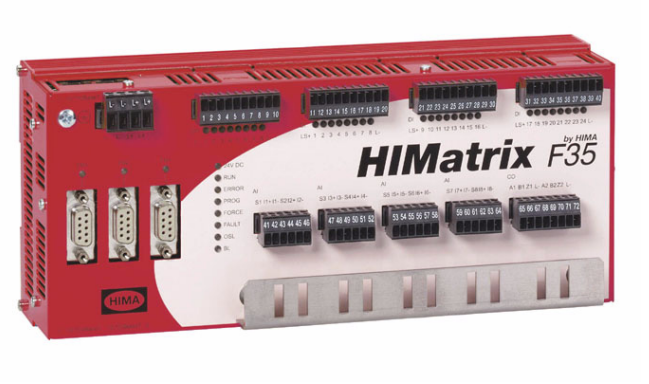
XPSMF35
Hardware Manual

07/2007

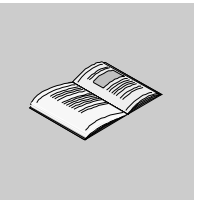


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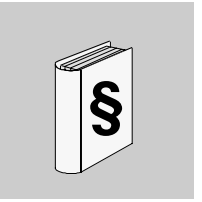
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Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION

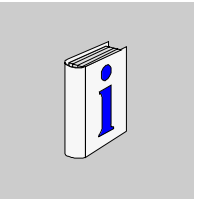
CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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About the Book



At a Glance

Document Scope

This manual describes the XPSMF35 Safety Programmable Logic Controller (PLC). XPSMF35 is identical to HIMatrix F35 Safety PLC.

The following descriptions of the XPSMF35 Safety PLC are included in this manual:

- dimensions and installation
- application and function
- equipment description
- application examples

Validity Note

The XPSMF35 Safety PLC has been tested and certified by TÜV for functional safety in accordance with CE and the standards listed below:

- TÜV Anlagentechnik GmbH Automation, software, and information technology Am Grauen Stein 51105 Köln
- Certificate and test report No. 968/EZ 128.04/03 Safety-related automation devices
  HIMatrix F35
- International standards
  - IEC 61508, parts 1-7: 2000, up to SIL 3
  - EN 954-1: 1996, up to Category 4
  - EN 298: 1994
  - NFPA 8501:1997
  - NFPA 8502: 1999
  - EN 61131-2: 1994 and A11: 1996, A12: 2000
  - EN 61000-6-2: 2000, EN 50082-2: 1996, EN 50081-2: 1993
  - EN 54-2: 1997
  - NFPA 72: 1999
- National standards
  - DIN V VDE 0801: 1990 and A1: 1994
  - DIN V 19250: 1994, up to RC6
  - DIN VDE 0116: 1989, prEN 50156-1: CDV 2000

The corresponding programming software is XPSMFWIN. The software is executable in the Microsoft Windows 2000/XP. The software helps you to create safety-related programs and operate the Programmable Electronic System (PES).

Note: The declaration of conformity is provided within the hardware product's packaging. All devices are labelled with the CE sign.

Product Related Warnings

Schneider Electric assumes no responsibility for any errors that may appear in this document. If you have suggestions for improvements or amendments or have found errors in this publication, please notify us.

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to ensure compliance with documented system data, only the manufacturer should perform repairs to components.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this product's safety-related warning can result in injury or equipment damage.

User Comments

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Overview: XPSMF35

1

At a Glance

Overview

This chapter contains an overview of the XPSMF35 Safety PLC.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Introduction	12
Representation	13
Dimensions	14
Installation	16

Introduction

XPSMF35 Safety PLC

XPSMF35 is a programmable Safety PLC designed to monitor safety functions up to safety Category 4 according to EN 954-1 and SIL 3 according to IEC 61508. XPSMF35 is a compact programmable electronic system (PES) in a metal housing with

- 24 programmable digital inputs,
- 8 programmable digital outputs,
- 2 counters,
- 8 analog inputs

The XPSMF35 is suitable for mounting in EX zone 2. There are 3 versions of the XPSMF35:

- XPSMF3502: contains no Field bus
- XPSMF3522: contains Modbus Serial Slave
- XPSMF3542: contains Profibus Serial Slave

The Safety PLC is a highly visible product thanks to its red color housing. The product's overall ingress protection rating is IP 20. The XPSMF35 is an extremely versatile product and can be used in all areas of a factory floor. In areas where conditions are harsh, explosive or generally dangerous, extra protection in the form of enclosures is available to optimize the product's performance, prolong its life, and enhanced safety within each factory environment. The XPSMF35 is a very powerful Safety PLC and is very easy to program and install.

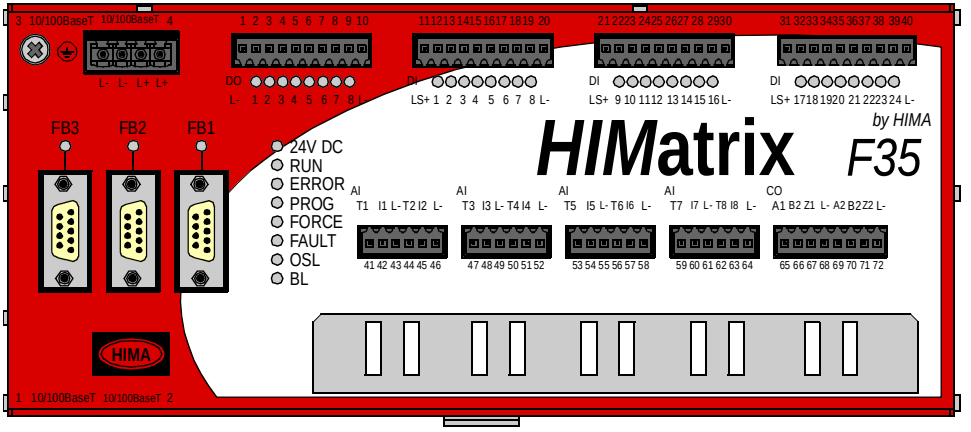
Representation

Overview

This section provides an image of the XPSMF35 Safety PLC.

Front View

The following image shows the front view of the XPSMF35 Safety PLC:



Dimensions

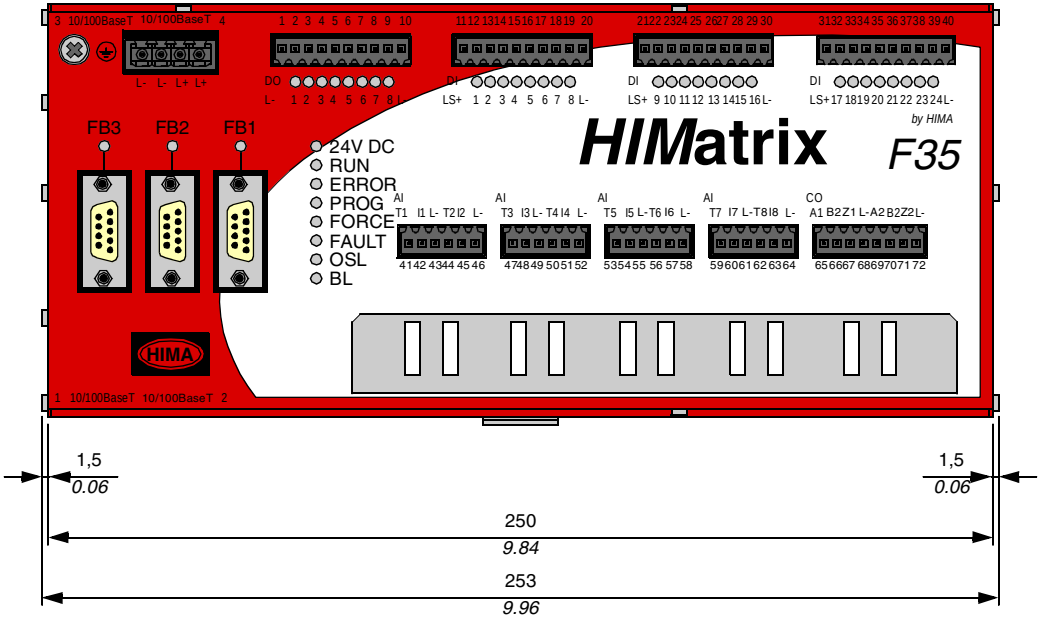
Overview

The following section contains information about the dimensions of the XPSMF35 Safety PLC showing the front and side views of the Safety PLC.

Front View Dimensions

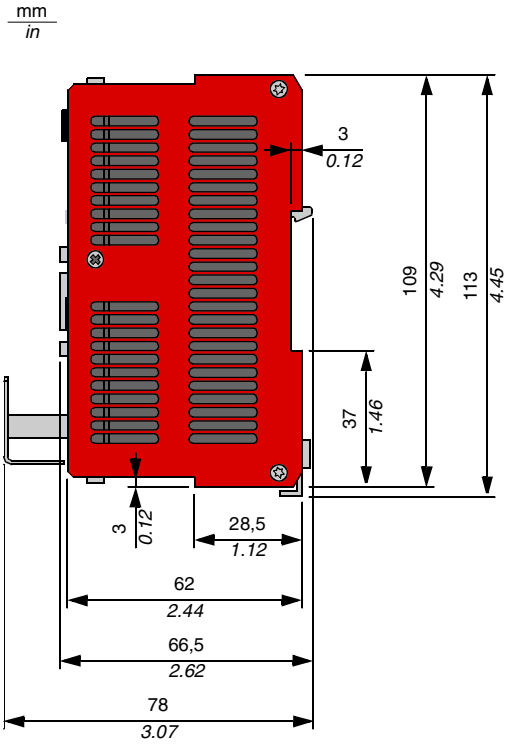
The following image shows the front view dimensions of the XPSMF35 Safety PLC:

mm
in



Side View Dimensions

The following image shows the side view dimensions of the XPSMF35 Safety PLC:



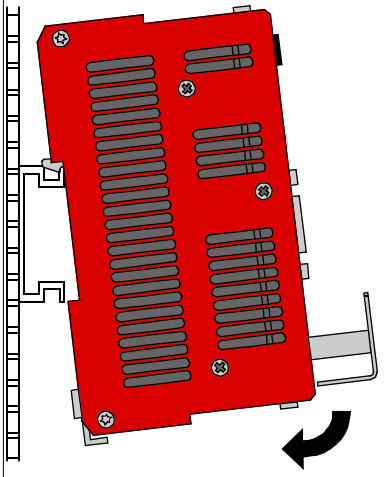
Installation

Introduction

The XPSMF35 Safety PLC can be installed on mounting bases and within closed cases, such as control stations, all terminal boxes, and control racks. The XPSMF35 has been developed in compliance with all applicable standards for EMC, climate, and environmental requirements.

Procedure

Mounting the Safety PLC requires the following steps:

Step	Action
1	Pull down the quick release clip.
2	Position the Safety PLC on the DIN rail. 
3	Release the clip.

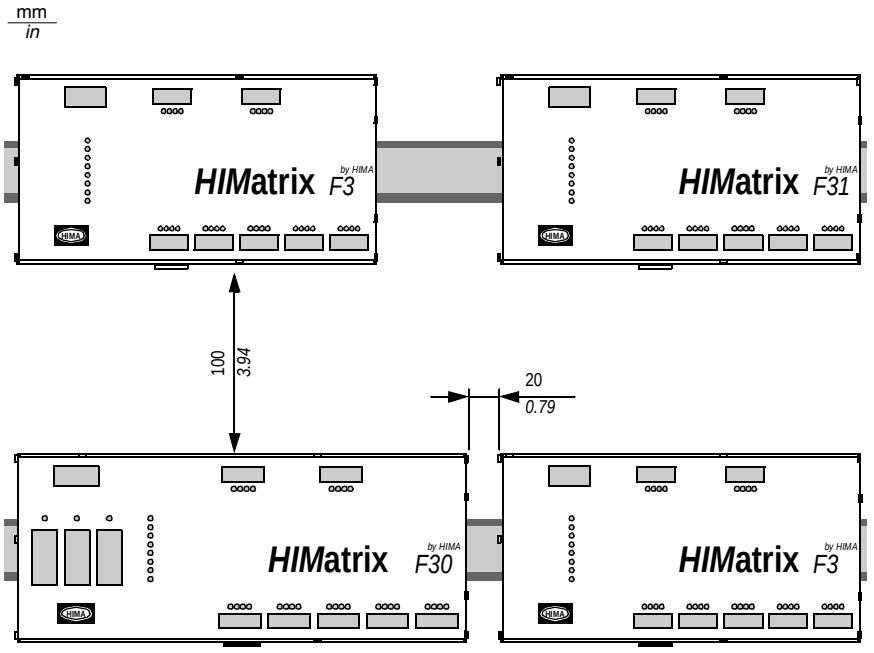
Mounting the Safety PLC

Mount the Safety PLC horizontally (so the F35 logo on the front panel is facing you) to allow sufficient ventilation. We advise you not to mount the Safety PLC in a vertical position, because this would require additional measures to ensure the device does not move.

The minimum distance to any neighboring device from another manufacturer is as follows:

- vertical space of at least 100 mm (3.93 in.)
- horizontal space of at least 20 mm (0.78 in.)

Minimum clearances for XPSMF35 and Remote I/O (Compact devices)



Note: The installation must be performed so that

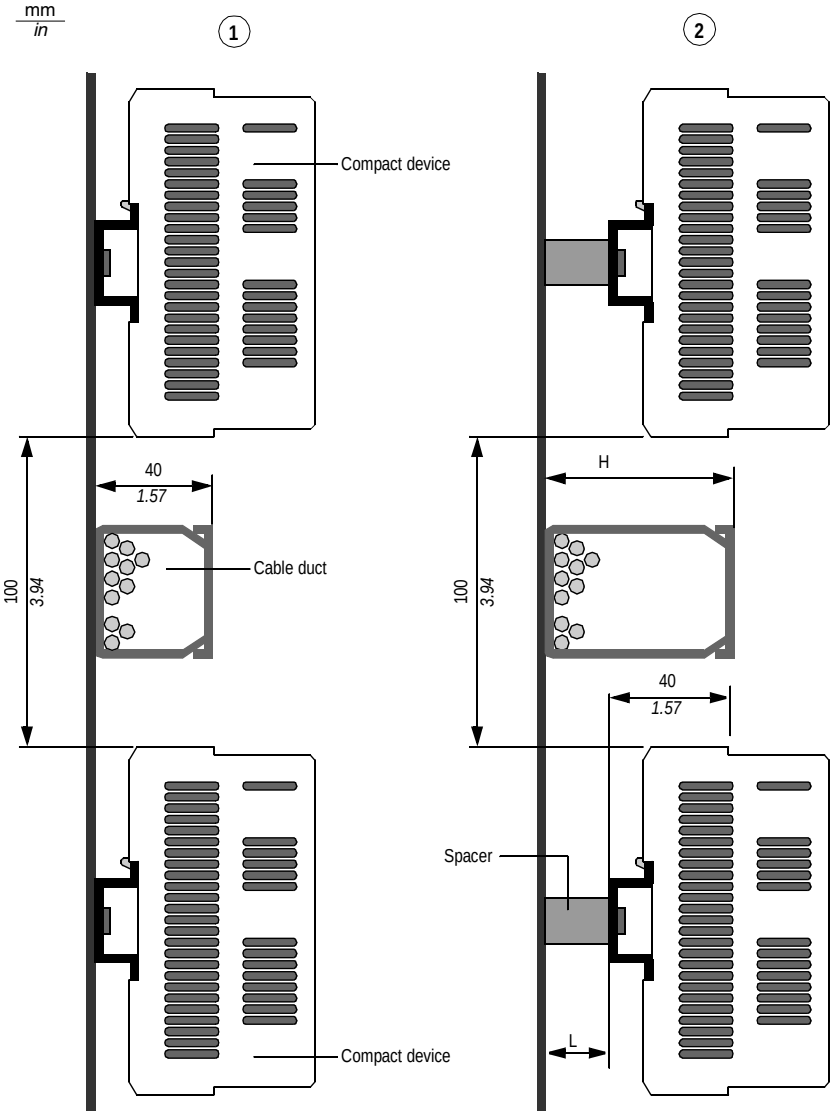
- the device is not subject to heat emission from neighboring devices and
- devices with high EMC interference do not affect the XPSMF35.

Devices from other manufacturers must be checked for heat emission and electromagnetic compatibility (EMC) to ensure that the Safety PLC's operation is not affected by any external device.
The overall installation space for all cables must also be taken into account to ensure sufficient ventilation. Additional measures, such as installing heat extraction fans, can be taken if the product's housing becomes warm.

Air Circulation

The ventilation slots in the housing must not be covered. When installing the XPSMF35 ensure that the height of the cable ducts does not exceed 40 mm (1.57 in.). If the cable duct is higher than 40 mm (1.57 in.), spacers must be placed behind the DIN rail. The illustration below shows an example of using spacers.

Use of cable ducts with horizontal mounting of compact devices on rails



Installation with spacers

No.	Description
1	The height of the cable ducts is less than 40 mm / 1.57 in.
2	The height of the cable ducts is greater than 40 mm/1.57 in.

The length of the required spacer is calculated as follows:

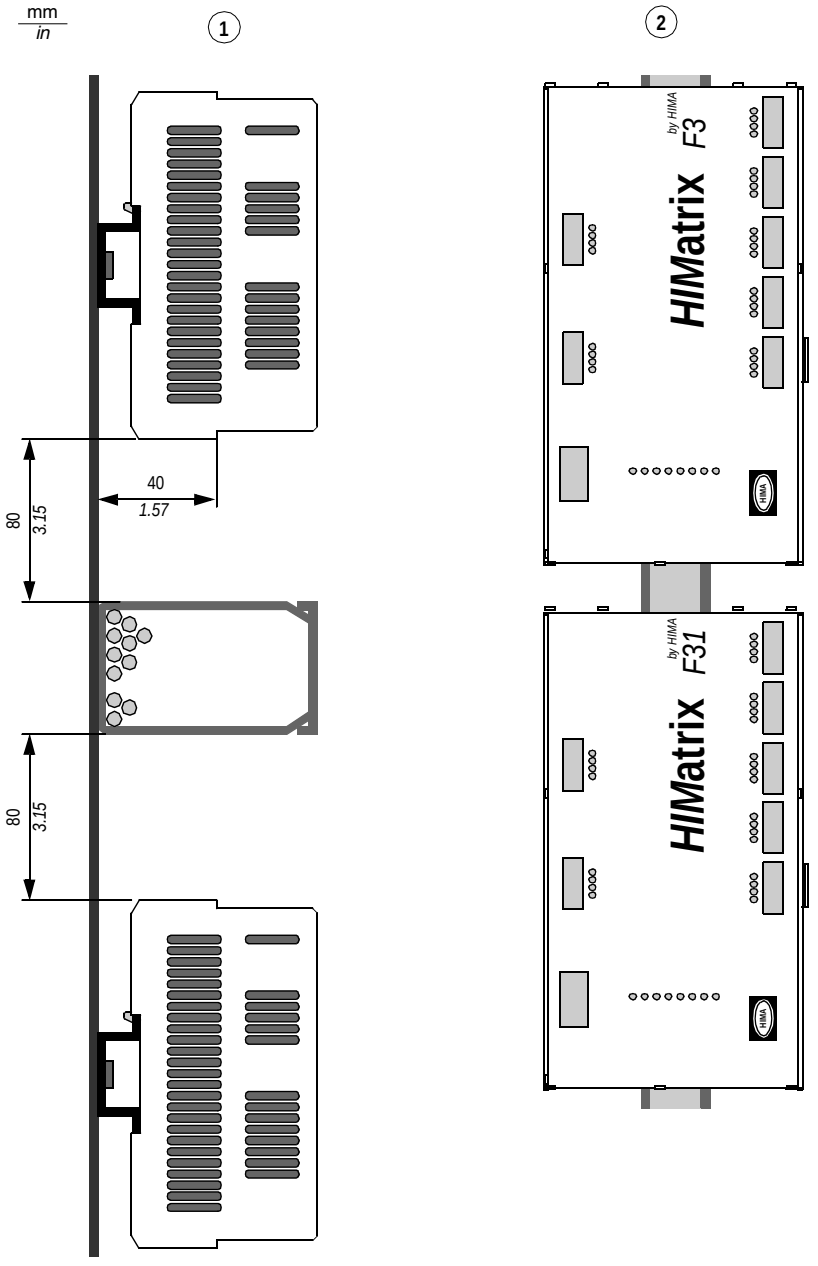
L = H - 40 mm (1.57 in.)

L = length of the spacer

H = height of the cable duct

If more than 2 devices (even when the minimum vertical clearance of 100 mm (3.94 in.) is observed) are installed 1 above the other, additional ventilation measures are required to ensure even temperature distribution. The illustration below shows the minimum clearance if the DIN rails are not installed on spacers.

The following images show the minimum clearance between the XPSMF35 Safety PLCs:



Minimum clearance between the Safety PLCs

No.	Description
1	Installation with spacers: the cable duct is higher than 40 mm / 1.57 in; the vertical separation increases.
2	The XPSMF35 Safety PLC is mounted vertically (not recommended).

Note: Additional means are required to ensure that the Safety PLC does not slide downwards while operating; any movement may cause strain on the wiring.

On open mounting surfaces, observing the minimum clearance and ensuring unobstructed air circulation will help maintain the optimum operating temperature.

Heat

Due to the increasing integration of electronic components into smaller parts large amounts of heat are dissipated on small surface areas. The amount of heat produced depends on the device's external load. Depending on the design of the device, installation, design location, air circulation, and environmental conditions have a very significant impact on the product’s operating temperature.

It is important to comply with the approved environmental conditions when installing the device. Reduced operating temperature extends the life of the device and reliability of the installed components.

If the XPSMF35 requires an additional enclosure to increase the ingress protection, the enclosure case must be designed in such a way that the heat generated inside it can dissipate from the surface of the enclosure. The type of enclosure and the installation location chosen must enable easy heat dissipation. If possible, a fan should be used to ensure air circulation.

Note: An additional enclosure can be used to increase the ingress protection of the XPSMF35 Safety PLC.

Depending on the mounting or installation type, the enclosure's surface area (A) is calculated as follows.

The following table is used to calculate the recommended enclosure size for mounting the XPSMF35:

Case installation		**Calculation of A [m^2] ($1m^2$=$10.76ft^2$)**
Single case free on all sides		A = 1.8 x H x (W + D) + 1.4 x W x D
Single case for wall mounting		A = 1.4 x W x (H + D) + 1.8 x H x D
End case free-standing		A = 1.4 x D x (W + H) + 1.8 x W x H
End case for wall mounting		A = 1.4 x H x (W + D) + 1.4 x W x D
Center case free-standing		A = 1.8 x W x H + 1.4 x W x D + H x D
Center case for wall mounting		A = 1.4 x W x (H + D) + H x D
Center case for wall mounting, top surface covered		A = 1.4 x W x H + 0.7 x W x D + H x D
A the enclosure's surface area **W** width **H** height **D** depth		

Internal Convection

Due to internal heat convection, the heat is dissipated outside through the walls of the housing. This is possible when the ambient temperature is lower than the temperature inside the housing.

The following table describes the variables used to calculate the internal convection:

Variable	Description
P_v [W]	heat output (heat dissipation) of the electronic components
A [m^2] / [ft^2]*	effective surface area of the housing
k [W/m^2 K]*	the housing heat transfer coefficient (e.g., Steel sheet: approximately 5.5 W/m^2 K)*

* ($1m^2$=$10.76ft^2$)

The maximum temperature increase of all electronic devices inside the housing is calculated as follows:

$$(\Delta T)max = \frac{Pv}{k \bullet A}$$

The power dissipation P_v can be calculated based on the values of the electrical power of the controller, its inputs, and outputs.

Temperature State/Operating Temperature

The controllers are designed to operate with the maximum temperature of 60 °C (140 °F). The temperature states in single modules and PLCs are evaluated by the CPU module or the PLC's CPU for compact systems. The temperature state of a particular module or PLC is measured by a sensor. The sensor monitors the temperature state of the PLC automatically and continuously.

The following table shows the ranges in which the temperature state signals the measured temperature:

Temperature Range	Temperature State
< 60 °C (<140 °F)	normal
60 to 70 °C (140 °F to 158 °F)	high temperature
> 70 °C (> 158 °F)	very high temperature
Return to 64 °C (147.2 °F)	high temperature
Return to < 54 °C (<129.2 °F)	normal

Note: The difference in temperature increase and decrease ranges is due to the sensor's hysteresis that equals 6 °C (10.8 °F).

Temperature state **High temperature** indicates the following:

operating temperature = max temperature (delta T) max + ambient temperature >= 60 °C (131 °F).

In this case, support the internal convection by adding air grilles or increasing the free space between the PLCs.

Temperature state **Very high temperature** indicates the following:

operating temperature = max temperature (delta T) max + ambient temperature >= 70 °C (140 °F).

In this case, support the internal convection by integrating additional active cooling elements (fan, coolant devices, etc.) or increasing the free space around the PLCs.

If the sensor indicates a temperature increase above the critical threshold, the temperature state changes. The temperature states can be evaluated using the **Temperature State** system signal of the XPSMFWIN.

Application and Function

2

At a Glance

Overview

This chapter describes the application and function of XPSMF35 Safety PLC.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Initial Operation	26
Application	27
Function	28
Offline Proof-Test	51

Initial Operation

Overview

The following section contains information about the initial operation of the XPSMF35 Safety PLC.

First Power-Up

The following table describes the first power-up behavior of the XPSMF35 Safety PLC:

Stage	Description
1	Power Supply LED (green) is illuminated for 0.5 s.
2	All LEDs are illuminated for 5 s.
3	24 VDC LED is illuminated. Prog LED (orange) is flashing. The Safety PLC is awaiting a program.

Connection with Existing Configuration and Program

The following table describes initial operation when the XPSMF35 Safety PLC is connected with an existing configuration and program:

Stage	Description
1	Power Supply LED (green) is illuminated for 0.5 s.
2	All LEDs are illuminated for 5 s.
3	24 VDC LED (green) is illuminated. Program LED (orange) is flashing for 15 s.
4	Program checked. 24 VDC LED (green) is illuminated. RUN LED (green) is illuminated or flashing dependant on the program settings.

⚠ DANGER

HAZARD OF ELECTRICAL SHOCK, EXPLOSION OR ARC FLASH

Disconnect all power before servicing equipment.

Failure to follow these instructions will result in death or serious injury.

Application

Overview

The XPSMF35 Safety PLC is certified to the following standards:

- SIL 3, according to IEC 61508
- Category 4, according to EN 954-1
- IEC 61131-2
- prEN 501156
- DIN V 19250 up to RC 6
- NFPA 8501, NFPA 8502
- EN 54-2: 1997
- NFPA 72: 1999

The extensive hardware range and safe data transmission allow the system to be optimized to suit anticipated or existing plant structures.

The safety-related networking of the Safety PLC takes place on Ethernet, which is based on standard Ethernet technology and is certified to TÜV/BG. Using the SafeEthernet protocol, the Ethernet medium allows safety data to be transmitted at 100 Mbit/s (half duplex) and 10 Mbit/s (full duplex) and supports the use of the entire range of Ethernet functions for networked applications.

A combination of a high-speed Safety PLC and a high-speed safety bus protocol (SafeEthernet) offers new levels of flexibility for automation process solutions.

Today's system limits of safety-related automation concepts are disappearing. Scope is being created for truly application-based solutions.

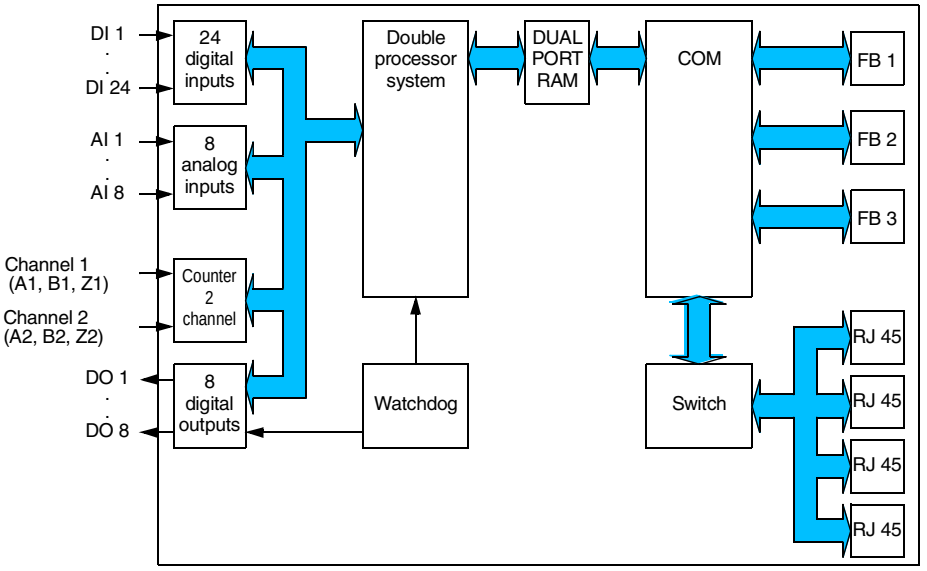
Key features of the XPSMF35 Safety PLC are

- certification up to SIL 3, according to IEC 61508.
  Category 4, EN 954-1
- communication via SafeEthernet and Modbus TCP/IP
- Field bus communications available for non-safety data transfer include: Profibus serial slave and Modbus serial slave
- versatility (You can use the Safety PLC in all environmental conditions with additional equipment.)
- quick and easy network configuration
- user-friendly interfaces
- use with fire alarm systems

Function

Overview This section describes functions of the XPSMF35 Safety PLC.

Block Diagram The following is a block diagram of the XPSMF35 Safety PLC:



The following table describes the components of the diagram

Item	Description
Inputs	• 24 digital inputs • 8 analog inputs • 6 counter inputs for 2 counters
Outputs	8 digital outputs
Double Processor System	Each processor processes the same data and is compared.
Watchdog	The watchdog control unit monitors cycle time.
Dual Port RAM	contains the PES memory
COM	Field bus 2 (FB2) for • Modbus Serial Slave • Profibus Serial Slave
Switch	4-port switch with a built-in **auto cross-over** function, which allows using both the 1:1 and cross-over cables
RJ45	4 RJ 45 connectors for 1:1 or cross-over cable

Line Monitoring

The analog inputs of the XPSMF35 can be used for the monitoring of line break and short-circuit (line monitoring) of its own digital outputs DO and digital outputs of other XPSMF Safety PLCs.

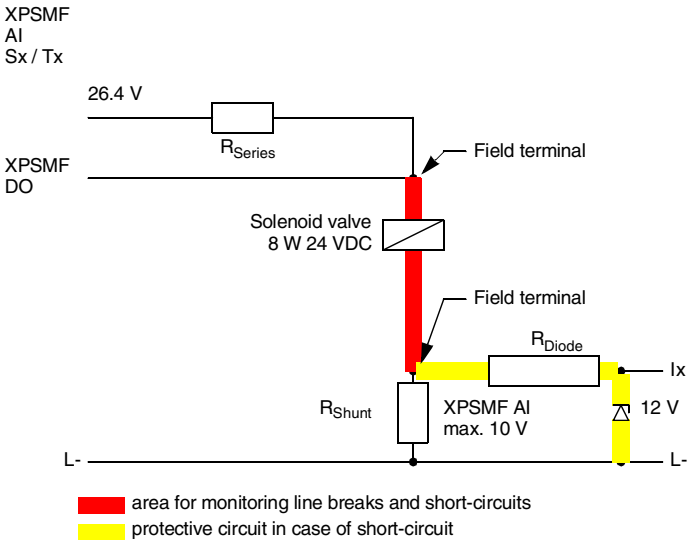
Preconditions:

The digital outputs of any XPSMF PLC can be monitored with analog inputs of any XPSMF device:

Provided that

- transmitter voltage for analog inputs is available and that
- the connection of an external measuring shunt resistor.

The following circuit scheme shows a method of monitoring the lines from a digital output to an actor (solenoid valve):



Note: The circuit has to be adapted to the used field devices and checked for correct operation!

The following tables show an example of parameterization of line monitoring of a digital output (scheme with solenoid valve 8 W 24 VDC):

Resistance Values	
Series	R_{series} = 1.6 kΩ
Resistor Solenoid Valve	$R_{solenoid\ valve}$ = 75 Ω
Shunt	R_{Shunt} = 10 Ω

Voltage Values	
Transmitter Voltage	26.4 V
Output Voltage DO (normal)	24 V
Output Voltage DO in Case of Short-Circuit	26.8 V
Voltage Drop at Solenoid Valve	21 V
Switching Voltage of Zener Diode	12 V

The following table shows voltage values at line monitoring of DO:

Measured Values for Voltage at AI With Line Monitoring of DO				
Voltage Drop R_{series}	Voltage Drop $R_{solenoid\ valve}$	Voltage Drop R_{shunt}	Values for AI (at resolution FSx000)	
			FS1000	FS2000
Output DO False or 0 (Output DO de-energized)				
25.08 V	1.15 V	0.15 V	14	28
Output DO True or 1 (Output DO energized)				
-	21 V	3 V	300	600
Break in Field Circuit				
-	-	0 V	0	0
Short-Circuit in Field Circuit or Actuator				
-	0 V	26.8 V	1000	2000
			(maximum resolution of the analog inputs AI at voltage limitation to 12 V by zener diode)	

Line Control (Line Break)

The supply voltage of the series (transmitter supply) varies within a tolerance range (see *Technical Data, p. 82*). Therefore, the voltage drops of the resistances can slightly change. Within the limits of variation of the transmitter voltage, a measurable voltage drop at the shunt R_{shunt} occurs.

The value of the series resistor (R_{series}) is such that when DO = FALSE a small voltage drop occurs at the solenoid valve (the valve is heated slightly), and the voltage drop at the shunt is measurable.

The shunt resistor (R_{shunt}) size is determined with reference to the solenoid valve resistance. If there is an energized output (DO = TRUE), the voltage drop at the solenoid valve is beyond the threshold of the valve, i.e., the solenoid of the valve operates.

The shunt resistor (R_{shunt}) size is determined so that with reference to the state of the digital output DO (TRUE or FALSE), a measurable voltage drop always occurs. No voltage drop at the shunt is observed, if a line break occurs within the red marked area.

A line break in the red marked area can be monitored by the voltage drop at the shunt resistor R_{shunt} with an input value of AI.

For line monitoring, the value of AI must be evaluated within a logic of the application program in XPSMFWIN.

Note: Connect the series resistor (R_{series}) and the shunt resistor (R_{shunt}) directly to the terminal at the controller or the remote I/O to maximize the monitored part of the circuit.

Line Control (Short-Circuit)

A short-circuit in the actuator circuit (including the actuator) results in a high voltage drop (≤ output voltage of DO) via the shunt. Here a short-circuit can be detected (maximum resolution of AI). Overvoltage protection of the analog inputs starts at approximately 15 V (see *Technical Data, p. 82*). A protective circuit consisting of zener diode and series must be built to avoid an overload of the internal overvoltage protection.

⚠ WARNING

PROTECTIVE CIRCUIT

To protect the input multiplexer of the analog inputs, a protective circuit consisting of zener diode and series parallel to the existing shunt must be built in the input circuit.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The configuration of the zener diode with series depends on the threshold of the overvoltage protection and must be configured in this way so that the internal overvoltage protection of the XPSMF does not react in the case of a short-circuit.

Configuration Example for a Short-Circuit

R_{shunt} = 10 Ω

$R_{solenoid\ valve}$ = 75 Ω

U_{max} = 26.8 Ω (maximum output voltage of digital output DO)

- zener diode with switching voltage of 12 V
- analog input AI with working range of 0 - 10 V
- overvoltage protection in XPSMF35 at input voltage > 15 V

In a normal case (no short-circuit), the following occurs:

- $U_{max} = U_{solenoid\ valve} + U_{shunt}$ = 26.8 V = 21 V + 5.8 V
- The voltage U_{shunt} drops also at protective circuit of zener diode and series.
- The zener diode does not switch at 5.8 V, i.e., the voltage drop of 5.8 V at the shunt is the same as at the analog input.

In case of a short-circuit, the following occurs:

- $U_{max} = U_{solenoid\ valve} + U_{shunt}$ = 26.8 V = 0 V + 26.8 V
- If a short-circuit in a field circuit (actuator or line) occurs, the voltage of DO drops only at the shunt.
- The threshold of the voltage protection of AI is approx. 15 V.
- The zener diode switches at 12 V. The voltage drops at AI and thus never exceeds 12 V. The full scale at AI is available.
- The maximum voltage drop U_{diode} at the series R_{diode} of the zener results in U_{diode} = 26.8 V - 12 V = 14.8 V.
- The current in the zener diode is limited to 20 mA (according to the specification of the zener diode). The minimum value for the series results in R_{diode} = 14.8 V / 20 mA = 740 Ω.
- The value of R_{diode} can be set to 1 kΩ.
- The maximum current in the zener diode is limited by this resistance to approximately 15 mA.

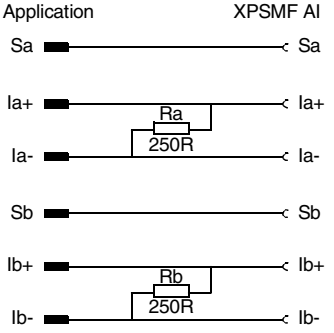
A short-circuit in the area marked in red (see the diagram above) can be monitored via the voltage drop at the shunt R_{shunt}, i.e., via input value of AI.

For line monitoring a short-circuit, the value of AI must be evaluated within a logic of the application program in XPSMFWIN.

Shunt Adapter

The shunt is a plug-in module for the analog inputs of the safety-related controller XPSMF35. The resistance value is 250 Ω or 500 Ω.

The following image is the wiring diagram of the shunt adapter (250 Ω):



The following table shows the terminal assignment of the shunt adapter:

Designation	Function (analog inputs)
Sa	transmitter supply a
Ia+	analog input a
Ia-	reference pole a
Sb	transmitter supply b
Ib+	analog input b
Ib-	reference pole b

Safety-Related Digital Inputs

The XPSMF35 Safety PLC has 24 digital inputs. The 24 LEDs (DI) indicate the status of the inputs.

The digital inputs are analog inputs that provide the program with an INT value ranging from 0 to 3000 (0 to 30 V). These are used to create limit values to calculate boolean signals for the digital inputs. The default values are adjusted to the following values:

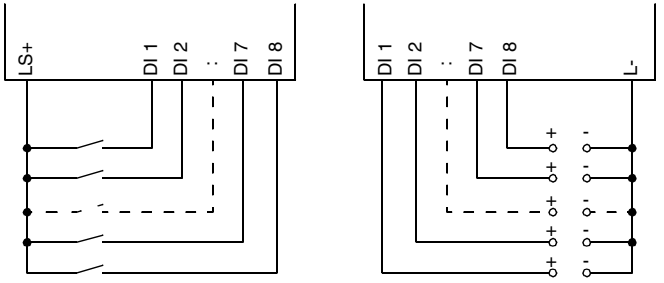
- 0-signal: < 7 V
- 1-signal: > 13 V

The settings of the thresholds are carried out using system signals (chapter 1.6) regarding the safety accuracy.

Note: The program only activates the LEDs that indicate the status of the digital inputs if the F35 is in RUN.

Short-circuit-proof 24 V sources supply potential free sensor contacts with LS+. A voltage source provides power to a group of 4 sensors.

Signal sources with their own dedicated power supply can also be connected instead of contacts. The reference pole of the signal source must then be connected to the reference pole of the input (L-).



Connection of potential-free contacts

Connection of signal voltage sources

The safe state of the input is indicated by a 0-signal being passed to the logic of the user program. If the test routines detect a fault in the digital inputs, a 0-signal is processed in the user program for the defective channel according to the deenergize to trip principle. The FAULT LED is then illuminated.

The deenergize to trip principle should be used with external wiring and when connecting sensors. To create a safe state in case of a fault, the input signals revert to the deenergized state (0-signal). The external line is not monitored, but a wire break is interpreted as a safe 0-signal.

The following table shows connections of the digital inputs to the corresponding terminals:

Terminal No.	Designation	Function (inputs)
11	LS+	sensor supply for inputs 1 to 8
12	1	digital input 1
13	2	digital input 2
14	3	digital input 3
15	4	digital input 4
16	5	digital input 5
17	6	digital input 6
18	7	digital input 7
19	8	digital input 8
20	L-	reference pole
21	LS+	sensor supply for inputs 9 to 16
22	9	digital input 9
23	10	digital input 10
24	11	digital input 11
25	12	digital input 12
26	13	digital input 13
27	14	digital input 14
28	15	digital input 15
29	16	digital input 16
30	L-	reference pole
31	LS+	sensor supply for inputs 17 to 24
32	17	digital input 17
33	18	digital input 18
34	19	digital input 19
35	20	digital input 20
36	21	digital input 21
37	22	digital input 22
38	23	digital input 23
39	24	digital input 24
40	L-	reference pole

Surge on Digital Inputs

In the case of digital inputs, an EN 61000-4-5 surge impulse can be read as a short-time high signal (caused by the short cycle time of the XPSMF35 system).

To avoid errors in these cases, 1 of the following measures must be taken in respect to the applications:

- installation of shielded input lines to prevent the effects of surges in the system
- noise blanking in the application program - a signal must be present for at least 2 cycles before it is evaluated

Note: Proper EMC design techniques will allow the designer of the safety system to achieve the maximum performance by using the minimum response time of the safety PLC.

Safety-Related Digital Outputs

The XPSMF35 Safety PLC has eight digital outputs. Each digital output has its own LED to indicate the status of the output.

An output is in a safe state when it is deenergized. At channel faults the concerning outputs are switched off. If the module has a fault all outputs are switched off. In the event of a fault occurring with the Ethernet communication the concerning outputs are set to their initial values. How the actuators respond in such a case should be taken into account.

Faults in one or more channels as well as a fault on the module are indicated by the FAULT LED on the front plate. In addition, the system signals in the application program of the controller can be evaluated.

The following table shows the dependence between the ambient temperature and current of the outputs:

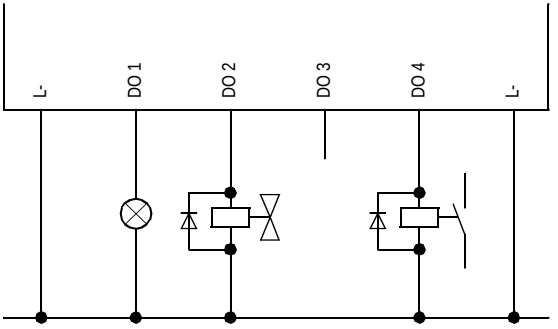
Ambient Temperature	Outputs
20 to 50 °C (68 to 122 °F)	Outputs 1-3 and 5-7 each supply up to 0.5 A. Outputs 4 and 8 can each supply up to 2 A.
50 °C (122 °F) (maximum)	Outputs 1-3 and 5-7 can each supply up to 0.5 A. Outputs 4 and 8 can each supply up to 1 A.
60 °C (140 °F) (overload)	One or all outputs are switched off. When the overload is eliminated, the outputs are activated again, according to the specified value (see *Technical Characteristics, p. 81*).

The external wiring of an output is not monitored, but a short-circuit will be detected.

The following table shows designations and functions of terminals 1-10:

Terminal No.	Designation	Function (outputs)
1	L-	reference pole channel group
2	1	digital output 1
3	2	digital output 2
4	3	digital output 3
5	4	digital output 4 (for increased load)
6	5	digital output 5
7	6	digital output 6
8	7	digital output 7
9	8	digital output 8 (for increased load)
10	L-	reference pole channel group

The following diagram shows an example of connecting actuators to the outputs:



The above diagram shows an example of how to connect actuators to the outputs of the Safety PLC system. It is possible for inductive loads to be connected to the Safety PLC without using a protection diode on the load. However, to suppress any possible interference voltage, we strongly recommend using the protection diode, as shown in the example above.

⚠ WARNING

INTERNAL PROTECTIVE CIRCUITS CANNOT WORK

For connection of a load the appertaining reference pole L- of the concerned channel group must be used (2-pole connection), so that internal protective circuits can work.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Safety-Related Counters

The device has 2 independent counters whose inputs can be configured for a voltage level of 5 V or 24 V. The required voltage level is determined by the initial value of the signal with the `Counter[0x].5/24 V Mode` system signal.

Input **A** is the counter input. Input **B** is the counter direction input. Input **Z** (zero track) is used for a reset. Alternatively, all inputs are 3-bit Gray Code inputs (with decoder operation, see below).

The following operating states can be implemented:

- Counter function 1 (depends on count direction input signal)
  System signal `Counter]0x].Auto.Advance Sense` set to TRUE, counting with falling edge on input: A1 (A2)
  `Low Signal` on count direction input B1 (B2) increments the counter value.
  `High Signal` on count direction input B1 (B2) decrements the counter value.
  The counter can not be reset within the XPSMFWIN software.
  For this mode, the Z1 (Z2) input must be set to `Low Signal`. The counter can be reset with a short-time `High Signal`.
- Counter function 2 (independent of count direction input signal)
  System signal `Counter[0x].Direction` set to FALSE, counting with falling edge on input A1(A2).
  The incrementing and decrementing is not controlled externally by input B1 (B2), but by the application program. System signal `Counter[0x].Direction` set to FALSE increase of the counter value. System signal `Counter[0x].Direction` set to TRUE decrease of the counter value.
  Input B1 (B2) has no function.
  the counter can be reset with XPSMFWIN via the system signal `Counter[0x].Reset`.
- Absolute rotary transducer (encoder) for Gray Code
  The 3-bit Gray Code of a rotary transducer (connected to inputs A1, B1, Z1 (A2, B2, Z2) is evaluated. This mode is defined in the application program with the system signal `Counter[0x].Gray Code`. This is done separately for each counter.

The safety-related counter has a 24-bit resolution, the maximum counter value is 2^{24} - 1 (= 16 777 215).

The following tables show the configuration of the counters for various operating states.

Configuration of counter function 1 (depends on count direction input signal):

System Signal	Meaning	Value
`Counter[0x].5/24 V Mode`	inputs: 24 V 5 V	 TRUE FALSE
`Counter[0x].Auto Advance Sense`	counter function 1 active	TRUE
`Counter[0x].Direction`	no function	FALSE
`Counter[0x].Gray Code`	pulse operation active	FALSE
`Counter[0x].Reset`	standard reset: short-time	TRUE FALSE

Configuration of counter function 2 (independent on count direction input signal):

System Signal	Meaning	Value
`Counter[0x].5/24 V Mode`	inputs 24 V 5 V	 TRUE FALSE
`Counter[0x].Auto Advance Sense`	counter function 2 active	FALSE
`Counter[0x].Direction`	increase decrease	FALSE TRUE
`Counter[0x].Gray Code`	pulse operation active	FALSE
`Counter[0x].Reset`	standard reset: short-time	TRUE FALSE

Configuration of the rotary transducer (encoder):

System Signal	Meaning	Value
`Counter[0x].5/24 V Mode`	inputs 24 V 5 V	 TRUE FALSE
`Counter[0x].Auto Advance Sense`	counter function 1 passive	FALSE
`Counter[0x].Direction`	no function	FALSE
`Counter[0x].Gray Code`	decoder operation active	TRUE
`Counter[0x].Reset`	standard (no function)	TRUE

When a counter is operated as a decoder in Gray Code, only 1 bit may change when a value of the inputs changes.

The following table provides a comparison of the codes used:

3.bit Gray Code	Decimal Value	Counter[0x].Value
000	0	0
001	1	1
011	2	3
010	3	2
110	4	6
111	5	7
101	6	5
100	7	4

The counter inputs must be connected using shielded twisted-pair cables for each measurement input. The shields must be connected at both ends. The input lines should be no more than 500 m (1640.4 ft) in length. All L-connections are interconnected on the module in the form of a common reference pole. To ensure the counters are used in a safety-related manner (SIL 3 in accordance to IEC 61508), the whole system (including the connected sensors or encoders) must satisfy these safety requirements.

The following table shows connections of the counters:

Terminal No.	Designation	Function (counter inputs)
65	A1	input A1 or bit 0 (LSB)
66	B1	input B1 or bit 1
67	Z1	input Z1 or bit 2 (MSB)
68	L-	common reference pole
69	A2	input A2 or bit 0 (LSB)
70	B2	input B2 or bit 1
71	Z2	input Z2 or bit 2 (MSB)
72	L-	common reference pole

Unused inputs must not be terminated.

Safety-Related Analog Inputs

The device has 8 analog inputs with transmitter supplies for the unipolar measurement of voltages ranging from 0 to 10 V, referenced to L-. With a shunt, currents of 0 to 20 mA can also be measured.

The following table shows input values for the analog inputs:

Input Channels	Polarity	Current, Voltage	Range of Values in the Application		Safety Accuracy
			FS1000[1]	FS2000[1]	
8	unipolar	0...+10 V	0...1000	0...2000	2%
8	unipolar	0...20 mA	0...500[2] 0...2000[3]	0...1000[2] 0...2000[3]	2%

[1] settable via type selection in XPSMFWIN

[2] with external shunt adapter 250 Ω

[3] with external shunt adapter 500 Ω

The resolution of the voltage and current values within the application program depends on the settings in the properties of the module.

In XPSMFWIN, in the **Properties** menu of the module, go to **Type**. The resolution 1000 (MI 24/8 FS1000) or 2000 (MI24/8 FS2000) can be selected. As to the subject of selection, different resolutions of the `AI[xx].Value` signal within the application program are available.

To monitor the `AI[xx].Value` signal, the `AI[xx].Error Code` signal must be evaluated in the application program.

The input signals are evaluated using the de-energize-to-trip principle. The feeder lines should be no more than 300 m (984.2 ft) in length and must be shielded twisted-pair cables for each measurement input. The shields must be connected at both ends (at the device and at the case of the sensor or actuator) over a wide area to create a Faraday cage.

Unused analog inputs must be short-circuited.

If an open-circuit fault occurs during the voltage measurement, unpredictable input signals will be received on the high-resistance inputs. The value resulting from this fluctuating input voltage is not reliable. Thus, with voltage inputs, a 10 kΩ resistor must terminate the channels. The internal resistance of the source should be taken into account.

For a current measurement, with the shunt connected in parallel, the 10 kΩ resistor is not required.

The analog inputs are not electrically isolated from each other.

The analog inputs are connected to the following terminals:

Terminal No.	Designation	Function (analog inputs)
41	S1	transmitter supply 1
42	I1	analog input 1
43	L-	reference pole
44	S2	transmitter supply 2
45	I2	analog input 2
46	L-	reference pole
47	S3	transmitter supply 3
48	I3	analog input 3
49	L-	reference pole
50	S4	transmitter supply 4
51	I4	analog input 4
52	L-	reference pole
53	S5	transmitter supply 5
54	I5	analog input 5
55	L-	reference pole
56	S6	transmitter supply 6
57	I6	analog input 6
58	L-	reference pole
59	S7	transmitter supply 7
60	I7	analog input 7
61	L-	reference pole
62	S8	transmitter supply 8
63	I8	analog input 8
64	L-	reference pole

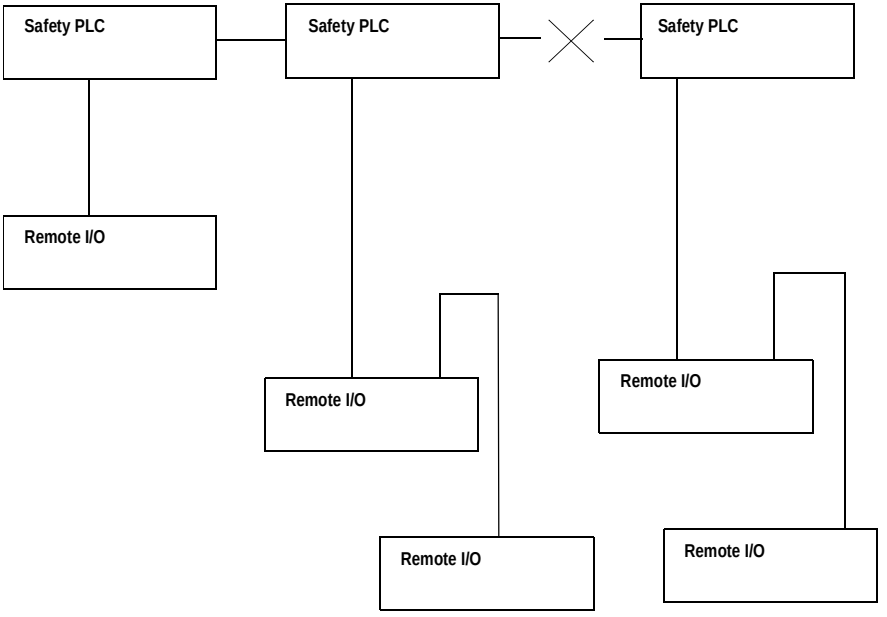
Cable Disconnection

In a Safety PLC network, areas are covered using the Safety network. Therefore, damage or disconnection of the communications cable may occur. In the system below, the X represents a cable break between Safety PLC 2 and Safety PLC 3. The communications between each of the systems will cease.

The following table shows what happens, if communication ceases:

If...	Then...
the Safety PLC 2 system was dependent on the inputs of the Safety PLC 3 system,	the corresponding outputs will automatically be set to zero.
the Safety PLC 3 system was dependent on the inputs of the Safety PLC system,	the corresponding outputs will automatically be set to zero.
the systems are still provided with the 24 VDC power supply,	2 systems will continue to operate the remaining inputs and outputs of each separate system.

The following diagram shows an example of the Safety PLC network interruption:



If the local network is reacting only on the inputs of the same system, the PLC system continues to run without failure.

Power Supply Interruption

The following table shows reactions to the changes in operating voltage:

Voltage Level	Reaction of the Controller
19.3 to 28.8 VDC	normal operation
< 18.0 VDC	alarm state (internal variables are written and put to the inputs/ outputs).
< 12.0 VDC	Inputs and outputs are switched off.

If the power supply is interrupted, all inputs and outputs discontinue and return to the off safe state.

Small System Reconfiguration

A Safety PLC can be reconfigured while the network is executing an existing configuration. The resources that require reconfiguration must be stopped. The following table describes the reconfiguration procedure:

Step	Action
1	Using the XPSMFWIN programming environment, stop the Safety PLC's system which requires the new configuration.
2	Download the new configuration fully checked by a qualified safety engineer to the Safety PLC or Remote I/O module via Ethernet cable Cat 5, grade D or better.
3	Once the module is re-programmed, start the device.
4	Execute the new configuration immediately.

Large System Reconfiguration

The following table describes the reconfiguration procedure for large systems:

Step	Action
1	Stop the relevant resources within the network using the XPSMFWIN programming environment. Small segments of a network can be reconfigured in stages.
2	Connect your PC to any Ethernet communications point.
3	Download the new configuration(s) fully checked by a qualified safety engineer to the Safety PLC network via Ethernet cable Cat 5, grade D or better.
4	Restart all devices, preferably in stages - system by system.

Short-Circuit Characteristics of the Output Channels

If...	Then...
a short-circuit occurs in an output channel	the Safety PLC switches off the affected channel.
multiple short-circuits occur,	the channels are switched off individually in accordance with their power consumption.
the permitted maximum current for all outputs is exceeded	all outputs are shut down and cyclically reconnected.

⚠ WARNING

SHORT-CIRCUIT CONDITION

The output circuit terminals must not be connected with the connected load. In case of a short-circuit, the resulting high current may damage the terminals.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Diagnostics

Using the XPSMFWIN programming environment, all the Safety PLC's inputs and outputs can be viewed. Each Safety PLC provides diagnostic signals with reference to their status, error codes, and channel status.

In XPSMFWIN all diagnostic information can be viewed in 2 ways:

- Using the online test function - it can monitor the values of the signals and variables within the logic plan, while the systems are executing the program.
- Using the **Diagnostics** window that displays all states of the CPU, COM, and I/O modules.

Replacing Faulty Modules

If a Safety PLC or remote I/O fails, the following replacement procedure is used:

Step	Action
1	Disconnect the power supply to the specific module.
2	Disconnect all terminals (removing the input or output wires is not required).
3	Disconnect communication - Ethernet and any other field buses - from the Safety PLC or remote I/O.
4	Loosen the DIN rail clip and dismount the module.
5	Mount the new module and tighten the DIN rail clip.
6	Re-connect power supply.
7	Connect to the PC that is executing XPSMFWIN via Ethernet cable.
8	Enter new communication settings for MAC address and IP address.
9	Download the configuration used by the previous module.
10	Connect all I/O terminals to the new module. Rewiring is not necessary, but the terminals must be inspected to ensure they are in good operating condition.
11	Re-establish network connection.
12	Run the module.

Testing I/Os for Interference Voltage and Earth Faults

Inadmissible interference voltage can be measured with a universal tester. We recommend testing every single terminal for unapproved interference voltage.

When testing the external cables for insulation resistance, short-circuit, and line break, the cables must not be connected at both ends to prevent defects or destruction of the XPSMF35 caused by excessive voltages.

Earth faults are to be tested before connecting the field cable to the devices. The feed voltage must be disconnected from the sensors, as well as between the negative pole and the actuators. If the negative pole is earthed during operation, the earth connection must be disconnected while testing for earth faults. This also applies to the earth connection of an existing earth fault tester. Every terminal can only be tested against earth with a resistance tester or a similar test instrument.

Testing the insulation of 1 or more wires against earth is admissible, but not 2 muted wires. High voltage testing is also not admissible.

Guidelines to measure circuit voltage and insulation resistance can be found in EN 50178.

Maintenance

The XPSMF35 Safety PLC is designed for industrial applications. All the Safety PLC's components have a very high availability and are compliant with the requirements of IEC 61508 for PFD and PFH in accordance with SIL 3.

Note: For safety-related use, the modules have to be subjected to an offline proof test in intervals of 10 years. For Offline Proof Test, see *Offline Proof-Test, p. 51*.

⚠ WARNING

OFFLINE PROOF TEST

Offline Proof Test according to IEC 61508-4 must be conducted to verify proper operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Repair of PLC Devices

You may not repair the XPSMF35 Safety PLC. Defective devices must be returned to Schneider Electric for repair.

The validity of the safety certificate will expire if unauthorized repairs have been made on the device. The manufacturer will bear no responsibility for unauthorized repairs. Unauthorized repairs will also cancel all warranties for the device.

Offline Proof-Test

Overview

The offline proof-test recognizes dangerous concealed faults that would affect the safe function of the plant.

Safety systems have to be subjected to an offline proof test in intervals of 10 years. By an analysis using the calculation tool SILence, the interval often may be extended. (SILence is a separate program. Contact the service for more information or take a look at the HIMA homepage for a test version of the software SILence.)

For relay modules, the proof test for the relays has to be carried out in intervals defined for the respective plant.

Execution of the Offline Proof Test

The execution of the offline proof test depends on the configuration of the plant (EUC = equipment under control), which risk potential it has, and which standards for operation are applied and form the bases for the approval by the test authority in charge.

According to the standards IEC 61508 1-7, IEC 61511 1-3, IEC 62061, and VDI/VDE 2180 sheet 1 to 4, in case of safety-related systems the operating company has to arrange for proof tests.

Periodic Proof Testing

The modules can be proof tested by executing the full safety loop.

In practice the input and output field devices have a more frequent proof test interval (e.g., every 6 or 12 months) than the modules. If the end-user tests the complete safety loop because of the field devices then the modules are automatically included in these tests. No additional periodic tests are required for the modules.

If the proof test of the field devices does not include the modules then the PES needs to be tested as a minimum once in 10 year. This can be done by executing a reset of the modules.

In case there are periodic proof test requirements for specific modules then the end-user should refer to the data sheets of these modules.

Equipment Description

3

At a Glance

Overview

This chapter contains the equipment description of XPSMF35 Safety PLC.

What's in this Chapter?

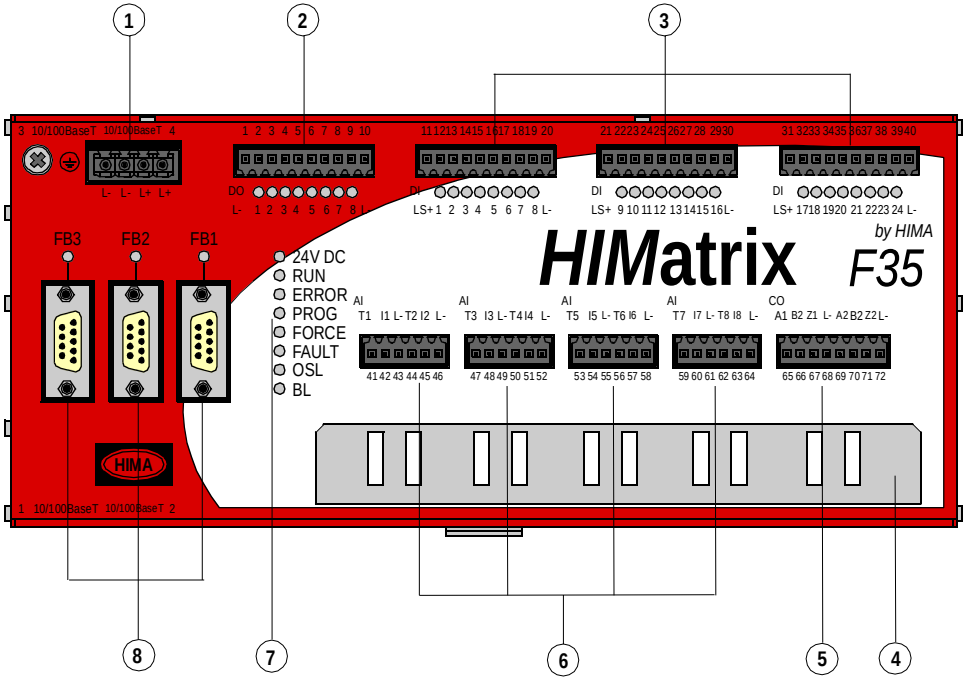
This chapter contains the following topics:

Topic	Page
Housing Elements	54
Reset Button	57
Communication	58
LEDs	63
Wiring	66
IP Addressing and System ID	72
SafeEthernet	73
Operating Conditions	78
Technical Characteristics	81
Additional Items	87

Housing Elements

Front View

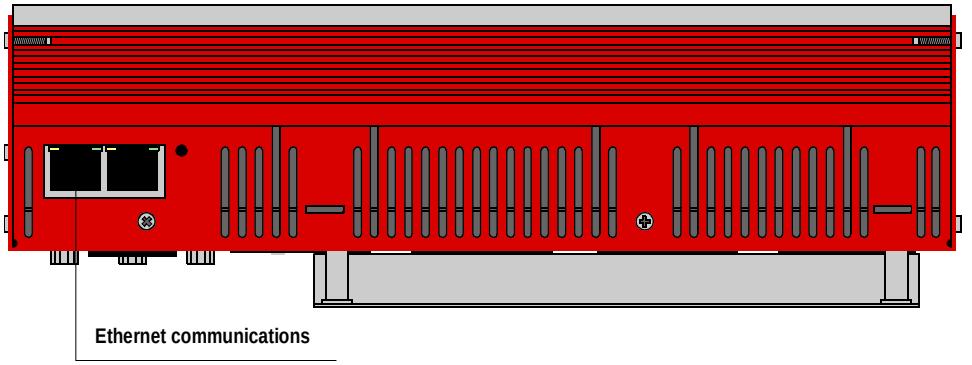
The following image shows the various elements of the XPSMF35 front panel:



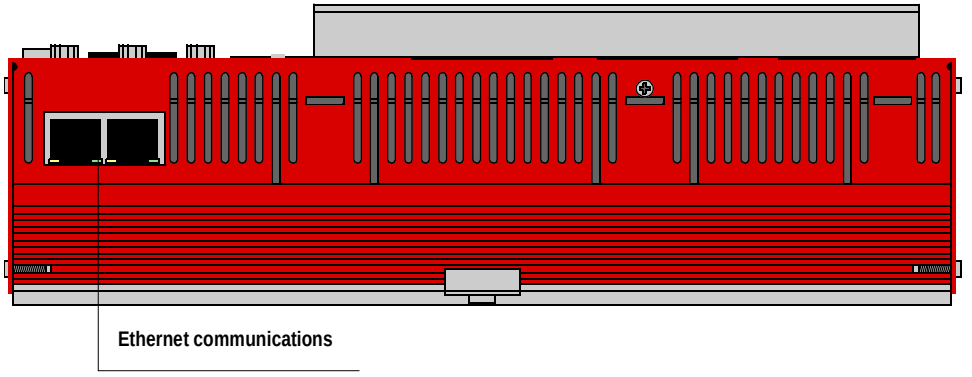
Elements of the front panel

No.	Description
1	Power Supply Input
2	Digital Outputs
3	Digital Inputs
4	Earth Rail
5	Counter Inputs
6	Analog Inputs
7	Indicators
8	Field Bus Connections

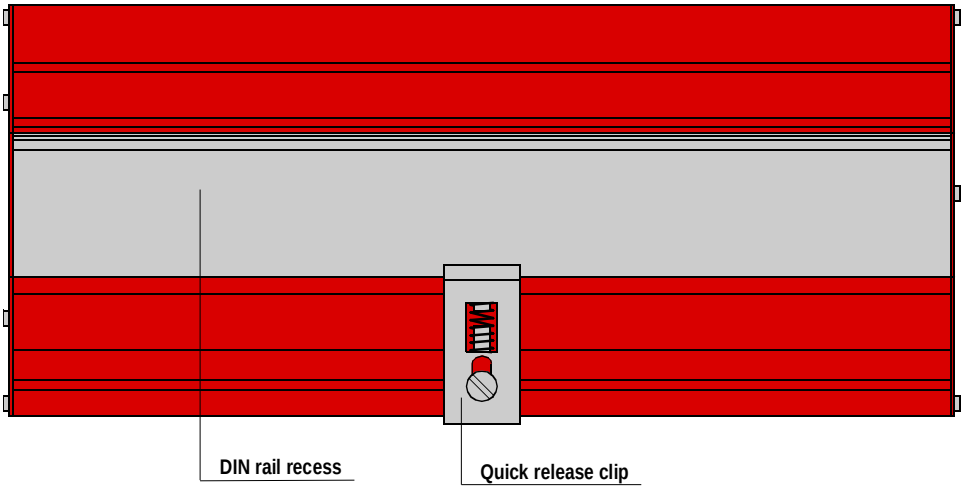
Top View The following image shows the elements of the top panel:



Bottom View The following image shows the elements of the bottom panel:



Back View The following image shows elements of the back panel:



Reset Button

Overview

The device is equipped with a reset button. The reset button is used if the PC connection password is lost.

Using Reset Button

You can access the push button through a small round opening on the upper side of the housing, about 40...50 mm (1.57...1.97 in) from the left rim.

Use the button only while you reboot the device and keep the button pressed for at least 20 s. Pushing the reset button while the device is running produces no result.

Effect

When you push the reset button,

- all accounts are deactivated (except the default `Administrator` account without password) and
- IP addresses and system ID (SRS) are set to default values.

Note: After the reset button has been activated, values are modified and remain valid until the next reboot. After the next reboot, the previous values are restored. You can enter new information, if necessary.

⚠ CAUTION

RISK OF UNINTENDED EQUIPMENT OPERATION

While operating the reset button, the field bus cables should be disconnected from the field bus terminals, to avoid malfunctions.

Failure to follow these instructions can result in injury or equipment damage.

Communication

Overview

The Safety PLCs communicate with each other and the PC via Ethernet using SafeEthernet protocol.

The Safety PLCs communicate with each other and with a PC through a star or linear Ethernet layout. A PC can be connected at any place in the network.

The communication section is connected to the safe microprocessor system via a Dual-Port RAM. It controls communication between PES and other systems via powerful interfaces. The XPSMF35 Safety PLC supports Modbus Serial Slave and Profibus Serial Slave communication for non-safety-related data transfer.

100 BaseT	SafeEthernet, Modbus TCP/IP
Field buses	Modbus Slave Serial, Profibus Slave Serial (dependant on version)

Safety-Related Communication

The switch integrated into each system for Ethernet communication is shown on the block diagram (see *Block Diagram, p. 28*).

In contrast to a hub, a switch can store data packets for a short period of time in order to establish a temporary connection between 2 communication partners (transmitter/receiver) for transferring data. Thus, collisions, which typically occur in hubs, can be avoided, and the load on the network can be reduced. For controlled data transfer, every switch needs an address/port relation table. This table will be automatically generated in a self-learning process. Each port in the switch is correlated to the defined MAC addresses. According to this table, incoming data packets are switched directly to the corresponding port.

The switch automatically switches between the transfer rates of 10 and 100 Mbit/s full and half duplex transmissions.

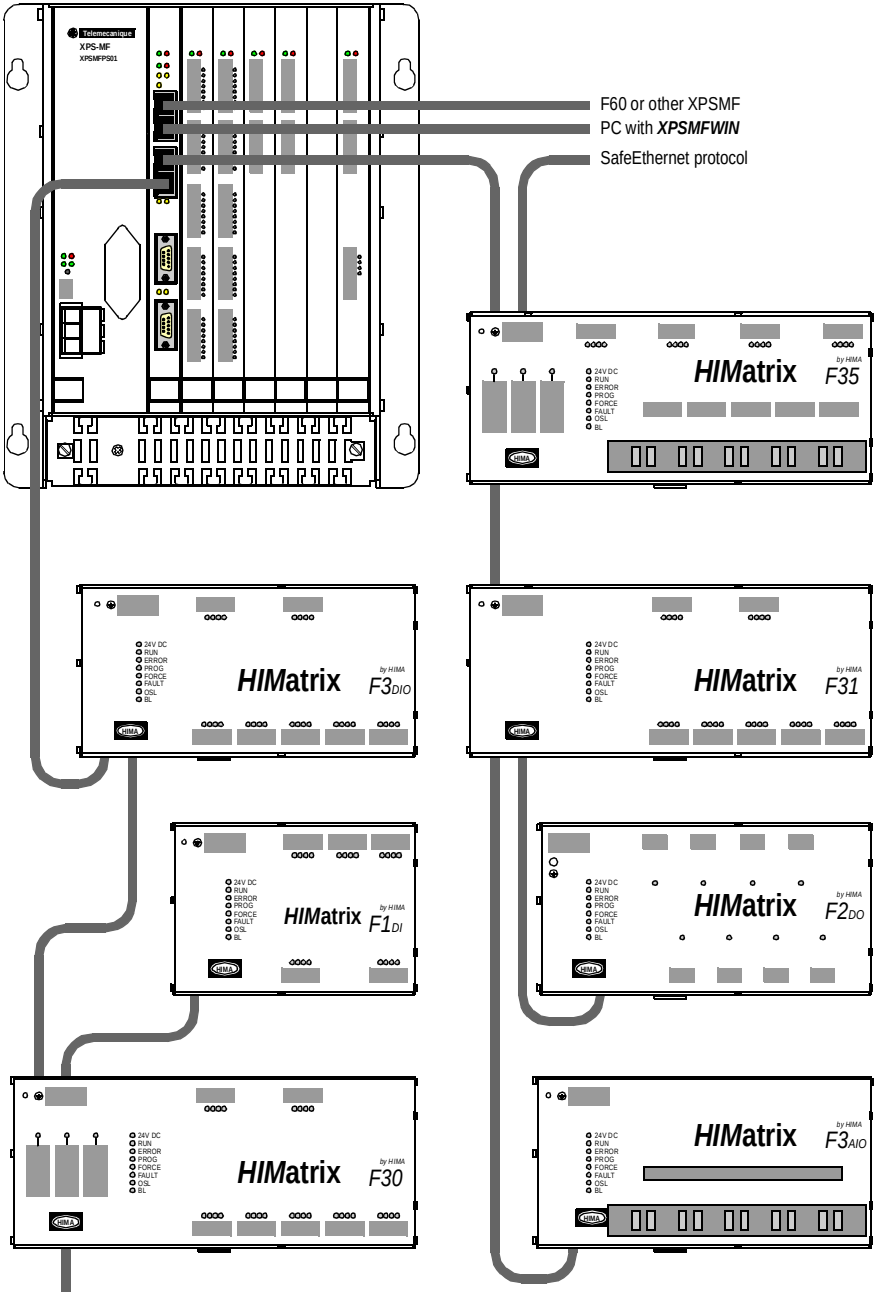
The switch controls communication between different devices. The switch can address up to 1000 absolute MAC addresses.

Autocrossing recognizes if cables with crossed wires have been connected, and the switch adjusts accordingly.

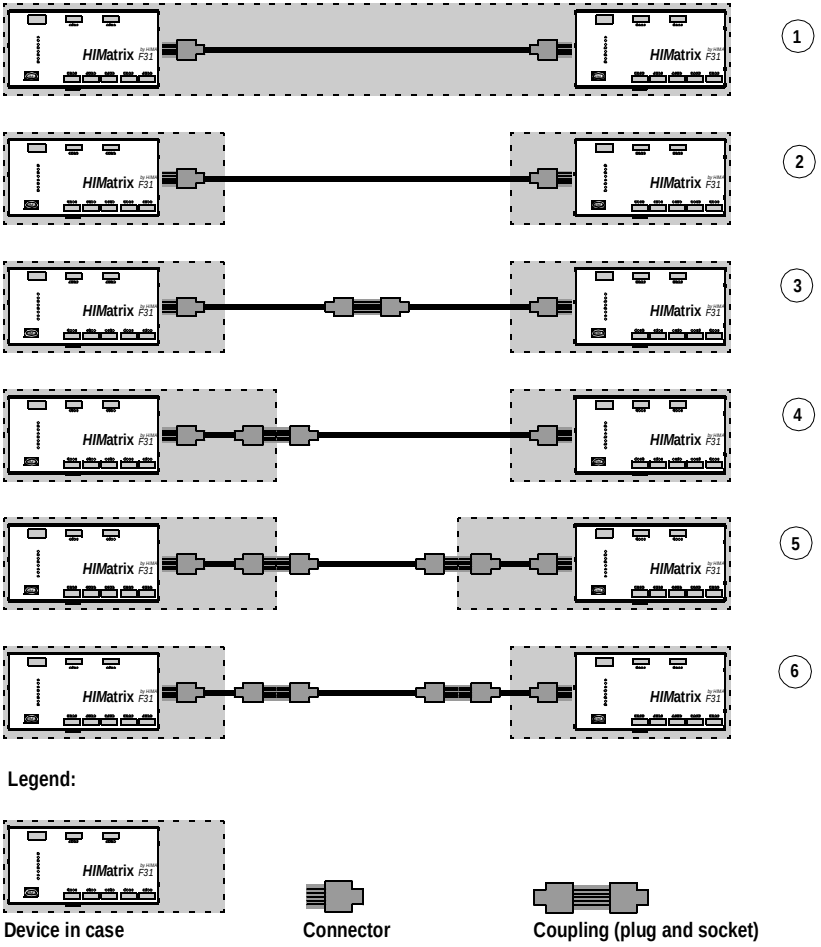
For networking via Ethernet, the XPSMF35 Safety PLC is equipped with 4 connections arranged on the lower and upper side panels of the case. Various systems can be networked as required via Ethernet star or line configuration. A PC can also be connected wherever required.

Note: When building the network, ensure that no network loops occur. The system must receive data along 1 path only.

The following scheme shows a SafeEthernet networking example:



The following is a Ethernet cable connection diagram:



Connector pairs and cable distances:

Number	Number of Plug Connector Pairs	Maximum Cable Distance
1	2	100 m / 328.1 ft
2	2	100 m / 328.1 ft
3	3	100 m / 328.1 ft
4	3	100 m / 328.1 ft
5	4	100 m / 328.1 ft
6	4	100 m / 328.1 ft

When using specified cables and plug connectors approved for 100 MHz, the maximum cable distance is 100 m (328.1 ft) with a maximum of 6 connector pairs. A combination of a plug and a socket is considered 1 pair.

Use optic fiber cables with converters for greater distances.

Configuring a SafeEthernet protocol connection over Ethernet has the following advantages:

- very fast packet transfer between the collision areas
- significant increase of data throughput with full-duplex mode
- prevention of collisions to prevent deterministic operation

Non-Safety-Related Communication

The XPSMF35 Safety PLC is equipped with sockets for field bus communication. The XPSMF35 Safety PLC supports the Modbus slave and Profibus slave field bus protocols.

The total length of the Modbus network with all branch lines can reach 1200 m (3936.99 ft). Bidirectional repeaters are required for greater lengths. In total,

3 repeaters can be used to reach a maximum range of 4800 m (15747.98 ft).

RS485 (Modbus slave) is on field bus 2.

Note: Safety-related communication is not possible with the field bus interfaces.

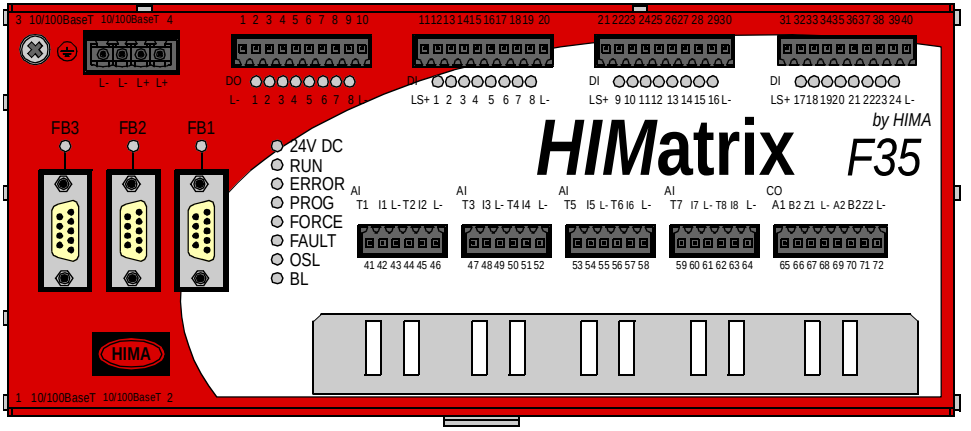
The following Modbus functions are supported by the Modbus slave:

Element	Code	Type	Description
READ COIL	01	BOOL	Reads several variables (BOOL) from the slave's import or export area.
READ DISCRETE INPUT	02	BOOL	Reads several variables (BOOL) from the slave's export area.
READ HOLDING REGISTER	03	WORD	Reads several variables of any type from the slave's import or export area.
READ INPUT REGISTER	04	WORD	Reads several variables of any type from the slave's import area.
READ WRITE HOLDING REGISTER	23	WORD	Writes and reads several variables of any type in and from the slave's import area.
WRITE MULTIPLE COIL	15	BOOL	Writes several variables (BOOL) in the slave's import area.
WRITE MULTIPLE REGISTER	16	WORD	Writes several variables of any type in slave's import area.
WRITE SINGLE COIL	05	BOOL	Writes 1 single variable (BOOL) in the slave's import area.
WRITE SINGLE REGISTER	06	WORD	Writes 1 single variable (WORD) in the slave's import area.
DIAGNOSTICS	08	x	Only subcode 0: loopback function of the slave.
READ DEVICE IDENTIFICATION	43	x	Supply the slave's identification data to the master.

LEDs

Overview

The XPSMF35 LEDs



LED Description

The following table describes behaviors of the LEDs:

LED	Color	Status	Meaning
Field bus 1, 2, 3	orange flashing irregularly	on	The interface is configured and communication is running.
	orange flashing regularly (1 s frequency)	on	The interface is configured, but no communication.
	not illuminated	off	The COM is in the state `STOP-INVALID-CONFIG` or the interface is not configured in XPSMFWIN.
Digital Inputs 1-24	orange	on	An Input signal is being received.
Digital Outputs 1-8	orange	on	An Output signal is being sent.
24 VDC	green	on	24 VDC operating voltage present
	not illuminated	off	No operating voltage

LED	Color	Status	Meaning
RUN	green	on	Normal state of PES (RUN); A loader user program is executed (not in remote I/O modules). The CPU reads inputs, processes the logic, and writes outputs; Communication and hardware/software tests are carried out.
	green	flash	The CPU is in STOP and is not executing any user program. All outputs are reset to a safe de-energized state. STOP can be triggered by setting the Emergency stop system variable to TRUE in the user program or by a direct command from the PC. Seen when PLC is switched on for approximately 10 s during the system check.
	not illuminated	off	The CPU in ERROR STOP (see ERROR below).
ERROR	red	on	The CPU has discovered a hardware fault in the CPU and is switching to ERROR STOP. The CPU has discovered a software error in the operating system. The watchdog has triggered ERROR STOP, because the cycle time has been exceeded. The CPU has stopped the execution of the user program, ended all hardware and software tests, and all outputs have been reset. The CPU can only be started again through a command from the PC.
	not illuminated	off	No error has been detected.
PROG	orange	on	The CPU is being loaded with a new configuration.
	orange	flash	The Flash ROM is being loaded with a new operating system.
	not illuminated	off	No loading of configuration or operating system.
FORCE	not illuminated	off	FORCE is not signalled.
	orange	on	Forcing active.

LED	Color	Status	Meaning
FAULT	orange	on	Error display for Line Control. The user program has caused an error. The PES configuration is faulty. The loading of a new operating system was faulty, and the operating system is corrupt.
	orange	flash	An error has occurred during the write cycle for a Flash ROM (during the operating system update). One or more I/O errors have occurred.
	not illuminated	off	None of the above errors has occurred.
OSL	orange	flash	Emergency loader of the operating system is active.
BL	orange	flash	COM in `INIT_FAIL` state.
RJ45	green	on	full duplex operation
		flash	collision
		off	Half-duplex operation, no collision
	yellow	on	connection established
		flash	interface activity

Wiring

Ethernet Wiring

Industrial standard cables can be subjected to extreme mechanical stresses. The minimum SafeEthernet protocol communication requires Category 5 twisted pair cables with a class D rating. To transmit data across greater distances and to minimize error probability, fiber optic cables should be used.

The controllers communicate at 100 Mbit/s (Fast Ethernet) and 10 Mbit/s (full duplex mode). The XPSMF35 Safety PLC has an auto cross-over function built into the switch, which allows the use of both a 1:1 cable and a cross-over cable.

The outer shielding of the twisted pair cable must be earthed at both ends. If an RJ 45 connector is used, it automatically connects the cable's shield to the controller’s housing.

Interface Elements

When connecting a PLC over Ethernet communication, the following interface elements are recommended: FL CAT5 TERMINAL BOX of Phoenix Contact (R). The controllers are mounted on an earthed EN mounting rail. The conductors of the field cable are attached to the interface terminals. It is important to make sure that the cable shield is also connected via the strain relief.

Prefabricated patch cables are used to connect the interface element and the XPSMF35 PLC. If the rail is earthed in accordance with the standards, it is enough to mount an interface element on a rail.

Specified Cables

Depending on their transmission and high-frequency properties, the cables are specified by category as follows:

Category	Specification	Approved
1	-	no
2	up to 1 MHz	no
3	up to 16 MHz	no
4	up to 20 MHz	no
5	up to 100 MHz	yes
6	up to 250 MHz	yes
7	up to 600 MHz	yes

The channel as a point-to-point transmission path is defined as follows:

Class	Specification	Approved
A	up to 0.1 MHz	no
B	up to 1 MHz	no
C	up to 16 MHz	no
D	up to 100 MHz	yes
E	up to 250 MHz	yes
F	up to 600 MHz	yes

The higher the letter, the greater the demand on the transmission channel. For Ethernet communication at 100 MHz, Category 5 (or higher) cables and at least Class D capacity are required.

RJ45 Connector

For direct Ethernet plug connections without interface elements, you can use connectors such as IP 20 Data Plug (Harting(R)). You can assemble the cable quickly by crimping the conductors; special tools are not required.

Switches

To span distances of more than 100 m (328 ft) using SafeEthernet protocol, rail switches of the RS2 series (Hirschmann(R)) with optical fibre ports are recommended.

RS-485 Transfer Mode System

The Modbus serial protocol and the Profibus DP slave protocol communicate via the non-safe RS-485 transfer mode system.

The following table shows an overview of the basic physical features of RS-485 transfer mode system:

Scope	Feature	Comment
Network Topology	linear bus, active bus termination on both ends	Branch lines should be avoided.
Medium	shielded twisted cable	Shielding may not be required, depending on the environment.
Number of Stations	32 stations in each segment without repeater	with a repeater extendable up to 126 stations
Connector	9-pole MIN-D connector	- - -

Modbus Wiring and Bus Termination

The following table shows the pin assignment of the SUB-D sockets FB2 (Modbus slave):

Connection	Signal	Function
1	- - -	- - -
2	- - -	- - -
3	RxD/TxD-A	receive/transmit data A
4	CNTR-A	control signal A
5	DGND	data reference potential
6	VP	5 V, positive pole of supply voltage
7	- - -	- - -
8	RxD/TxD-B	receive/transmit data B
9	CNTR-B	control signal B

Profibus Wiring

In the physical layer of Profibus DP, data are transferred symmetrically, according to the RS-485 standard.

A shielded symmetrical two-wire data line is designed as transfer medium. It should contain the following parameters (RS-485 cable, type A, used for Profibus DP):

Parameter	Cable Type A
Wire Resistance	135 to 165 Ω
Capacitance	≤ 30 pf/m
Loop Resistance	≤ 110 Ω/km (0.0335 Ω/ft)
Wire Diameter	> 0.64 mm (0.025 in)
Wire Cross-Section	> 0.34 mm^2 (AWG 22)

The bit rate (transmission speed) can be set between 9.6 kbps and 12 Mbps. It applies to all stations connected to the bus.The maximum line length depends on the bit rate selected.

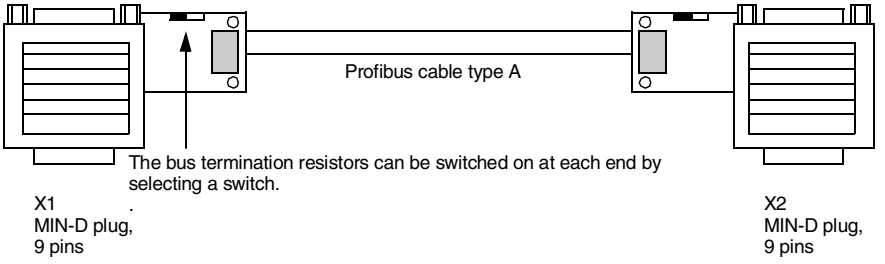
The following table provides information about the line length:

Bit Rate	Range per Segment
9.6 kbps	1200 m (3937 ft)
19.2 kbps	1200 m (3937 ft)
93.75 kbps	1200 m (3937 ft)
187.5 kbps	1000 m (3280 ft)
500 kbps	400 m (1312 ft)
1.5 Mbps	200 m (656 ft)
3 Mbps	100 m (328 ft)
6 Mbps	100 m (328 ft)
12 Mbps	100 m (328 ft)

Note: The line length can be increased by means of bidirectional repeaters. A maximum of 3 repeaters may be switched between 2 participants. A line length of 4.8 km (15,748) is possible. For time-critical applications, not more than 32 stations should be connected. For not time-critical applications, up to 126 participants are permissible (with repeater).

In the IEC 61158, 2 bus cable types are specified. Cable type A may be used for all transfer rates up to 12 Mbps. Cable type B is outdated and should not be used any longer.

The following image shows a Profibus DP bus cable, type A, with bus connector plug:



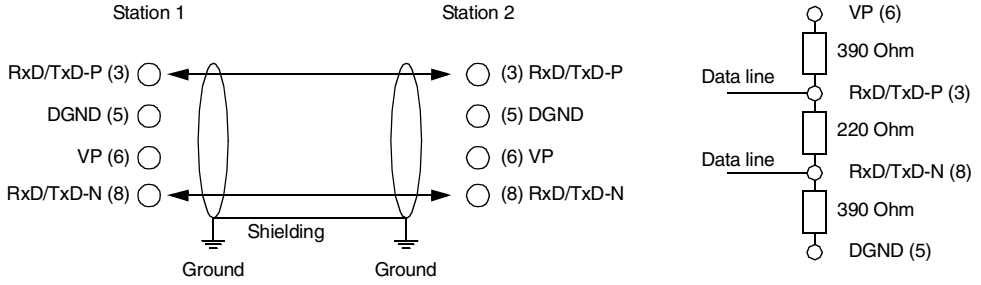
Profibus Connection and Termination

The incoming and the outgoing data cable can be directly connected to the bus connector plug. Branch lines are thus avoided, and the bus connector plug can be connected and disconnected from the field bus device at any time, without interruption of data traffic.

IEC 61158 recommends a 9-pin SUB-D connector for Profibus DP. According to the protection class specified to the field bus device, other available connectors may also be used.

The following image shows the pin assignment with the 9-pin SUB-D connector. At the field bus device, the bus connection is designed as a socket. Bus termination of Profibus DP consists of a resistance combination ensuring a defined zero potential on the bus. The resistance combination is integrated into the Profibus DP bus connector and can be activated using jumpers or switches. Additionally, stations, in which the bus ends, should provide a 5 V supply at pin 6.

The following image shows the bus connection and termination as well as the pin assignment of the field bus interface:



The signals on pins 3, 5, 6, and 8 are so-called mandatory signals and must always be available.

The following table shows pin assignment of the interfaces FB1 and FB2 for Profibus DP master and slave:

Pin	Signal	Description
1	-	not used
2	-	not used
3	RxD/TxD-P	receiving/transmitting data plus (B wire)
4	RTS	direction control for fiber-optic modems (TTL-signal)
5	DGND	data transfer reference potential (ground to 5 V)
6	VP	supply voltage of the termination resistors P (+ 5 V)
7	-	not used
8	RxD/TxD-N	receiving/transmitting data minus (a wire)
9	-	not used

IP Addressing and System ID

Overview

A transparent label provided with the controller can be used to note the IP address and system ID (SRS, System-Rack-Slot) following a modification:

IP_._._._SRS_._._

Default value for IP address: 192.168.0.99

Default value for SRS: 60000.0.0

The ventilation slots in the housing of the Safety PLC must not be covered with the label.

For more information about changing the IP address and system ID, see the XPSMFWIN Software manual.

Note: Each Ethernet board has a unique Ethernet address. It is a 48-bit number: the first 24 bits indicate the manufacturer, whereas the last 24 bits are a unique number for each Ethernet board/controller-chip assigned by the manufacturer. The number is also called MAC ID.

TCP/IP Description

The IP address is an identifier for a device in a network. IP addresses are 32-bit numbers. To make it easier to memorize them, they are usually expressed in four 8-bit numbers (e.g. 192.168.10.1).

IP addresses are unique, which means that no other device within a network can share the same address:

- the IP address is assigned to the PC,
- another part of the IP address is the subnet mask, which distinguishes other networks.

Note: The operator must ensure that the Ethernet used for Peer-to-Peer communication is adequately protected from unauthorized access (i.e. by hackers). The nature and extent of the measures to be taken must be determined in conjunction with the approval authorities.

SafeEthernet

Overview

This section provides information about SafeEthernet protocol and OSI model.

Description

In the field of automation, requirements, such as determinism, reliability, interchangeability, extensibility, interoperability and the overall safety are central themes. Based on the Ethernet technology, SafeEthernet provides a transfer protocol for transmitting safety-related data up to RC 6 or SIL 3. SafeEthernet implements a mechanism that can detect and react to the following:

- corruption of transmitted data
- incorrect address allocation for the messages (transmitter, receiver)
- incorrect data sequence (repetition, loss, change)
- incorrect timing (delay, echo)

SafeEthernet is based on the standard Ethernet or FastEthernet according to IEEE 802.3.

The transmission of the safety-related data does not change the protocol frame of the standard Ethernet.

According to the Black Channel Approach in SafeEthernet, insecure transmission channels (Ethernet) are used and controlled by safety-related protocol mechanism at transmitter and receiver. This way, regular Ethernet network components, such as hubs, switches, routers, and PCs supplied with network interfaces can be used within a safety-related network. The significant difference to standard Ethernet is determinism, the real-time ability of SafeEthernet.

A special protocol mechanism ensures deterministic behavior even in case faults occur or new communication participants emerge. New components are automatically integrated into the running system. All components of the network could be changed while the system is running. With the use of switches, transmission times can be clearly defined. This way, Ethernet works in real time. Possible transfer speed up to 100 Mbit/s for safety-related data is higher than the speed normally used. Copper lines as well as fiber optic cables can be used as transmission media. The integration of firm intranets as well as connections to the Internet, can be realized with SafeEthernet technology. The terms for safety-related communication have to be considered.

Therefore, only 1 network for safety and non-safety data transfer is necessary. SafeEthernet can be fitted to existing Ethernet networks with adjustable network profiles. With SafeEthernet, you can set up flexible built-up system structures for decentral automation with defined reaction times. According to the requirements, the intelligence can be centralized or distributed to the participants in a decentral way within the network. There is no limit to the number of safe participants of the network and the amount of transferred safe data to get the needed reaction times. A central controller and the built-up of parallel structures is therefore superfluous.

The transmission of standard and safe data can be integrated into 1 network. A separate safety bus can be saved. The Safety PLC's switches perform the tasks normally carried out by network switches.

Operation Parameters of the Ethernet Interfaces

Up to COM OS version 8.32 all Ethernet ports of the integrated Ethernet switches have the same settings:

- Autoneg/Autoneg for Speed Mode
- Flow-control Mode

Other settings are not possible and will be rejected by the PLC when loading a configuration.

The Ethernet interfaces 10/100 BaseT of the device have the following parameters:

Firm operating parameters	
Speed Mode	Autoneg
Flow-Control Mode	Autoneg

Other devices combined with the Safety PLC or remote I/O device must have the following network settings:

Admissible settings of other devices	
Speed Mode	Autoneg
Flow-Control Mode	Autoneg
or	
Speed Mode	Autoneg
Flow-Control Mode	Half Duplex
or	
Speed Mode	10 or 100 Mbit/s
Flow-Control Mode	Half Duplex

Non-admissible settings of other devices	
Speed Mode	Autoneg or 10 or 100 Mbit/s
Flow-Control Mode	Full Duplex

For COM OS version > 8.32 and XPSMFWIN Hardware Management version > 7.56.10 each Ethernet port of the integrated switch can be individually configured. See also in the appendix *Connection Diagrams, Examples of Application, and Error Codes, p. 91*.

Connections for SafeEthernet/ Networking Examples

For the networking via SafeEthernet protocol, the devices are equipped - depending on the design - with two connections arranged on the lower side panel of the case. See example of a *Safety-Related Communication, p. 58*.

The various systems can be networked together as required via Ethernet (star or line configuration). A programming unit (PC) can also be connected wherever required.

Note: Ensure that no network loops are formed when connecting systems together. The system must receive data packets along one path only.

Modbus TCP/IP

The Modbus serial slave field bus protocol can communicate with the Modbus TCP/IP protocol via the Ethernet interfaces on the Safety PLC.

Standard Modbus communication transfers the slave address and a CRC checksum in addition to the instruction code and the data. In Modbus TCP/IP the subordinate TCP/IP protocol handles this function.

Note: More information about Modbus TCP/IP protocol can you find in the online help of XPSMFWIN.

Used Network Ports for Ethernet Communication

UDP ports and usage

UDP Ports	Usage
8000	programming and operation with XPSMFWIN
8001	configuration of the remote I/O via PLC
6010	SafeEthernet
6005/6012	if TCS_DIRECT was not activated within HH network

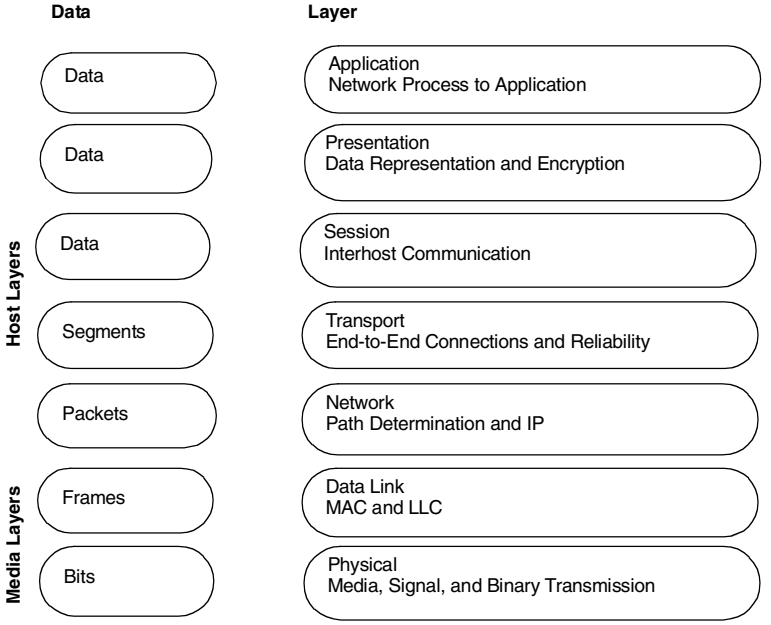
TCP ports and usage

UDP Ports	Usage
502	Modbus (changeable by user)

OSI Model

The model divides the functions of a protocol into a series of layers known as a protocol stack (e.g., TCP/IP stack). Lower layers are implemented in hardware, while higher layers are used in software. Each of the layers is a transport platform for the next higher level and relies on the next lower level.

The following image is a graphic representation of the OSI layers:



The following table describes the 7 OSI layers (bottom-top):

Number	Layer	Data	Description
Media Layers			
1	physical layer media, signal, and binary transmission	bits	Defines all electrical and physical specifications for the devices.
2	data link layer MAC and LLC	frames	Provides the functional and procedural means to transfer data between network entities and detect and correct errors that may occur in the Physical layer.
3	network layer path determination and IP	packets	Provides the functional and procedural means of transferring variable length data sequences from a source to a destination via one or more networks.
Host Layers			
4	transport layer end-to-end connections and reliability	segments	Provides transparent transfer of data between end users.
5	session layer interhost communication	data	Provides the mechanism for managing the dialog between end-user application processes.
6	presentation layer data representation and encryption	data	Relieves the Application layer of concern regarding syntactical differences in data representation within the end-user systems.
7	application layer network process to application	data	Interfaces directly to and performs common application services for the application processes.

Operating Conditions

Overview

The XPSMF35 Safety PLC has been developed in compliance with the requirements of the following standards for EMC, climate and environment:

IEC 61131-2	programmable controllers, part 2, equipment requirements and tests
IEC 61000-6-2	EMC generic standards, part 6-2
IEC 61000-6-4	EMC general emission standard, industrial environment

To use the XPSMF35 Safety PLC, the following conditions must be fulfilled:

Protection Class	protection class II according to IEC/EN 61131-2
Pollution	pollution degree II
Altitude	< 2000 m (6561 ft)
Enclosure	standard: IP 20 If requested by the relevant application standards (e.g., EN 60204, EN 954-1), the device must be installed in a required enclosure (e.g., IP 54).

Climatic Conditions

The most important tests and limit values for climatic conditions are listed in the following table:

EN 61131-2	**Climatic Tests**
-	operating temperature: 0 to 60 °C (32 to 140 °F) test limits -10 to +70 °C (14 to 158 °F)
-	storage temperature: -40 to 85 °C (-40 to 185 °F), with battery only -30 °C (-22 °F)
6.3.4.2	dry heat and cold withstand test: 70 / -25 °C (158 to -13 °F), 96 h, EUT power supply disconnected
6.3.4.3	change of temperature, withstand and immunity test: -25 / 70 °C (-13 to 158 °F) and 32 / 55 °C (90 / 131 °F), EUT power supply disconnected
6.3.4.4	cyclic damp heat withstand test: 25 / 55 °C (77 / 131 °F), 95% relative humidity, EUT power supply disconnected

Mechanical Conditions

The most important test and limit values for mechanical conditions are listed in the following table:

EN 61131-2	Mechanical Tests
-	vibration test, operating: 5 to 9 Hz / 3.5 mm (0.14 in), 9 to 150 Hz / 1g (0.035 oz)
6.3.5.1	immunity vibration test: 10 to 150 Hz, 1 g (0.035 oz), EUT operating, 10 cycles per axis
6.3.5.2	immunity shock test: 15 g (0.53 oz), 11 ms, EUT operating, 2 cycles per axis

EMC Conditions

The most important tests and limit values for EMC conditions are listed in the following tables:

EN 61131-2	Noise Immunity Tests
6.3.6.2.1 IEC/EN 61000-4-2	ESD test: 4 kV contact/ 8 kV air discharge
6.3.6.2.2 IEC/EN 61000-4-3	RFI test (10 V/m): 26 MHz to 1 GHz, 80% AM
6.3.6.2.3 IEC/EN 61000-4-4	burst test: 2 kV power supply / 1 kV signal lines
6.3.6.2.4 IEC/EN 61000-4-12	damped oscillatory wave immunity test: 1 kV

IEC/EN 61000-6-2	Noise Immunity Tests
IEC/EN 61000-4-6	radio frequency common mode: 10 V 150 kHz to 80 MHz, AM
IEC/EN 61000-4-3	900 MHz pulses
IEC/EN 61000-4-5	surge: 1 kV, 0.5 kV

IEC/EN 61000-6-4	Noise Emission Test
EN50011 Class A	emission test: radiated, conducted

Voltage Supply

The most important tests and limit values for the voltage supply of the equipment are listed in the following table:

IEC/EN 61131-2	Verification of DC Power Supply Characteristics
-	The power supply must meet alternatively the following standards: IEC 61131-2 or SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage)
-	Fusing the XPSMF35 Safety PLC must be performed according to this manual only.
6.3.7.1.1	voltage range test: 24 VDC, -20 to 25% (19.2 to 30.0 VDC)
6.3.7.2.1	momentary interruption immunity test: DC, PS 2: 10 ms
6.3.7.4.1	reversal of DC power supply polarity test
6.3.7.5.1	backup duration withstand test: test B, 1000 h, Lithium battery is used for backup.

Technical Characteristics

Mechanical Data

Power Supply Connectors 1

Connection Diameters, Single Lead Connection	
Without Lead End Sleeves	solid 0.2 to 2.5 mm^2 stranded 0.2 to 2.5 mm^2 AWG 24-12
Stranded with Lead and Sleeves (without Plastic Sleeves)	0.25 to 2.5 mm^2 AWG 22-14
Stranded with Lead End Sleeves (with Plastic Sleeves)	0.25 to 2.5 mm^2 AWG 22-14

Power Supply Connectors 2

Connection Diameters, Multiple Lead Connections (2 Leads Max., Same Diameters)	
Without Lead End Sleeves	solid 0.14 to 1.5 mm^2 stranded 0.14 to 1.5 mm^2 AWG 28-16
Stranded with Lead and Sleeves (without Plastic Sleeves)	0.25 to 1.5 mm^2 AWG 22-16
Stranded with Lead End Sleeves (with Plastic Sleeves)	0.25 to 0.5 mm^2 AWG 22-20

Signal Line Connectors 1

Connection Diameters, Single Lead Connection	
Without Lead End Sleeves	solid 0.14 to 1.5 mm^2 stranded 0.14 to 1.5 mm^2 AWG 28-16
Stranded with Lead End Sleeves (without Plastic Sleeves)	0.25 to 1.5 mm^2 AWG 22-16
Stranded with Lead End Sleeves (with Plastic Sleeves)	0.25 to 0.5 mm^2 AWG 22-20

Signal Line Connectors 2

Connection diameters, multiple Lead connections (2 Leads max, same diameters)	
Without Lead End Sleeves	solid 0.14 to 0.5 mm^2 AWG 28-20 stranded 0.14 to 0.75 mm^2 AWG 28-18
Stranded with Lead and Sleeves (without Plastic Sleeves)	0.25 to 0.34 mm^2 AWG 22
Stranded with Lead End Sleeves (with Plastic Sleeves)	0.5 mm^2 AWG 20

Stripping Length and Torque

Stripping length	9 mm (0.35 in)
Torque	0.22 to 0.25 Nm (1.9 to 2.2 lb-in)

Technical Data

The XPSMF35 Safety PLC technical data are presented in the following tables:

User Memory	max 250 kB user program max 250 kB user data
Interface Safe Ethernet	4*RJ-45, 10/100 Base T with integrated switch
Modbus Serial Slave, Profibus DP Slave	SUB-D 9-pin FB2
Operating Voltage	24 VDC -15%/+20%, Wss <=15%, from a power supply with protective separation, conforming to IEC61131-2 requirements
Current Consumption	max 9 A (with maximum load) idle current: 0.75 A
Operation Temperature	0 to 60 ^oC (32 to 140 ^oF)
Temperature Class	T4
Storage Temperature	-40 to +85 ^oC (-40 to 185 ^oF)
Fuse (external)	10 A (slow blow)
Battery Backup	none
Protection	IP 20
Max Dimensions	width: 257 mm (10.12 in), with housing screws height: 114 mm (4.5 in), with latch depth: 97 mm (3.82 in), with grounding bolt
Weight	1,200 g (42.33 oz)

Digital inputs

Number of Inputs	24 (not electrically isolated)
1-signal: Voltage Current Consumption	15 to 30 VDC (default value 13 V + 2 V safety range can be configured up to 30 VDC) approx. 3.5 mA @ 24 VDC approx. 4.5 mA @ 30 VDC
0-signal: Voltage Current Consumption	max 5 VDC (default value 7 V - 2 V safety range is freely parameterizable up to max. 1-signal -4 V and min. 2 V) max 1.5 mA (1 mA @ 5 VDC)
Input Resistance	< 7 kΩ
Overvoltage Protection	-10 V, +35 V
Max. Line Length	300 m (11,811 in)
Supply	3 outputs to supply sensors for digital inputs each providing 20 VDC/100 mA at mains voltage of 24 VDC, short circuit proof as per IEC 61131-2
Metrological Accuracy Channel Error Zero Point Calibration End-Point Channel Error Temperature Error Zero Point Temperature Error End-Point Linearity Error	 +/-1 % +/-4 % +/-0.5 % +/-1 % / 10 K +/-1 % / 10 K +/-0.5 % of zero point

Analog inputs

Number of Inputs	8 (unipolar, not electrically isolated)
External Shunt Adapter for Current Measurement	250 Ω 500 Ω
Input Values • Nominal Value • Service Value	related to L- 0 to +10 VDC, 0 to +20 mA with shunt 500 Ω -0.1 to +11.5 VDC, -0.4 to +23 mA with shunt 500 Ω
Input Impedance	1 MΩ
Input Line	max. 300 m (11,811 in), shielded, twisted pair cabling
Internal Resistance of the Signal Source	≤ 500 Ω
Overvoltage Protection	+15 V, -4 V
Resolution (A/D Converter)	12 bit

Accuracy	0.1% @ 25 °C 0.5% @ 60 °C
Transmitter Supplies	25.37 to 28.24 V / ≤ 46 mA, short-circuit-proof as per IEC 61131-2
Metrological Accuracy: Channel Error Zero Point Calibration End-Point Channel Error Temperature Error Zero Point Temperature Error End-Point Linearity Error	 +/-0.5% +/-0.5% +/-1% +/-0.5% of final value / 10 K +/-0.5% of final value / 10 K +/-1% of final value
Safety Accuracy	+/-2%

Shunt adapter

Resistance Value	250 Ω 500 Ω
Tolerance	0.1%
Temperature Coefficient	25 ppm/°C
Permanent Load at Current Measurement	See service value of analog inputs
Maximum Power Loss	0.4 W
Operating Temperature	0 to +60 °C (32 to 140 °F)
Storage Temperature	-40 to +85 °C (-40 to 185 °F)
Dimensions	width: 5 mm (0.2 in) height: 5 mm (0.2 in) depth: 5 mm (0.2 in)

Counters

Number of Counters	2 (not electrically isolated)
Inputs	3 on each (A, B, Z)
Input Voltages: High Signal (5 V) High Signal (24 V) Low Signal (5 V) Low Signal (24 V)	5 and 24 V 4 to 6 V 13 to 33 V 0 to 0.5 V -3 to 5 V
Input Currents	1.4 mA @ 5 V, 6.5 mA @ 24 V
Input Impedance	3.7 kΩ
Input Line	max. 500 m (0.5 km), shielded, twisted pair cabling
Counter Resolution	24 bit
Max. Input Frequency	100 kHz (@ 5 V and 24 V input voltage)
Triggered	on negative edge
Edge Steepness	1 V/µs
Pulse Duty Factor	1: 1

Digital Outputs

Number of Outputs	8 (not electrically isolated)
Output Voltage	>=L+ minus 2 VDC
Output Current	channels 1 to 3 and 5 to 7: 0.5 A @60 °C (140 °F) channels 4 and 8: 1 A @ 60 °C (140 °F), 2 A @ 50 °C (122 °F)
Minimum Load	2 mA per channel
Internal Voltage Drop	max 2 VDC @ 2 A
Leakage Current (with 0-signal)	max 1 mA @ 2 VDC
Response to Overload	shutting down relevant outputs with cyclical reconnecting
Total Output Current	max 7 A (when exceeded, shutdown of all outputs and cyclic recondition occurs)

Supply Voltage

The XPSMF35 Safety PLC is a single voltage system. The required operating voltage is defined as follows in accordance with IEC/EN 61131-2.

Supply Voltage	
Nominal Value	24 VDC, -15...+20%
Max. Permissible Function Limits in Continuous Operation	18.5 to 30.2 VDC (including ripple)
Max. Peak Value	35 VDC for 0.1s
Permissible Ripple	w < 5% as r.m.s. value w_{ss} < 15% as value peak-to-peak
Reference Potential	L - (negative pole) Earthing the reference potential is permitted.

Additional Items

Overview

This section lists additional items that can be used with or alongside the Safety PLC.

List of Additional Items

Additional Equipment	Description
Power Supply Unit	24 VDC with protective separation from power supply ● IEC 61131-2 ● product ranges: ABL7RE or ABL8RP ● location: *www.telemecanique.com*
DIN Rail	A suitable DIN Rail for mounting the controller. AM1•• range of DIN rail is acceptable and can be found under the Cable and Wiring Accessories in Control and Connection Components Catalog.
XPSMF60••	The XPSMF60 safe PLC controller is a modular PES in a rack system housing. The controller is able to house up to 6 of the following modules (see the table below). The number of times a particular module is used in the XPSMF60 is not restricted.
XPSMF3DIO••	remote input and output modules The number of inputs and outputs may vary depending on the model.
XPSMF2DO••	remote output module The number of outputs varies.
XPSMF1DI1601	remote input module with 16 digital outputs
Safety Modules	various safety modules and safety controllers (see *Machine Safety in the Essential Guide*) Module functions range from emergency stop to light curtain monitoring.
Standard Controllers	non-safety data transfer (see *Automation, Automation and Control, Essential Guide, 2005*) Standard controllers operate both large and small machinery. Ranges: ● Twido ● Micro ● Premium ● Quantum

Additional Equipment	Description
Safety Switches	• coded magnetic switches • limit switches • rotary lever or spindle • emergency stops • foot switches • switch disconnectors (See *Safety Section or the Essential Guide* for more details.)
Safety Devices and Actuators	• mat • light curtains • 2-hand control units • motor starters (See *Safety Section or the Essential Guide* for more details.)
Human Machine Interface Devices	Increase safety awareness: • pushbuttons and pilot lamps • beacons • sirens • magelis displays (See *Operator Dialog Section of the Essential Guide* for more details.)

Note: All the catalogs and guides are available at *http://www.telemecanique.com*.

Appendices



At a Glance

Overview

Additional information that is not necessarily required to understand the documentation.

What's in this Appendix?

The appendix contains the following chapters:

Chapter	Chapter Name	Page
A	Connection Diagrams, Examples of Application, and Error Codes	91

Connection Diagrams, Examples of Application, and Error Codes

A

At a Glance

Overview

This chapter contains connection diagrams, examples of application, and error codes.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Error Codes	92
Wiring Examples	100
Configuration of Ethernet Interfaces	105

Error Codes

Description of Error Codes

The error codes listed in this section appear in XPSMFWIN programming environment.

Digital inputs F35

System Signal	R/W	Meaning	
Module.SRS [UDINT]	R	slot number (system-rack-slot)	
Module.Type [UINT]	R	type of module, setpoint: 0x00D2 [210 $_{dez}$] (FS 1000), 0x0096 [150 ^{dez}] (FS 2000)	
Module.Error Code [WORD]	R	error codes of the module	
		0x0000	I/O processing, may be with faults, see further error codes
		0x0001	no I/O processing (CPU not in RUN)
		0x0002	no I/O processing during start-up tests
		0x0004	manufacturer interface in operation
		0x0010	no I/O processing: incorrect configuration
		0x0020	no I/O processing: error rate exceeded
		0x0040/ 0x0080	no I/O processing: configured module not inserted
AI.Error Code [WORD]	R	error codes for all analog and digital inputs	
		0x0001	module error
		0x0004	MEZ test: time monitoring of conversion
		0x0008	FTZ test: walking bit of data bus faulty
		0x0010	FTZ test: error checking coefficients
		0x0020	FTZ test: operating voltages faulty
		0x0040	A/D conversion faulty (DRDY_LOW)
		0x0080	MEZ test: cross links of MUX faulty
		0x0100	MEZ test: walking bit of data bus faulty
		0x0200	MEZ test: multiplexer addresses faulty
		0x0400	MEZ test: operating voltages faulty
		0x0800	MEZ test: measuring system (characteristic) faulty (unipolar)
		0x1000	MEZ test: measuring system (final values, zero point) faulty (unipolar)
		0x8000	A/D conversion faulty (DRDY_HIGH)

System Signal	R/W	Meaning	
DI[xx].Error Code [BYTE]	R	error codes for the digital input channels (1 to 24)	
		0x01	error in digital input module
		0x02	<= V3 operating system CPU: measuring values not valid >= V4 operating system CPU: unused
		0x04	A/D converter faulty, measuring values not valid since V4 operating system CPU: measuring values not valid
		0x08	measured value not within the safety accuracy
		0x10	measured value overflow
		0x20	channel not in operation
		0x40	address error of both A/D converters
		0x80	parameterization of hysteresis faulty
DI[xx].Value Analog [INT]	R	analog value of DI channels (1 to 24) [INT] from 0 to +3000 (0 to +30 V) the validity is dependent on DI[xx].Error Code	
DI[xx].Value [BOOL]	R	digital value of DI channels (1 to 24) [BOOL] according to hysteresis the validity is dependent on DI[xx].Error Code	
DI[xx].Hysteresis LOW [INT]	W	upper limit of the 0-signal voltage range DI[xx].Value	
DI[xx].Hysteresis HIGH [INT]	W	lower limit of the 1-signal voltage range DI[xx].Value	
DI[xx].Used [BOOL]	W	configuration for indicating utilization of channels 1 to 24 **1** in use **0** not in use	

Analog inputs F35

System Signal	R/W	Meaning	
Module.SRS [UDINT]	R	slot number (system-rack-slot)	
Module.Type [UINT]	R	type of module, setpoint: 0x00D2 [210 $_{dez}$] (FS 1000), 0x0096 [150 ^{dez}] (FS 2000)	
Module.Error Code [WORD]	R	error codes of the module	
		0x0000	I/O processing, may be with faults, see further error codes
		0x0001	no I/O processing (CPU not in RUN)
		0x0002	no I/O processing during start-up tests
		0x0004	manufacturer interface in operation
		0x0010	no I/O processing: incorrect configuration
		0x0020	no I/O processing: error rate exceeded
		0x0040/ 0x0080	no I/O processing: configured module not inserted
AI.Error Code [WORD]	R	error codes for all analog and digital inputs	
		0x0001	module error
		0x0004	MEZ test: time monitoring of conversion
		0x0008	FTZ test: walking bit of data bus faulty
		0x0010	FTZ test: error checking coefficients
		0x0020	FTZ test: operating voltages faulty
		0x0040	A/D conversion faulty (DRDY_LOW)
		0x0080	MEZ test: cross links of MUX faulty
		0x0100	MEZ test: walking bit of data bus faulty
		0x0200	MEZ test: multiplexer addresses faulty
		0x0400	MEZ test: operating voltages faulty
		0x0800	MEZ test: measuring system (characteristic) faulty (unipolar)
		0x1000	MEZ test: measuring system (final values, zero point) faulty (unipolar)
		0x8000	A/D conversion faulty (DRDY_HIGH)

System Signal	R/W	Meaning	
AI[xx].Error Code [BYTE]	R	error codes for the analog input channels	
		0x01	error in analog input module
		0x02	<= V3 operating system CPU: measuring values not valid >= V4 operating system CPU: unused
		0x04	A/D converter faulty, measuring values not valid since V4 operating system CPU: measuring values not valid
		0x08	measured value not within the safety accuracy
		0x10	measured value overflow
		0x20	channel not in operation
		0x40	address error of both A/D converters
		0x80	parameterization of hysteresis faulty
AI[xx].Value [INT]	R	analog value of AI channels (1 to 8) [INT] from 0 to +1000 (version: FS1000), 0...+2000 (version FS2000) (0 V to +10 V) the validity is dependent on AI[xx].Error Code	
AI[xx].Used [BOOL]	W	configuration for indicating utilization of channels 1 to 8 **1** in use **0** not in use	

Digital outputs F35

System Signal	R/W	Meaning	
Module.SRS [UDINT]	R	slot number (system-rack-slot)	
Module.Type [UINT]	R	type of module, setpoint: 0x00B4 [180 $_{dez}$]	
Module.Error Code [WORD]	R	error codes of the module	
		0x0000	I/O processing, may be with faults, see further error codes
		0x0001	no I/O processing (CPU not in RUN)
		0x0002	no I/O processing during start-up tests
		0x0004	manufacturer interface in operation
		0x0010	no I/O processing: incorrect configuration
		0x0020	no I/O processing: error rate exceeded
		0x0040/ 0x0080	no I/O processing: configured module not inserted
DO.Error Code [WORD]	R	error codes for all digital outputs	
		0x0001	error in the digital output range
		0x0002	MEZ test of safety shutdown 1 failed
		0x0004	MEZ test of safety shutdown 2 failed
		0x0008	FTZ test of test pattern failed
		0x0010	MEZ test of test pattern of the output switch failed
		0x0020	MEZ test of test pattern of the output switch (disconnection test of outputs) failed
		0x0040	MEZ test, active disconnection via WD failed
		0x0400	FTZ test: 1. temperature threshold exceeded
		0x0800	FTZ test: 2. temperature threshold exceeded
		0x1000	FTZ test: monitoring of auxiliary supply 1: undervoltage

System Signal	R/W	Meaning	
DO[xx].Error Code [BYTE]	R	error codes of the digital output channels	
		0x01	error in digital output module
		0x02	output switched off due to overload
		0x04	error when reading back the activation of the digital outputs
		0x08	error when reading back the status of the digital outputs
DO[xx].Value [BOOL]	W	output value of the digital output channels **0** output is not set **1** output is set	

Counter F35

System Signal	R/W	Meaning	
Module.SRS [UDINT]	R	slot number (system-rack-slot)	
Module.Type [UINT]	R	type of module, setpoint: 0x0003 [3 $_{dez}$]	
Module.Error Code [WORD]	R	error codes of the module	
		0x0000	I/O processing, may be with faults, see further error codes
		0x0001	no I/O processing (CPU not in RUN)
		0x0002	no I/O processing during start-up tests
		0x0004	manufacturer interface in operation
		0x0010	no I/O processing: incorrect configuration
		0x0020	no I/O processing: error rate exceeded
		0x0040/ 0x0080	no I/O processing: configured module not inserted

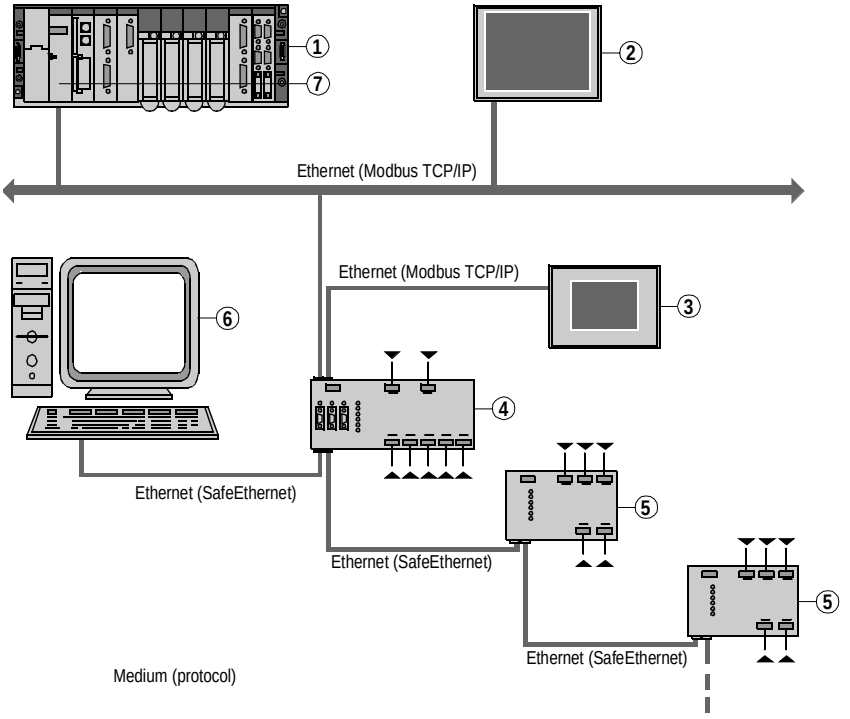
System Signal	R/W	Meaning	
Counter.Error Code [WORD]	R	error codes of the counter module	
		0x0001	error in module
		0x0002	error comparing the time base
		0x0004	address error reading the time base
		0x0008	parameters for the time base faulty
		0x0010	address error reading the counter content
		0x0020	configuration of counter damaged
		0x0040	address error reading the Gray Code
		0x0080	FTZ test of the test pattern failed
		0x0100	FTZ test, error checking the coefficients
		0x0200	fault at initial parameterization of module
Counter[0x].Error Code [BYTE]	R	error codes of counter channels1, 2	
		0x01	error in counter module
		0x02	error comparing contents of counters
		0x04	error comparing the time stamps of the counters
		0x08	error setting the parameters (reset)
Counter[0x].Value [UDINT]	R	content of counters: 24 bit for pulse counter, 3 bit for Gray Code	
Counter[0x].Time stamp [UDINT]	R	time stamp for Counter[0x].Value 24 bit, time resolution 1 µs	
Counter[0x].Value Overflow [BOOL]	R	counter overflow indication **TRUE** 24 bit overflow since last cycle (only if Counter[0x].Auto.Advance Sense FALSE) **FALSE** no overflow since last cycle	
Counter[0x].Time Overflow [BOOL]	R	overflow indication for the time stamp of the counters **TRUE** 24 bit overflow since last measurement **FALSE** no 24 bit overflow since last measurement	
Counter[0x].Direction [BOOL]	R/W	counting direction of counter (only if Counter[0x].Auto.Advance Sense FALSE) **TRUE** downwards (decrement) **FALSE** upwards (increment)	
Counter[0x].Auto.Advance Sense [BOOL]	R/W	automatic counter direction recognition **TRUE** automatic recognition On **FALSE** manual setting of counter direction	

System Signal	R/W	Meaning
Counter[0x].Reset [BOOL]	R/W	reset counter **TRUE** no reset **FALSE** reset
Counter[0x].5/24V Mode [BOOL]	R/W	counter input 5 V or 24 V **TRUE** 24 V **FALSE** 5 V
Counter[0x].Gray Code [BOOL]	R/W	decoder/pulse operation **TRUE** Gray Code decoder **FALSE** Pulse operation

Wiring Examples

SafeEthernet protocol and Ethernet Wiring Example

The following scheme shows an example of Ethernet and SafeEthernet protocol networking:



Elements of the network

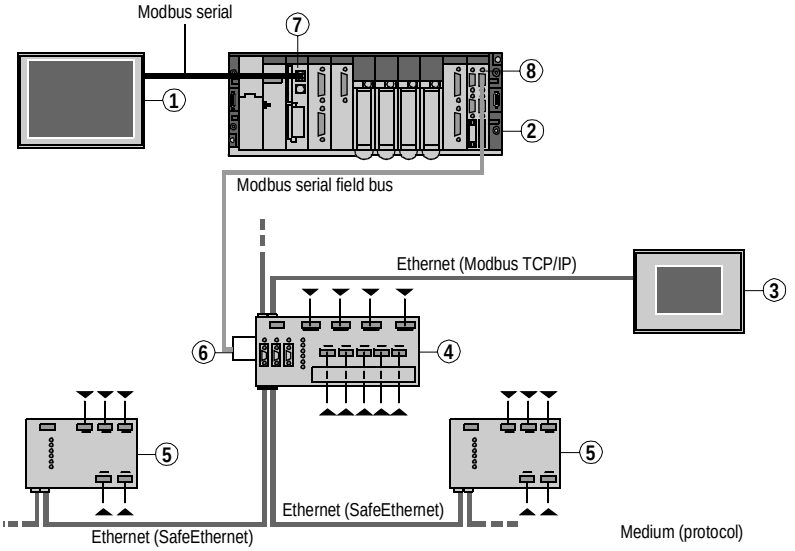
No.	Element
1	Atomation Platform Premium PLC
2	Magelis Graphic Terminal
3	Magelis Graphic Terminal
4	XPSMF30 Safety PLC
5	XPSMF 1/2/3 DIO/AIO Remote I/O
6	PC
7	TSX ETY100 (Modbus TCP/IP) Module

The above application shows the communication between a Safety PLC and a Premium PLC over Ethernet using Modbus TCP/IP protocol and Ethernet using SafeEthernet protocol. The data exchange between the Safety PLC and the Premium PLC is non-safety data transfer. The 2 systems can work together sending and receiving data in both directions using Modbus TCP/IP protocol. In this case, it allows non-safe data transfer over Ethernet through the master PLC.

Now, the data from a safety-related input can control a safety output within the Safety PLC system and a non-safety output through the Premium PLC system. The PLC system can transmit its non-safe data over Ethernet controlling a non-safety-related output. This allows the cabling system to be used to transfer both safe and non-safe data.

SafeEthernet Wiring Example

The following scheme shows an example of SafeEthernet protocol and Modbus protocols networking:



Elements of the network

No.	Element
1	Magelis Graphic Terminal
2	Automation platform 'Premium'
3	Magelis Graphic Terminal
4	XPSMF30 Safety PLC
5	XPSMF 1/2/3 DIO/AIO
6	XPSMF ADAPT
7	TER Connection on Premium Processor
8	TSXSCY21601 Modbus Serial Module

The application above shows the combination of a Safety PLC system and a Premium PLC system connected via Modbus serial. The data exchange between the Safety PLC system and the Premium PLC system over Modbus serial is non-safe data transfer. The communication allows the 2 systems to work together. The PLC system can send the non-safe data over to the Safety PLC. The Safety PLC can transmit the non-safety-related data over Ethernet to 1 of the remote I/O modules. The module can control a non-safety-related output. This enables the use of a single transmission line over large distances for safe and non-safe data transfer.

Fire Alarm Systems

All XPSMF systems with analog inputs can be used for central fire alarm systems in accordance with DIN EN 54-2 and NFPA 72.

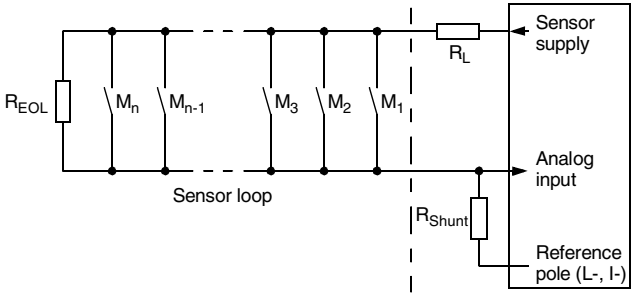
The application program must fulfil the functions for central fire alarm systems according to the cited standards.

The required maximum cycle time for central fire alarm systems is 10 s (DIN EN 54-2). This cycle time can be reached very easily. The cycle time of the XPSMF PLCs can be measured in milliseconds. Similarly, the required safety time (error response time) of 1 s can also be achieved very easily.

The DIN EN 54-2 standard requires that the central fire alarm system must be in the fault report state within 100 s after the XPSMF system has received the fault report.

The fire alarms are connected using the energize to trip principle with line monitoring for the detection of short-circuits and breaks. The digital and analog outputs can be used with the XPSMF35, analog inputs with the XPSMF3AIO8401 and the XPSMFAI801 analog input module with XPSMF60.

The following diagram shows the wiring of the fire alarm system:



- M: Fire alarm
- R_{EOL}: Terminating resistor on the last sensor in the loop
- Terminating resistor on the last sensor in the loop
- R_L: Limitation of the permitted maximum current in the loop
- R_{Shunt}: Measuring resistor

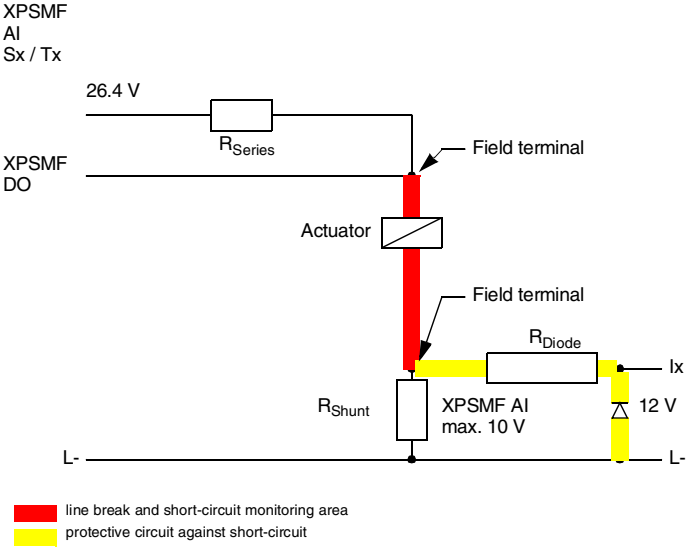
For the application, the resistance of R_{EOL}, R_L and R_{Shunt} must be calculated according to the sensor type which is used and the number of sensors per alarm loop. The required data are contained in the relevant data sheet of the sensor manufacturer.

The alarm outputs, which are used for activating lamps, sirens etc. are operated using the energize to trip principle. These outputs must be monitored for line breaks and short-circuits. This can be done by performing a read back from the output signals, directly from the actuator to the inputs.

The current in the actuator circuit should preferably be monitored via an analog input with an appropriate shunt. A series connection of zener diode and series protects the input against overvoltage in case of a short-circuit.

For explicit line break monitoring (at de-energized outputs (DO)), a transmitter supply must added to the analog inputs.

The following diagram shows and example of line break and short-circuit monitoring of digital outputs (actuator circuits):



Visual display systems, indicator light panels, LED displays, alphanumeric displays, audible alarms, etc. can all be controlled using the application program. The routing of fault signals via input and output modules or to routing equipment must be carried out using the deenergize to trip mode.

Fire alarms can be transmitted from 1 XPSMF system to another using Ethernet communications (OPC) standard. Any breakdown in communications must be signalled.

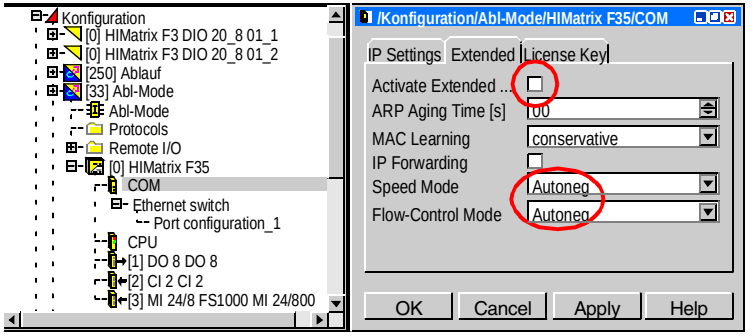
XPSMF systems that are used as central fire alarm systems must have a redundant power supply. Precautions must also be taken against a power supply failure, i.e., a battery-powered horn should be used. Operation may not be interrupted while switching between the main supply and the back-up supply. Voltage dips of up to 10 ms are permitted.

If a system fault occurs, the system signals specified in the application program are written by the operating system. Thus, error signalling can be assigned to signal errors detected by the system. If an error occurs, safety-related inputs and outputs are switched off, i.e., 0-signals are applied to all the channels of faulty inputs, and all channels with faulty outputs are switched off.

Configuration of Ethernet Interfaces

Communication Settings

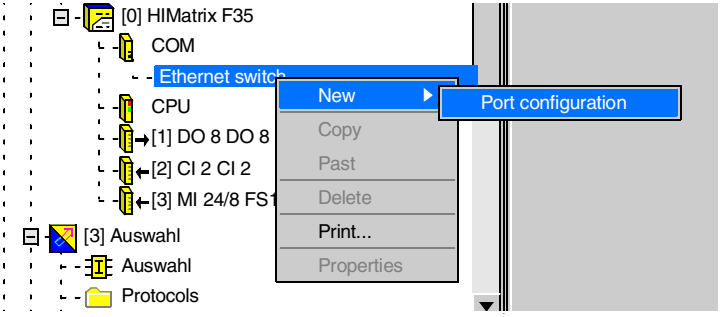
For setting the communication parameters proceed as follows:

Step	Action
1	Open the **Extended** tab.
2	In the **Speed Mode** list, select **Autoneg**.
3	In the **Flow-Control Mode** list, select **Autoneg**.
4	Select the **Activate Extended Settings** check box. **Result:** The selected parameters are activated.  **Note:** The parameters of the **Extended** tab are explained in detail in the online help of XPSMFWIN.

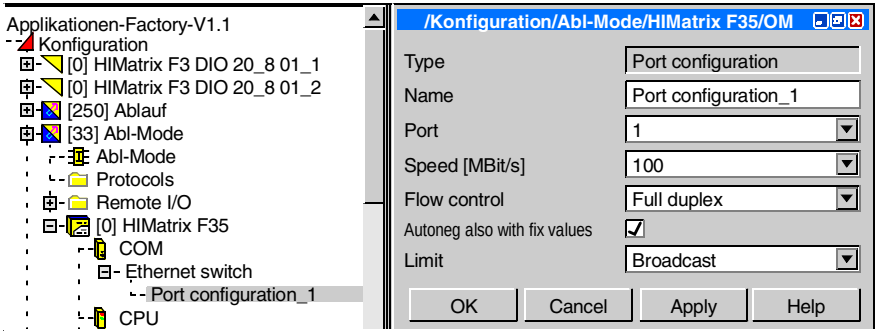
Port Settings

The port settings of the integrated switch can be parameterized individually from COM OS version > 8.32 and XPSMFWIN Hardware Management version > 7.56.10. Using the context menu of the communication **COM** settings select **Ethernet switch** → **New** → **Port configuration**. A configuration menu can be established for each switched port.

Setting a port configuration



Parameters of a port configuration



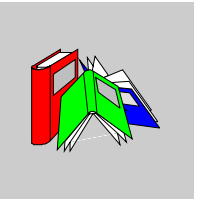
The following table contains the parameter descriptions:

Parameter	Description
Port	Port number, as assigned on device. **Note:** Only 1 configuration is possible per port. **Value range** 1...n, depending on the resource
Speed [MBit/s]	The following selections are available: **10 MBit/s** data rate 10 MBit/s **100 MBit/s** data rate 100 MBit/s **Autoneg (10/100)** automatic setting of the baud rate The default setting is **Autoneg**.
Flow control	The following selections are available: **Full duplex** communication in both directions at the same time **Half duplex** communication in one direction **Autoneg** automatic control of communication The default setting is **Autoneg**.
Autoneg also with fix values	The *Advertising* (transfer of **Speed** and **Flow control** properties) is made with fixed parameter values. Thereby other devices, whose port settings are **Autoneg**, can recognise how the PLC ports are set.
Limit	Limit incoming Multicast and/or Broadcast packages. The following selections are available: **Off** no limit **Broadcast** limit Broadcast (128 kbit/s) **Multicast and Broadcast** limit Multicast and Broadcast (1024 kbit/s) The default setting is **Broadcast**.

Activation of Settings

Parameters are set in the **COM** window of the Hardware Management screen. Before the changes/settings become active the application program must be compiled using the Code Generator and then transferred to the PLC(s). The communication properties can be changed in the online mode using the Control Panel. The settings become active immediately, but are not transferred to the application program.

Glossary



A

AWG american wire gage (wire diameter)

C

COM communication module

CPU central processing unit

D

DI digital input

DIO digital input/output

DO digital output

E

EMC electromagnetic compatibility

F

FB field bus

FBD functional block diagram

FTT fault tolerance time

FTZ see FTT

I

IEC international electrotechnical commission

L

LC line control

M

MEZ see MFOT

MFOT multi-fault occurrence time

N

NSP non-safety-related protocol

O

OLE object linking and embedding

OSI Model open system interconnection model

P

PELV protective extra low voltage

PES programmable electronic system

R

R read

R/W read/write

RC requirement class

S

SELV	safety extra low voltage
SFC	sequential function chart
SIL	safety integrity level (according to IEC 61508)
SRS	system-rack-slot

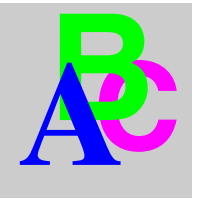
T

TMO	timeout

W

W	write
WD	watchdog
WDT	watchdog time

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