFIsafe parameters received and valid.
1-7	Reserved	-

Byte 2-5: Reserved for PROFIsafe communication container specified by PROFIsafe.

10.5. Safe digital I/O - Safe power supply (outputs)

For an SI unit configuration using Safety Mode (Channel Passivation), it occupies 5 bytes of Output data as shown below.

Table 10-5 Byte 0 Safe power supply for Safety Mode (Channel Passivation) (outputs)

Bit	Description	Explanation
0	Safe power supply of US2 to the IO modules	0: OFF, 1: ON
1	Safe power supply of US2 to the valve zone 1	0: OFF, 1: ON
2	Safe power supply of US2 to the valve zone 2	0: OFF, 1: ON
3	Safe power supply of US2 to the valve zone 3	0: OFF, 1: ON
4...7	Reserved	Fixed 0

Note: The safe power supply supplies the power also directly to the first valve for pilot air of the respective valve zone. Refer to Section 6 Valve manifold.

Byte 1-4: Reserved for PROFIsafe communication container specified by PROFIsafe.

10.6. Safe parameter values

For an SI unit configuration using Safety Mode (Module Passivation/xxx), it occupies 12 bytes of Output data, 8 of which are user settable. The parametrization values can be written as either Word data type or Bit data type, where the choice is determined by the module type residing in slot 1 of the EX245-FPS hardware configuration e.g.

Slot 1 contains 'Safety Mode (Module Passivation/Word)': use Word data type

or

Slot 1 contains 'Safety Mode (Module Passivation/Bit)': use Bit data type

Note: Safety Mode (Module Passivation/xxx) can refer to either type

Note: To disable an 'Output feedback' (bytes 1, 2 or 3) or a 'Safe input' (bytes 4, 5, 6 or 7) simply write a value of 0x00 to the corresponding parameter byte. However, when all 'Output feedbacks' and 'Safe Inputs' are disabled at least one bit in the parametrization bytes 1 - 7 must be set to logic '1' e.g. Byte 1: 0x01, Bytes 2 - 7: 0x00

Hardware reset can be performed by downloading a project to the PLC using the configuration software and resetting the power supply of the SI unit.

Table 10-6 Overview for Safety Mode (Module Passivation/xxx)

Byte	Description	Data type for Bits	Data type for Word
0	Safe power supply of US2 to the I/O module and the valve zone1-3	Unsigned8	Unsigned8
1	Output feedback parameter for zone M	Unsigned8	Unsigned8
2	Output feedback parameter zone 1	Unsigned8	Unsigned8
3	Output feedback parameter zone 2 and zone 3	Unsigned8	Unsigned8
4*	Safe input parameter for Ch.0 and Ch.4 (input connector 0)	Unsigned8	Integer16
5*	Safe input parameter for Ch.1 and Ch.5 (input connector 1)	Unsigned8	
6*	Safe input parameter for Ch.2 and Ch.6 (input connector 2)	Unsigned8	Integer16
7*	Safe input parameter for Ch.3 and Ch.7 (input connector 3)	Unsigned8	
8-11	Reserved for PROFIsafe communication protocol	-	-

* When slot 1 is occupied by module Safety Mode (Module Passivation/Word), the following byte pairs must be written as a single word: bytes 4 & 5 as a Word, bytes 6 & 7 as a Word

Table 10-7 Byte 0 Safe power supply for Safety Mode (Module Passivation/xxx) (outputs)

Bit	Description	Explanation
0	Safe power supply of US2 to the IO modules	0: OFF, 1: ON
1	Safe power supply of US2 to the valve zone 1	0: OFF, 1: ON
2	Safe power supply of US2 to the valve zone 2	0: OFF, 1: ON
3	Safe power supply of US2 to the valve zone 3	0: OFF, 1: ON
4...7	Reserved	Fixed 0

Table 10-8 Byte1 Output feedback parameter for zone M for Safety Mode (Module Passivation/xxx)

Bit 2	Bit 1	Bit 0	Value for OFF feedback delay time for Zone M
0	0	0	Reserved
0	0	1	Reserved
0	1	0	Reserved
0	1	1	5 sec
1	0	0	1 sec
1	0	1	500 msec
1	1	0	200 msec
1	1	1	100 msec
Bit 5	Bit 4	Bit 3	Value for ON feedback delay time for Zone M
0	0	0	Reserved
0	0	1	Reserved
0	1	0	Reserved
0	1	1	5 sec
1	0	0	1 sec
1	0	1	500 msec
1	1	0	200 msec
1	1	1	100 msec
Bit 6			Output feedback for Zone M
0			Disable
1			Enable
Bit 7			Reserved

Table 10-9 Byte2 Output feedback parameter zone 1 for Safety Mode (Module Passivation/xxx)

Bit 2	Bit 1	Bit 0	Value for OFF feedback delay time for zone 1
Same as Table 10-8			
Bit 5	Bit 4	Bit 3	Value for ON feedback delay time for zone 1
Same as Table 10-8			
Bit 6		Output feedback for Zone 1	
0		Disable	
1		Enable	
Bit 7		Reserved	

Table 10-10 Byte3 Output feedback parameter zone 2 and zone 3 for Safety Mode (Module Passivation/xxx)

Bit 2	Bit 1	Bit 0	Value for OFF feedback delay time for zone 2 and zone 3
Same as Table 10-8			
Bit 5	Bit 4	Bit 3	Value for ON feedback delay time for zone 2 and zone 3
Same as Table 10-8			
Bit 6		Output feedback for Zone 2	
0		Disable	
1		Enable	
Bit 7		Output feedback for Zone 3	
0		Disable	
1		Enable	

Table 10-11 Byte4 Safe input parameter for Ch.0 and Ch.4 (input connector 0) for Safety Mode (Module Passivation/xxx)

Bit 1	Bit 0	Sensor evaluation for Ch.0 and Ch.4 (input connector 0)	
0	0	Disable	
0	1	1 out of 1 evaluation (Input 0, 4) *	
1	0	1 out of 2 evaluation, 2-channel equivalent	
1	1	1 out of 2 evaluation, 2-channel non-equivalent	
Bit 3	Bit 2	Power source for cross circuit detection and Clock pulse for Ch.0 and Ch.4 (input connector 0)	
0	0	Input 0 power source: UT1 with clock pulse Input 4 power source: UT2 with clock pulse	
0	1	Input 0 & 4 power source: UT1 with clock pulse	
1	0	Input 0 & 4 power source: UT2 with clock pulse	
1	1	Input 0 & 4 power source: each power source without clock pulse	
Bit 6	Bit 5	Bit 4	Discrepancy time for Ch.0 and Ch.4 (input connector 0)
0	0	0	Reserved
0	0	1	No limit (Disable)
0	1	0	10 msec
0	1	1	50 msec
1	0	0	100 msec
1	0	1	1 sec
1	1	0	5 sec
1	1	1	Reserved
Bit 7			Input filter time for Ch.0 and Ch.4 (input connector 0)
0			3 msec
1			5 msec

* When using 1oo1, please set "No limit (Disable)" for Discrepancy time in Ch.n and Ch.n+4.

Table 10-12 Byte5 Safe input parameter for Ch.1 and Ch.5 (input connector 1) for Safety Mode (Module Passivation/xxx)

Bit 1	Bit 0	Sensor evaluation for Ch.1 and Ch.5 (input connector 1)	
0	0	Disable	
0	1	1 out of 1 evaluation (Input 1, 5)	
1	0	1 out of 2 evaluation, 2-channel equivalent	
1	1	1 out of 2 evaluation, 2-channel non-equivalent	
Bit 3	Bit 2	Power source for cross circuit detection and Clock pulse for Ch.1 and Ch.5 (input connector 1)	
0	0	Input 1 power source: UT1 with clock pulse Input 5 power source: UT2 with clock pulse	
0	1	Input 1 & 5 power source: UT1 with clock pulse	
1	0	Input 1 & 5 power source: UT2 with clock pulse	
1	1	Input 1 & 5 power source: each power source without clock pulse	
Bit 6	Bit 5	Bit 4	Discrepancy time for Ch.1 and Ch.5 (input connector 1)
Same as Table 10-11			
Bit 7			Input filter time for Ch.1 and Ch.5 (input connector 1)
Same as Table 10-11			

Table 10-13 Byte6 Safe input parameter for Ch.2 and Ch.6 (input connector 2) for Safety Mode (Module Passivation/xxx)

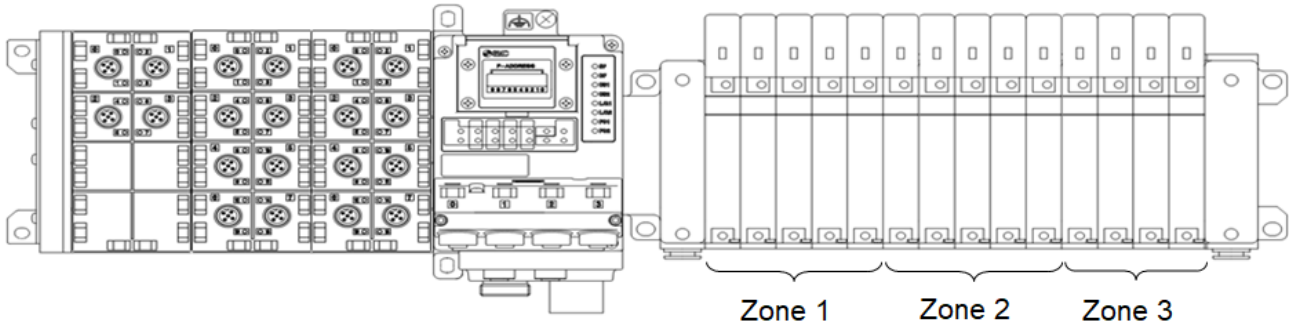
Bit 1	Bit 0	Sensor evaluation for Ch.2 and Ch.6 (input connector 2)	
0	0	Disable	
0	1	1 out of 1 evaluation (Input 2, 6)	
1	0	1 out of 2 evaluation, 2-channel equivalent	
1	1	1 out of 2 evaluation, 2-channel non-equivalent	
Bit 3	Bit 2	Power source for cross circuit detection and Clock pulse for Ch.2 and Ch.6 (input connector 2)	
0	0	Input 2 power source: UT1 with clock pulse Input 6 power source: UT2 with clock pulse	
0	1	Input 2 & 6 power source: UT1 with clock pulse	
1	0	Input 2 & 6 power source: UT2 with clock pulse	
1	1	Input 2 & 6 power source: each power source without clock pulse	
Bit 6	Bit 5	Bit 4	Discrepancy time for Ch.2 and Ch.6 (input connector 2)
Same as Table 10-11			
Bit 7			Input filter time for Ch.2 and Ch.6 (input connector 2)
Same as Table 10-11			

Table 10-14 Byte7 Safe input parameter for Ch.3 and Ch.6 (input connector 3) for Safety Mode (Module Passivation/xxx)

Bit 1	Bit 0	Sensor evaluation for Ch.3 and Ch.7 (input connector 3)	
0	0	Disable	
0	1	1 out of 1 evaluation (Input 3, 7)	
1	0	1 out of 2 evaluation, 2-channel equivalent	
1	1	1 out of 2 evaluation, 2-channel non-equivalent	
Bit 3	Bit 2	Power source for cross circuit detection and Clock pulse for Ch.3 and Ch.7 (input connector 3)	
0	0	Input 3 power source: UT1 with clock pulse Input 7 power source: UT2 with clock pulse	
0	1	Input 3 & 7 power source: UT1 with clock pulse	
1	0	Input 3 & 7 power source: UT2 with clock pulse	
1	1	Input 3 & 7 power source: each power source without clock pulse	
Bit 6	Bit 5	Bit 4	Discrepancy time for Ch.3 and Ch.7 (input connector 3)
Same as Table 10-11			
Bit 7			Input filter time for Ch.3 and Ch.7 (input connector 3)
Same as Table 10-11			

10.7. Process data for valves

The SI Unit occupies 3 bytes of output data for valves. The counting of valve coils starts at the SI Unit from left to right.



Valve Zone	Bit	Description	Explanation
1	0-7	Valve coils 0-7 (of the 1st valve zone)	0: OFF, 1: ON
2	0-7	Valve coils 0-7 (of the 2nd valve zone)	0: OFF, 1: ON
3	0-7	Valve coils 0-7 (of the 3rd valve zone)	0: OFF, 1: ON

Fig. 10-3 The process data

10.8. Output status unit

Overview

Table 10-15 Overview

Byte	Description
0	Status of safe outputs
1	Status of the status bit in Byte 0
2	Switch ON ready

Byte 0: Status of safe outputs

The status of the safe outputs is shown after all internal safety tests have been performed

Table 10-16 Byte 0 Status of safe outputs

Bit	Description	Explanation
0	Status of safe output for IO Module	0: OFF, 1: ON
1	Status of safe output for valve zone 1	0: OFF, 1: ON
2	Status of safe output for valve zone 2	0: OFF, 1: ON
3	Status of safe output for valve zone 3	0: OFF, 1: ON
4...7	Reserved	Fixed 0

Byte 1: Status of the status bit in Byte 0
 This indicates if Byte 0 status bits are valid or not

Table 10-17 Byte 1 Status of the status bit in Byte 0

Bit	Description	Explanation
0	Status of status bit for safe output for IO Module	0: invalid, 1: valid
1	Status of status bit for safe output for valve zone 1	0: invalid, 1: valid
2	Status of status bit for safe output for valve zone 2	0: invalid, 1: valid
3	Status of status bit for safe output for valve zone 3	0: invalid, 1: valid
4...7	Reserved	Fixed 0

Byte 2: Switch ON ready
 This indicates if the safe output can turn ON without error due to the output feedback function ([see 8.2.2.5 for details](#)).

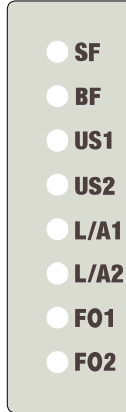
Table 10-18 Byte 2 Switch ON ready

Bit	Description	Explanation
0	Switch on ready for output for IO Module	0: cannot turn on, 1: can turn on
1	Switch on ready for output for valve zone 1	0: cannot turn on, 1: can turn on
2	Switch on ready for output for valve zone 2	0: cannot turn on, 1: can turn on
3	Switch on ready for output for valve zone 3	0: cannot turn on, 1: can turn on
4...7	Reserved	Fixed 0

10.9. LED indicators

10.9.1. LED indicators 1

The LED indicators 1 are arranged on the SI Unit as shown in the illustration below



Designation	Description	Colour
SF	System fault	Red
BF	Bus fault	Red
US1	Supply for the logic/sensors	Green
US2	Supply for the valves/loads	Green
L/A1 *	A combination of Link LED and Act LED. Connection via PROFINET on Port1 (XF1), and Data exchange on Port1 (XF1)	Green/Yellow
L/A2 *	A combination of Link LED and Act LED. Connection via PROFINET on Port2 (XF2), and Data exchange on Port2 (XF2)	Green/Yellow
FO1 **	Fibre-Optic communication diagnostics for Port 1 (XF1)	Orange
FO2 **	Fibre-Optic communication diagnostics for Port 2 (XF2)	Orange

*: When Link LED and Act LED are both on the combined colour may appear to be orange

** . Only EX245-FPS1 has this function

Fig. 10-4 LED indicators 1 of the EX245-FPS1/2/3

10.9.1.1. SF and BF indicators

Table 10-19 SF and BF indicators

SF	BF	Meaning
OFF	OFF	No fault (The SI Unit is currently exchanging data with the Controller without errors.)
---	Flash	Faulty or no connect message frame (although the SI Unit is physically connected to the bus) <ul style="list-style-type: none"> •IO configuration is defective, or before initial commissioning has been done. •Device name or IP Address is different from the programmed setting. •The GSD file is not correct. •The IO Controller is defective
---	ON	No IO Controller on the bus.
Flashing at 2 Hz	---	PROFIsafe communication is not established due to the following reason(s). <ul style="list-style-type: none"> •The SI unit is not parameterised by the Safe Controller. •The parameterisation is not acceptable. •The F-address is not matched.
Flashing at 0.5 Hz	---	The Safe Controller requests operator acknowledgment
ON	---	The following diagnostic event occurred. <ul style="list-style-type: none"> •No safe communication. •The configuration data sent by the Controller does not match the actual layout. •Power supply is not present or is below the dropout level •At least one valve coil has a short circuit, or at least one connected module has a short circuit, or the module layout has changed. •Self-test has failed and a power reset is required. •An incompatible module is connected to the SI Unit.

10.9.1.2. US1 indicator

Table 10-20 US1 indicator

US1	Meaning
OFF	US1 is not present or is below the dropout level (< approx. 17 VDC).
Flash	US1 is below the permissible level but above the dropout level (17 to 20.4 VDC).
ON	US1 is present (> approx. 21.6 VDC).

10.9.1.3. US2 indicator

Table 10-21 US2 indicator

US2	Meaning
OFF	US2 is not present or is below the dropout level (< approx. 17 VDC). *
Flash	US2 is below the permissible level but above the dropout level (17 to 21.6 VDC).
ON	US2 is present (> approx. 22.8 VDC).

*: If the US2 power supply is not present or below the dropout level, the SF LED will also flash and the error code "0x01F1" will be generated.

To clear the error -

Step 1 Turn on the US2 power supply.

Step 2 For module passivation mode send a reset signal to ACK_REI (Acknowledgement for Reintegration).For channel passivation mode use the Function Block FB60.

10.9.1.4. L/A indicator

Table 10-22 L/A indicator

L/A 1/2	Meaning
Green ON	Connection via Ethernet to the SI Unit via Port 1/2 (XF1/2)
Green OFF	No connection established via Port 1/2 (XF1/2)
Yellow ON	Transmission or reception of Ethernet telegrams on Port 1/2 (XF1/2)
Yellow OFF	No transmission or reception of Ethernet telegrams on Port 1/2 (XF1/2)
Orange Flash *	Received Node flash request

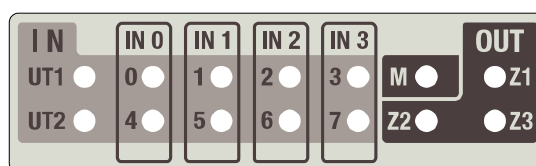
*: When Link LED and Act LED are both on the combined colour may appear to be orange

10.9.1.5. FO 1/2 Indicator

Table 10-23 FO 1/2 indicator

FO 1/2	Meaning
OFF	The strength of the Fibre-Optic communication is more than 2 dB.
Flashing	The strength of the Fibre-Optic communication is more than 0 dB but less than 2 dB.
ON	The strength of the Fibre-Optic communication is less than 0 dB.

10.9.2. LED Indicators 2



Designation	Description	Colour
UT1, UT2	Status for the clock power supply UT1 and UT2	Red
IN0, IN1, ..., IN7	Status for safe inputs	Green
M	Status for safe US2 power supply for IO modules	Green/Red
Z1, Z2, Z3	Status for safe US2 zone power supplies for valves	Green/Red

Fig. 10-4 LED indicators 2 of the EX245-FPS1/2/3

10.9.2.1. UT1 and UT2 LEDs

Table 10-24 UT1 and UT2 LEDs

UT1/2	Meaning
OFF	No error
Flashing at 1 Hz	At least one of the safe inputs has a cross circuit with another signal (e.g. the other safe input, 24 V or an external signal)
ON	The clock power supply has a short circuit or overload.

10.9.2.2. IN0-7 LEDs

Table 10-25 IN0-7 LEDs

IN0-7	Meaning
ON	Input is ON
OFF	Input is OFF

10.9.2.3. OUT M, OUT Z1-Z3 LEDs

Table 10-26 OUT M, OUT Z1-Z3 LEDs

OUT	Meaning
OFF	Safe output is OFF
Green ON	Safe output is ON
Red ON	Error detected. (e.g. Short circuit, overload of the safe output, internal test error) The safe output is switched OFF.

10.9.3. LED indicators 3

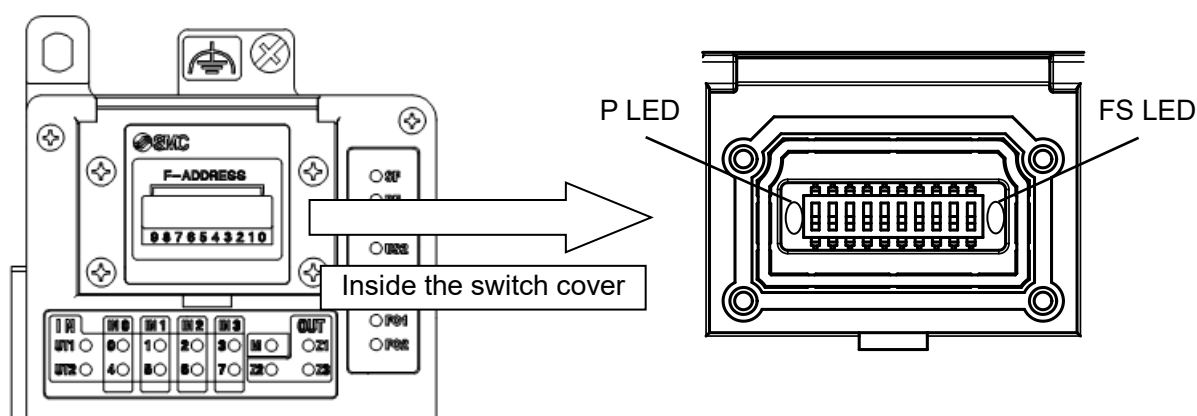


Fig. 10-5 LED indicators 3 of the EX245-FPS1/2/3

10.9.3.1. FS LED

Table 10-27 FS LED

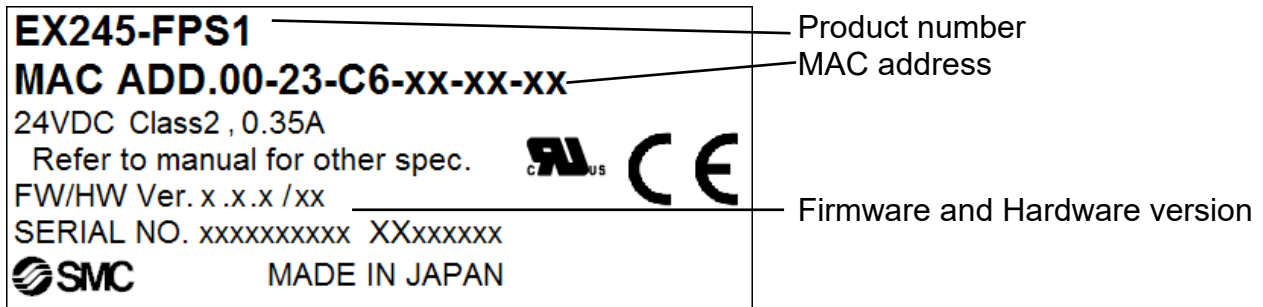
LED state	Meaning
OFF	The safety application has valid F-Parameters and i-Parameters (Only applies if US1 is on at the same time)
Red ON	Hardware fault. Communication to the higher level safe controller is disabled
Red Flash	Module is not parameterized or parameterization was not accepted

10.9.3.2. P LED

Table 10-28 P LED

LED state	Meaning
OFF	No safe communication
Green ON	Safe communication is running.
Green Flash	Safe communication is running. The controller is requesting 'operator acknowledgment'

10.10. Production label



- Firmware version (FW) : 2.1.X
- Hardware version (HW): 03 and higher

Fig. 10-6 Production label

10.11. DIP Switches

10.11.1. PROFIsafe address switch

A ten bit DIP-Switch is provided for the safety address setting. The switch setting is only checked at power-up. Any changes made during operation are ignored and may lead to problems during the next power-up sequence

Using the DIP switches:

- Unscrew the cover and hinge it upwards.
- The DIP switches can be adjusted with a small flat-blade screwdriver.
- Tighten the cover again, making sure that the seals are positioned correctly. (torque = 0.3 N·m)

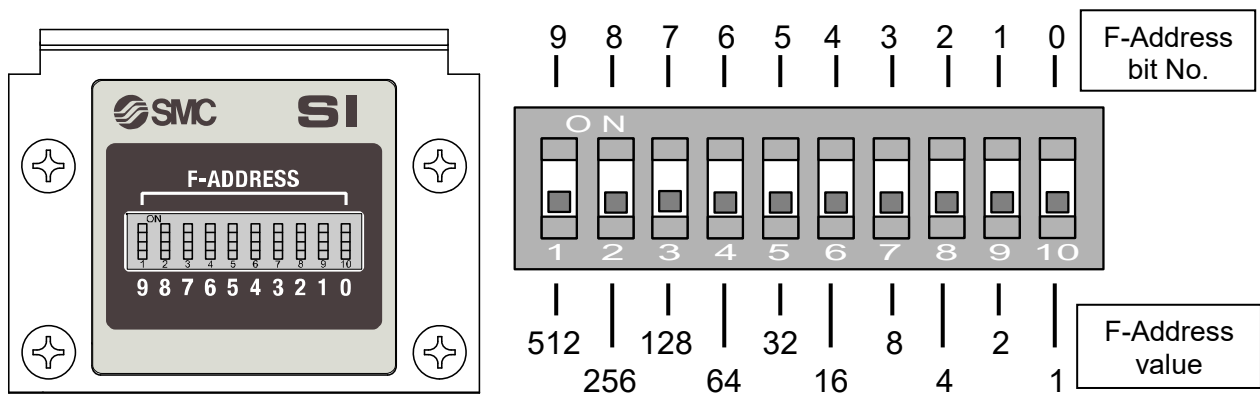


Fig. 10-7 PROFIsafe address switch

Note:

- The F-Address bit numbering shown on the label has priority over any numbers printed on the DIP switch e.g. in the example above the DIP switch is printed with numbers 1 to 10 where 1 is on left and 10 is on the right. In this case the numbers are provided for reference only and play no part in the address numbering.
- The default state (factory setting) for this DIP switch is all OFF.

10.11.2. A two bit DIP-Switch and a six bit DIP-Switch

Two DIP-Switches SW2 and SW3 are under the M12 safe input connector box. To access the switches remove the retaining screws as shown below.

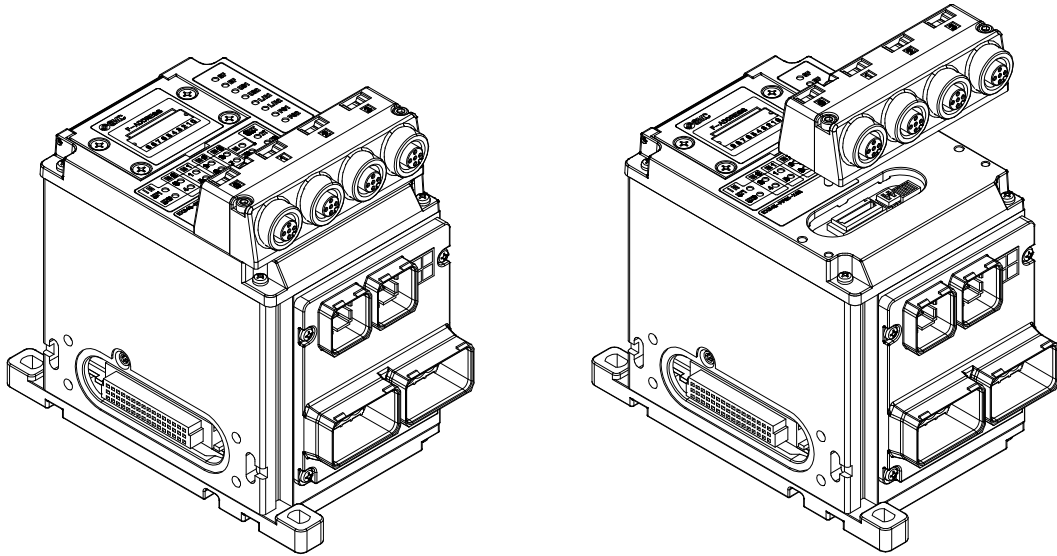


Fig. 10-8 Retaining Screws

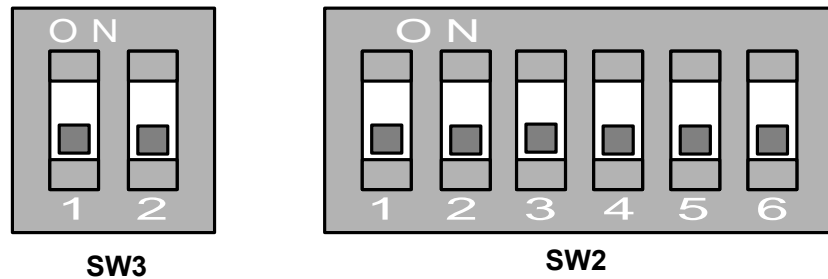


Fig. 10-9 SW3 and SW2 DIP switches

When the DIP-Switches have been set ensure the M12 connector block and all retaining screws are refitted. (torque = 0.4 N·m)The module must be used in a fully assembled state with all parts securely fastened before using the product

It is forbidden to make modifications to the module whilst setting the DIP-Switch values. Non-approved modifications may compromise the module safety functionality and will invalidate the product guarantee

10.11.2.1. SW2

Not in use.

10.11.2.2. SW3

The two bits of the DIP-Switch “SW3” are used for the commissioning mode (COMNG_MODE).

Table 10-29 SW3 details

Bit 1	Bit 2	Meaning
OFF	OFF	SM (Safety mode)
ON	OFF	Failure state
OFF	ON	Failure state
ON	ON	CM (Commissioning mode)

- The setting of the DIP switch SW3 is read during power-up. It is not permitted to change the settings during normal operation as this may cause an error.
- The hardware configuration must include the correct ‘Safe digital I/O’ module. If the DIP switch is set for SM (Safety mode) then use the ‘Safe digital I/O (SM)’ module. Alternatively if the DIP switch is set for CM (Commissioning mode) then use the ‘Safe digital I/O (CM)’ module. Both modules are resident in the Step7 or PCWorx hardware catalogue after the device GSDML (Step7/TIA) or FDCML (PCWorx) file has been imported into it. [Refer to Section: 8.1.1“GSD file and symbol files” for details.](#)
- “COMNG_MODE” occupies 1 byte for input data and 1 byte for output data.
- Diagnostics messages are supported.
- Parameters for safe-IOs are fixed in the firmware and are not adjustable
- F-Address should be in a parameter

Caution

In a production environment the SI unit must only be used in SM (Safety Mode)

IO mapping for the commissioning mode

IO Mapping for “COMNG_MODE”

Table 10-30 IO Mapping for “COMNG_MODE”

Byte	Meaning	
	INPUT	OUTPUT
0	Input data from safe inputs	Output data for safe outputs

Byte 0 of “COMNG_MODE”

Table 10-31 Byte 0 of “COMNG_MODE” details

Bit	Meaning	
	INPUT	OUTPUT
0	Input status of safe input 0	Safe power supply of US2 to the IO modules
1	Input status of safe input 1	Safe power supply of US2 to the valve zone 1
2	Input status of safe input 2	Safe power supply of US2 to the valve zone 2
3	Input status of safe input 3	Safe power supply of US2 to the valve zone 3
4	Input status of safe input 4	Reserved: Fixed 0 A non-zero value generates an error
5	Input status of safe input 5	
6	Input status of safe input 6	
7	Input status of safe input 7	

Parameter setting for the commissioning mode

Fixed parameter setting during the commissioning mode

Table 10-32 Fixed Parameters

Parameter	Value
Sensor power supply (Clock configuration)	
UT1 clock pulse	Disable
UT2 clock pulse	Disable
Input parameter	
Sensor evaluation	1oo1 evaluation (Input N, N+4)
Filter time	3 ms
Power source for cross-circuit detection	Disable
Discrepancy time	Disable
Output feedback	
Output feedback	Disable

10.12. Block diagram

The following figure shows the block diagram of each SI Unit.

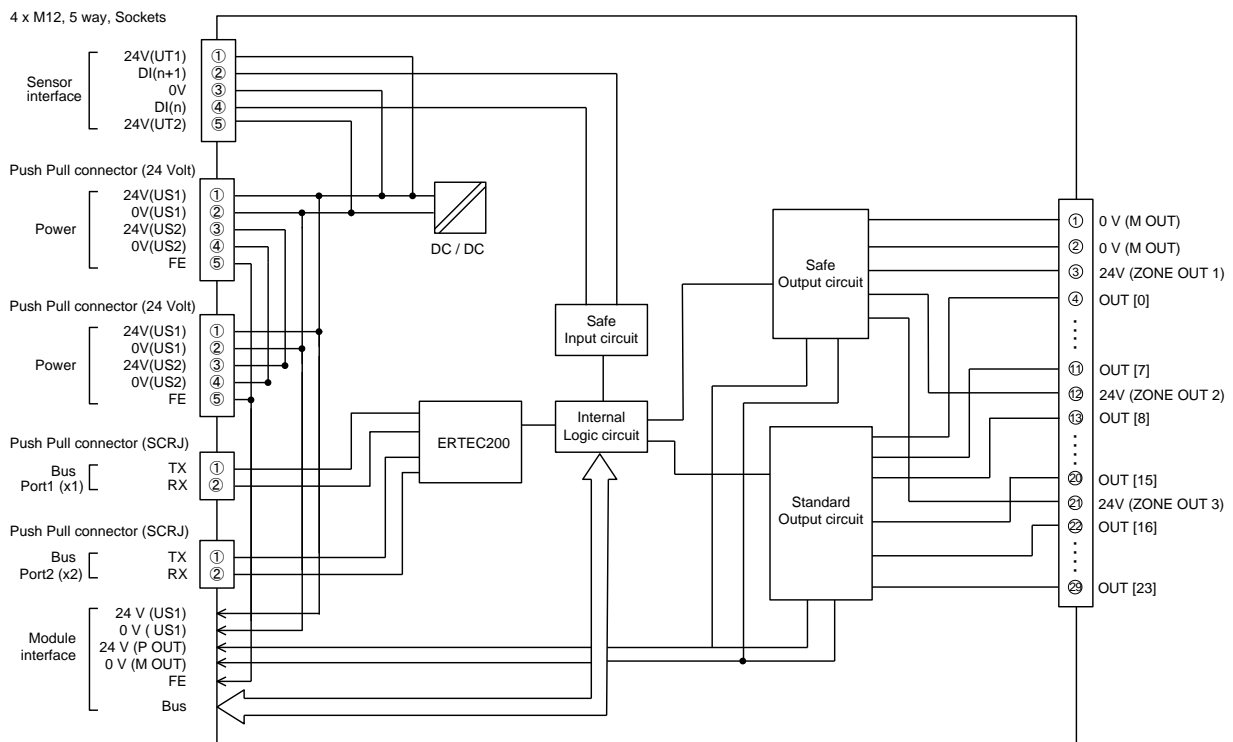


Fig. 10-10 Block diagram of the EX245-FPS1

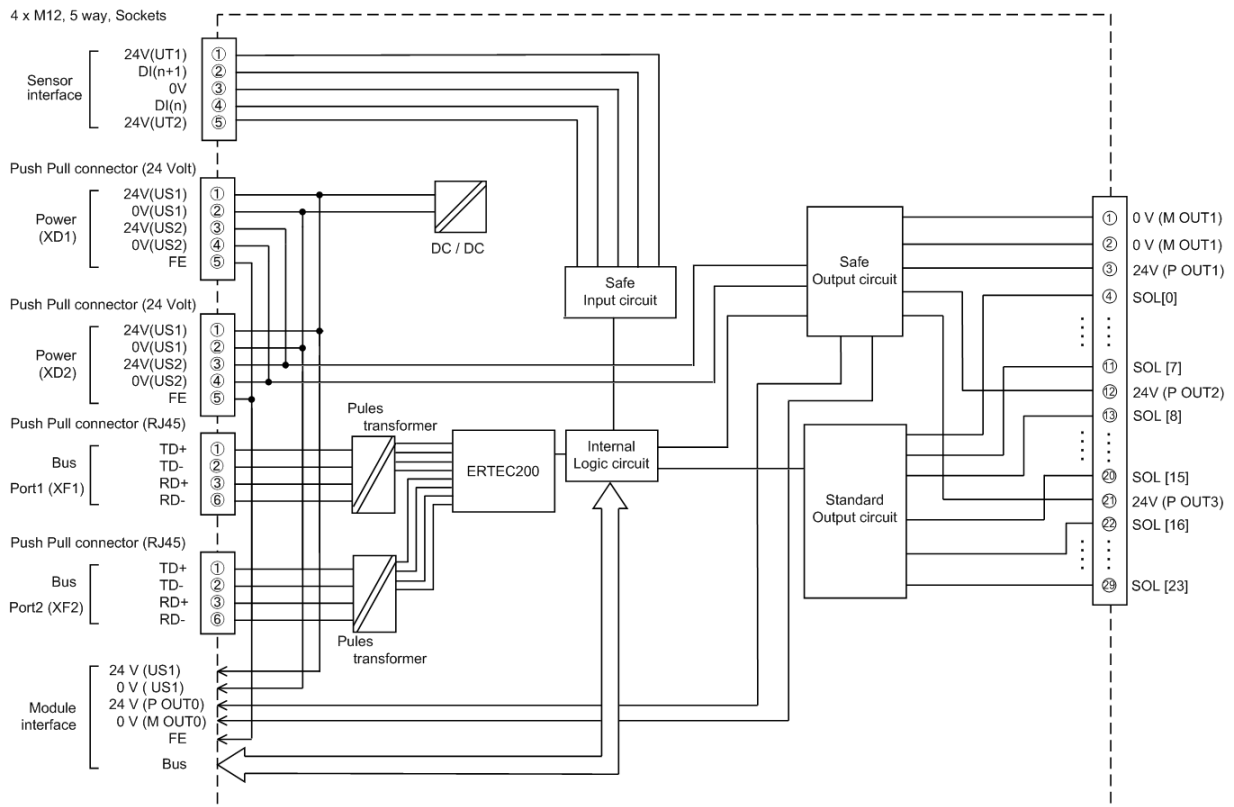


Fig. 10-11 Block diagram of the EX245-FPS2

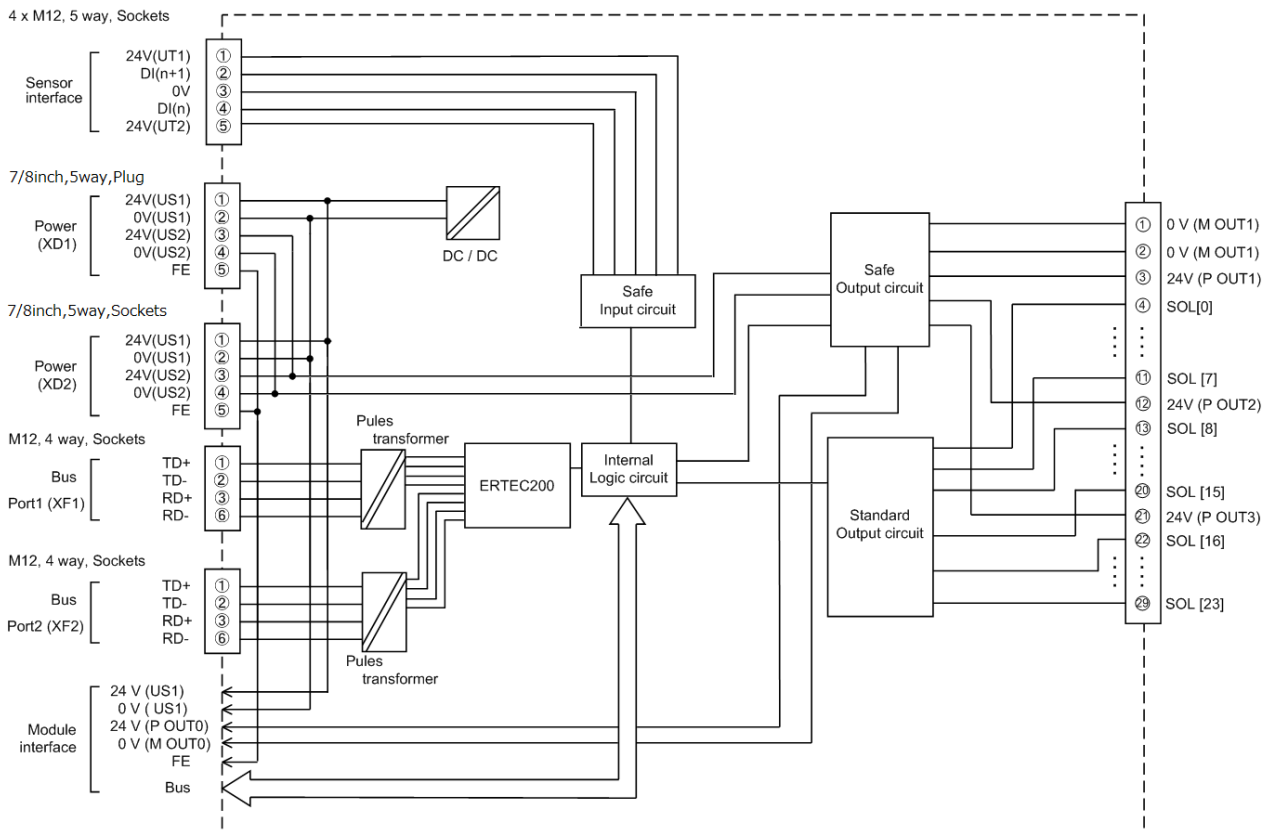


Fig. 10-12 Block diagram of the EX245-FPS3

11. Digital Input Module - EX245-DX1

11.1. Parts and description

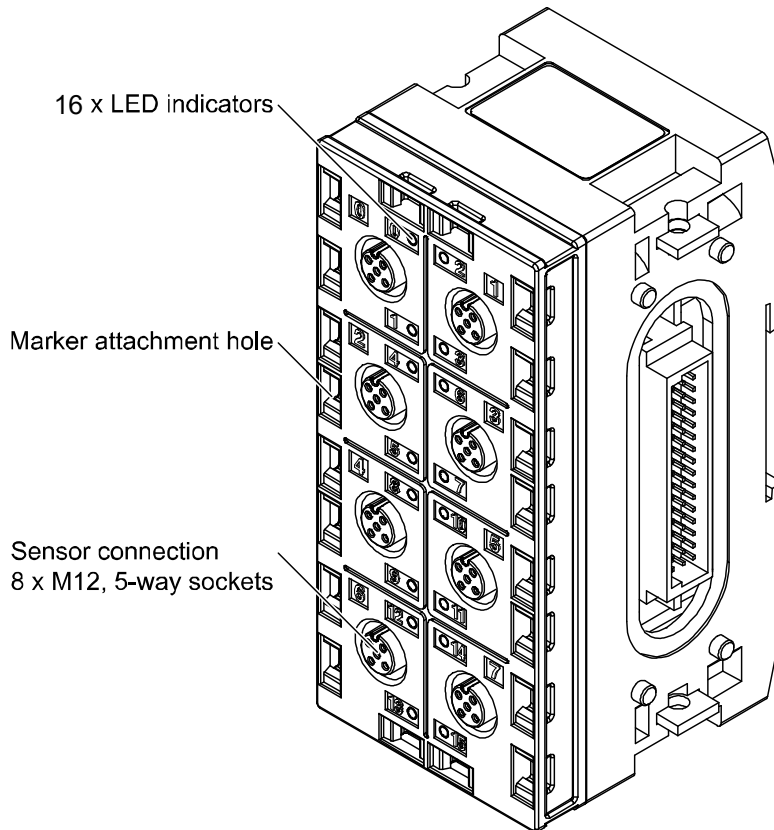


Fig. 11-1 Allocation of parts on the EX245-DX1

Note: EX245-DX1 is the new part number for the EX245-DX1-X36

11.2. Specifications

Table 11-1 EX245-DX1 specifications

Item	Description
General	
Dimensions (W x L x H) in mm	54 x 120 x 61
Weight	280g or less
Housing material	Nylon, PBT
Electrical	
Rated supply voltage	24 V DC
Voltage drop to sensor supply	Max. 1.6 V
Internal current consumption at 24V DC	50 mA or less
Input connection type	8 x M12, 5-way sockets with double allocation
Over Voltage protection	Yes, more than 30 V DC at US1(solenoid/output)
Short circuit protection	Yes
Sensor supply current per connector	Max. 0.5A
Sensor supply current per module	Max. 2 A
Status indication	Yes, per input
Short circuit indication	Yes, per connector
Digital input	
Number of inputs	16
Input type	PNP
Signal 1	11 to 30 V
Signal 0	-3 to 5 V
Permissible residual current	Max. 1.5mA
Input current signal 1	Typ. 4.5 mA

11.3. Wiring

⚠ Caution

- To prevent damage, all power for the SI Unit and modules must be turned off (i.e. de-energized) before the modules are installed or removed.
- For a protection rating of IP65 to be ensured, sockets that are not used must be closed with M12 covering caps.
- For a protection rating of IP65 to be ensured, all covering caps must be screwed down correctly after wiring and setting have been performed.

Pin allocation of the M12, 5-way socket connector as shown in the following table:

Table 11-2 Pin allocation of the connector for EX245-DX1

Pin	Allocation	View of connector (module side)
1	24 V	
2	DI (input signal "n+1")	
3	0 V (US1)	
4	DI (input signal "n")	
5	FE/Shield	

11.4. Process data

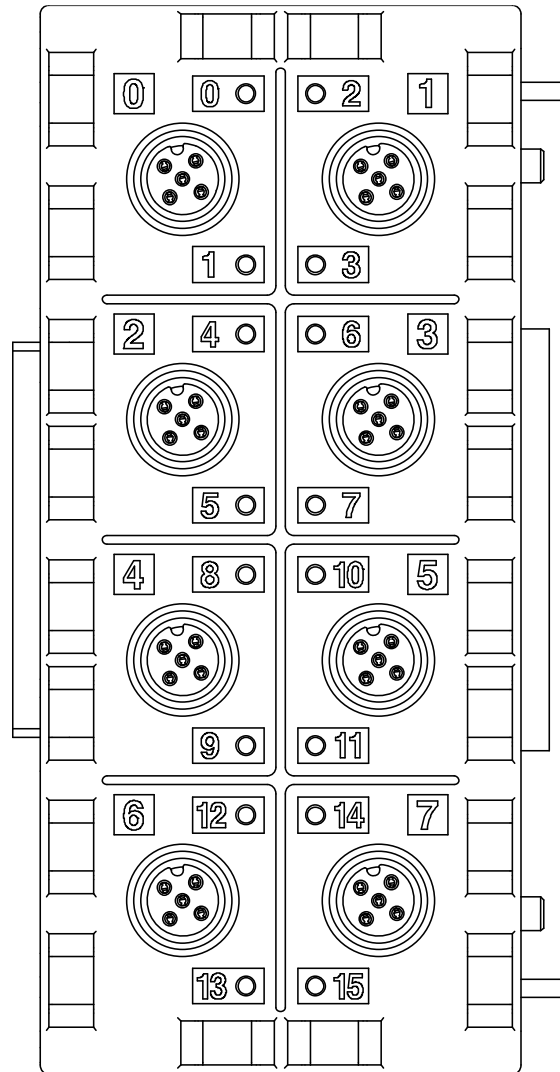
The EX245-DX1 occupies 2 bytes of input data. The following table shows the allocation of the digital inputs and the process image.

Table 11-3 Digital input allocation and the process data

Connector position									
Connector designation	0	1	2	3	4	5	6	7	
Input	Pin 2	Bit 1	Bit 3	Bit 5	Bit 7	Bit 9	Bit 11	Bit 13	Bit 15
	Pin 4	Bit 0	Bit 2	Bit 4	Bit 6	Bit 8	Bit 10	Bit 12	Bit 14

11.5. LED indicators

The status indicators are arranged on the EX245-DX1 as shown in the illustration below.



0 to15	Description
OFF	Input is not activated and no errors.
Green ON	Input is activated.
Red ON	Short circuit is detected.

Fig. 11-2 Status indicators of the EX245-DX1

11.6. Block diagram

The following figure shows the block diagram of the EX245-DX1.

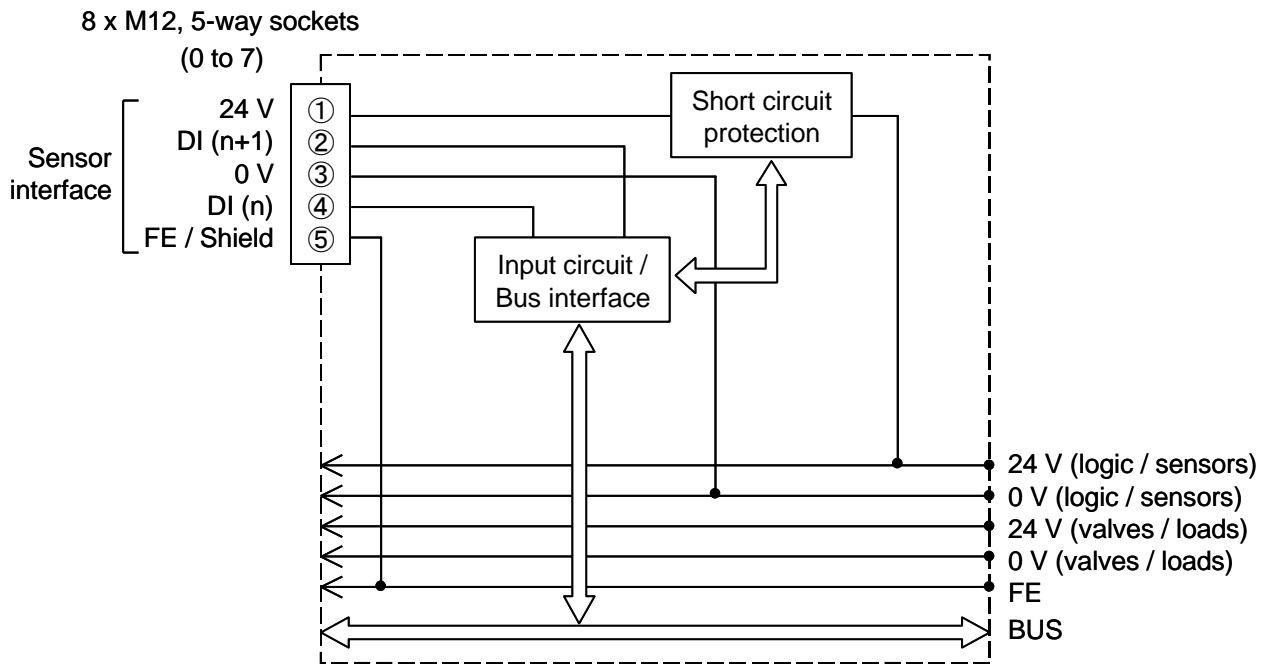


Fig. 11-3 Block diagram of the EX245-DX1

12. Digital Output Module - EX245-DY1

12.1. Parts and description

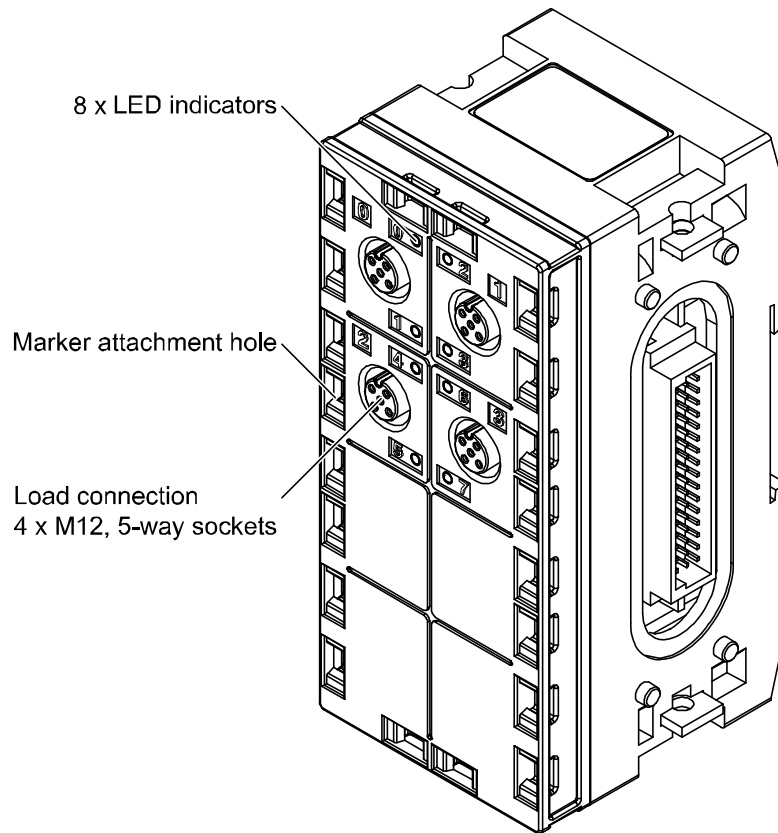


Fig. 12-1 Allocation of parts on the EX245-DY1

Note: EX245-DY1 is the new part number for the EX245-DY1-X37

12.2. Specifications

Table 12-1 EX245-DY1 specifications

Item	Description
General	
Dimensions (W x L x H) in mm	54 x 120 x 61
Weight	280 g or less
Housing material	Nylon, PBT
Electrical	
Rated supply voltage	24 V DC
Voltage drop to load supply	Max. 1.6 V
Internal current consumption at 24 V DC	50 mA or less
Load connection	4 x M12, 5-way sockets with double allocation
Over Voltage protection	Yes, more than 30 V DC at US2(solenoid/output)
Short circuit protection	Yes
Output current per output	Max.0.5A
Output current per module	Max.2 A
Status indication	Yes, per output
Short circuit indication	Yes, per output
Digital output	
Number of outputs	8
Output type	PNP

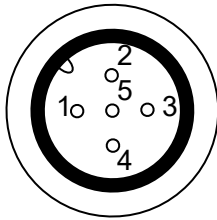
12.3. Wiring

⚠ Caution

- To prevent damage, all power for the SI Unit and modules must be turned off (i.e. de-energized) before the modules are installed or removed.
- For a protection rating of IP65 to be ensured, sockets that are not used must be closed with M12 covering caps.
- For a protection rating of IP65 to be ensured, all covering caps must be screwed down correctly after wiring and setting have been performed.

Pin allocation of the M12, 5-way socket connector as shown in the following table:

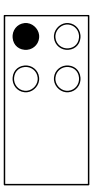
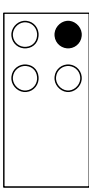
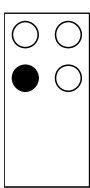
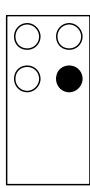
Table 12-2 Pin allocation of the connector for EX245-DY1

Pin	Allocation	View of connector (module side)
1	N.C.	
2	DO (output signal "n+1")	
3	0 V (valves/loads)	
4	DO (output signal "n")	
5	FE/Shield	

12.4. Process data

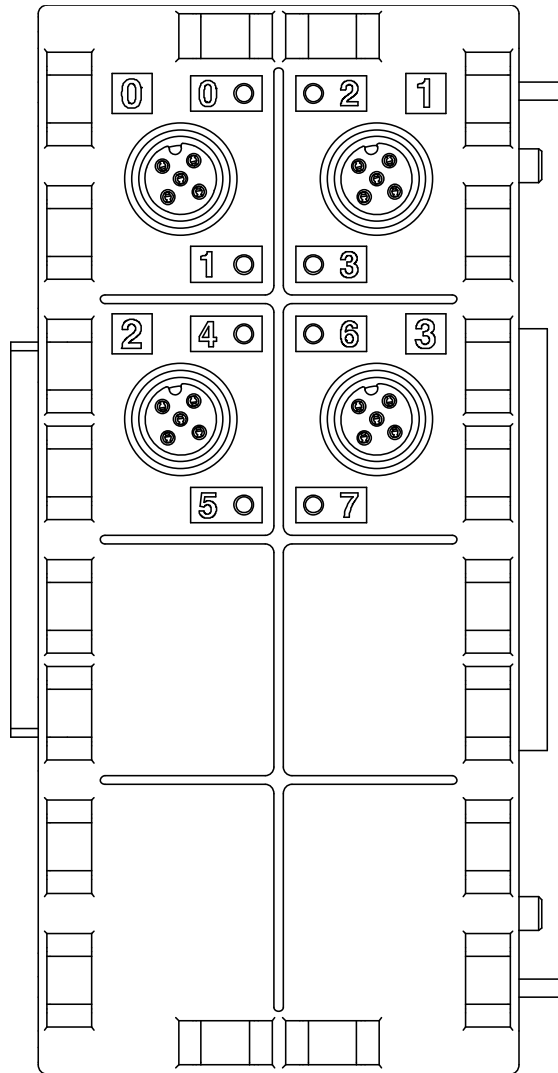
The EX245-DY1 occupies 1 byte of output data. The following table shows the allocation of the digital outputs and the process image.

Table 12-3 Digital output allocation and the process data

Connector position					
Connector designation		0	1	2	3
Output	Pin 2	Bit 1	Bit 3	Bit 5	Bit 7
	Pin 4	Bit 0	Bit 2	Bit 4	Bit 6

12.5. LED indicators

The status indicators are arranged on the EX245-DY1 as shown in the illustration below.



0 to 7	Description
OFF	Output is not activated and no errors.
Green ON	Output is activated.
Red ON	Short circuit is detected.

Fig. 12-2 Status indicators of the EX245-DY1

13. Accessories

13.1. Markers

Markers are available in single sheets each containing 88 pieces,
For the EX245-DX1 and EX245-DY1 use the part No.EX600-ZT1.

Model No. : EX600-ZT1

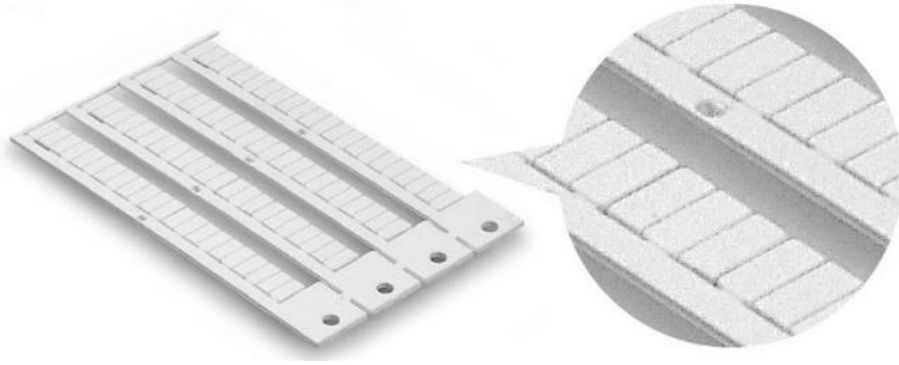


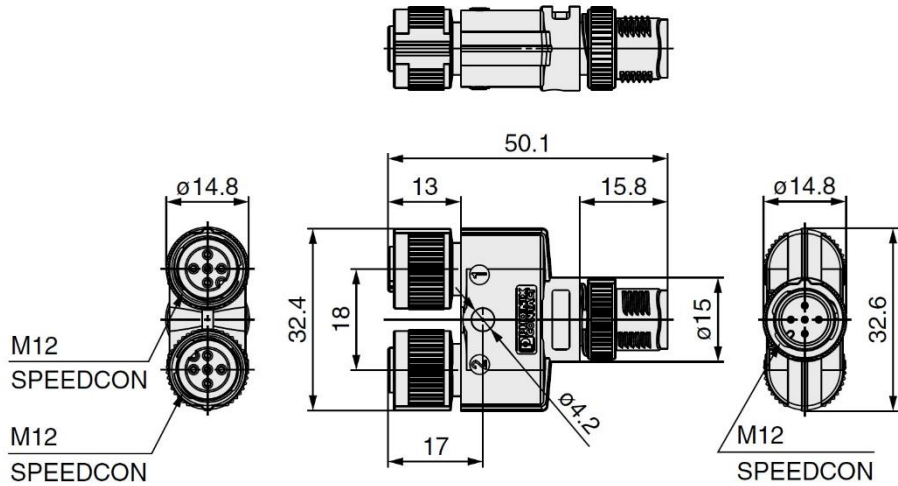
Fig. 13-1 EX600-ZT1

13.2. Y Connector

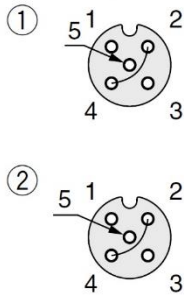
Y connectors can be used with the EX245-DX1 and EX245-DY1.

- There are two options –
- 2 x M12 to M12
- 2 x M8 to M12

Model No. : PCA-1557785
 (Y branch Connector (2 x M12 to M12))

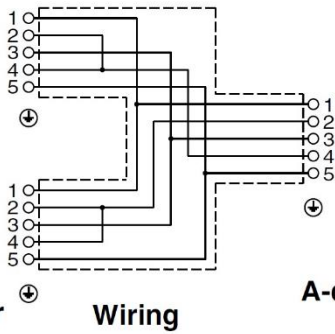


Socket connector pin assignment A-coded (Normal key)



Socket connector pin assignment A-coded (Normal key)

Wiring



Plug connector pin assignment A-coded (Normal key)

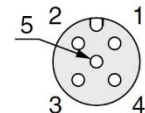
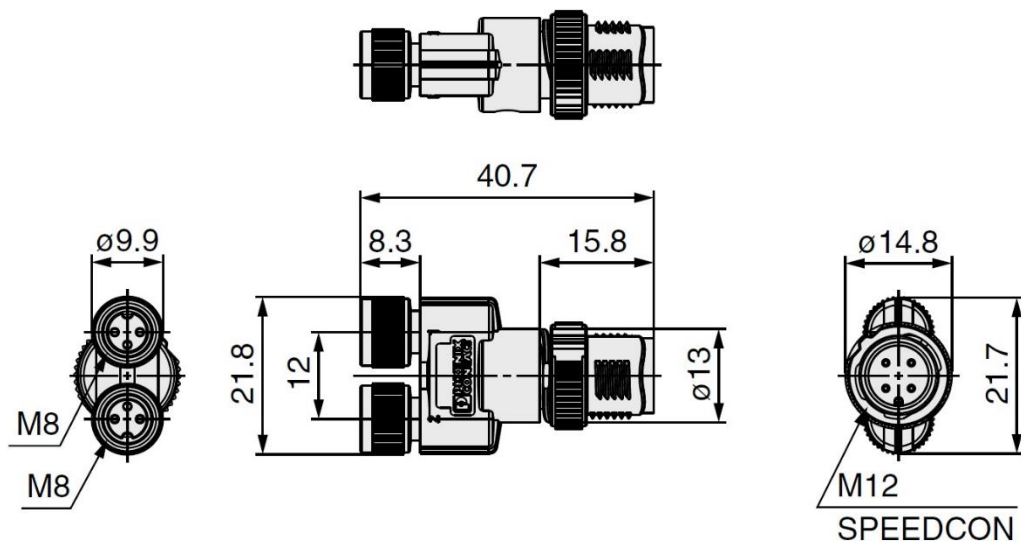
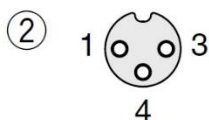
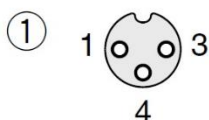


Fig. 13-2 PCA-1557785

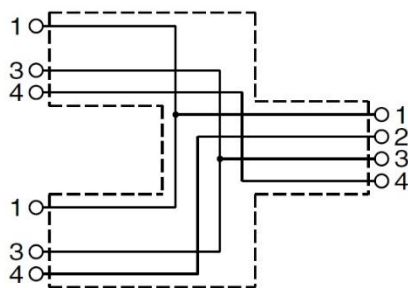
Model No. : PCA-1557798
 (Y branch Connector (2 x M8 to M12))



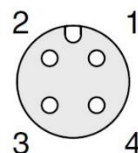
**Socket connector
 pin assignment**



**Socket connector
 pin assignment**



Wiring



**Plug connector
 pin assignment
 A-coded (Normal key)**

Fig. 13-3 PCA-1557798

13.3. Seal cap

Seal caps can be used with the EX245-FPS1/2/3, EX245-DX1, EX245-DY1.
 Mount the seal cap in the unused socket.
 IP65 is satisfied by using the seal cap properly.

Model No. : EX9-AWTS
 (M12 connector for socket 10 pieces.)



Fig. 13-4 EX9-AWTS

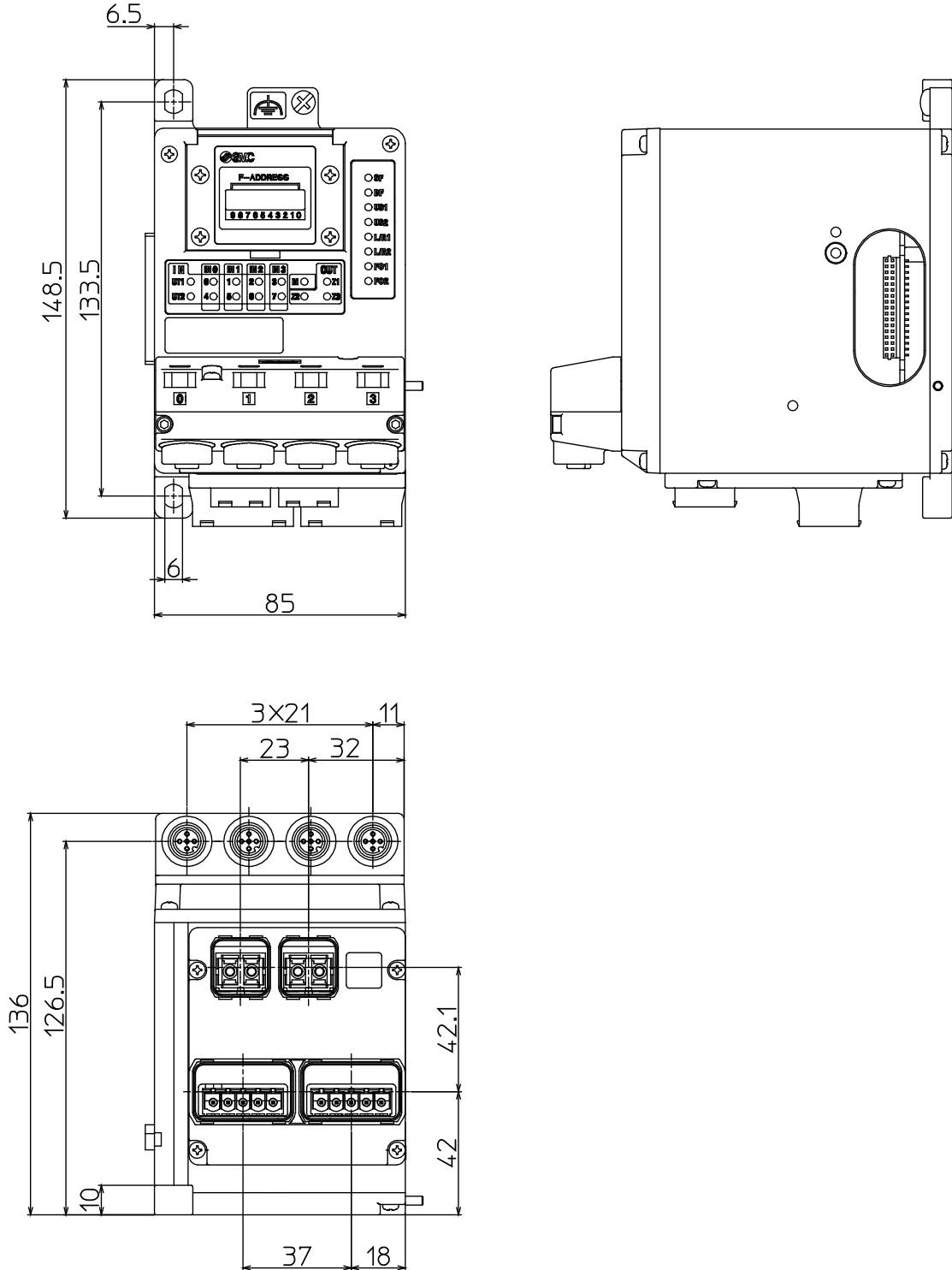
Note : Tighten the seal caps to the tightening torque specified (0.2Nm).

14. Dimensions

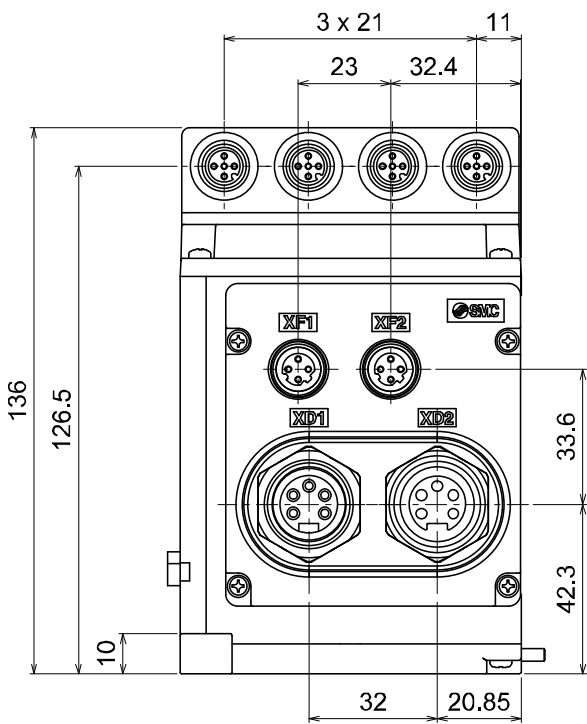
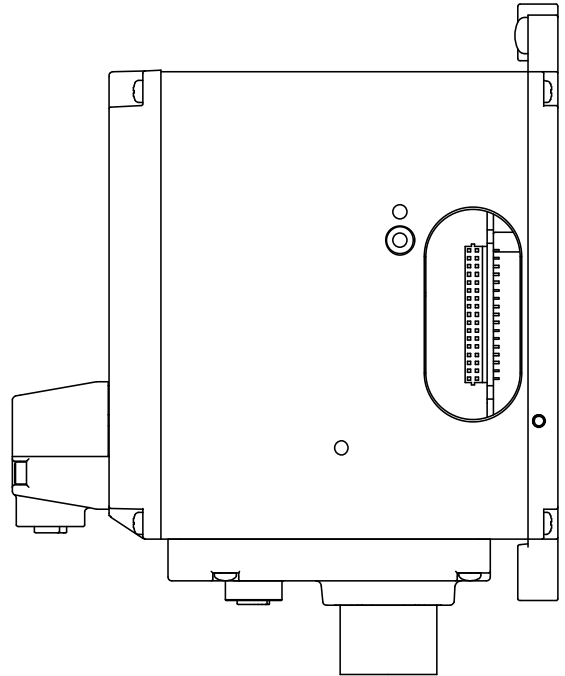
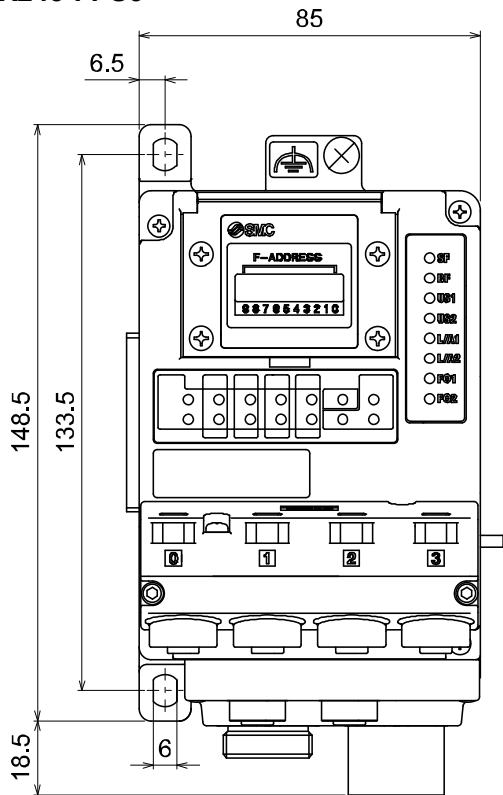
14.1. EX245-FPS1/2/3

The following figure shows the dimensions.

EX245-FPS1/2



EX245-FPS3



14.2. I/O Modules Manifold

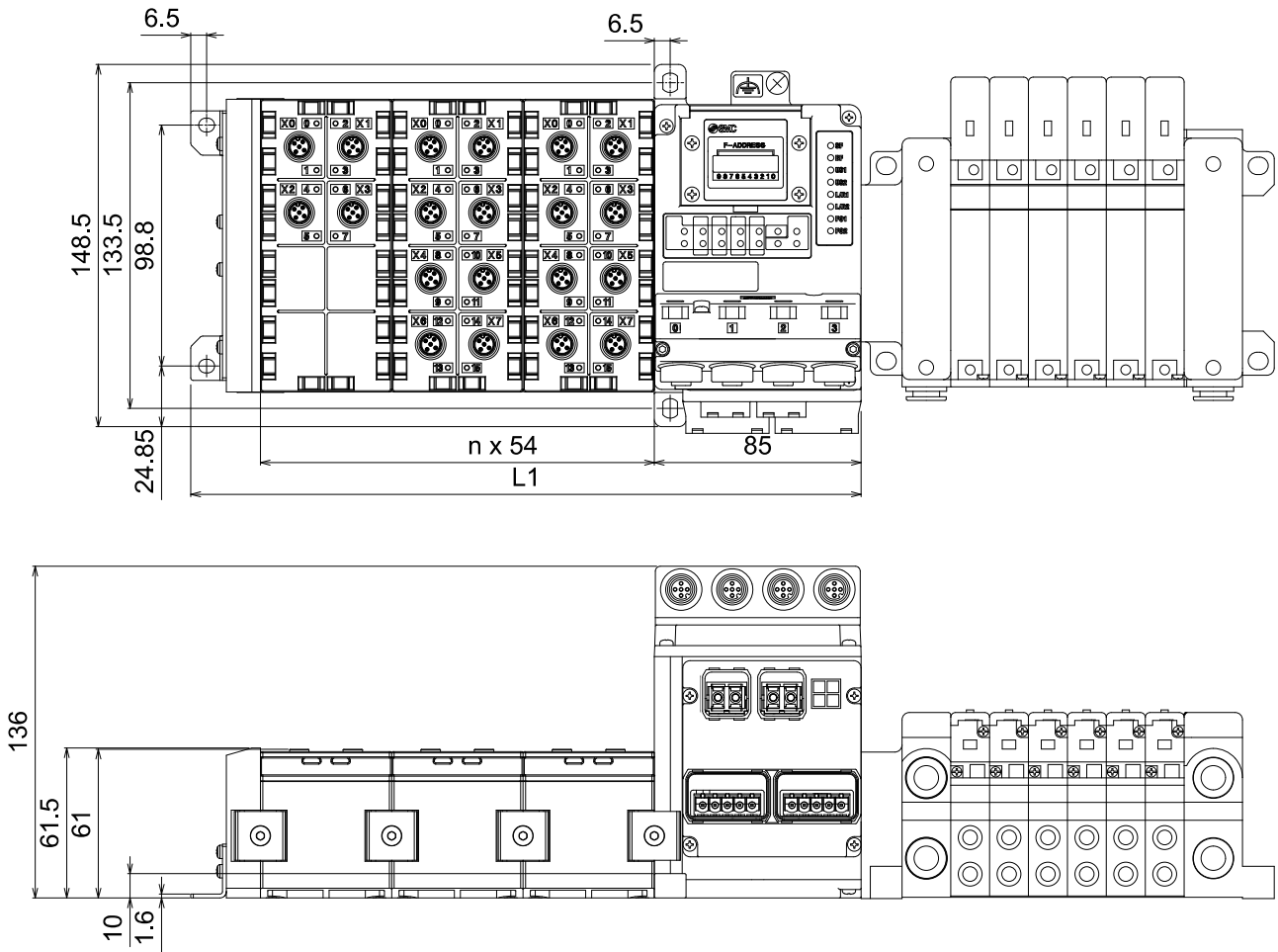


Fig. 15-1 Dimensions of the Modules manifold

The following table shows the length of the I/O Modules manifold.

Table 15-1 Length of the EX245 series module

M	0	1	2	3	4	5	6	7	8
L1	113.6	167.6	221.6	275.6	329.6	383.6	437.6	491.6	545.6

Formulas: $L1 = 54n + 113.6$ (max. 8 modules)

15. Troubleshooting

15.1. EX245-FPS1/2/3

Table 16-1 Troubleshooting for Ethernet communication on Port 1 (XF1) and Port 2 (XF2)

No.	Problem	Possible cause	Remedy
1	<ul style="list-style-type: none"> ●LINK indicator is OFF. ●ACT indicator is OFF. 	No connection to the IO Controller (no IO Controller available on the bus)	<ul style="list-style-type: none"> ●Check the bus connection. ●Auto negotiation not successful.

Table 16-2 Troubleshooting for PROFINET communication

No.	Problem	Possible cause	Remedy
1	BF indicator is flashing.	The EX245-FPS1/2/3 is physically connected to the IO Controller but the following problem has occurred.	---
		●Configuration is defective.	Check the configuration.
		●Device name is not correct.	Check the device names.
		●The GSD file is not correct.	Check the GSD file.
5	SF indicator is ON.	The following diagnostic event occurred.	Check the diagnostic event.
		(1) The configuration data sent by the IO Controller does not match the actual layout.	●Check the configuration of the SI Unit and the module layout.
		(2) Power supply is not present or is below the dropout level.	●Check the power supply and supply voltage level.
		(3) At least one valve coil has a short circuit and at least one connected module has a short circuit or the module layout has changed.	●Check both the solenoid valve for a short circuit and the module error/layout.
6	FO indicator is ON.	(4) A connected module is defective.	●Check the connected module.
		Strength of the Fibre-Optic communication is 0 dB.	<ul style="list-style-type: none"> ●Check the cable ●Check the next device
7	FO indicator is flashing.	Strength of the Fibre-Optic communication is more than 0 dB but less than 2 dB.	<ul style="list-style-type: none"> ●Check the cable ●Check the next device

Table 16-3 Troubleshooting for Overall system

No.	Problem	Possible cause	Remedy
1	US1 indicator is OFF.	Incorrect wiring.	<ul style="list-style-type: none"> ●Check the cable. ●Check the wiring and pin numbers.
		US1 is not present or below the dropout level (< approx. 17 VDC).	Check the supply for the logic/sensors.
2	US1 indicator is flashing.	US1 is below the permissible level but above the dropout level (17 to 21.6 VDC).	Check the supply for the logic/sensors.
3	US2 indicator is OFF.	Incorrect wiring.	<ul style="list-style-type: none"> ●Check the cable. ●Check the wiring and pin numbers.
		US2 is not present or below the dropout level (< approx. 17 VDC).	Check the supply for the valves/loads.
4	US2 indicator is flashing.	US2 is below the permissible level but above the dropout level (17 to 22.8 VDC).	Check the supply for the valves/loads.
5	A solenoid valve is not operating.	Incorrect connection.	Check the connection with the SI Unit.
		Solenoid valve is faulty.	Check the solenoid valve.

15.2. EX245-DX1

Table 16-4 Troubleshooting for EX245-DX1

No.	Problem	Possible cause	Remedy
1	Signals cannot be received even with sensor.	Incorrect wiring.	Check the wiring and pin numbers.
		US1 is not present or below the dropout level (< approx. 17 VDC).	Check the supply for the sensors.
		Sensor is faulty.	Check the sensor.
2	Status indicator is red ON.	Connector has a short circuit.	<ul style="list-style-type: none"> ●Check the wiring and pin numbers. ●Check the sensor.

15.3. EX245-DY1

Table 16-5 Troubleshooting for EX245-DY1

No.	Problem	Possible cause	Remedy
1	A load is not operating.	Incorrect wiring.	Check the wiring and pin numbers.
		US2 or additional supply for the loads is not present or below the dropout level (< approx. 17 VDC).	Check the (additional) supply for the loads.
		Load is faulty.	Check the load.
2	Status indicator is red ON.	Output has a short circuit.	<ul style="list-style-type: none"> ●Check the wiring and pin numbers. ●Check the load.

16. Error codes

16.1. Module replacement following an error

Please contact SMC if error codes are indicated by the system which do not appear in:

- The tables below in this user manual

LED

The “LED” column specifies which local diagnostics LED indicates the error.

Acknowledgment and restart

For every error that occurs, first remove the cause of the error. If necessary, acknowledge the error.

⚠️ WARNING: Hazardous machine state/unintentional machine startup

With the exception of a few special cases, the acknowledgment of an error can result in a hazardous state as well as unintentional machine startup since the safe input is immediately returned to the operating state.

- Before acknowledging an error you must make sure that acknowledgment will not cause the machine to switch to a hazardous state.
- When planning the machine or system, make sure that acknowledgment is only possible if the danger zone is visible.

⚠️ WARNING: Unintentional machine startup

Startup/restart following power up and when there is no longer a demand of the safety function can result in unintentional machine startup.

- Please note that:
 - The module starts up once the configuration and parameterization data record has been downloaded successfully and internal testing has been completed without errors.
 - A safety-related input is automatically reset to “1” when the safety function trigger is reset.
- If you do not want the machine to restart automatically, configure the safety logic accordingly.

Error Codes for Diagnostic Messages

Code	Additional Information	Brief Description	Solution
0x021X 529dez 530dez 531dez	The least significant four bits display information on the affected output. Range of values: 1: Zone Z1 2: Zone Z2 3: Zone Z3	Error in the internal monitoring of the return read signals. The output displayed cannot be switched off or there is a hardware error.	Until error acknowledgement all outputs are also returned to the safe state via the general shutdown paths. Possible cause is a hardware or cross-circuit error. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x023X 560dez 561dez 562dez 563dez	The least significant four bits display information on the affected output. Range of values: 0: M 1: Zone Z1 2: Zone Z2 3: Zone Z3	At the output displayed a short-circuit or an overload was detected.	The error is displayed by the red illuminated LED for the affected output on the device. An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message and enables a restart of the affected output.
0x025X 592dez 593dez 594dez 595dez 600dez	The least significant four bits display information on the affected output. Range of values: 0: M (High side switch) 1: Zone Z1 2: Zone Z2 3: Zone Z3 8: M (Low side switch)	Hardware test error detected. Test through "light switching" on the displayed output failed.	An error was detected during the test by briefly switching on at the displayed output. A possible cause could be a short-circuit/cross-circuit. The test error could, however, indicate a hardware error. As a result, until error acknowledgement all outputs are also returned to a safe state via the general shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x026X 608dez 609dez 610dez 611dez 616dez 617dez	The least significant four bits display information on the affected output. Range of values: 0: M (High side switch) 1: Zone Z1 (High side switch) 2: Zone Z2 (High side switch) 3: Zone Z3 (High side switch) 8: M (Low side switch) 9: Zone Z1, Z2, Z3 (Common low side switch)	Hardware test error detected. Test through "dark switching" on the displayed output failed.	An error was detected during the test by briefly switching off at the displayed output. The test error could however indicate a cross-circuit or a hardware error. As a result, until error acknowledgement all outputs are also returned to a safe state via the general shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x028X 640dez 648dez 649dez	The least significant four bits display information on the affected output. Range of values: 0: M (High side switch) 8: M (Low side switch) 9: Zone Z1, Z2, Z3 (Common low side switch)	Error in the internal monitoring of the return read signals. The state does not correspond to the expected value. All outputs are maintained in a safe state.	The US2 supply should be checked. The state error could, however, indicate a hardware error. As a result, until error acknowledgement all outputs are also returned to a safe state via the general shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.

Code	Additional Information	Brief Description	Solution
0x029X 656dez 657dez 658dez	The least significant four bits display information on the affected reference voltage source. Range of values: 0 – Internal ref voltage source 1 1 – Internal ref voltage source 2 2 – Internal ref voltage source 3	Hardware test error detected regarding a reference voltage source. All outputs are maintained in a safe state.	The test error could indicate a hardware error at one of the three reference voltage sources in the outputs. As a result, until error acknowledgement all outputs are also returned to a safe state via the general shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x02AX 672dez 673dez 674dez 675dez 680dez 681dez	The least significant four bits display information on the affected output. Range of values: 0: M (High side switch) 1: Zone Z1 (High side switch) 2: Zone Z2 (High side switch) 3: Zone Z3 (High side switch) 8: M (Low side switch) 9: Zone Z1, Z2, Z3 (Common low side switch)	Hardware test error detected regarding the mutual interlocking of the outputs.	During the test an error was detected by briefly switching off via the mutual interlocking of both channels. The test error could indicate a hardware error regarding the mutual switching off capacity of the channels or a cross-circuit between outputs or between the output and external signal. As a result, until error acknowledgement all outputs are also returned to a safe state via the general shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x02CX 704dez 705dez 706dez 707dez	The least significant four bits display information on the affected output. Range of values: 0: M 1: Zone Z1 2: Zone Z2 3: Zone Z3	Implausible signal in the feedback monitoring of the local outputs via the local inputs.	The error is displayed by the red illuminated LED for the affected output on the device. An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message and enables a restart of the affected output.
0x02DX 721dez 722dez 723dez	The least significant four bits display information on the affected output. Range of values: 1: Zone Z1 2: Zone Z2 3: Zone Z3	An error was detected when controlling the relevant valves (non-safe outputs).	The error could indicate a hardware error regarding the activation of the non-safe outputs using SPI communication. The local display is executed by the red illuminated LED for the affected output on the device. An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message and enables a restart of the affected output.

Code	Additional Information	Brief Description	Solution
0x02EX 736dez 737dez 738dez 739dez	The least significant four bits display information on the affected shutdown path of the watchdog module or outputs. Range of values: 0: M 1: Zone Z1 2: Zone Z2 3: Zone Z3	Hardware test error detected regarding the shutdown path via the watchdog module.	An error was detected during the test by briefly switching off via the watchdog module. The test error could indicate a hardware error regarding the switching off capacity of the watchdog module or a cross-circuit between outputs or between the output and external signal. As a result, until error acknowledgement all outputs are also returned to a safe state via the common shutdown paths. The error is displayed on the device by the red illuminated output LEDs. An acknowledgement of this diagnostic message, provided there are no other relevant error messages present, deletes the message, cancels the red LEDs and restarts the outputs.
0x012X 288dez 289dez 290dez 291dez 296dez 297dez 298dez 299dez	The least significant four bits display information on the affected input. Range of values: 0: IN0 1: IN1 2: IN2 3: IN3 8: IN4 9: IN5 A: IN6 B: IN7	Cross-circuit on the displayed input.	A cross-circuit was detected to another input or to an external clock output. The affected input is maintained in a safe state. An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message and releases the affected input provided no other errors are present.
0x013X 304dez 305dez 306dez 307dez	The least significant four bits display information on the affected input pair. Range of values: 0: IN0, IN4 1: IN1, IN5 2: IN2, IN6 3: IN3, IN7	Symmetry violation at the displayed input.	At an input pair in the two-channel mode a violation of the parameterised symmetry was detected. This is only used for the evaluation of contacts in the connected switches. In the event that the switch-on lock is activated during the symmetry violation the inputs are blocked until the acknowledgement of the diagnostic message. Otherwise the input information continues to be captured and sent to the safe control system. An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message.
0x014X 320dez 321dez 322dez 323dez 328dez 329dez 330dez 331dez	The least significant four bits display information on the affected input. Range of values: 0: IN0 1: IN1 2: IN2 3: IN3 8: IN4 9: IN5 A: IN6 B: IN7	Hardware error at the displayed input.	A hardware error was detected at the displayed input by performing internal tests. An acknowledgement of this diagnostic message is possible. The acknowledgement only deletes the message. The restart is only possible after an error-free power-up self-test.

Code	Additional Information	Brief Description	Solution
0x0170 368dez	None	Hardware errors detected. All inputs are maintained in a safe state.	By using an internal self-test mechanism a hardware error at the reference voltage source for the inputs was detected. As a result, all inputs are maintained in a safe state. The acknowledgement deletes the diagnostic message. The restart is only possible after an error-free power-up self-test.
0x018X 384dez 385dez 386dez 387dez	The least significant four bits display information on the affected input pair. Range of values: 0: IN0, IN4 1: IN1, IN5 2: IN2, IN6 3: IN3, IN7	Implausible signal change at the displayed input pair.	An implausible signal change was detected at an input pair in the two-channel mode. In order to reset the error state both inputs must be moved to the safe state. For the depiction of a "1" signal for the affected input pair both inputs must be set (Observe negation in the case of antivalent inputs) An acknowledgement of this diagnostic message is possible. The acknowledgement deletes the message.
0x01EX 480dez 488dez	The least significant four bits display information on the affected clock output. Range of values: 0 – Clock output UT1 8 – Clock output UT2	Short-circuit or overload at the displayed clock output.	At the displayed clock output a short-circuit or overload was detected and, as such, the affected clock output was switched off. The error is displayed by the red illuminated clock output LED on the device. The restart is carried out by the corresponding acknowledgement of the diagnostic message. This means that the relevant connected inputs are also switched on.
0x01F0 496dez	None	Undervoltage was detected at the US1 supply.	Undervoltage was detected at the US1 supply. The error is displayed by the flashing (1 Hz) US1 LED on the device. The LED then illuminates permanently as soon as no undervoltage can be detected. The acknowledgement deletes the message.
0x01F1 497dez	None	Undervoltage was detected at the US2 supply.	Undervoltage was detected at the US2 supply. The error is displayed by the flashing (1 Hz) US2 LED on the device. The LED then illuminates permanently as soon as no undervoltage can be detected. The acknowledgement deletes the message.
0x01F2 498dez	None	The device temperature has reached a critical value.	Critical temperature on the safe slave device. The shutdown (Failure State) is immediately pending. In the event of a further increase in temperature the device firmware puts the device in the failure state. The acknowledgement deletes the diagnostic message.

Code	Additional Information	Brief Description	Solution
0x01F3 499dez	None	Error caused by receiving an unexpected message for the acknowledgement of diagnostic messages.	The allocation of the diagnostic and activation variables on the acknowledgement module should be checked. The device firmware handles this diagnostic message with the highest priority. It is not until this is correctly acknowledged that other errors, if present, are notified.
0x01F4 500dez	None	Error caused by receiving an unexpected value regarding the process data image. All outputs are switched off immediately.	At least one reserved bit in the process data image was set. The process data allocation should be checked. The acknowledgement deletes the message and releases all outputs.
0x01F5 501dez	None	The time between two restarts of the outputs is too short – the time interval must be at least 30 seconds.	By acknowledging one of the following diagnostic messages 0x021X, 0x025X, 0x026X, 0x028X, 0x029X, 0x02AX or 0x02EX, provided there are no other relevant error messages, a restart of the outputs can be triggered. The repetition of this process is only possible after a waiting time.
0x01FD 509dez	None	Only applies to Safety Mode (Module Passivation/xxx)– The SI unit received an invalid process image for the parameter values.	The process image for parameter values must contain valid values. The SI unit needs a HW reset when the process image contains new parameter values. Hardware reset can be performed by downloading a project to the PLC using the configuration software and resetting the power supply of the SI unit.
0x01FE 510dez	None	The start-up mode (CM) was activated.	The acknowledgement deletes the message.

Error Codes for Parameter Errors

Code	Additional Information	Brief Description	Solution
0x04CX 1216dez 1217dez 1218dez 1219dez	The least significant four bits display information on the affected output. Range of values: 0: M 1: Zone Z1 2: Zone Z2 3: Zone Z3	At least one value of the parameter data regarding the feedback monitoring is outside the permitted range of values.	Correct value and resend the parameter data to the device.
0x04DX 1232dez 1233dez 1234dez 1235dez	The least significant four bits display information on the affected output. Range of values: 0: M 1: Zone Z1 2: Zone Z2 3: Zone Z3	In the case of an activated feedback monitoring the relevant input(s) must be occupied.	Correct value and resend the parameter data to the device.
0x030X 768dez 769dez 770dez 771dez	The least significant four bits display information on the affected input. Range of values: 0: IN0, IN4 1: IN1, IN5 2: IN2, IN6 3: IN3, IN7	The parameter sensor evaluation for the input pair displayed is outside the permitted range.	Correct value and resend the parameter data to the device.
0x031X 784dez 785dez 786dez 787dez 792dez 793dez 794dez 795dez	The least significant four bits display information on the affected input. Range of values: 0: IN0 1: IN1 2: IN2 3: IN3 8: IN4 9: IN5 A: IN6 B: IN7	The filter time setting for the displayed input is outside the permitted range.	Correct value and resend the parameter data to the device.
0x032X 800dez 801dez 802dez 803dez 808dez 809dez 810dez 811dez	The least significant four bits display information on the affected input. Range of values: 0: IN0 1: IN1 2: IN2 3: IN3 8: IN4 9: IN5 A: IN6 B: IN7	The clock allocation for the displayed input is outside the permitted range.	Input parameter regarding the clock allocation is not permitted. Correct value and resend the parameter data to the device.

Code	Additional Information	Brief Description	Solution
0x035X 848dez 849dez 850dez 851dez	The least significant four bits display information on the affected input. Range of values: 0: IN0, IN4 1: IN1, IN5 2: IN2, IN6 3: IN3, IN7	The value for the symmetry monitoring is outside the permitted range of values.	For the displayed input pair the value for the symmetry monitoring (discrepancy time) is not in the permitted range. Set the discrepancy time to 'NO LIMIT' and resend the parameter data to the device.
0x03CX 960dez 961dez 962dez 963dez	The least significant four bits display information on the affected input pair. Range of values: 0: IN0, IN4 1: IN1, IN5 2: IN2, IN6 3: IN3, IN7	The filter time for two-channel inputs must be identical.	The value for the filter time for two-channel parameterised inputs must be identical. Correct value and resend the parameter data to the device.
0x03EX 992dez 1000dez	The least significant four bits display information on the affected clock output. Range of values: 0 Clock output channel UT1 8 Clock output channel UT2	The setting for the displayed clock output is outside the permitted range.	Parameters for the displayed clock output are not permitted. Correct value and resend the parameter data to the device.
0x03F2 1010dez	None	Calculated and received checksum for the parameter data does not coincide.	Check the F_iPar_CRC checksum and resend the parameter data to the device.
0x03F5 1013dez	None	At least one reserved bit in the process data is set.	Reserved bits in the received parameter data may not be set.

Parameter error in the COMNG_MODE operating mode.

Code	Additional Information	Brief Description	Solution
0x03F7 1015dez	None	Received F address does not correspond to the expected value.	The F address received and set on the device does not coincide.

Additional parameter error in the transfer of the iParameters.

Code	Additional Information	Brief Description	Solution
0x03FB 1019dez	None	Incorrect sequence of the parameter sets. iParameters follow F parameters.	Internal error. Contact SMC if error persists.
0x03FD 1021dez	None	The PST_DEVICE_ID in the iParameters is incorrect.	Correct value and resend the parameter data to the device. Contact SMC for further details

Error codes for F parameter errors

Code	Additional Information	Brief Description	Solution
0x0040 64dez	None	The parameterised F_destination_address does not coincide with the PROFIsafe address set on the safety module (F module).	Profisafe address on the safety module and value in the F_destination_address must be made to coincide.
0x0041 65dez	None	Invalid parameterisation of the F_destination_address. The addresses 0x0000 and 0xFFFF are not permitted.	Correct the value.
0x0042 66dez	None	Invalid parameterisation of the F_source_address. The addresses 0x0000 and 0xFFFF are not permitted.	Correct the value.
0x0043 67dez	None	Invalid parameterisation of the F_WD_time. A monitoring time of 0 ms is not permitted.	Correct the value.
0x0044 68dez	None	Invalid parameterisation of the F_SIL. The required SIL cannot be supported by the safety module (F module).	Use the device with the required SIL. The safety module reaches SIL 3 as a maximum.
0x0045 69dez	None	Invalid parameterisation of the F_CRC_length. The CRC length generated by the safety module (F module) does not correspond to the required length.	Check device description.
0x0046 70dez	None	F parameter set version is invalid. The version of the safety module (F module) does not coincide with the required version.	Check device description. Only V2 mode permitted.

Code	Additional Information	Brief Description	Solution
0x0047 71dez	None	The checksum calculated by the safety module (F module) via the PROFIsafe parameters (CRC1) does not coincide with the CRC1 transferred in the parameter telegram.	Check F parameters, repeat the calculation.
0x0048 72dez	None	Device-specific diagnosis.	
0x0049 73dez	None	Save iParameter watchdog time exceeded.	-
0x004A 74dez	None	Restore of the iParameter watchdog time exceeded.	-
0x004B 75dez	None	Invalid F_iParCRC	Correct the value.
0x004C 76dez	None	F_Block_ID is not supported.	Check device description.
0x004D 77dez	None	Reserved	-
0x004E 78dez	None	Reserved	-
0x004F 79dez	None	Unspecified (unknown) error.	-

16.2. PROFIsafe errors

The following errors can also occur:

- PROFIsafe system errors: see [Section 20 “Diagnostic messages for parameter errors for PROFIsafe”](#) or PROFINET system errors. For information on these errors, refer to the documentation for the system used.

16.3. Acknowledging an error for PROFIsafe

- Remove the cause of the error.
- Acknowledge the diagnostic message.
- Parameterization errors cannot be acknowledged. In this case, proceed as follows:
- Check the parameterization.
- Adapt the parameterization.
- Download the new data record.

For instructions on error acknowledgment, refer to the documentation for the controller used.

⚠️ WARNING: Hazardous machine state/unintentional machine startup

With the exception of a few special cases, the acknowledgment of an error can result in a hazardous state as well as unintentional machine startup since the safe input is immediately returned to the operating state.

- Before acknowledging an error you must make sure that acknowledgment will not cause the machine to switch to a hazardous state.
- When planning the machine or system, make sure that acknowledgment is only possible if the danger zone is visible.

⚠️ WARNING: Unintentional machine startup

Startup /restart following power up and when there is no longer a demand of the safety function can result in unintentional machine startup.

- Please note that:
 - The module starts up once the configuration and parameterization data record has been downloaded successfully and internal testing has been completed without errors.
 - A safety-related input is automatically reset to “1” when the safety function trigger is reset.
- If you do not want the machine to restart automatically, configure the safety logic accordingly.

17. Appendix A: glossary

A definition of PROFIsafe terms is also provided in the PROFIsafe profile.

CRC

Cyclic Redundancy Check

A cyclic redundancy check is used to verify the validity of the process data contained in the safety telegram, check whether the assigned address books are correct, and verify the safety-related parameters. This value is part of the safety telegram.

Cross circuit

A wiring fault where 2 signals are accidentally swapped e.g. UT1 and UT2 are incorrectly wired to the wrong inputs. See also definition for 'Short circuit'

Consecutive number

Method for ensuring that the safe data is transmitted completely and in the correct order.

F-Parameter

(According to PROFIsafe system description, Version 09, November 2007)

F-Parameters contain information for adapting the PROFIsafe layer to customer specifications and for checking the parameterization by means of a separate method (diverse). The main F-Parameters are:

F_Source/Destination_Address (F-Address for short)

The F-Source address is combined with the F-destination address to generate a 'Codename' to identify the communication relationship between two devices. The technology part of the F-Device compares the value with the address switch locally or with an assigned F-Address in order to check the authenticity of the connection.

F_WD_Time

Specifies the millisecond value for the watchdog timer. The timer monitors the time that elapses until the next valid PROFIsafe message is received.

F_SIL

Indicates the SIL that the user can expect from the relevant F-Device. It is compared with the manufacturer's specification that is stored locally.

F_iPar_CRC

A checksum that is calculated from all i-Parameters of the technology-specific part of the F-Device.

F_Par_CRC

A CRC signature, which is created via all F-Parameters and ensures error-free transmission of the F-Parameters.

F-CPU

Failsafe controller, safe controller

F_Destination_Address

F-Parameter; PROFIsafe destination address; address of the safe module (see also ["F-Parameter"](#))

F-I/O device

Failsafe I/O device, safe input and/or output modules

Modules with integrated safety functions, which are approved for safety-related operation.

F-Slave

Failsafe slave

F_Source_Address

F-Parameter, PROFIsafe source address; address of the safe controller (see also [“F-Parameter”](#))

F-System

Failsafe system

A failsafe system is a system that remains in the safe state or immediately enters a safe state when specific failures occur.

i-Parameter

Individual safety parameters of a module

OSSD

An Output Signal Switching Device is a safety related output of a sensor that are self-checked.

Passivation

If the safety module (F-I/O device) detects an error, it switches the affected channel or all channels of the module to the safe state. The channels are passivated. The detected errors are indicated at the safe controller.

For a safe input module when the F-System is passivated, instead of the process values present at the safe inputs, “0” substitute values are provided for the safety program.

For a safe output module when the F-System is passivated, instead of the output values provided by the safety program, “0” substitute values are transferred to the safe outputs.

PI

PROFIBUS & PROFINET International

PNO

Profibus Nutzerorganisation e.V

Process Image

Area within system memory that holds an image of the CPU and distributed IO values

PROFIsafe

Safety-related bus profile based on PROFIBUS DP or PROFINET. The profile defines the communication between a safety program and the safe I/O device (F-I/O device) in a safe system (F-System).

PROFIsafe address

Each safe module has a PROFIsafe address. Set this address on the safety module (F-I/O device) via DIP switches and then configure it in the configuration tool for the safe controller.

PROFIsafe monitoring time

Monitoring time for safety-related communication between the safe controller (F-CPU) and safe I/O device (F-I/O device).

This time is parameterized in the F_WD_Time F-Parameter.

Short circuit


Signal is either short circuited to another signal or 0V. See also definition for ‘Cross circuit’

18. Appendix B: F-Parameters



The values indicated in italics in Table are preset by the system and cannot be modified manually.

Table 19-1 Overview of the F-Parameters for the module

F-Parameter	Default value	Description
F_Source_Address	1	The parameter uniquely identifies the PROFsafe source address (controller address). The address is assigned automatically.
F_Destination_Address	1	PROFsafe destination address (address of the safe module). The address is assigned automatically. However, the value can be modified. Ensure each individual device is assigned a unique address. Make sure that the value set under F_Destination_Address is the same as the value that you have set via the 10-pos. DIP switch. Value range: 1 ... 1023
F_WD_Time	150	Monitoring time in the module. A valid current safety telegram must arrive from the safe controller during the monitoring time. Otherwise the module enters the safe state. The selected monitoring time must be sufficiently high for telegram delays to be tolerated by the communication, but still ensure a sufficiently fast error response in the event of an error (e.g., interruption in communication). Value range: 1 ... 10000, in 1 ms increments Unit: ms
F_SIL	SIL 3	Safety integrity (SIL according to IEC61508) of the module.  Safety functions up to SIL 3 can be achieved with the module. The safety integrity level that can actually be achieved depends on the parameterization, the structure of the sensor, and the cable installation: See Section 8.2 "Parameterisation" .
F_CRC_Length	3 byte CRC	This parameter transmits the length of the CRC2 code to be expected in the safety telegram to the safe controller.
F_Block_ID	1	Parameter block type identification. 1: the parameter block of the F-Parameters contains the F_iPar_CRC parameter.
F_Par_Version	1	Version number of the F-Parameter block. 1: valid for V2 mode.
F_iPar_CRC	0	CRC checksum via the i-Parameters. The value must be greater than 0. When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all modules. IF not, check the i-Parameters and the CRC checksum in the i-Parameter and F-Parameter.

19. Appendix C: i-Parameters

The i-Parameters are individual module parameters. These include:

- Module parameters: see [Section 8.2.2.4](#) and [Section 8.2.2.5](#).

iPar_CRC

The module parameters are verified with a checksum: iPar_CRC.

F_Destination_Address

This address is the PROFIsafe address of the module. Make sure that it matches the switch position of the 10-pos. DIP switch.

20. Appendix D: Diagnostic messages for parameter errors for PROFI-safe

Table 21-1 F-Parameter parameter errors

Error code		Error cause	Remedy
dec	hex		
64	40	The parameterized F_Destination_Address does not match the PROFI-safe address set on the module (F-Module).	Make sure that the PROFI-safe address of the module and the value in F_Destination_Address are the same.
65	41	Invalid parameterization of F_Destination_Address. Addresses 0000 _{hex} and FFFF _{hex} are not permitted.	Correct value.
66	42	Invalid parameterization of F_Source_Address. Addresses 0000 _{hex} and FFFF _{hex} are not permitted.	Correct value.
67	43	Invalid parameterization of F_WD_Time. A monitoring time of 0 ms is not permitted.	Correct value.
68	44	Invalid parameterization of F_SIL. The safety module (F-Module) cannot support the required SIL.	Use a module with the required SIL. The safety module achieves SIL 3, maximum.
69	45	Invalid parameterization of F_CRC_Length. The CRC length generated by the safety module (F-Module) does not match the required length.	Check device description.
70	46	Invalid F_Parameter record version. The safety module (F-Module) version does not match the required version.	Check device description. Only V2 mode permitted.
71	47	The checksum determined by the safety module (F-Module) via the PROFI-safe parameters (CRC1) does not match the CRC1 transmitted in the parameter telegram.	Check F-Parameters. Repeat calculation.
72	48	Device-specific diagnostics.	
73	49	Save i-Parameter watchdog time exceeded.	
74	4A	Restore i-Parameter watchdog time exceeded.	
75	4B	Invalid S_iParCRC.	Correct value.
76	4C	F_Block_ID is not supported.	Check device description.
77	4D	Reserved.	
78	4E	Reserved.	
79	4F	Non-specified (unknown) error.	

Table 21-2 i-Parameter parameter errors

AddValue (hex)	Error cause	Remedy
03F2	iPar_CRC is incorrect.	Check i-Parameters. Repeat calculation.
03FD	PST_Device_ID is incorrect.	Contact SMC

21. Appendix E: Checklists

The checklists listed in this section provide support when carrying out the following tasks on the EX245-FPS1/2/3 SI unit: planning, assembly and electrical installation, startup, parameterization, and validation.

These checklists may be used as planning documentation and/or as verification to ensure the steps in the specified phases are carried out carefully.

Archive the completed checklists to use as reference for recurring tests.

The checklists do not replace the validation, initial startup, and regular testing performed by qualified personnel.

The following section of a checklist shows an example of a completed checklist.

Checklist				
Device type/equipment identification		EX245-FPS1		
Version: HW/SW	01/1.1.1	Date	2015-July-1st	
Test engineer 1	John Smith	Test engineer 2	Jane Brown	
Remark	System XXX has been checked for engine hood production			
No.	Requirement (mandatory)	Yes		Remark
X				
No.	Requirement (Option)	Yes	No	Remark
Y				

Key:

Equipment identification:

Enter the device type and/or the equipment identification for the relevant module.

Version:

HW/FW enter the hardware and firmware version of the module as shown on the label on the SI Unit."

For details of the label on the SI Unit, see [Section 10.10](#).

Date:

Enter the date on which you began to fill in this checklist.

Editor:

Enter the name of the editor.

Test engineer:

Enter the name of the test engineer.

Remark:

Enter a remark, if necessary.

Requirement (mandatory):

These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.

Requirement (optional):

These requirements are optional. For points that are not met, please enter an appropriate remark in the relevant field.

E1: Planning

Checklist for planning the use of the module				
Device type/equipment identification				
Version: HW/FW		Date		
Test engineer 1		Test engineer 2		
Remark				
No.	Requirement (mandatory)	Yes	Remark	
1	Has the current module user manual been used as the basis for planning?		Revision:	
2	Are the actuators approved for connection to the module (according to the technical data and parameterization options?)			
3	Has the voltage supply been planned according to the specifications for the protective extra-low voltage in according with PELV?			
4	Has the power supply of US1 and US2 from a power supply unit been planned?			
5	Is external protection of the module planned (according to the specifications in this user manual for supply voltage US1 and US2)			
6	Are measures planned to prevent simple manipulation of US1 and US2?			
7	Are measures planned to prevent connectors being mixed up?			
8	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved and is the corresponding implementation planned?			
9	Are the specifications for the parameterization for each channel specified?			
10	Are test intervals specified for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?			
11	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?			
12	Does the planned use correspond to the intended use?			
13	Are the ambient conditions as well as the maximum mechanical load observed according to the technical data?			
14	Have test intervals been defined and has the maximum duration of use been taken into consideration?			
15	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?			
No.	Requirement (optional)	Yes	No	Remark
16	Have specifications for assembly and electrical installation been defined (e.g., EPLAN) and communicated to the relevant personnel?			
17	Have specifications for startup been defined and communicated to the relevant personnel?			
		Date	Signature (editor)	
		Date	Signature (test engineer)	

E2: Assembly and Electrical Installation

Checklist for Assembly and Electrical Installation of the module				
Device type/equipment identification				
Version: HW/FW		Date		
Editor		Test engineer		
Remark				
No.	Requirement (optional)	Yes		Remark
1	Was assembly completed according to the specifications (specifications form the planning phase or according to the user manual)?			
2	Are all unused ports fitted with a blanking cap?			
3	Do the cable cross sections and installation correspond to the specifications?			
4	Does the connection technology correspond to the specifications in the technical data and in the relevant user manual?			
No.	Requirement (optional)	Yes	No	Remark
5	Is the data width set correctly according to the specifications?			
6	Is the profile/PROFIsafe address set correctly according to the specifications?			
		Date	Signature (editor)	
		Date	Signature (test engineer)	

E3: Startup and Parameterisation

Checklist for startup and parameterization of the module				
Device type/equipment identification				
Version: HW/FW		Date		
Editor		Test engineer		
Remark				
No.	Requirement (optional)	Yes		Remark
1	Was startup completed according to the specifications (specifications from the planning phase or according to the user manual)?			
2	During startup, is it ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?			
3	Are all parameters parameterized for the outputs & inputs and is the F_WD_Time set correctly/			
4	Are the output test pulses parameterized according to the actuator to be connected?			
No.	Requirement (optional)	Yes	No	Remark
5	Have safety distances that must be observed been calculated according to the response and delay times implemented/			
		Date	Signature (editor)	
		Date	Signature (test engineer)	

E4: Validation

Checklist for			
Device type/equipment identification			
Version: HW/FW		Date	
Editor		Test engineer	
Remark			
No.	Requirement (optional)	Yes	Remark
1	Have all the mandatory requirements for the "Planning" checklist been met?		
2	Have all the mandatory requirements for the "Assembly and electrical installation" checklist been met?		
3	Have all the mandatory requirements for the "Startup and parameterization" checklist been met?		
4	Does the parameterization of the safe outputs correspond to the version and the actual connection of the controlled device?		
5	Has the assignment of the actuators to the outputs and the variables of the safe application program been tested(online status in SafetyProg)?		
6	Has a function test been performed to check all safety functions, in witch the module is involved?		
7	Have measures been taken to achieve a specific Cat.?		
8	Do all cables correspond to he specifications?		
9	Does the voltage supply correspond to the specifications for the protective extra-low voltage in accordance with PELV?		
10	Have the voltage supply of US1 and US2 in system from a power supply unit been implemented?		
11	Is external protection of the module implemented (according to the specifications in this user manual for supply voltage US1 and US2)?		
12	Have measures been taken to prevent simple manipulation?		
13	Are the requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL?		
14	Are the specifications for the parameterization for each channel implemented?		
15	Are test intervals specified for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?		
16	Has it been ensured that any person intentionally starting hazardous movements can only do so with a directly view of the danger zone?		
		Date	Signature (editor)
		Date	Signature (test engineer)

22. Appendix F: Safety Characteristics

Operation Item	Output with Two Channel Input	Outputs (only)	Two Channel Input (only)	Output with Single Channel Input	Single Channel Input (only)
SFF		99.98%			99.98%
PFDAV (T) Average Probability of Dangerous Failure		1% of 10^{-3}			1% of 10^{-2}
PFH (T) Probability of dangerous failure per hour		1% of 10^{-7}			1% of 10^{-6}
Achievable Safety Level		SIL3 / PL e			SIL2 / PL d

Comment:

The Outputs and internal Safety Logic always operate in Two-Channel Mode.
 The Module achieves with or without Two-Channel-Inputs Safety Level SIL3 / PL e.
 In combination with Single-Channel-Inputs the Module can only achieve SIL2 / PL d.

23. Appendix G: EX245-FPS Timing Values

Specific timing values of SMC EX245-FPS1/2/3

Input delay	: tFilter + 2 ms
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tFilter = Parameterized filter time

Output delay ¹	: 1 ms
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WCDT in	: Input delay + 12 ms
----------------	------------------------------

WCDT out	: Output delay ¹ + 12 ms
-----------------	--

One Fault delay time (OFDT) IN 1oo2	: WCDT in
--	------------------

One Fault delay time (OFDT) IN 1oo1	: 122 ms
--	-----------------

One Fault delay time (OFDT) OUT M	: WCDT out
--	-------------------

One Fault delay time ¹ (OFDT) OUT Z1..3	: 30 ms
---	----------------

Device acknowledge time (DAT)	: 20 ms
--------------------------------------	----------------

For calculating/determining the response time (safety function response time – SFRT) please look at the user manual of the used safe profinet controller.

¹Output delay time of the valves are not considered

24. Appendix H: Cybersecurity

In recent years, factories have introduced industrial IoT, building up complex networks of production machines. These systems maybe subject to a new threat, cyberattack. To protect the industrial IoT from cyberattacks, it is important to take multiple measures (multi-layer protection) for IoT devices, networks and clouds.

For this purpose, SMC recommends that the following measures are always taken into consideration. For further details of the following measures, please see security information published by your local country security agencies.

1. Do not connect the devices via a public network.

- If you unavoidably need to access the device or cloud via a public network, ensure to use a secure, private network such as VPN.
- Do not connect an office IT network and factory IoT network.

2. Build a firewall to prevent a threat from entering the device and system.

- Set up a router or firewall at network boundaries to allow minimum required communications.
- Disconnect from the network or turn off the device, if no continuous connection is required.

3. Physically block an access to unused communication ports or disable them.

- Inspect regularly each port if any unnecessary device is connected to the network system.
- Operate necessary services (SSH, FTP, SFTP, etc.) only.
- Set a transmission range of the device using a wireless LAN or other radio system to the minimum required and use only devices approved according to the radio act in the country concerned.
- Install a device generating radio waves in such place as there is no interference from indoor or outdoor.

4. Set up a secure communication method such as data encryption.

- Encrypt data in every environment, including IoT networks, secure gate-way connections, for secure communications.

5. Grant access permissions by user accounts and limit the number of users.

- Regularly review accounts and delete all unused accounts or permissions.
- Establish an account lockout system to block an access to the account for a certain period if log-in fails more than the given threshold.

6. Protect passwords.

- Change the default password when you first use the device or system.
- Choose a long password (minimum 8 characters) using a mix of different letters and characters to make the password more secure and harder to hack.

7. Use the latest security software.

- Install antivirus software on all computers to detect and remove viruses.
- Keep the antivirus software up to date.

8. Use the latest version of the device and system software.

- Apply patches to keep the OS and applications up to date.

9. Monitor and detect abnormalities in the network.

- Keep monitoring the network for any abnormalities to take a prompt measure and issue an alert if any abnormality is detected. Install an intrusion detection system (IDS) and intrusion prevention system (IPS).

10. Delete data from devices when disposed of.

- Before disposing of any IoT devices, delete stored data or physically destruct media to prevent any misuse of the data.

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SMC Corporation

4-14-1, Sotokanda, Chiyoda-ku, Tokyo 101-0021 JAPAN

Tel: + 81 3 5207 8249 Fax: +81 3 5298 5362

URL <https://www.smcworld.com>

Note: Specifications are subject to change without prior notice and any obligation on the part of the manufacturer.
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