TECHNICAL INFORMATION

safeRS3 PROFIsafe communication

SICK
Sensor Intelligence.

Described product

safeRS3 PROFIsafe communication

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1 Scope

This document defines the data exchanged through the PROFINET/PROFIsafe Fieldbus interface of safeRS/safeRS3 mixed system and safeRS3.

The scope of this document is to describe and specify the PROFINET/PROFIsafe Fieldbus interface provided by safeRS3 Control PROFINET as part of both safeRS/safeRS3 mixed system and safeRS3.

The following topics will be covered:

- Overview of the PROFINET/PROFIsafe Fieldbus interface;
- Definition of the exchanged data;
- Network integration and configuration.

2 Applicability

This release of this document is applicable to the safeRS/safeRS3 mixed system and safeRS3 in accordance with GSDML file GSDML-V2.4-SICK-0101-safeRS3-20220308 and control firmware version 1.6.0.

2.1 NOTICE

The following considerations shall be taken into account:

- safeRS3 supports four protective fields and it is a multi-target system, able to detect up to four targets for each sensor.
- safeRS/safeRS3 mixed system supports two protective fields and it is a mono-target system, able to detect only the nearest target to each sensor.

For this reason, some data are available only in safeRS3. In the document, a note is present where a difference between safeRS3 and safeRS/safeRS3 mixed system is present.

3 System Overview

safeRS3 Control PROFINET , part of both safeRS/safeRS3 mixed system and safeRS3, communicates with the machine control via PROFINET/PROFIsafe by means of one of the two RJ45 connectors **[A]** at the bottom (Refer to Figure 2).

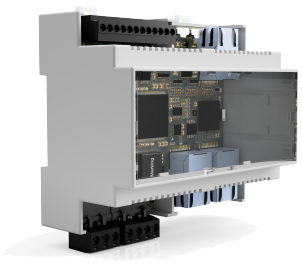


Figure 1 *safeRS3 Control PROFINET device*

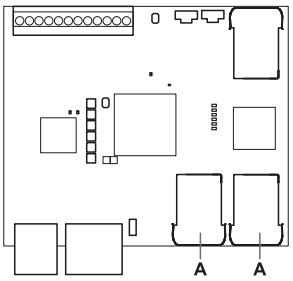


Figure 2 *safeRS3 Control PROFINET structure*

Exchanged input and output information are logically shared into different PROFINET submodules:

- 16 x F-submodules (PROFIsafe safety related modules);
- 1 x Submodule (PROFINET non-safe modules).

IMPORTANT
In order to ensure compliance with both PROFIsafe V2.6 and PROFIsafe V2.4, the same information block is provided in two sequential F-submodules, one V2.6 compatible and the other V2.4 compatible. They have to be activated in exclusive mode.

The list of the submodules available on the safeRS/safeRS3 mixed system and safeRS3 is reported in the table below.

Sub-Module	Slot	Description	F-addresses
F-submodule 1	Slot 1	Configuration and Status module (PS2v6)	145
F-submodule 2	Slot 2	Configuration and Status module (PS2v4)	146
F-submodule 3	Slot 3	Sensors Information (PS2v6)	147
F-submodule 4	Slot 4	Sensors Information (PS2v4)	148
F-submodule 5	Slot 5	Sensor 1 Target Information (PS2v6)	149
F-submodule 6	Slot 6	Sensor 1 Target Information (PS2v4)	150
F-submodule 7	Slot 7	Sensor 2 Target Information (PS2v6)	151
F-submodule 8	Slot 8	Sensor 2 Target Information (PS2v4)	152
F-submodule 9	Slot 9	Sensor 3 Target Information (PS2v6)	153
F-submodule 10	Slot 10	Sensor 3 Target Information (PS2v4)	154
F-submodule 11	Slot 11	Sensor 4 Target Information (PS2v6)	155
F-submodule 12	Slot 12	Sensor 4 Target Information (PS2v4)	156
F-submodule 13	Slot 13	Sensor 5 Target Information (PS2v6)	157
F-submodule 14	Slot 14	Sensor 5 Target Information (PS2v4)	158
F-submodule 15	Slot 15	Sensor 6 Target Information (PS2v6)	159
F-submodule 16	Slot 16	Sensor 6 Target Information (PS2v4)	160
Submodule 17	Slot 17	Extended info module	N.A.

3.1 F-addresses

At the PROFIsafe layer, F-submodules require an unique address inside the network where they are installed.

The valid range of a F-address is [1..65534].

The F-address (F-DestAddress) of each F-module is settable by the safeRS3 Designer application.

4 Exchanged data

Data is exchanged in different submodules as described in the following paragraphs.

Note: 16-bit data are transmitted in big endian format by default. The endianness format is settable by the safeRS3 Designer application during the configuration of the system.

4.1 Configuration and Status modules

These F-submodules (F-submodule 1 and 2) provide input and output data:

- Outputs of the device (inputs of the control host) communicate the status of the system, the current dynamic configuration, the status of the OSSDs and hardware input lines, and possible errors.
- Inputs of the device (outputs of the control host) allow the control host to set a new dynamic configuration, to set the state of the OSSDs, perform muting commands on the sensors and save the reference for the anti-tampering functions.

Both exchanged inputs and outputs are encoded in 12-bytes size structures as reported in Table 1 and Table 2 .

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Control status							
1	Restart signal feedback							
2	Static Object Detection Status							
3	Single channel digital inputs							
4	Configuration ID currently in use							
5	CRC32 of the configuration ID currently in use (32 bit)							
6								
7								
8								
9	Digital inputs							
10	Digital outputs							
11	Muting status							

Table 1 *Device outputs structure of Configuration and Status modules*

Note: Safety stop signal message sent by the control to the host corresponds to the condition: (control status value != 0xFF), refer to Control status (Device output) on the next page for details.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	ID of configuration to be set							
1	*NA*	*NA*	Muting command					
2	*NA*	*NA*	Saving of anti-tampering reference					
3	*NA*	*NA*	*NA*	*NA*	Digital output command			
4	*NA*	*NA*	*NA*	*NA*	Restart signal			
5	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	System recondition
6	*NA*							
7								
8								
9								
10								
11								

Table 2 *Device inputs structure of Configuration and Status modules*

4.1.1 Control status (Device output)

The byte containing the status of the control is encoded as a bit mask as follows:

Bit 0	PROTECTIVE FIELD 1	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 1	PROTECTIVE FIELD 2	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 2	PROTECTIVE FIELD 3 (available only in safeRS3)	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 3	PROTECTIVE FIELD 4 (available only in safeRS3)	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 4	RESTART FEEDBACK SIGNAL	(Values: 0 is “The system is waiting for the restart signal”, 1 otherwise)
Bit 5	STOP FEEDBACK SIGNAL	(Values: 0 is “Stop signal activated”, 1 otherwise)
Bit 6	SYSTEM DIAGNOSTIC SIGNAL	(Values: 0 is “The system is in error”, 1 otherwise)
Bit 7	CONFIGURATION FEEDBACK	(Values: 0 is “The system is in configuration”, 1 otherwise)

Note: detection in one field means that at least one connected sensor is in detection in that field.

Note[1)]: from firmware version 1.5.0 of the control, Bit 0, 1, 2 and 3 have a value of 0 even when the system is in configuration, in error (fault) or if the stop signal is activated.

4.1.2 Restart signal feedback (Device output)

The byte containing the status of the restart signal feedback as a bit mask as follows:

Bit 0	PROTECTIVE FIELD 1	(Values: 0 is WAITING FOR MANUAL RESTART, 1 otherwise)
Bit 1	PROTECTIVE FIELD 2	(Values: 0 is WAITING FOR MANUAL RESTART, 1 otherwise)
Bit 2	PROTECTIVE FIELD 3 (available only in safeRS3)	(Values: 0 is WAITING FOR MANUAL RESTART, 1 otherwise)
Bit 3	PROTECTIVE FIELD 4 (available only in safeRS3)	(Values: 0 is WAITING FOR MANUAL RESTART, 1 otherwise)
Bit 4	*NA*	
Bit 5	*NA*	
Bit 6	*NA*	
Bit 7	*NA*	

4.1.3 Static Object Detection status (Device Output)

The byte containing the status of the Static Object Detection option is encoded as a bit mask as follows:

Bit 0:	STATIC OBJECT DETECTION FIELD 1 (available only in safeRS3*)	(Values: 0 is DETECTION, 1 is FREE)
Bit 1:	STATIC OBJECT DETECTION FIELD 2 (available only in safeRS3*)	(Values: 0 is DETECTION, 1 is FREE)
Bit 2:	STATIC OBJECT DETECTION FIELD 3 (available only in safeRS3*)	(Values: 0 is DETECTION, 1 is FREE)
Bit 3:	STATIC OBJECT DETECTION FIELD 4 (available only in safeRS3*)	(Values: 0 is DETECTION, 1 is FREE)
Bit 4:	*NA*	
Bit 5:	*NA*	
Bit 6:	*NA*	
Bit 7:	*NA*	

Note*: only if control has firmware version 1.5.0 or later.

4.1.4 Status of the single channel inputs (Device output)

The byte containing the status of the single channel inputs is encoded as follows:

Bit 0:	Single channel 1 (Input 1.1)	(Values: 1 is HIGH, 0 is LOW)
Bit 1:	Single channel 2 (Input 1.2)	(Values: 1 is HIGH, 0 is LOW)
Bit 2:	Single channel 3 (Input 2.1)	(Values: 1 is HIGH, 0 is LOW)
Bit 3:	Single channel 4 (Input 2.2)	(Values: 1 is HIGH, 0 is LOW)
Bit 4:	*NA*	
Bit 5:	*NA*	
Bit 6:	*NA*	
Bit 7:	*NA*	

4.1.5 Current configuration ID and its CRC32 (Device output)

Byte 4 of the device output is the ID of the current dynamic configuration in use. Valid range is from 0 to 31, depending on the configuration of the system.

Byte 5,6,7 and 8 contain its relevant signature (32-bit checksum). Byte 5 is the most significant byte (MSB), byte 8 is the least significant byte (LSB).

4.1.6 Status of the digital inputs lines (Device output)

The byte containing the status of the digital inputs lines is encoded as follows:

Bit 0:	Input 1 logical status	(Values: 1 is HIGH, 0 is LOW)
Bit 1:	Input 1 diagnostic error	(Values: 1 is in ERROR, 0 is OK)
Bit 2:	*NA*	
Bit 3:	Input 1 configuration	(Values: 1 is NOT CONFIGURED, 0 is in USE)
Bit 4:	Input 2 logical status	(Values: 1 is HIGH, 0 is LOW)
Bit 5:	Input 2 diagnostic error	(Values: 1 is in ERROR, 0 is OK)
Bit 6:	*NA*	
Bit 7:	Input 2 configuration	(Values: 1 is NOT CONFIGURED, 0 is in USE)

4.1.7 Status of digital outputs (Device output)

The byte containing the status of the digital outputs is encoded as follows:

Bit 0:	Output 1 status	(Values: 1 is ON, 0 is OFF)
Bit 1:	Output 2 status	(Values: 1 is ON, 0 is OFF)
Bit 2:	Output 3 status	(Values: 1 is ON, 0 is OFF)
Bit 3:	Output 4 status	(Values: 1 is ON, 0 is OFF)
Bit 4:	Output 1 diagnostic error	(Values: 1 is in ERROR, 0 is OK)
Bit 5:	Output 2 diagnostic error	(Values: 1 is in ERROR, 0 is OK)
Bit 6:	Output 3 diagnostic error	(Values: 1 is in ERROR, 0 is OK)
Bit 7:	Output 4 diagnostic error	(Values: 1 is in ERROR, 0 is OK)

4.1.8 Muting status (Device output)

The byte containing the status of the system muting is encoded as follows:

Bit 0:	Muting status of sensor 1	(Values: 0 is MUTED, 1 is not MUTED)
Bit 1:	Muting status of sensor 2	(Values: 0 is MUTED, 1 is not MUTED)
Bit 2:	Muting status of sensor 3	(Values: 0 is MUTED, 1 is not MUTED)
Bit 3:	Muting status of sensor 4	(Values: 0 is MUTED, 1 is not MUTED)
Bit 4:	Muting status of sensor 5	(Values: 0 is MUTED, 1 is not MUTED)
Bit 5:	Muting status of sensor 6	(Values: 0 is MUTED, 1 is not MUTED)
Bit 6:	*NA*	
Bit 7:	*NA*	

4.1.9 Configuration ID to be set (Device input)

Byte 0 of the device input is the ID of the dynamic configuration to be set. Valid range from 0 to 31.

The control will consider the input value only if no HW input line is set as dynamic configuration selector; otherwise the value will be ignored.

Depending on the configuration of the system, in case a not valid or out-of-range dynamic configuration ID is required, the current dynamic configuration ID shown in Byte 4 of the device output will be 0 and its CRC32 will be set to 0xFFFFFFFF.

4.1.10 Muting command (Device input)

A muting request from the control host can be send to each sensor as follows:

Bit 0:	Muting command of sensor 1	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 1:	Muting command of sensor 2	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 2:	Muting command of sensor 3	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 3:	Muting command of sensor 4	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 4:	Muting command of sensor 5	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 5:	Muting command of sensor 6	(Values: 1 is MUTING ON, 0 is MUTING OFF)
Bit 6:	*NA*	
Bit 7:	*NA*	

4.1.11 Saving of anti-tampering reference (Device input)

A request to save the reference used for the anti-tampering function from the control host can be sent with valid value 0x3F.

4.1.12 Digital output command (Device input)

Depending on the system configuration, if outputs are configured as “Fieldbus controlled”, the state of the Outputs can be set as follows:

Bit 0:	Output 1	(Values: 1 is ON-STATE, 0 is OFF-STATE)
Bit 1:	Output 2	(Values: 1 is ON-STATE, 0 is OFF-STATE)
Bit 2:	Output 3	(Values: 1 is ON-STATE, 0 is OFF-STATE)
Bit 3:	Output 4	(Values: 1 is ON-STATE, 0 is OFF-STATE)
Bit 4:	*NA*	
Bit 5:	*NA*	
Bit 6:	*NA*	
Bit 7:	*NA*	

4.1.13 Restart signal (Device input)

Depending on the system configuration, if at least one protective field is configured as manual or safe manual restart, the restart signal can be generated as follows:

Bit 0:	Restart protective field 1	(Values: 1 is PRESSED, 0 is RELEASED)
Bit 1:	Restart protective field 2	(Values: 1 is PRESSED, 0 is RELEASED)
Bit 2:	Restart protective field 3	(Values: 1 is PRESSED, 0 is RELEASED)
Bit 3:	Restart protective field 4	(Values: 1 is PRESSED, 0 is RELEASED)
Bit 4:	*NA*	
Bit 5:	*NA*	
Bit 6:	*NA*	
Bit 7:	*NA*	

4.1.14 System recondition signal (Device input)

The system recondition signal can be generated as follows:

Bit 0:	System recondition signal	(Values: 1 is PRESSED, 0 is RELEASED)
Bit 1:	*NA*	
Bit 2:	*NA*	
Bit 3:	*NA*	
Bit 4:	*NA*	
Bit 5:	*NA*	
Bit 6:	*NA*	
Bit 7:	*NA*	

4.2 Sensors Information module

The F-submodules 3 and 4 provide (one compliant to Profisafe V2.6 and the other compliant to Profisafe V2.4) information related to each sensor.

These F-submodules provide only output data: the sensor status of each sensor.

Exchanged outputs are encoded in 12-bytes size structures as follows.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Sensor 1 status (1/2)							
1	Sensor 1 status (2/2)							
2	Sensor 2 status (1/2)							
3	Sensor 2 status (2/2)							
4	Sensor 3 status (1/2)							
5	Sensor 3 status (2/2)							
6	Sensor 4 status (1/2)							
7	Sensor 4 status (2/2)							
8	Sensor 5 status (1/2)							
9	Sensor 5 status (2/2)							
10	Sensor 6 status (1/2)							
11	Sensor 6 status (2/2)							

4.2.1 Sensor status (1/2) (Device output)

The byte contains the status of the relevant sensor encoded as follows:

Bit 0:	PROTECTIVE FIELD 1	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 1:	PROTECTIVE FIELD 2	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 2:	PROTECTIVE FIELD 3 (available only in safeRS3)	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 3:	PROTECTIVE FIELD 4 (available only in safeRS3)	(Values: 0 is DETECTION[1)], 1 is FREE)
Bit 4:	DIAGNOSTIC FEEDBACK	(Values: 0 is in FAULT, 1 is OK)
Bit 5:	MUTING FEEDBACK	(Values: 0 is in MUTED, 1 otherwise)
Bit 6:	*NA*	
Bit 7:	INSTALLATION STATUS	(Values: 0 is INSTALLED, 1 is not INSTALLED)

Note[1)]: from firmware version 1.5.0 of the control, Bit 0, 1, 2 and 3 have a value of 0 even when the system is in configuration, in error (fault) or if the stop signal is activated.

4.2.2 Sensor status (2/2) (Device output)

The byte contains the status of the relevant sensor encoded as follows:

Bit 0:	PRESENCE FIELD 1	(Values: 0 is PRESENT, 1 is FREE)
Bit 1:	PRESENCE FIELD 2	(Values: 0 is PRESENT, 1 is FREE)
Bit 2:	PRESENCE FIELD 3 (available only in safeRS3)	(Values: 0 is PRESENT, 1 is FREE)
Bit 3:	PRESENCE FIELD 4 (available only in safeRS3)	(Values: 0 is PRESENT, 1 is FREE)
Bit 4:	WORKING MODE FIELD 1	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)
Bit 5:	WORKING MODE FIELD 2	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)
Bit 6:	WORKING MODE FIELD 3	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)
Bit 7:	WORKING MODE FIELD 4	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)

4.3 Sensor Target Information modules

The F-submodules from F-submodule 5 to F-submodule 16 provide, two by two (one compliant to Profisafe V2.6 and the other compliant to Profisafe V2.4), target information detected by each sensor.

Each couple of f-submodules provide target information of up to four protective fields (DF) of a specific sensor: distance and azimuth angle of the targets.

Exchanged outputs are encoded in 12-bytes size structures as reported in the table below.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	PROTECTIVE FIELD 1 distance (16 bit)							
1								
2	PROTECTIVE FIELD 1 angle (8 bit)							
3	PROTECTIVE FIELD 2 distance (16 bit)							
4								
5	PROTECTIVE FIELD 2 angle (8 bit)							
6	PROTECTIVE FIELD 3 distance (16 bit)							
7								
8	PROTECTIVE FIELD 3 angle (8 bit)							
9	PROTECTIVE FIELD 4 distance (16 bit)							
10								
11	PROTECTIVE FIELD 4 angle (8 bit)							

Note: for safeRS/safeRS3 mixed system, the only Sensor Target Information available is the distance of the nearest target. This distance is reported equal in both DF 1 and DF 2 distance fields.

4.3.1 Protective Field distance (Device output)

Protective Field x distance represents the minimum distance of the target detected in the field x. The distance is reported in mm. Value 0 is used in case of no detection.
By default, the value is given in big endian format. It is possible during the configuration of the system to select a little endian format.

4.3.2 Protective Field angle (Device output)

Protective Field x angle represents the azimuth angle of the minimum distance of the target detected in the field x. The angle is reported in degrees (°) in the range (0°, +180°) and centered in 90°.

Note: this section is not available for safeRS/safeRS3 mixed system.

4.4 Extended info module

Extended info is a non-safe submodule reporting some system information to be used in a non-safe context.

It provides 120-byte output data (inputs of the control host) divided in:

- Control and sensor diagnostics as reported in Table 3 . Refer to Control and sensor error status on page 19 for details.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Control - Error status							
1 - 2	Control - Detailed error status (16 bit)							
3	Sensor 1 - Error status							
4 - 5	Sensor 1- Detailed error status (16 bit)							
6	Sensor 2 - Error status							
7 - 8	Sensor 2 - Detailed error status (16 bit)							
9	Sensor 3 - Error status							
10 -11	Sensor 3 - Detailed error status (16 bit)							
12	Sensor 4 - Error status							
13 - 14	Sensor 4 - Detailed error status (16 bit)							
15	Sensor 5 - Error status							
16 - 17	Sensor 5 - Detailed error status (16 bit)							
18	Sensor 6 - Error status							
19 - 20	Sensor 6 - Detailed error status (16 bit)							

Table 3 *Extended Info module - Error status*

- Target distance and azimuth angle of each sensor (as reported in Table 4 , Table 5 , Table 6 , Table 7 , Table 8 and Table 9). They are the current distance and azimuth angle of a target detected by each sensor. For details as data are encoded, refer to Protective Field distance (Device output) above and par. Protective Field angle (Device output) above.

Note: for safeRS/safeRS3 mixed system, the only Sensor Target Information available is the distance of the nearest target. This distance is reported equal in both Protective Field 1 and Protective Field 2 distance fields.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
21 - 22	Sensor 1 - Protective Field 1 distance (16 bit)							
23	Sensor 1 - Protective Field 1 angle (8 bit)							
24 - 25	Sensor 1 - Protective Field 2 distance (16 bit)							
26	Sensor 1 - Protective Field 2 angle (8 bit)							
27 - 28	Sensor 1 - Protective Field 3 distance (16 bit)							
29	Sensor 1 - Protective Field 3 angle (8 bit)							
30 - 31	Sensor 1 - Protective Field 4 distance (16 bit)							
32	Sensor 1 - Protective Field 4 angle (8 bit)							

Table 4 *Extended Info module - Target distances and azimuth angles for Sensor 1*

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
33 - 34	Sensor 2 - Protective Field 1 distance (16 bit)							
35	Sensor 2 - Protective Field 1 angle (8 bit)							
36 - 37	Sensor 2 - Protective Field 2 distance (16 bit)							
38	Sensor 2 - Protective Field 2 angle (8 bit)							
39 - 40	Sensor 2 - Protective Field 3 distance (16 bit)							
41	Sensor 2 - Protective Field 3 angle (8 bit)							
42 - 43	Sensor 2 - Protective Field 4 distance (16 bit)							
44	Sensor 2 - Protective Field 4 angle (8 bit)							

Table 5 *Extended Info module - Target distances and azimuth angles for Sensor 2*

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
45 - 46	Sensor 3 - Protective Field 1 distance (16 bit)							
47	Sensor 3 - Protective Field 1 angle (8 bit)							
48 - 49	Sensor 3 - Protective Field 2 distance (16 bit)							
50	Sensor 3 - Protective Field 2 angle (8 bit)							
51 - 52	Sensor 3 - Protective Field 3 distance (16 bit)							
53	Sensor 3 - Protective Field 3 angle (8 bit)							
54 - 55	Sensor 3 - Protective Field 4 distance (16 bit)							
56	Sensor 3 - Protective Field 4 angle (8 bit)							

Table 6 *Extended Info module - Target distances and azimuth angles for Sensor 3*

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
57 - 58	Sensor 4 - Protective Field 1 distance (16 bit)							
59	Sensor 4 - Protective Field 1 angle (8 bit)							
60 -61	Sensor 4 - Protective Field 2 distance (16 bit)							
62	Sensor 4 - Protective Field 2 angle (8 bit)							
63 - 64	Sensor 4 - Protective Field 3 distance (16 bit)							
65	Sensor 4 - Protective Field 3 angle (8 bit)							
66 - 67	Sensor 4 - Protective Field 4 distance (16 bit)							
68	Sensor 4 - Protective Field 4 angle (8 bit)							

Table 7 *Extended Info module - Target distances and azimuth angles for Sensor 4*

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
69 - 70	Sensor 5 - Protective Field 1 distance (16 bit)							
71	Sensor 5 - Protective Field 1 angle (8 bit)							
72 -73	Sensor 5 - Protective Field 2 distance (16 bit)							
74	Sensor 5 - Protective Field 2 angle (8 bit)							
75 - 76	Sensor 5 - Protective Field 3 distance (16 bit)							
77	Sensor 5 - Protective Field 3 angle (8 bit)							
78 - 79	Sensor 5 - Protective Field 4 distance (16 bit)							
80	Sensor 5 - Protective Field 4 angle (8 bit)							

Table 8 *Extended Info module - Target distances and azimuth angles for Sensor 5*

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
81 - 82	Sensor 6 - Protective Field 1 distance (16 bit)							
83	Sensor 6 - Protective Field 1 angle (8 bit)							
84 -85	Sensor 6 - Protective Field 2 distance (16 bit)							
86	Sensor 6 - Protective Field 2 angle (8 bit)							
87 - 88	Sensor 6 - Protective Field 3 distance (16 bit)							
89	Sensor 6 - Protective Field 3 angle (8 bit)							
90 - 91	Sensor 6 - Protective Field 4 distance (16 bit)							
92	Sensor 6 - Protective Field 4 angle (8 bit)							

Table 9 *Extended Info module - Target distances and azimuth angles for Sensor 6*

Note: only one target data (distance) is available for safeRS/safeRS3 mixed system.

- Control and sensors status as reported in Table 10 . Refer to par. Control status (Device output) on page 9 and par. Sensors Information module on page 14 for details.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
93	Control status							
94	Sensor 1 status (1/2)							
95	Sensor 1 status (2/2)							
96	Sensor 2 status (1/2)							
97	Sensor 2 status (2/2)							
98	Sensor 3 status (1/2)							
99	Sensor 3 status (2/2)							
100	Sensor 4 status (1/2)							
101	Sensor 4 status (2/2)							
102	Sensor 5 status (1/2)							
103	Sensor 5 status (2/2)							
104	Sensor 6 status (1/2)							
105	Sensor 6 status (2/2)							

Table 10 *Extended Info module - Status*

- Static Object Detection status of sensors as reported (as reported in Table 11). Refer to par. Static Object Detection status (Device Output) on page 10 for details.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
106	Static object detection status of sensor 1							
107	Static object detection status of sensor 2							
108	Static object detection status of sensor 3							
109	Static object detection status of sensor 4							
110	Static object detection status of sensor 5							
111	Static object detection status of sensor 6							

Table 11 *static object detection status of sensors*

- Reserved extra info for future implementation (as reported in Table 12).

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
112 - 119	*NA*							

Table 12 *Extended Info module - Extra info*

5 Control and sensor error status

Erroneous conditions related to the control and/or the sensors are sent via Fieldbus filling up the relevant error code and detailed error mask fields.

The error code indicates the type of the error occurred. The detailed error mask represents the details related to the type of the error occurred and it is reported in this

document where relevant and useful to understand in detail the fault.

In the following paragraphs, all the control and sensor error codes are listed and described.

5.1 Control error codes

The error codes of the control are reported in the table below.

Error Code	Error	Description
0x01	Power supply error	At least one voltage value on the control is wrong. Detailed error is a bit mask composed of the following faults: • 0x0001 Vin Undervoltage • 0x0002 Vin Overvoltage • 0x0004 1.2V Undervoltage • 0x0008 1.2V Overvoltage • 0x0010 1.2V Sensor Undervoltage • 0x0020 1.2V Sensor Overvoltage • 0x0040 VUSB Undervoltage • 0x0080 VUSB Overvoltage • 0x0100 VRef Undervoltage • 0x0200 VRef Overvoltage • 0x0400 ADC conversion error
0x02	Internal temperature error	Control temperature value is wrong. Detailed error is a bit mask composed of the following faults: • 0x0001 Low Temperature • 0x0002 High Temperature
0x03	OSSD error	At least one digital output (OSSD) is in error. Detailed error is a bit mask composed of the following faults: • 0x0001 OSSD 1 SHORT-CIRCUIT • 0x0002 OSSD 2 SHORT-CIRCUIT • 0x0004 OSSD 3 SHORT-CIRCUIT • 0x0008 OSSD 4 SHORT-CIRCUIT • 0x0010 OSSD 1 NO LOAD • 0x0020 OSSD 2 NO LOAD • 0x0040 OSSD 3 NO LOAD • 0x0080 OSSD 4 NO LOAD • 0x0100 OSSD 1 SHORT-CIRCUIT (VDD) • 0x0200 OSSD 2 SHORT-CIRCUIT (VDD) • 0x0400 OSSD 3 SHORT-CIRCUIT (VDD) • 0x0800 OSSD 4 SHORT-CIRCUIT (VDD)

Error Code	Error	Description
0x04	Input error	At least one digital input is in error. Detailed error is a bit mask composed of the following faults: • 0x0001 input 1 error • 0x0002 input 2 error • 0x0003 encoding error • 0x0004 0-1-0 plausibility transition error
0x05	Internal peripheral error	There is an error with at least one of the control peripherals Detailed error not relevant.
0x06	Sensor communication error	Communication error with at least one sensor. Detailed error is a bit mask composed of the following faults: • 0x0010 Communication lost • 0x0100 Polling timeout
0x07	Internal EEPROM error	Configuration saving error, configuration not performed or memory error. Detailed error not relevant.
0x08	Internal flash error	Flash memory error. Detailed error not relevant.
0x09	Internal RAM error	Invalid checksum of the internal RAM. Detailed error not relevant.
0x0A	Fieldbus error	At least one of the inputs and outputs has been configured as “Fieldbus controlled”, but the Fieldbus communication is not established, in error or passivated by the host. Detailed error not relevant.
0x0B	Dynamic configuration error	An invalid dynamic configuration has been selected. Detailed error not relevant.
0x0C	Internal communication error	An internal communication issue occurred between microprocessors. Detailed error not relevant.
0x0D	Sensor configuration error	Error occurred on the sensors during the configuration process or at system power up. At least one of the connected sensors did not get the correct configuration. The list of the not-configured sensors is reported as the detail of this error.
0x0E	Backup or Restore error	Error occurred during the backup or restore via SD card

5.2 safeRS Sensor error codes

The error codes of the safeRS Sensor are reported in the table below.

Error Code	Error	Description
0x06	Control communication error	Communication error with the control. Detailed error is a bit mask composed of the following faults: • 0x0010 Communication lost
0x81	Power supply error	At least one voltage value of the sensor is wrong . Detailed error is a bit mask composed of the following faults: • 0x0001 Vin Undervoltage • 0x0002 Vin Overvoltage • 0x0004 3.3V Undervoltage • 0x0008 3.3V Overvoltage • 0x0010 1.2V Undervoltage • 0x0020 1.2V Overvoltage • 0x0040 V+ Undervoltage • 0x0080 V+ Overvoltage • 0x0100 V DC/DC Undervoltage • 0x0200 V DC/DC Overvoltage • 0x0400 VOp.Amp. Undervoltage • 0x0800 VOp.Amp. Overvoltage • 0x1000 VADC Ref. Undervoltage • 0x2000 VADC Ref. Overvoltage • 0x4000 ADC conversion error
0x82	Internal temperature error	Sensor temperature value is wrong. Detailed error is a bit mask composed of the following faults: • 0x0001 Low Temperature • 0x0002 High Temperature • 0x0004 Chip - Low Temperature • 0x0008 Chip - High Temperature • 0x0010 Generic Temperature Error
0x84	Internal peripheral error	At least one of the sensor peripherals is in error. Detailed error not relevant.

Error Code	Error	Description
0x85	Control communication error	Communication error with the control. Detailed error is a bit mask composed of the following faults: • 0x0001 Communication timeout • 0x0002 Cross-check error • 0x0004 Sequence number error • 0x0008 Wrong CRC • 0x0020 Protocol error • 0x0040 Message ID error • 0x0080 Data format error • 0x0100 Polling timeout • 0x0200 Generic CANbus error
0x8F	Signal error	Signal errors of the sensor. Detailed error is a bit mask composed of the following faults: • 0x0001 Not used • 0x0002 Head fault • 0x0004 Head power off • 0x0008 Signal dynamic • 0x0010 Signal Min • 0x0020 Signal Min Max • 0x0040 Signal Max • 0x0080 Signal Avg • 0x0100 Dynamic Low • 0x0200 Min Dynamic High • 0x0400 Min Dynamic Low • 0x0800 Max Dynamic Low • 0x1000 Avg Dynamic Low • 0x2000 Generic Signal Error
0x90	Accelerometer error	Placement error of the sensor. Detailed error is a bit mask composed of the following faults: • 0x0001 Tilt angle error • 0x0002 Roll angle error • 0x0004 Reading error
0xFD	Masking error	Masking/Occlusion error

5.3 safeRS3 Sensor error codes

The error codes of the safeRS3 Sensor are reported in the table below.

Error Code	Error	Description
0x06	Control communication error	Communication error with the control. Detailed error is a bit mask composed of the following faults: • 0x0010 Communication lost
0x81	Misconfiguration error	The misconfiguration error occurs when the sensor does not have a valid configuration or it has received an invalid configuration from the control. Detailed error not relevant.
0x82	Status error	The status error occurs when the sensor is in an internal invalid status. Detailed error not relevant.
0x83	Protocol error	The protocol error occurs when the sensor receives commands with an unknown format. Detailed error not relevant.
0x84	Fault error	The fault error occurs when the sensor has reached an internal fault condition. Detailed error not relevant.
0x85	Control communication error	Communication error with the control. Detailed error is a bit mask composed of the following faults: • 0x0001 Communication timeout • 0x0002 Cross-check error • 0x0004 Sequence number error • 0x0008 Wrong CRC • 0x0020 Protocol error • 0x0040 Message ID error • 0x0080 Data format error • 0x0100 Polling timeout • 0x0200 Generic CANbus error

Error Code	Error	Description
0x86	Power error	At least one voltage value of the sensor is wrong . Detailed error is a bit mask composed of the following faults: • 0x0001 Vin Undervoltage • 0x0002 Vin Overvoltage • 0x0004 3.3V Undervoltage • 0x0008 3.3V Overvoltage • 0x0010 182V Undervoltage • 0x0020 1.8V Overvoltage • 0x0040 1.2V Undervoltage • 0x0080 1.2V Overvoltage • 0x0100 1V Undervoltage • 0x0200 1V Overvoltage
0x87	MSS error	Error detected by diagnostics relative to the internal micro-controller (MSS), its internal peripherals or memories. Detailed error not relevant.
0x88	Signal error	The signal error occurs when the sensor detects an error in the RF signals part. Detailed error not relevant.
0x89	Internal temperature error	Sensor temperature value is wrong. Detailed error is a bit mask composed of the following faults: • 0x0001 Low Temperature • 0x0002 High Temperature • 0x0004 Chip - Low Temperature • 0x0008 Chip - High Temperature • 0x0010 IMU - Low Temperature • 0x0020 IMU - High Temperature
0x8A	Tamper error	Placement error of the sensor. Detailed error is: first 4 bits, a bit mask composed of the following faults: • 0x0001 Pan angle error • 0x0002 Roll angle error • 0x0004 Tilt reading error bit 4 to bit 7: tilt angle deviation (in degrees) bit 8 to bit 11: roll angle deviation (in degrees) bit 12 to bit 15: pan angle deviation (in degrees) Max deviation in degrees: 15.

Error Code	Error	Description
0x8B	DSS error	Error detected by diagnostics relative to the internal micro-controller (DSS), its internal peripherals or memories. Detailed error not relevant.
0xFD	Masking error	Masking/Occlusion error
0xFE	Masking reference error	The sensor is not able to acquire the reference for masking functionality.

6 Integration of safeRS3 Control PROFINET in a PROFINET/PROFIsafe network

In order to integrate the control in a PROFINET/PROFIsafe network, an external tool is needed. Using this tool, it should be also possible to program the PLC with the updated network project. The following guide refers to the software *Siemens TIA Portal* with *STEP 7 Safety option* (v.17) for Windows.

The following aspects are covered:

1. how to add the control in a PROFINET/PROFIsafe network and to program a PLC to deal with the new device
2. how to exchange data between the PLC and the control
3. how to manage all data exchanged with the control safety module using TIA Portal Library file

Note: the control supports the connection with a single PLC.

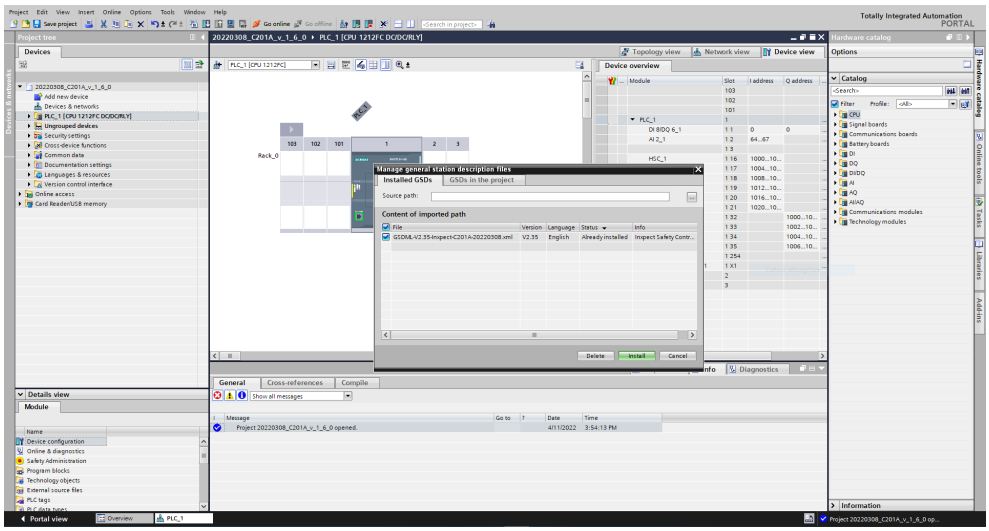
6.1 Add the control

6.1.1 Update the GSDML files list

To manage the new GSDML file, go to the menu:

- *Options -> Manage general station description files (GSD)*

and select the path where the GSDML file for the control is located on your computer. Then check the file and click on *Install*.



6.1.2 Search and add the control

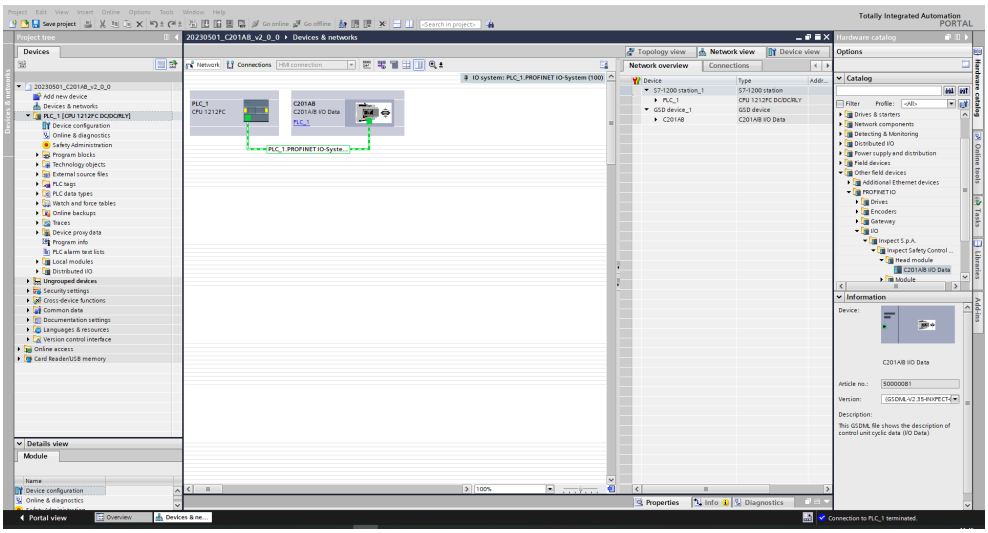
After updating the GSDML files list, open the *Devices and networks* menu. In the Hardware catalog go to the folder:

- *Other field devices -> PROFINET IO -> Sensors -> SICK AG -> Safety Laser Scanners -> Safety Radar*

and select *safeRS3 Control PROFINET I/O Data*. With a double click or with a drag and drop operation, it is possible to add the device in the network project.

In the *Network view*, click on the link label *not assigned* and choose the PLC to connect to.

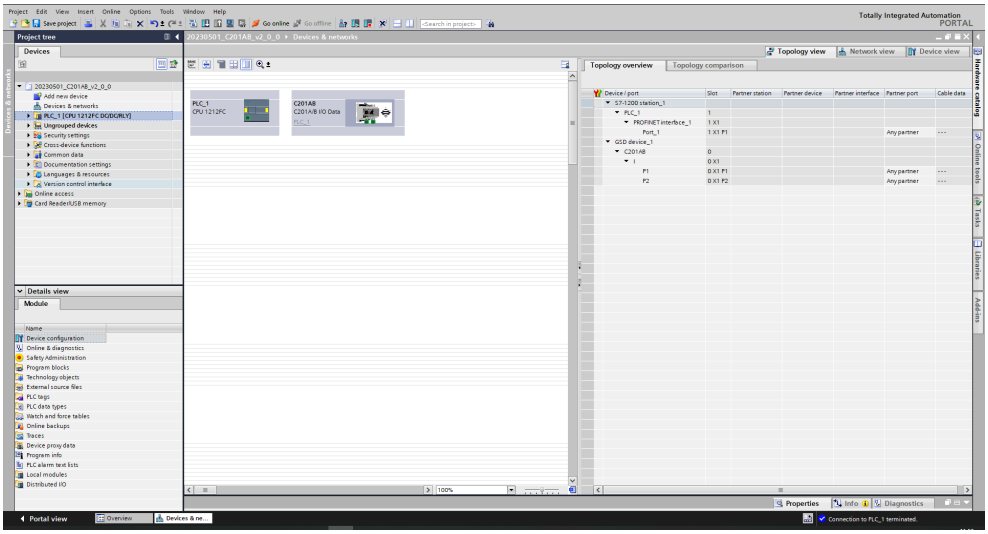
In this way, the control has been added to the PROFINET/PROFIsafe network of the PLC.



6.1.3 Set the topology

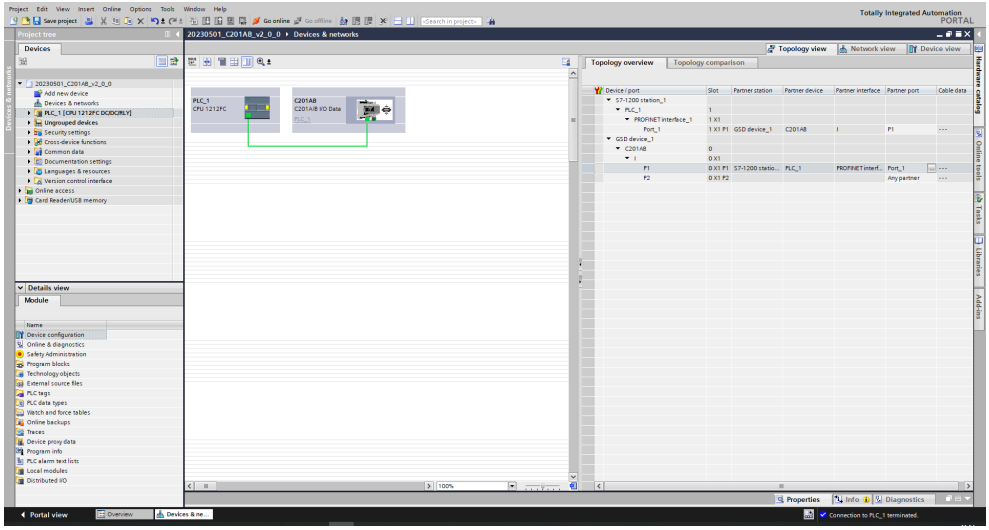
The control has two Ethernet ports reserved for the Fieldbus interface.

Note: the control is able to automatically manage them and to switch among them, if needed.



In order to configure the topology connection, please select the PLC Ethernet port and drag and drop it to the specific control Ethernet port used for this purpose.

Note: every connection of the PLC on the wrong port is going to lead to an error on the Fieldbus communication.



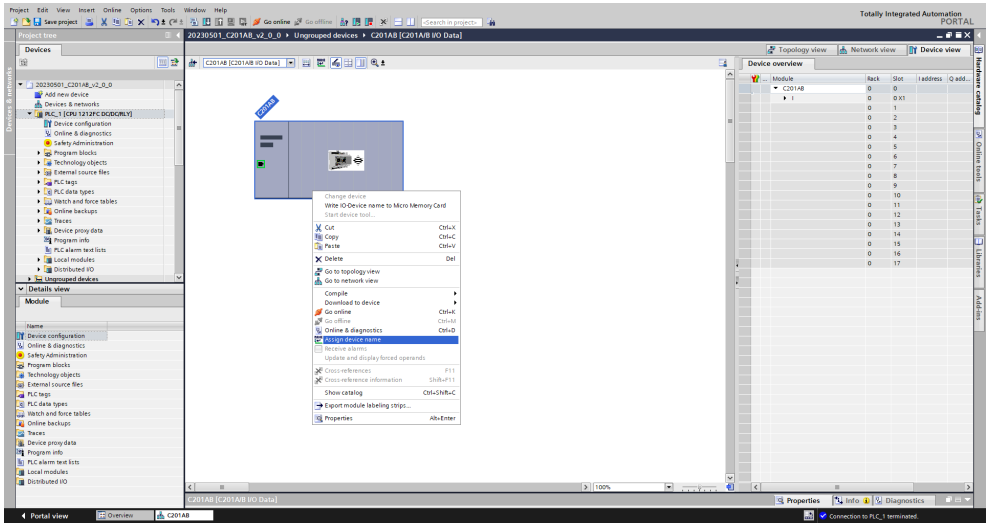
6.1.4 Set the device name

A brand new control has the following default values:

- device name: *void*
- IP address: 0.0.0.0

Once the device is connected to the network, it is possible to set its device name through the TIA Portal interface.

In the *Device view* form, choose the control, right click on the device image and select *Assign device name*.

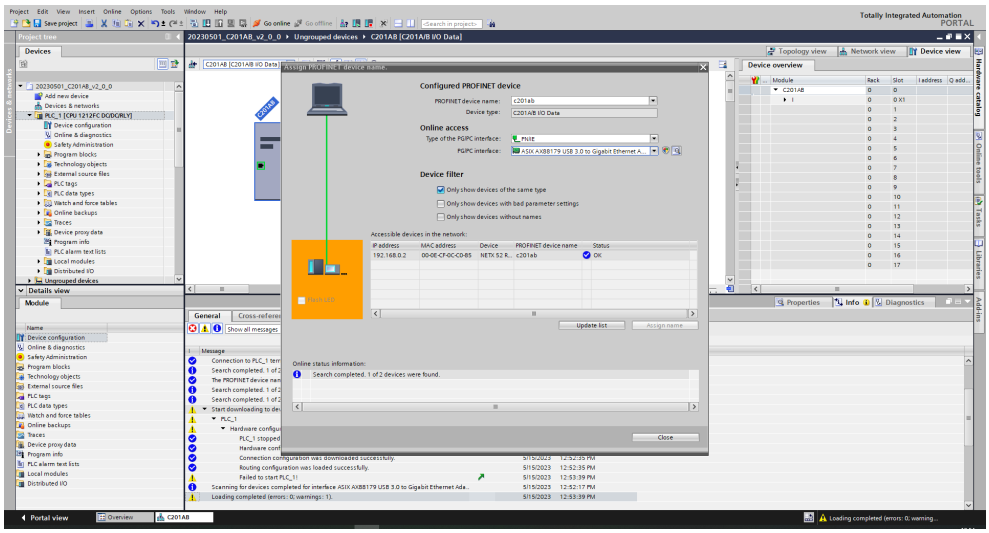


In the following window:

1. Set the device name; note that the same name cannot be used for more than one device in the same network.

2. Set the *Online access* interface.
3. Click on *Update list*.

Then, search for the actual MAC address of your device in the list and click on *Assign name*.



The device name must comply with the coding rules following the PROFINET specification, excerpt from the "Name of Station".

A Name of Station:

- has a length of 1–240 characters.
- may consist of one or more labels.
- must contain only the following characters:
  - lower case letters (a–z),
  - digits (0–9),
  - minus sign (-),
  - dot (.), used to separate labels.
- must not begin or end with a dot or with a minus sign.

A Name of Station label:

- has a length of 1–63 characters
- is separated from another label by a dot.
- must not begin or end with a minus sign.

6.1.5 Add I/O modules

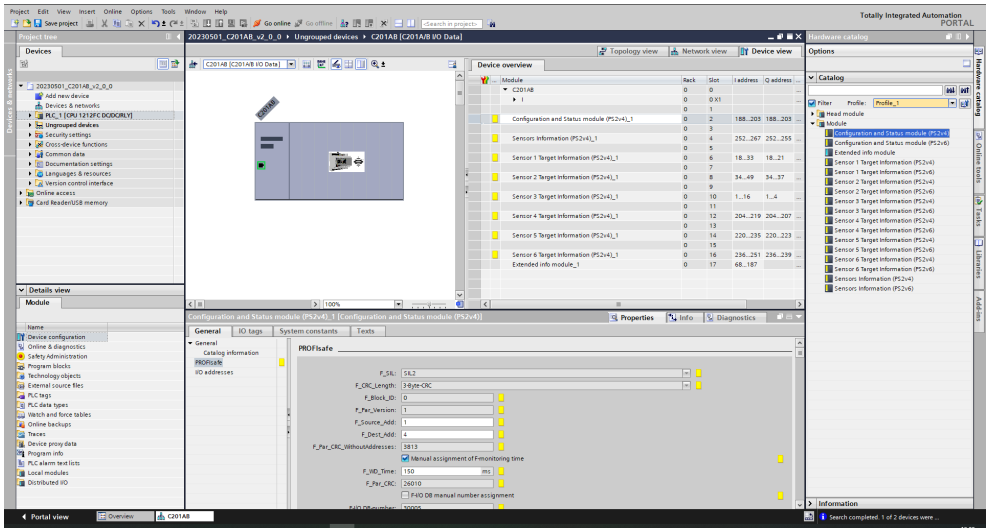
In the *Device view* form, it is possible to add to the project the desired modules with a double click (or a drag and drop operation) from the folder *Module*.

The safety modules are divided in v2.4 and v2.6. All modules have a fixed slot position.

When a module is added, the tool assigns automatically the I/O variables addresses used by the PLC code.

Each safety module must have the same PROFIsafe F-address *(F_Dest_Add)* configured within the safeRS3 Designer application *(Settings > Fieldbus parameters)*.

Note: on the contrary, the F_Source_Add depends on the PLC configuration.



6.2 Use the control in a Safety PLC program

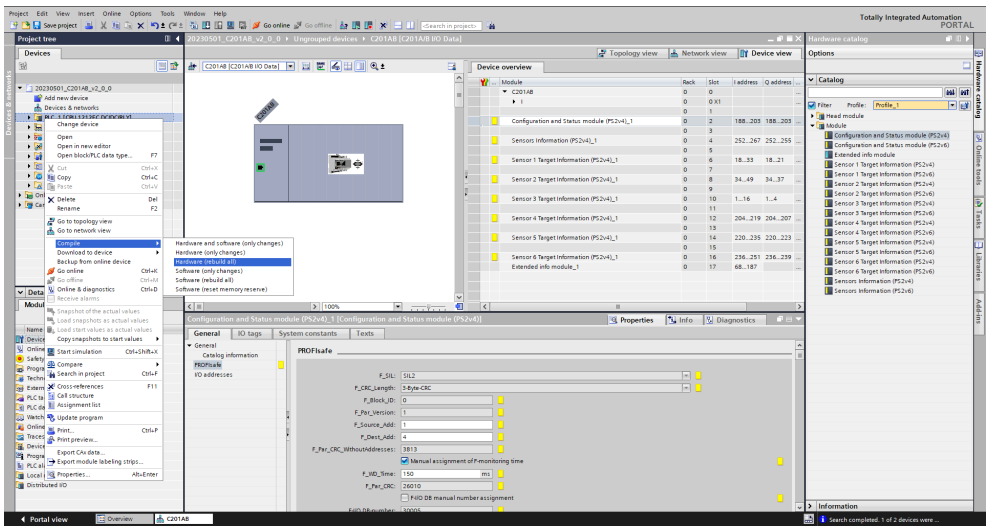
6.2.1 Connection and module test

At the startup, the first LED (G1) on the control is steady green (normal behavior) and the third LED (G3) is steady red (no physical link).

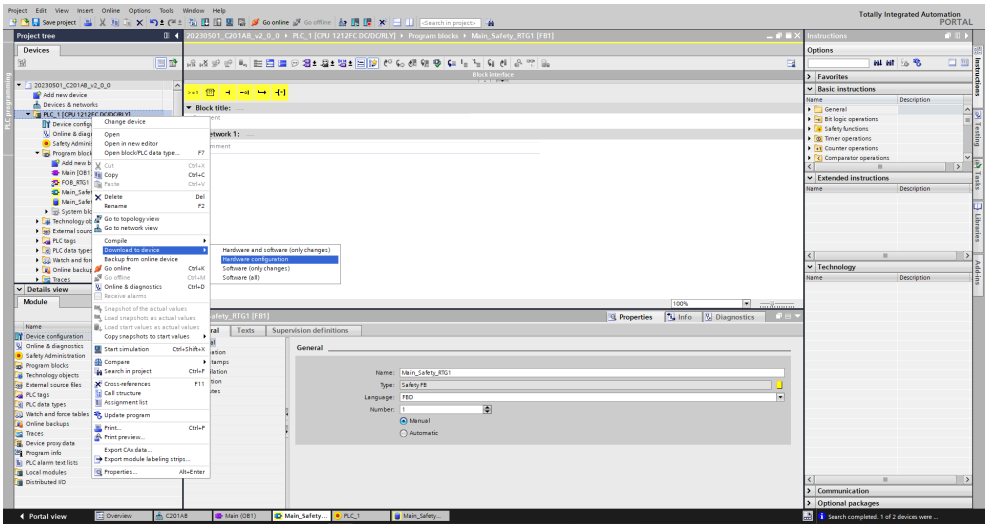
Once an Ethernet cable is connected, G3 starts flashing red (no data exchange) and then, if the connection is established correctly, it switches off.

Regardless of the connection status, the fifth LED (G5) is going to switch on (steady red) if an error occurs on PROFINET or PROFIsafe layers (e.g., errors about device name or safety destination addresses settings).

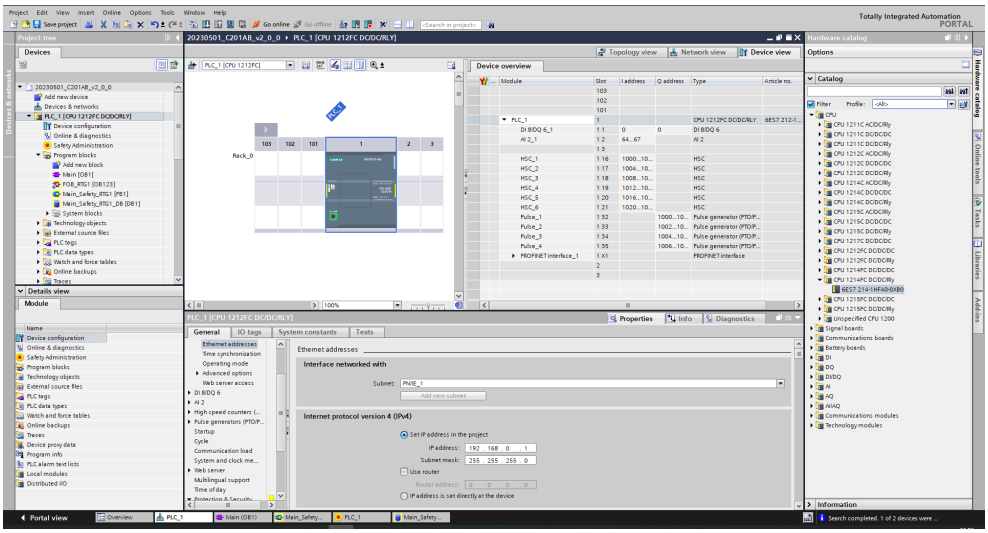
In order to test the connection, it is necessary to do a HW compile, by right clicking in the Project tree on *PLC > Compile > Hardware*.



After that, it is necessary to load the network configuration on the PLC *(PLC > Download to device > Hardware configuration)*.



Note: a connection between the PLC and the computer on which the TIA Portal is running is needed. In the Device view form, it is possible to choose as PROFINET device also the PLC and see its properties like the IP address. This is useful to establish an Ethernet connection between PLC and computer.



6.2.2 Modules and variables test

In order for a specific variable to be visible in the *Watch and force table* and for the user to have the possibility to test if the data exchange is working correctly, at least a variable (even if different from the previously mentioned specific variable) of the same module must be used in a PLC program.

Otherwise, all the variables of the module are passivated.

Manage the variables

In a PLC program, it is possible to refer to a variable using its address or a Tag name. For example, if the first input byte of a module has address 1, it is possible to refer to its first bit 0 with address:

- *%I1.0*

where “I” is the abbreviation for input, the “1” is the module number and the “0” is the bit number.

Note: if the user wants to refer to an output variable, he must use the “Q” instead of “I” (for example %Q1.0).

Note: this is true for boolean type management.

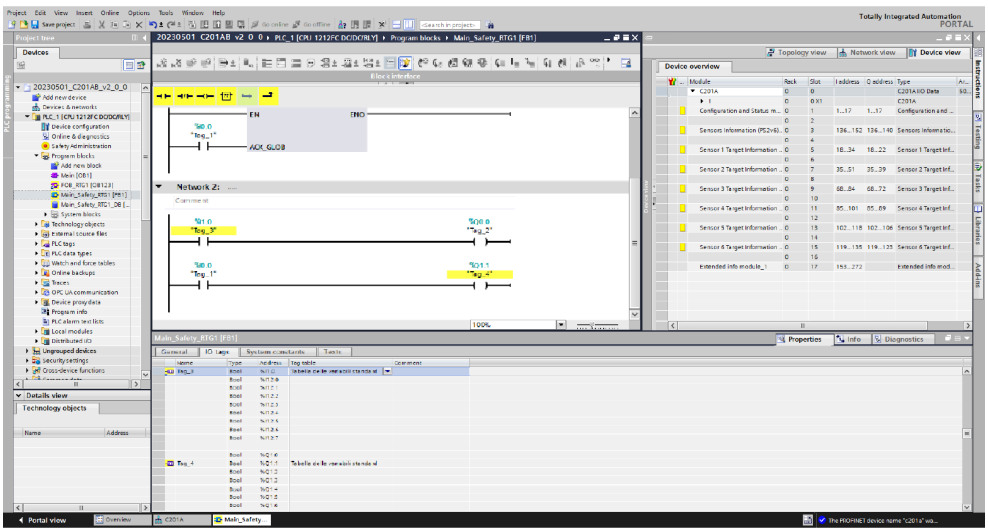
Variables and their addresses and types are visible in the properties of the modules *(Properties > IO tags)* and here it is possible to set the Tag names for each variable. All tag names are visible also in the Project tree *(PLC > PLC tags)*.

Manage the instructions

To create a simple program, two instructions are enough: a *Normally open contact* instruction (input variable) linked with an *Assignment* instruction (output variable).

It is suggested to use PLC physical I/O or PLC internal memory variables as support variables.

In the following example, we use the control safety input variable to set a PLC physical output and a PLC physical input to set the control safety output variable.

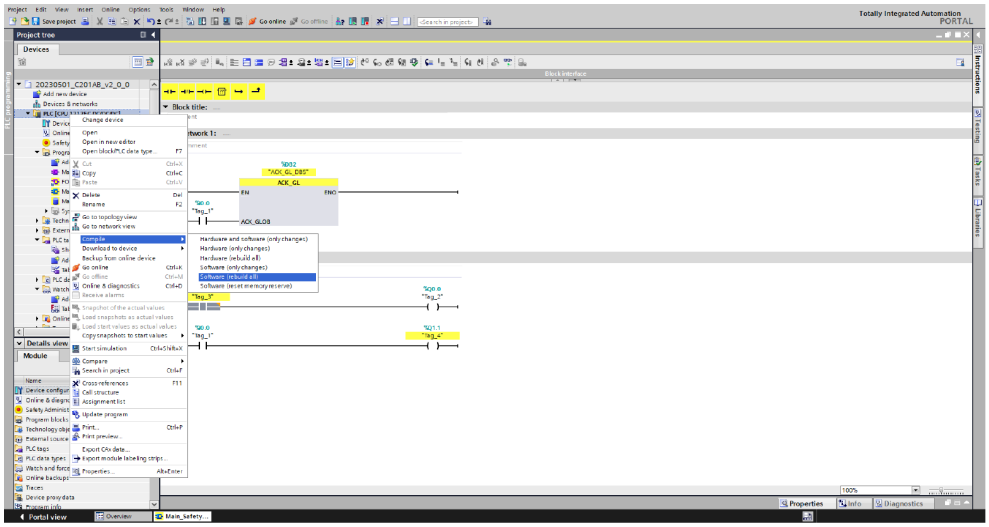


Manage the program

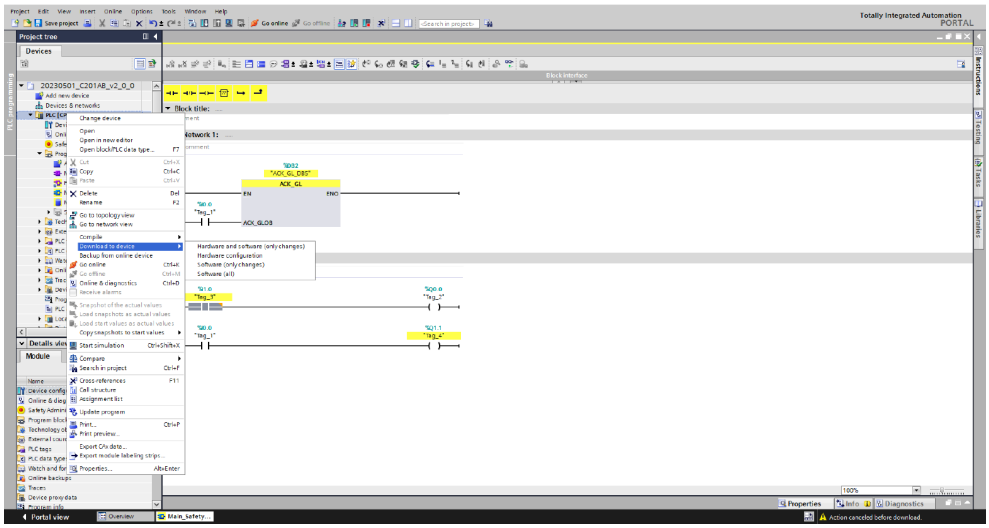
Starting from a *Main_Safety_RTG* program (Project tree > Program block), the user can drag and drop the instruction blocks into the program segment.

Above the instruction blocks the user has to insert the address or the tag of the variable.

In order to test the program, it is necessary to do a SW compile, by right clicking in the Project tree on *PLC > Compile > Software*.



After that, it is necessary to load the program on the PLC *(PLC > Download to device > Software)*.



Note: a connection between the PLC and the computer on which the TIA Portal is running is needed. In the Device view form, it is possible to choose as PROFINET device also the PLC and see its properties like the IP address. This is useful to establish an Ethernet connection between PLC and computer.

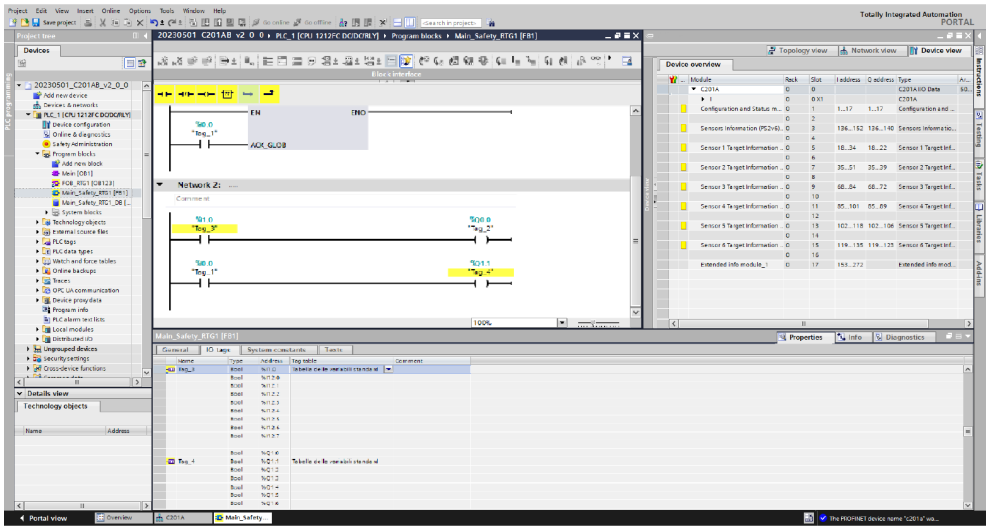
Monitoring the variables

In order to watch the behavior of the variables, please click on *Watch and force table (Project Tree > PLC)*.

Note: a connection between the PLC and the computer on which the TIA Portal is running is needed. By clicking on Go online to connect the two parts and then using the Monitoring buttons, it is possible to:

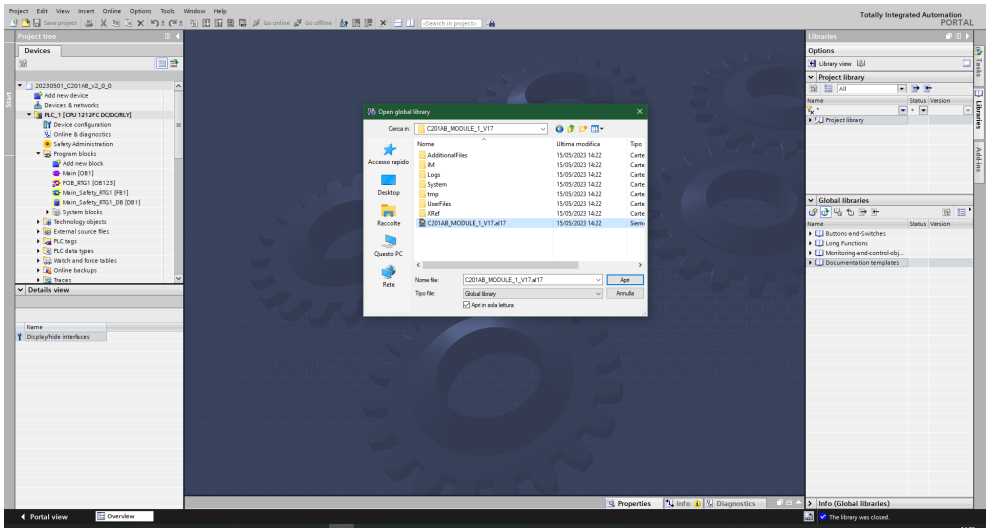
- view the variables values in the *Watch and force table*
- view the status of program block in the *Main_Safety_RTG*

When the PLC is online, it is possible to click on *Online and diagnostics* to monitor the status of the connection and the relative errors.



6.3 Use the PROFIsafe library

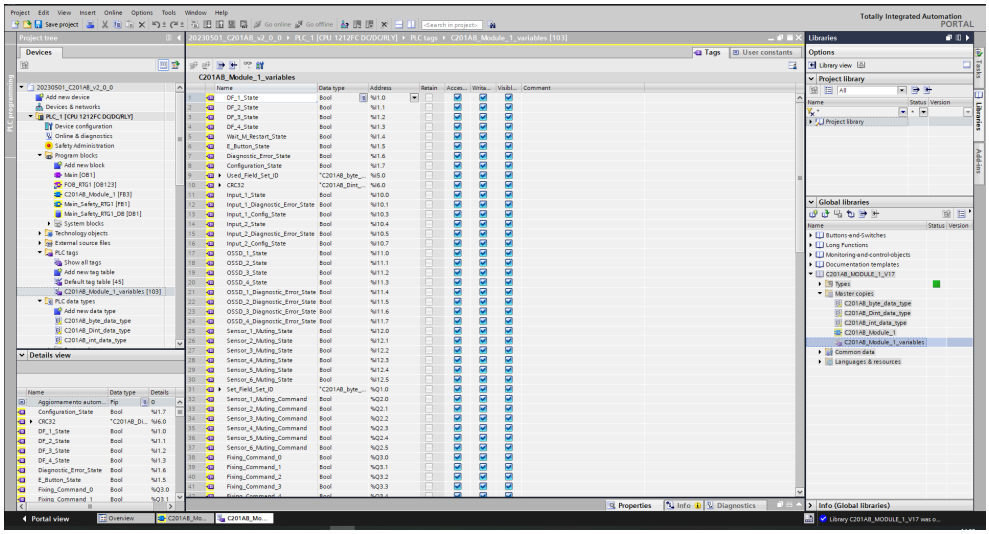
To use the PROFIsafe library for TIA Portal, the first step is to click on *Open global library* (menu Libraries).



6.3.1 Add a library component in the PLC project

After that, users can drag and drop the *ISC_Module* from the library menu (on the right side of the following image) to the Program Blocks folder (in the project tree).

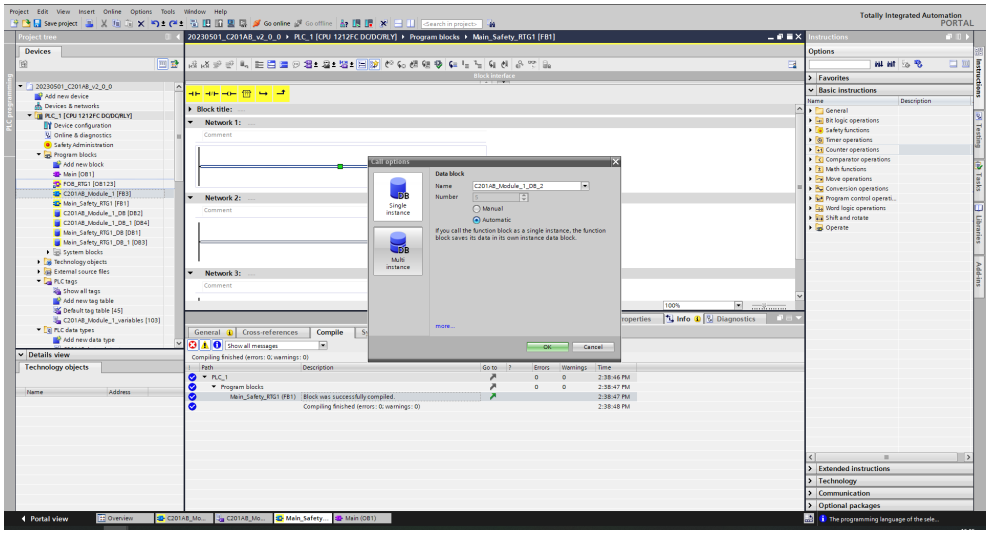
In the same way, all the ISC Data Types and the variables can be added respectively to the folders *PLC data types* and *PLC tags*.



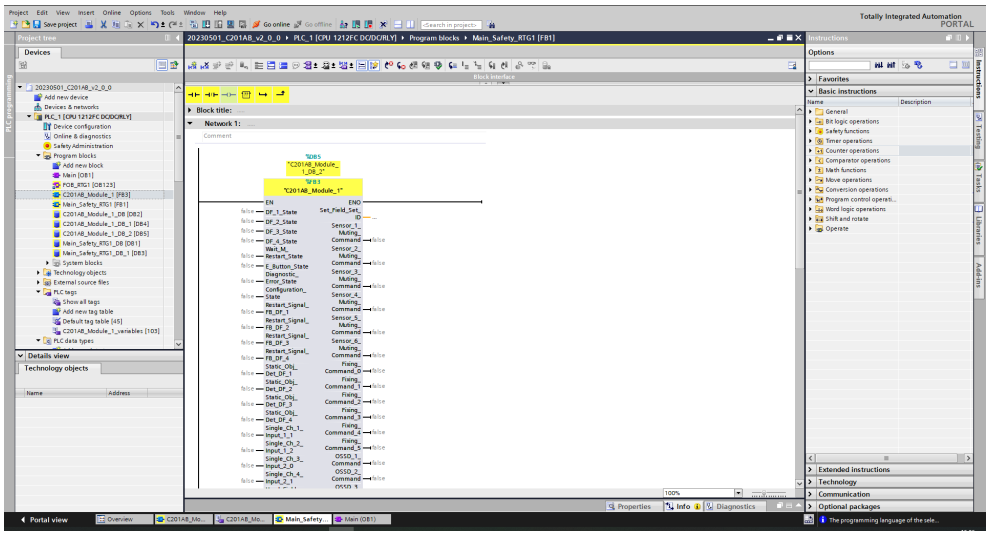
6.3.2 Add a module block in the PLC program

With a drag and drop operation, it is possible to add an ISC Module program block in the *Main_Safety_RTG*.

This operation requires the generation of a Safety Data Base (ISC_Module_DB).



The following step will be to connect all the I/O of the ISC Module block to the relative tags.



When all the I/O are connected, it will be possible to compile program and load it onto the PLC. While the PLC is running, all the variables of the module can be viewed in the *Watch and force table* folder.

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