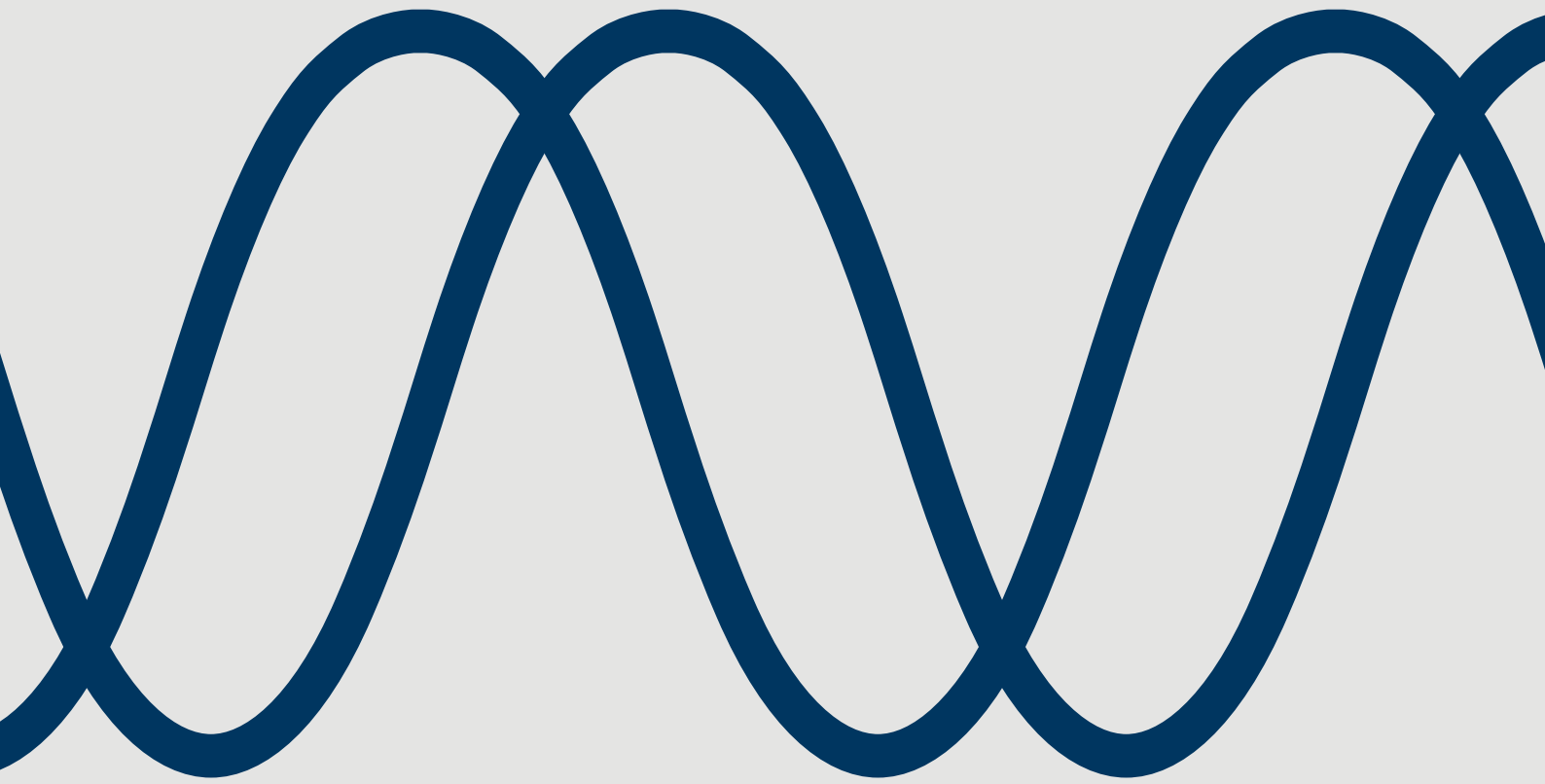




PROFIsafe over PROFINET IO

FOR FSI 600 SERIES ENCODERS
MANUAL / USERS GUIDE



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LEINE  LINDE

Contents

1 INTRODUCTION	12
1.1 APPLICABILITY OF MANUAL	12
1.2 ABOUT LEINE LINDE	12
1.3 ABOUT ABSOLUTE ENCODERS	12
1.4 ABOUT PROFINET TECHNOLOGY	13
1.5 ABOUT PROFISAFE TECHNOLOGY	14
1.6 ENCODER PROFILES	15
2 DECLARATION OF CONFORMITIES	16
3 TECHNICAL AND COMMERCIAL SUPPORT	17
3.1 REFERENCES	17
3.2 ABBREVIATIONS	17
4 INSTALLATION	19
4.1 INSTALLATION CHECKLIST	19
4.2 CABLES AND STANDARDS	19
4.3 CONNECTORS AND PIN CONFIGURATION FOR ABSOLUTE ENCODER	20
4.4 SHIELDING CONCEPT OF THE DEVICE	21
4.5 MAC-ADDRESS AND CHANGE INDEX	21
4.6 LED INDICATION	22
5 CONFIGURATION EXAMPLE WITH TIA-PORTAL	23
5.1 SELECT HARDWARE	23
5.2 INSTALLATION OF GSDML FILES	24
5.3 SETTING THE ENCODER CONFIGURATION	24
5.4 ASSIGN THE DEVICE TO IO-CONTROLLER	26
5.5 SETTING THE ENCODER DEVICE NAME	27
5.6 ASSIGN DEVICE NAME	28
5.7 SETTING PROFINET PARAMETERS	30
5.8 SETTINGS OF PLC	31
5.9 SETTING F-PARAMETERS AND IPARAMETERS	34
5.10 GO ONLINE WITH THE PROJECT	35
5.11 ACCESS SAFE POSITION AND SAFE SPEED DATA	37
6 PARAMETERS	41
6.1 IPARAMETERS	41
6.1.1 Safe code sequence	41
6.1.2 Safe position value scaling	41
6.1.3 Safe measuring units per revolution	42
6.1.4 Total safe measuring range	42
6.1.5 Safe velocity measuring unit	43

6.1.6 Time base for safe velocity	43
6.1.7 Safe acceleration measuring unit	43
6.1.8 Time base for safe acceleration	43
6.2 F-PARAMETERS	43
6.2.1 F_SIL	44
6.2.2 F_CRC_Length	44
6.2.3 F_Block_ID	44
6.2.4 F_Par_Version	44
6.2.5 F_Source_Add / F_Dest_Add	44
6.2.6 F_Passivation	45
6.2.7 F_CRC_Seed	45
6.2.8 F_WD_Time	45
6.2.9 F_iPar_CRC	45
6.2.10 F_Par_CRC	45
6.3 PROFINET IO PARAMETERS	45
6.3.1 Parameter initialization control	46
6.3.2 Parameter write protect	46
6.3.3 Parameter 65005 write protect control	46
6.3.4 Reset control write protect	46
6.3.5 Code sequence	46
6.3.6 Class 4 functionality	47
6.3.7 G1 XIST1 Preset control	47
6.3.8 Scaling function control	47
6.3.9 Alarm channel control (Profile V3)	47
6.3.10 Encoder profile V3.1 Compatibility	48
6.3.11 Scaling function parameters	48
6.3.12 Maximum Master Sign-Of-Life failures	50
6.3.13 Velocity measuring unit	50
6.3.14 Velocity reference value	50
6.3.15 Velocity derivation time	51
6.3.16 Acceleration measuring unit	51
6.3.17 Acceleration derivation time	51

7 PROFINET IO AND PROFISAFE DATA DESCRIPTION 52

7.1 ENCODER PROFILE OVERVIEW	52
7.2 APPLICATION CLASS DEFINITION	52
7.3 STANDARD AND MANUFACTURER SPECIFIC SIGNALS	52
7.4 STANDARD AND MANUFACTURER SPECIFIC TELEGRAMS	53
7.5 STANDARD TELEGRAM 36 (SAFETY)	54
7.6 STANDARD TELEGRAM 37 (SAFETY)	55
7.7 STANDARD TELEGRAM 81	55
7.8 STANDARD TELEGRAM 82	56
7.9 STANDARD TELEGRAM 83	57
7.10 STANDARD TELEGRAM 84	57
7.11 STANDARD TELEGRAM 86	58
7.12 STANDARD TELEGRAM 87	59
7.13 STANDARD TELEGRAM 88	59
7.14 STANDARD TELEGRAM 89	60
7.15 MANUFACTURER SPECIFIC SAFETY TELEGRAM 58001	60
7.16 MANUFACTURER SPECIFIC SAFETY TELEGRAM 58003	61
7.17 MFR 60600 ACCELERATION 32 BITS	62
7.18 FORMAT OF G1 XIST1 AND G1 XIST2	62

7.19 FORMAT OF G1 XIST3	62
7.20 SAFE POSITION ACTUAL VALUE (S_XIST32)	63
7.21 SAFE SPEED ACTUAL VALUE (S_NIST16)	63
7.22 SAFETY CONTROL WORD 1 (S_STW1_ENC)	63
7.23 SAFETY STATUS WORD 1 (S_ZSW1_ENC)	64
7.24 SAFETY POSITION PRESET VALUE (S_PRESET32)	64
7.25 SENSOR PRESET CONTROL WORD (G1 XIST1 PRESET B)	65
7.26 SENSOR PRESET CONTROL WORD (G1 XIST1 PRESET B1)	65
7.27 SENSOR PRESET CONTROL WORD (G1 XIST1 PRESET C)	65
7.28 CONTROL WORD 2 (STW2 ENC)	66
7.29 STATUS WORD 2 (ZSW2 ENC)	66
7.30 CONTROL WORD (G1 STW)	67
7.31 STATUS WORD (G1 ZSW)	67
7.32 REAL-TIME COMMUNICATION	68

8 ALARMS AND WARNINGS 70

8.1 DIAGNOSTICS AND ALARMS	70
8.2 CHANNEL DIAGNOSTICS	70
8.3 ERROR CODES IN G1 XIST 2	71

9 ACYCLIC PARAMETER DATA 73

9.1 ACYCLIC DATA EXCHANGE	73
9.2 IDENTIFICATION AND MAINTENANCE (I&M FUNCTIONS)	73
9.3 BASE MODE PARAMETER ACCESS	73
9.3.1 General characteristics	73
9.4 SUPPORTED PARAMETERS	74
9.4.1 Parameter 922, read only	75
9.4.2 Parameter 925, read/write	75
9.4.3 Parameter 944-952, read/write	75
9.4.4 Parameter 964, read only	75
9.4.5 Parameter 965, read only	75
9.4.6 Parameter 971, read/write	75
9.4.7 Parameter 972, read/write	75
9.4.8 Parameter 975, read only	76
9.4.9 Parameter 979, read only	76
9.4.10 Parameter 980, read only	76
9.4.11 Parameter 20000 read/write	76
9.4.12 Parameter 20001 read/write	76
9.4.13 Parameter 20002 read/write	76
9.4.14 Parameter 60000, read/write	77
9.4.15 Parameter 60001, read/write	77
9.4.16 Parameter 60022, read only	77
9.4.17 Parameter 60023, read only	77
9.4.18 Parameter 60024, read only	77
9.4.19 Parameter 60025, read only	77
9.4.20 Parameter 60044-60052, read only	78
9.4.21 Parameter 61000, read only	78
9.4.22 Parameter 61001, read only	78
9.4.23 Parameter 61002, read only	78
9.4.24 Parameter 61003, read only	78
9.4.25 Parameter 61004, read only	78

9.4.26 Parameter 65000, read/write	78
9.4.27 Parameter 65001, read only	78
9.4.28 Parameter 65004, read/write	78
9.4.29 Parameter 65005, read/write	79
9.4.30 Parameter 65006, read/write	79
9.4.31 Parameter 65007, read/write	79
9.4.32 Parameter 65010, read only	79
9.4.33 Parameter 65100, read only	79
9.5 EXAMPLE OF READING AND WRITING TO A PARAMETER	80

10 LL WEBSERVER 85

10.1 ACCESS AND LOG IN TO LL WEBSERVER	85
10.2 OVERVIEW	85
10.3 SETTINGS	86
10.4 GENERATE IPARCRC	87
10.5 FIRMWARE UPDATE	88
10.6 SUPPORT	89

11 ISOCHRONOUS REAL-TIME SETTINGS (RT CLASS 3) 90

12 MEDIA REDUNDANCY PROTOCOL 95

13 DEVICE REPLACEMENT USING LLDP 96

14 REVISION HISTORY 98

Tables

Table 1 Power supply connection	20
Table 2 Bus connection	20
Table 3 LED indication	22
Table 4 List of all iParameters for the device	41
Table 5 List of all F-parameters for the device	44
Table 6 List of all PROFINET IO parameters of the device	46
Table 7 Code sequence	46
Table 8 Class 4 functionality	47
Table 9 G1 XIST1 Preset control	47
Table 10 Scaling function control	47
Table 11 Scaling function control	48
Table 12 Profile V3.1 compatibility mode	48
Table 13 Compatibility mode overview	48
Table 14 Measuring units per revolution	49
Table 15 Standard and manufacturer specific signals	53
Table 16 Standard and manufacturer specific telegrams	54
Table 17 Output data Telegram 36	54
Table 18 Output data Telegram 36	55
Table 19 Output data Telegram 37	55
Table 20 Input data Telegram 37	55
Table 21 Output data Telegram 81	56
Table 22 Input data Telegram 81	56
Table 23 Output data Telegram 82	56
Table 24 Input data Telegram 82	57
Table 25 Output data Telegram 83	57
Table 26 Input data Telegram 83	57
Table 27 Output data Telegram 84	58
Table 28 Output data Telegram 84	58
Table 29 Output data Telegram 86	58
Table 30 Input data Telegram 86	59
Table 31 Output data Telegram 87	59
Table 32 Input data Telegram 87	59
Table 33 Output data Telegram 88	59
Table 34 Input data Telegram 88	60
Table 35 Output data Telegram 89	60
Table 36 Output data Telegram 89	60
Table 37 Output data Manufacturer specific safety telegram 58001	61
Table 38 Output data Manufacturer specific safety telegram 58003	61
Table 39 Input data Manufacturer specific safety telegram 58003	61
Table 40 Format of ACC B	62
Table 41 Format of G1 XIST3	63
Table 42 Safe actual position value (S_XIST32)	63
Table 43 Safe speed actual value (S_NIST16)	63
Table 44 Safety control word 1 (S_STW1_ENC)	63
Table 45 Safety status word 1 (S_ZSW1_ENC)	64
Table 46 Safe position preset value (S_PRESET32)	64
Table 47 G1 XIST1 PRESET B	65
Table 48 G1 XIST1 PRESET B1	65
Table 49 G1 XIST1 PRESET C	65
Table 50 Control word 2 (STW2 ENC)	66
Table 51 Detailed assignment of Control word 2 (STW2 ENC)	66
Table 52 Status word 2 (ZSW2 ENC)	67

Table 53 Control word (G1 STW)	67
Table 54 Status word (G1 ZSW)	68
Table 55 Channel diagnostics	71
Table 56 Error codes in G1 XIST 2	72
Table 57 All supported PNU parameters	75
Table 58 Hardware and software components in this example	80
Table 59 Revision history	98

Figures

Figure 1 Black Channel principle and the layers of PROFIsafe communication.....	14
Figure 2 Structure of a PROFIsafe data package.....	15
Figure 3 Encoder power supply.....	20
Figure 4 Encoder BUS port 1 and 2.....	20
Figure 5 MAC-address.....	21
Figure 6 Add the hardware controller to the project.....	23
Figure 7 Selected IO controller visible in the Network view.....	24
Figure 8 Installation of GSDML file.....	24
Figure 9 Setting up the encoder configuration.....	25
Figure 10 Select what Telegram/Module to be used.....	25
Figure 11 Assign IO controller.....	26
Figure 12 IP-address and device name settings.....	27
Figure 13 Assigning device name.....	28
Figure 14 Assigning device name.....	29
Figure 15 Assigned device name OK.....	29
Figure 16 Setting PROFINET parameters of the encoder.....	30
Figure 17 Example of parameter data.....	30
Figure 18 F-capability must be activated in the F-CPU.....	31
Figure 19 Select the access level of the PLC and enter a password.....	31
Figure 20 Offline access protection of safety program.....	32
Figure 21 Password for Protection of the PLC configuration data.....	32
Figure 22 Change F_Source_Add in PLC.....	33
Figure 23 Setting iParameters of the encoder.....	34
Figure 24 F-parameters for the safety program.....	35
Figure 25 Compile the program.....	35
Figure 26 Download configuration to device.....	36
Figure 27 Load preview, download the configuration to the IO device.	36
Figure 28 Start CPU in order to put PLC in run mode.....	37
Figure 29 F-Runtime group handling safety program blocks, automatically generated for a safety program.....	38
Figure 30 Switch programming language to FBD.....	39
Figure 31 Add an assignment block for ACK_REI signal to Network 1 in Main_Safety_RTG1 (FB1)	39
Figure 32 Tags for data of telegram 36 created. The yellow tags indicate failsafe data.	40
Figure 33 Monitor safe values from the PROFIsafe and PROFINET communication in a watch table.	40
Figure 34 Safe free scaling.....	42
Figure 35 Free scaling.....	49
Figure 36 Maximum Master Sign-of-Life failures.....	50
Figure 37 Velocity measuring units for encoders.....	50
Figure 38 Absolute value in G1 XIST1.....	62
Figure 39 Absolute value in G1 XIST2.....	62
Figure 40 Real-time communication.....	68
Figure 41 Definition of variables for read record.....	80
Figure 42 Definition of variables for writing the write record.....	80
Figure 43 Networks added to FB_AcyclicDataRDWR with read and write blocks.....	81
Figure 44 Variable definition of function block FB_AcyclicDataRDWR.....	82
Figure 45 Data block called "ReqPNDData".....	82
Figure 46 Calling the function block "FB_AcyclicDataRDWR".....	83
Figure 47 Finding the hardware identity number of the Parameter Access point of the PROFINET module.....	83
Figure 48 Watch table with example to read parameter 922, which gives 81 (Telegram 81)......	84
Figure 49 FSI Online web server "Overview" tab.....	85
Figure 50 Settings tab for F-Address assignment.....	86
Figure 51 Tab where the F-parameter "iParCRC" is generated, that is entered to the PLC program.....	87
Figure 52 Select the update file.....	88

Figure 53 Progress bar to follow the update of the device.....	88
Figure 54 Approve the update.....	89
Figure 55 Support tab of the webserver.....	89
Figure 56 Add an External encoder as a Technology object.....	90
Figure 57 Settings of encoder configured as a technology object.....	90
Figure 58 Data exchange of encoder configured as a technology object.....	91
Figure 59 Define the ports connected for the controller and encoder to use it in IRT mode. Port 1 (PLC) and Port 1 (Encoder) are connected in this example.....	91
Figure 60 Settings in Isochronous mode of the encoder.....	92
Figure 61 Real time settings of the encoder.....	92
Figure 62 I/O addresses of the encoder in isochronous mode.....	93
Figure 63 Select “Make “high performance” possible” in the Sync domain used for the communication.....	94
Figure 64 Organization blocks used to access the encoder as a technology object.....	94
Figure 65 LLDP Properties.....	96
Figure 66 Port configuration in Topology view.....	97
Figure 67 Factory reset of PROFINET.....	97

1 Introduction

This manual describes the installation procedures and configuration of absolute encoders with PROFINET interface and PROFIsafe profile. If you are in need of assistance during the system design phase, commissioning, or during operation, please make sure that you contact your local Leine Linde representative.

1.1 Applicability of manual

This product manual is applicable to Leine Linde's encoders with PROFINET interface and PROFIsafe profile within following series.

FSI 608

For additional information about the FSI encoders, refer to the corresponding mounting instruction available for download at www.leinelinde.com.

1.2 About Leine Linde

Leine Linde is a Swedish company with international presence. For more than 50 years, Leine Linde has concentrated on development and manufacturing of advanced encoders that meet the most rigorous demands a user can place on them. That is why a wide assortment of incremental and absolute encoders with obvious concentration on robust products and quality down to the last detail can be offered. Leine Linde encoders provide the utmost in reliability year after year, in working conditions where vibration, dirt, cold and other harsh environments are common.

Leine Linde can meet very specific individual demands. Due to a modular design in the collection, the encoders are easily adapted exactly to the customer's needs with respect to resolution, electrical connections and interfaces, voltage, casings, etc. Leine Linde concentrates on advanced development of intelligent encoders with integrated ASICs, new special features and with adaptations to different fieldbus systems. Thereby the company can meet the need for increasingly effective and dependable machines and automation to an even higher degree.

1.3 About absolute encoders

With an absolute encoder each angular position is assigned a coded position value generated by optical or inductive scanning. The optical encoder has a code disc equipped with several fine graduations tracks which are scanned as a specific pattern for every position. The inductive encoder has a stator and rotor. It works with electromagnetic inductance meaning that electric current is generated in an electrical conductor if a magnetic field varies within its present generating signals.

Absolute encoders can be single-turn or multi-turn. Single-turn encoders produce absolute positions within one revolution, the absolute position information repeats itself with every revolution. Multi-turn encoders can also distinguish the revolutions. The numbers of unique revolutions is determined by the resolution of the multi-turn scanning and repeats itself after the total resolution is reached. A major benefit of the absolute encoder type is that if the encoder loses power, the encoder is able to keep track of its position also if the shaft is turned during the power loss. This is due to the genuine absolute scanning principle.

An absolute encoder can also be used to calculate a digital speed or acceleration value. By internally dividing the difference in position with a small delta time an accurate speed can be calculated and transmitted to the subsequent electronics for closed loop control.



1.4 About PROFINET technology

PROFINET is the open industrial Ethernet standard of PROFIBUS & PROFINET International (PI) for automation. PROFINET uses TCP/IP and IT standards, and is in effect, real-time Ethernet. The PROFINET concept features a modular structure so that users can select the cascading functions themselves. They differ essentially because of the type of data exchange in order to fulfill the sometimes very high speed requirements.

In conjunction with PROFINET, the two perspectives PROFINET CBA and PROFINET IO exist. PROFINET CBA is suitable for the component-based communication via TCP/IP and the real-time communication for real-time requirements in modular systems engineering. Both communication options can be used in parallel.

PROFINET IO was developed for real-time (RT) and isochronous real-time (IRT) communication with the Decentralized periphery. The designations RT and IRT merely describe the real-time properties for the communication within PROFINET IO.

To achieve these functions, three different protocol levels are defined:

- TCP/IP for PROFINET CBA and the commissioning of a plant with reaction times in the range of 100 ms.
- RT (Real-Time) protocol for PROFINET CBA and PROFINET IO applications down to 1 ms cycle times.
- IRT (Isochronous Real-Time) for PROFINET IO applications in drive systems with cycle times of less than 1 ms.

Interfacing the peripherals devices such as encoders is performed through PROFINET IO. Its basis is a cascading real-time concept. PROFINET IO defines the entire data exchange between controllers (devices with “master functionality”) and the devices (devices with “slave functionality”), as well as parameter setting and diagnosis.

PROFINET IO is designed for the fast exchange of data between Ethernet-based field devices and follows the provider-consumer model. The configuration of an IO-System has been kept nearly identical to the “look and feel” of PROFIBUS.

A PROFINET IO system consists of the following devices:

- The IO Controller, which controls the automation task.
- The IO Device, which is a field device such as an encoder, monitored and controlled by an IO Controller.
- The IO Supervisor is software typically based on a PC for setting parameters and diagnosing individual IO Devices.

An application relation (AR) is established between an IO Controller and an IO Device. These ARs are used to define communication relations (CR) with different characteristics for the transfer of parameters, cyclic exchange of data and handling of alarms.

The characteristics of an IO Device are described by the device manufacturer in a General Station Description (GSD) file. The language used for this purpose is the GSDML (GSD Markup Language) – an XML based language. The GSD file provides the supervision software with a basis for planning the configuration of a PROFINET IO system.

Within PROFINET IO, process data and alarms are always transmitted in real-time (RT). Real-time in PROFINET is based on the definition of IEEE and IEC, which allows for only a limited time for execution of real-time services within a bus cycle. The RT communication represents the basis for the data exchange for PROFINET IO and real-time data are always treated with a higher priority than TCP (UDP)/IP data.

1.5 About PROFIsafe technology

PROFIsafe is an industrial communication profile over Ethernet or fieldbus that defines how safety-related devices (emergency brakes, stop buttons, light grids and more) communicate with safety PLCs and controllers over PROFINET or Profibus in such a way that they can be used in safety-related automation tasks up to Safety Integrity Level 3 (SIL) according to IEC 61508 / IEC 62061, or Performance Level “e” (PL)/Category 4 according to ISO 13849.

One advantage with the PROFIsafe technology is the implementation in coexistence with standard PROFINET or Profibus communication using the so called black channel principle. A black channel is interpreted as the transport medium for the communication, without any additional safety checks or measures, just following the standard (PROFINET/Profibus) protocols. The safety checks occur in the safety layers at the F-Host (failsafe host) and F-Device (failsafe device). An advantage of the black channel principle is that existing cabling and standard protocols for PROFINET/Profibus can be used in the communication system.

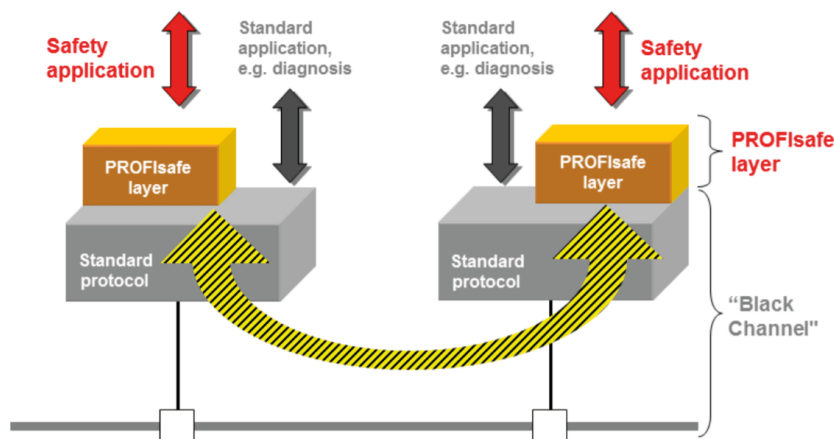


Figure 1 Black Channel principle and the layers of PROFIsafe communication.

The safety measures that are done in the F-Host and F-Device for safety protocols are

- Numbering of the PROFIsafe messages
- Timeout error detection (using the “Watchdog timer”)
- Authentication between sender and receiver (F_S/D_Address)
- Data integrity checks with cyclic redundancy check (CRC)

which are defined in IEC 61784-3-3.

A PROFIsafe data package consists of the safe input/output data (F-I/O), a control byte and the CRC signature. The F-I/O data is recommended to be from 1 to 12/13 bytes for factory automation applications. However PROFIsafe supports up to 123 bytes of F-I/O data in a data package. The control byte helps to synchronize the sender and receiver for PROFIsafe communication. While CRC signature is used for checking the integrity of the data.

F-Input/Output data	Status / Control Byte	CRC signature
		across F-Parameter, F-I/O data, Status/Control Byte, Monitoring Number
1 to 12/13 (max. 123) bytes	1 byte	4 bytes

Figure 2 Structure of a PROFIsafe data package

In the PROFIsafe layer a number of F-parameters (failsafe parameters) are implemented for the user to adapt the communication for specific customer needs and verify the correctness of the assignments (of iParameters for example).

Since many different safety device technologies exist there is also a set of parameters called individual safety parameters (iParameters) used in PROFIsafe. The iParameters are defined in the GSD file and need to be verified with a special signature through the F-parameter F_iParCRC.

1.6 Encoder Profiles

Profiles are pre-defined configurations of the functions and features available from PROFINET and PROFIsafe for use in specific devices or applications such as encoders. They are specified by PI (PROFIBUS & PROFINET International) working groups and are published by PI. Profiles are important for openness, interoperability and interchangeability, so that the end user can be sure that similar equipment from different vendors perform in a standardized way.

Leine Linde devices comply with the definitions in the encoder profile 3.162 version 4.2 for PROFINET and PROFIsafe version 2.6.1 and 2.4. The encoder device profile describing encoder functionality and additional information about PROFINET and PROFIsafe can be ordered from PROFIBUS User Organization, PNO.

PROFIBUS User Organization

Haid-und-Neu Straße 7
DE-76131 Karlsruhe, Germany
Tel: +49-(0)721-96 58 590
Fax: +49-(0)721-96 58 589
Web: www.profibus.com

2 Declaration of conformities

This device conforms to prevailing legal requirements and is designed in accordance with proper engineering practices. A certificate of conformity can be provided upon request from Leine Linde.

3 Technical and commercial support

Leine Linde is represented by subsidiaries in many countries around the world. In addition to the address listed here, there are many services agencies and distributors located worldwide ready to reply to commercial enquires or technical support. For more information, please visit our website or contact Leine Linde in Strängnäs, Sweden.

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3.1 References

Profile Encoders for PROFIBUS and PROFINET V4.1,
Order No. 3.162

Profile Encoders for PROFIBUS and PROFINET V4.2,
Order No. 3.162

Profile Drive Technology, PROFIdrive V4.2,
PROFIBUS International, Order No. 3.172

PROFIBUS Encoder profile V1.1, PROFIBUS International, Order No. 3.062

PROFIBUS Guidelines, Part 1: Identification & Maintenance Functions V1.1, PROFIBUS International, Order No. 3.502

PROFIBUS Guidelines, Part 3: Diagnosis, Alarms and Time Stamping V1.0, PROFIBUS International, Order No. 3.522

PROFINET Application Layer Service Definition Application Layer Protocol Specification, Version 2.0,
PROFIBUS International, Order No. 2.332

PROFIBUS Guidelines: PROFIBUS Interconnection Technology V1.1, PROFIBUS International, Order No. 2.142

PROFINET Guidelines: PROFINET Cabling and Interconnection Technology V1.99, PROFIBUS International,
Order No. 2.252

PROFIsafe – Profile for Safety Technology on PROFIBUS and PROFINET V2.6.1, Order No. 3.192

PROFIsafe - Profile for Safety Technology on PROFIBUS and PROFINET V2.4, Order No. 3.192b

3.2 Abbreviations

0x	Hexadecimal representation
AR	Application Relation
CR	Communication Relation
CRC	Cyclic redundancy check
DCP	Discovery and Configuration Protocol

DHCP	Dynamic Host Configuration Protocol
DO	Drive Object
DU	Drive Unit
EMC	Electro Magnetic Compability
ESD	Electro Static Discharge
F	Generally means Safety or Fail-safe
F-Device	Safety device for safety applications
F-Host	Safety control for safety applications
FSI	Functional safety integrated
GSD	General Station Description
GSDML	General Station Description Markup Language
I&M	Identification & Maintenance
IO	Input/Output
IP	Internet Protocol
IRT	Isochronous Real Time Ethernet
IsoM	Isochronous Mode
LLDP	Link Layer Discovery Protocol
LSW	Least Significant Word (Lower part of Unsigned64)
MAC	Media Access Control
MLS	Master Sign-of-Life
MRP	Media Redundancy Protocol
MRP-D	Media Redundancy Planned Duplication
MSW	Most Significant Word (upper part of Unsigned64)
OB	Organizational Block
PI	PROFIBUS and PROFINET International
RPM	Revolutions Per Minute
RT	Real-time communication
SIL	Safety integrity level
TCP	Transmission Control Protocol
TFTP	Trivial File Transfer Protocol
UDP	User Datagram Protocol

4 Installation

A summary of the PROFINET guideline: PROFINET Cabling and Interconnection Technology V 1.99, Profibus International, Order No 2.252 is provided in this section.

4.1 Installation checklist

This chapter contains a simplified checklist for installation and setup of the device.

- Setup the hardware and connect the cabling according to the mounting instruction. Always use shielded cables, also for the power supply.
- Install the correct GSDML-file for the device.
- Configure the device/devices according to this manual.

Standard PROFINET

- Select the encoder
- Choose telegram
- Configure the IP-address settings and give the device a unique device name
- Configure the encoder module parameters

Safety (PROFIsafe over PROFINET)

- Choose safety telegram
- Configure F_Dest_Address (with LL Webserver)
- Configure the iParameters
- Generate iParCRC (with LL Webserver)
- Configure F-parameters

Compile and download the configuration

If a Device_Fault (error bit 1) is set, the device can only terminate this state with a power cycle of the device.

4.2 Cables and standards

Two shielded copper cables twisted in pairs are defined as the normal transmission medium for PROFINET networks. In such networks, the signal transmission is performed in accordance with 100BASE-TX at a transmission speed of 100 Mbps (Fast-Ethernet).

Only shielded cables and connecting elements are allowed in a PROFINET network. The individual components have to satisfy the requirements of Category 5 in accordance with IEC 11801. The entire transmission path has to meet the requirements of Class D in accordance with IEC 11801. Furthermore, PROFINET cables must have a cable cross-section of AWG 22 in order to enable even complex cabling structures through minimum damping. For this reason, the specification of the PROFINET cables supports a modular setup, which ensures an IEC 11801-compliant structure in adherence to simple installation rules.

Transmission channel lengths are determined by the type of cable being used. The choice of cable shall be such that a transmission channel length of 100 meters is achieved between two active network devices. The use of a high number of plug connections has a negative effect on attenuation and reflection and consequently reduces the transmission channel length. A maximum of three interconnections can be inserted between two active devices without reduction of the permissible transmission lengths of 100 meters.

4.3 Connectors and pin configuration for absolute encoder

The M12 connector used for power supply of the encoder is constituted by a 4-pin male shielded A-coded version



Signal	Function	Pin
+E Volt	Power supply	1
Not connected	-	2
0 Volt	0 Volt	3
Not connected	-	4

Table 1 Power supply connection

Figure 3 Encoder power supply

M12 connectors are used for PROFINET data communication of the encoder, constituted by a 4-pin female shielded D-coded version



Signal	Function	Pin
Tx+	Transmission data +	1
Tx-	Transmission data -	3
Rx+	Receiver data +	2
Rx-	Receiver data -	4

Table 2 Bus connection

Figure 4 Encoder BUS port 1 and 2

Note: The encoder provides integrated switch functionality between the two M12 connectors used for PROFINET communication. It is important to distinguish between these ports when IRT-communication is being used.

Note: It is not possible to use passive T-couplings in a PROFINET network. All devices must be connected through active network components.

4.4 Shielding concept of the device

Automation systems in an industrial environment are subjected to high levels of electromagnetic disturbance. Switching large electrical loads creates high interference levels that can be picked up in various ways by electronic devices with detrimental effects. Even under such conditions, electrical components within an automation system must still guarantee a continuous, uninterrupted function.

The electromagnetic compatibility (EMC) of the entire plant must be ensured by using suitably designed components and assembling them correctly to create the system. Data cabling is considered a passive system and cannot be tested for EMC compliance individually. Nevertheless, cabling and connection elements for PROFINET support compliance with devices requirements by providing a high-quality, comprehensive shielding concept.

To achieve the highest possible noise immunity and resistance against other EMC related disturbances, **the bus and power supply cables must always be shielded**. The screen should be connected to ground on both ends of the cable. In certain cases, compensation current might flow over the screen.

4.5 MAC-address and Change Index

To make the device unique, it is given an ID, i.e. the MAC address, which is a string loaded in the device. The MAC address is constituted by a 6-byte Ethernet address for each individual station and is unique world-wide. A MAC-ID consists of two parts, the first 3 bytes represents the manufacturer-specific ID and the last 3 bytes represents a consecutive number. For the encoder and the encoder gateway, the MAC address is always printed on the encoder label for commissioning purposes. See picture.

FSI 6XXXXXX2XXXX	
Part no. 1234567-xx	
Ser. no. 123456789A	
MAC Id:AA:BB:CC:DD:EE:FF	
Output: PROFIsafe	
Prod. Date: yy/ww, HW: 01	
Supply: 10..30 Vdc	
	
LEINE LINDE	
Phone + 46 152 26500 www.leinelinde.com Olivehällsvägen 8, 645 21 Strängnäs, Sweden	

Figure 5 MAC-address

4.6 LED indication

The following table defines diagnostic indications shown by the encoder's two bi-colored LEDs (see figure 3 or 4 for location of LEDs).

Bus	Module	Meaning	Cause
Off	Off	No power	
Red	Green	No connection to another device. Criteria: No data exchange	– Bus disconnected – Controller not available/switched off
Blinking red	Green	Parameterization fault, no data exchange Criteria: Data exchange correct, however the encoder did not switch to the data exchange mode	– I/O device not configured yet or wrong configuration – Wrong station address assigned – Actual configuration of the slave differs from the nominal configuration
Green	Red	System failure	– Diagnosis exists, slave in data exchange mode
Green	Green	Data exchange and encoder functions properly	
Blinking green	Green	Safety communication ok, but operator acknowledgement requested	– Operator acknowledgement (re-integration) is requested
Blinking green	Blinking green	Firmware upgrade in process	
Blinking orange	Blinking orange	Identification from IO controller	
Green	Orange	Warning present	– Command not supported – Preset out of range

*) The blinking frequency is 1 Hz. Minimal indication time is 3 seconds

Table 3 LED indication.

5 Configuration example with TIA-portal

This chapter will illustrate an example on how to setup and configure a safety program for a PROFIsafe over PROFINET multi-turn encoder with the TIA-portal. In the following example, **Totally Integrated Automation Portal version V17** with the package S7 Safety advanced V17 were used with the F-CPU (CPU1511F-1 PN) from Siemens. Please refer to the manufacturer of the configuration tool if other configuration tools are being used.

5.1 Select hardware

Start by selecting the hardware by clicking on *Add new device* in the device folder. In this example an F-CPU of model CPU1511F-1 PN is selected from the list. The F indicates that the CPU supports safety applications and PROFIsafe.

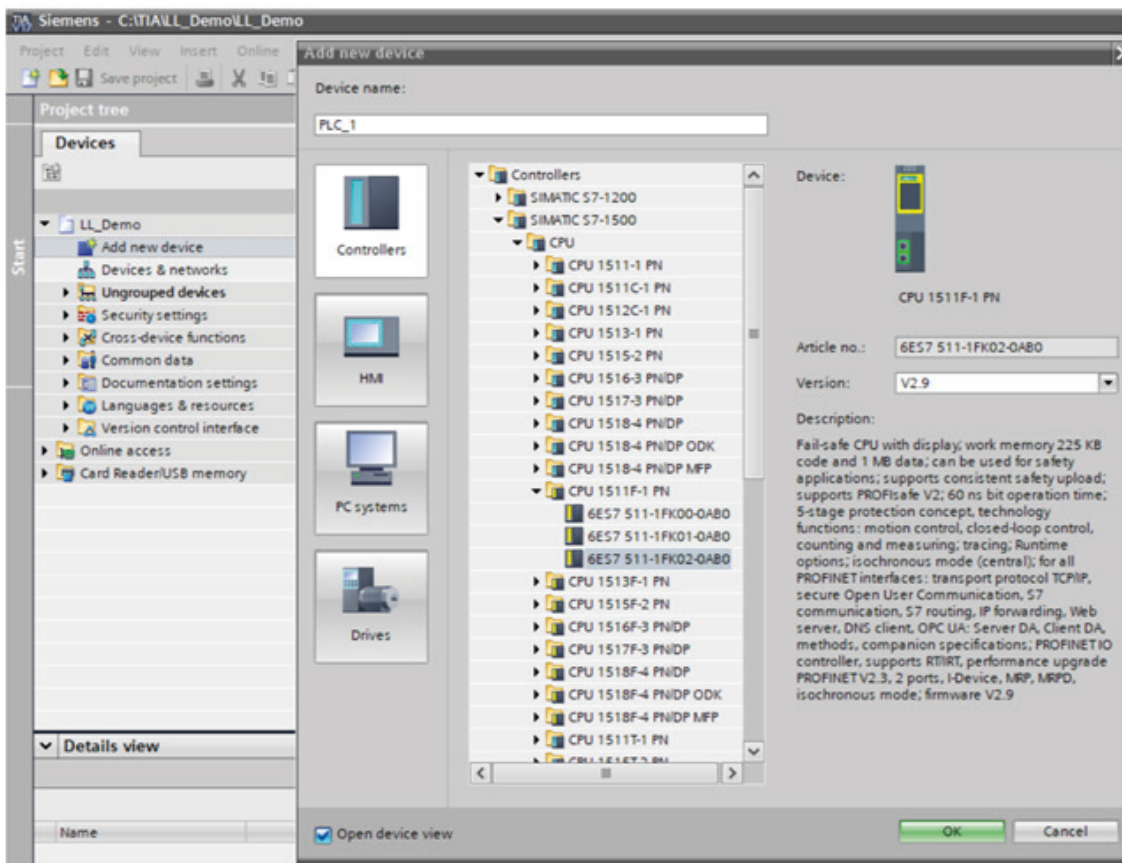


Figure 6 Add the hardware controller to the project

In the *Devices & Networks* window the PLC is now visible in the network view.

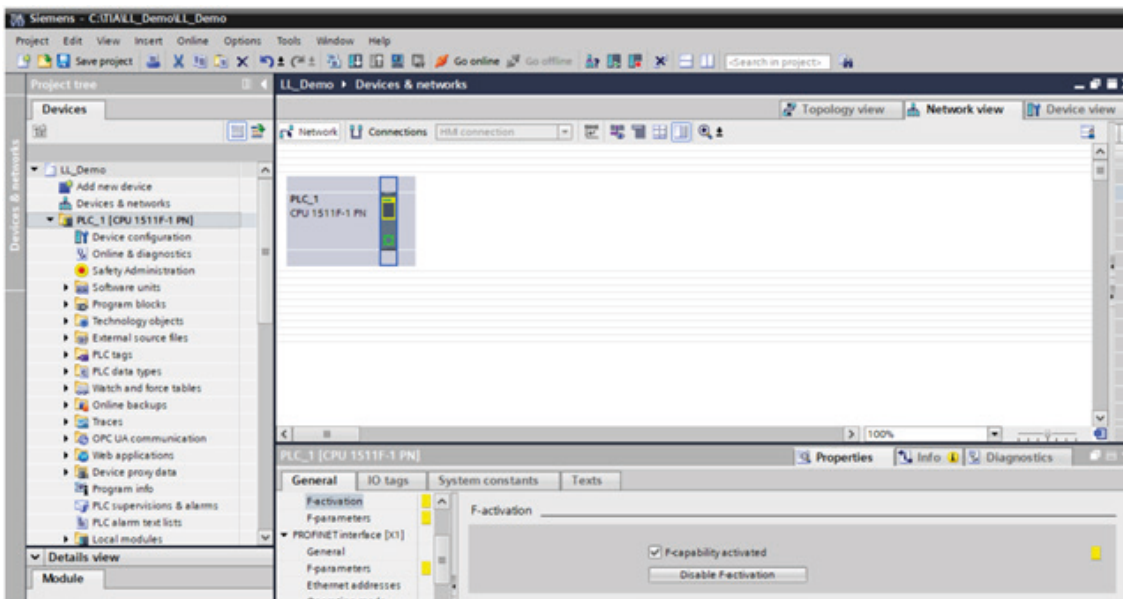


Figure 7 Selected IO controller visible in the Network view

5.2 Installation of GSDML files

In order to start configure a PROFIsafe over PROFINET device a GSDML file needs to be imported into the software.

The necessary GSDML-file can be downloaded from www.leinelinde.com.

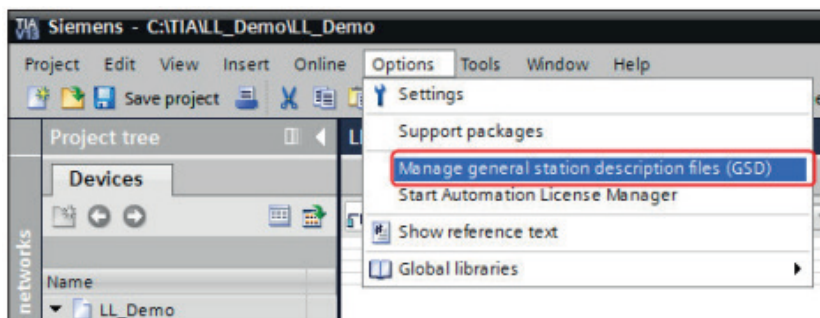


Figure 8 Installation of GSDML file

1. Select **Options** -> **Manage general station description files (GSD)** and click the **Browse** button to navigate to the location of the GSDML file. If a bitmap picture representing the encoder is requested, make sure that the bitmap file is located in the same folder as the GSDML file. A bitmap file is included in the zip-file downloadable from www.leinelinde.com.
2. Select the GSDML file and click the **Install** button to start installing the selected GSDML file.

5.3 Setting the encoder configuration

When the GSDML file has been installed the supported encoder types can be found in the **Hardware catalog** under **Other Field Devices** → **PROFINET IO** → **Leine & Linde AB** → **LEINE LINDE PROFINET Encoders**. Select the type of encoder to be configured. Drag and drop the device as shown in the Figure 9 below. If more than one encoder

shall be configured, then the following steps need to be done once for each device.

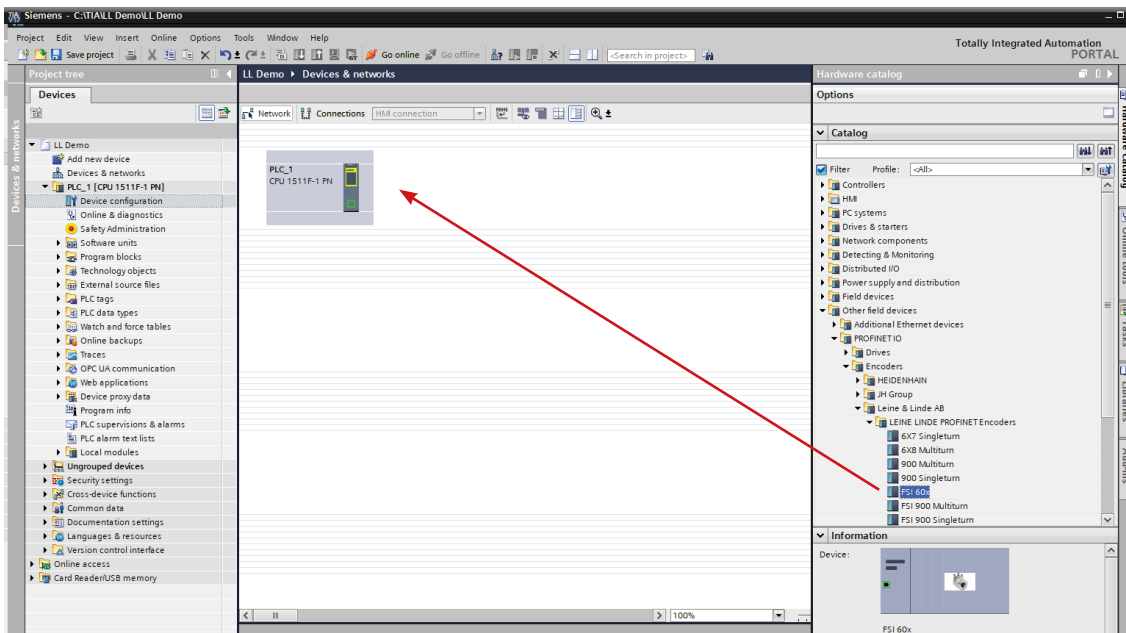


Figure 9 Setting up the encoder configuration

Expand the Module folder in the catalogue tree and double-click on the Module you want to select. There are two safety modules and one standard module. The selected safety module will be located in slot 5 and the standard modules can be in slot 1-4. Then open the Submodule folder to select the telegrams to be used, in this example telegram 81 and telegram 37 are used. For more information regarding details of the different telegrams see chapter 7.

Note: The steps above need to be performed once for each device.

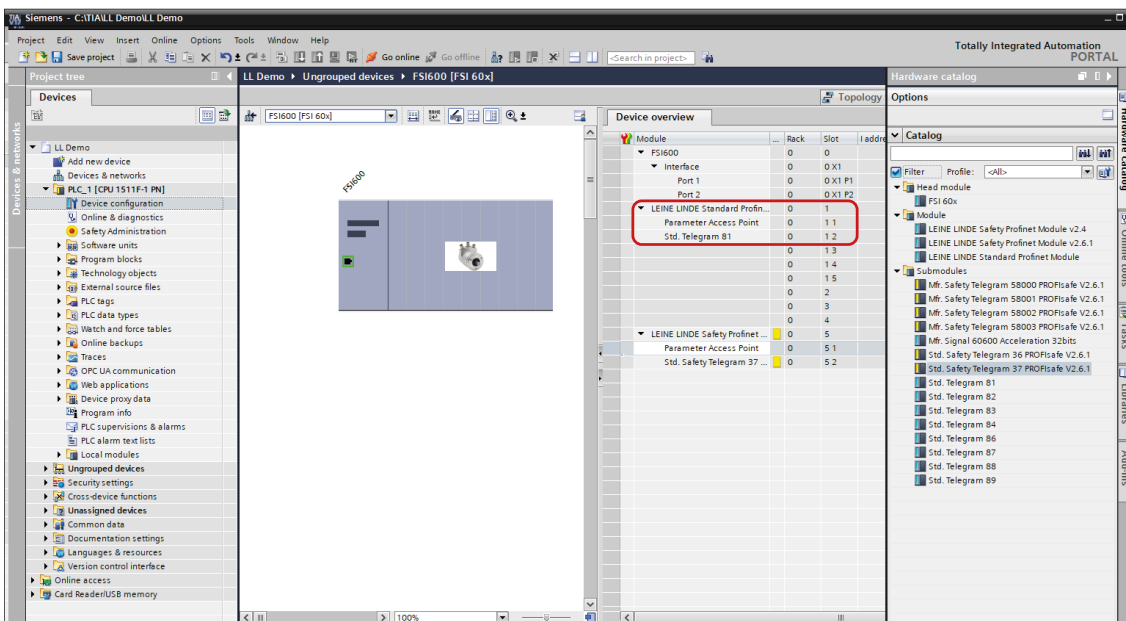


Figure 10 Select what Telegram/Module to be used

5.4 Assign the device to IO-controller

In the *Network* view, right-click *Not assigned* and click on the *Assign new IO controller* to connect the device to the IO controller in the project.

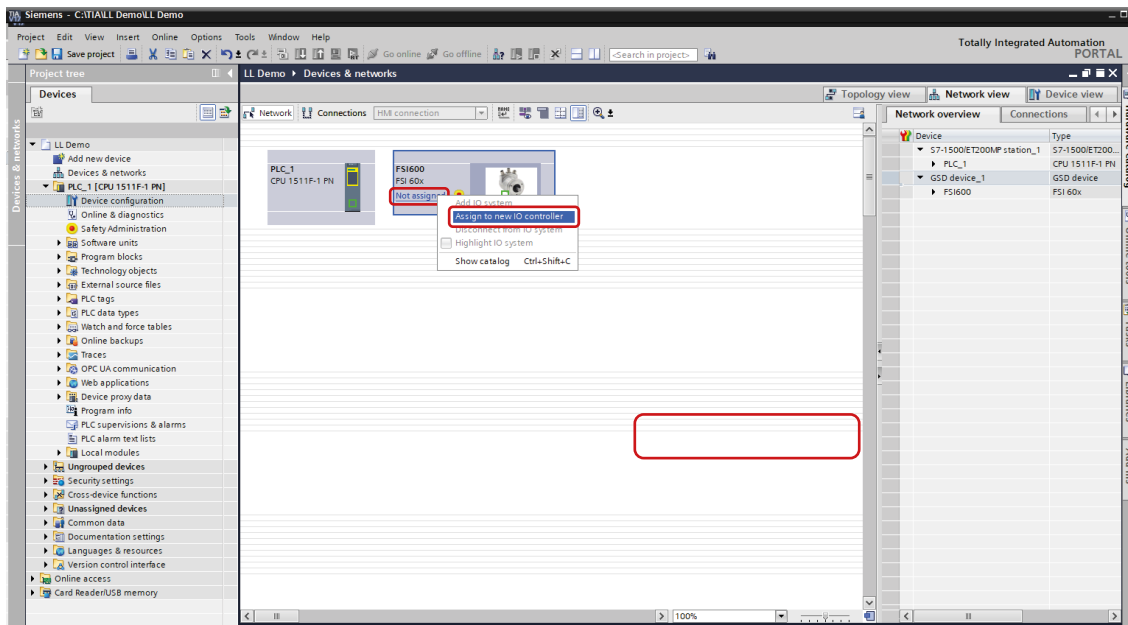


Figure 11 Assign IO controller

5.5 Setting the encoder device name

In a PROFINET network all IO devices needs to have a unique IP-address (but be in the same subnet) and device name. In the Network view, click on the “PROFINET ENCODER” device. Then click on the *Properties* tab. The setting for the IP-address and device name can be found under *General->PROFINET interface [X1]-> Ethernet addresses*. Set the IP-address and enter a suitable device name. Unclick the box “Generate PROFINET device name automatically” to set your own device name.

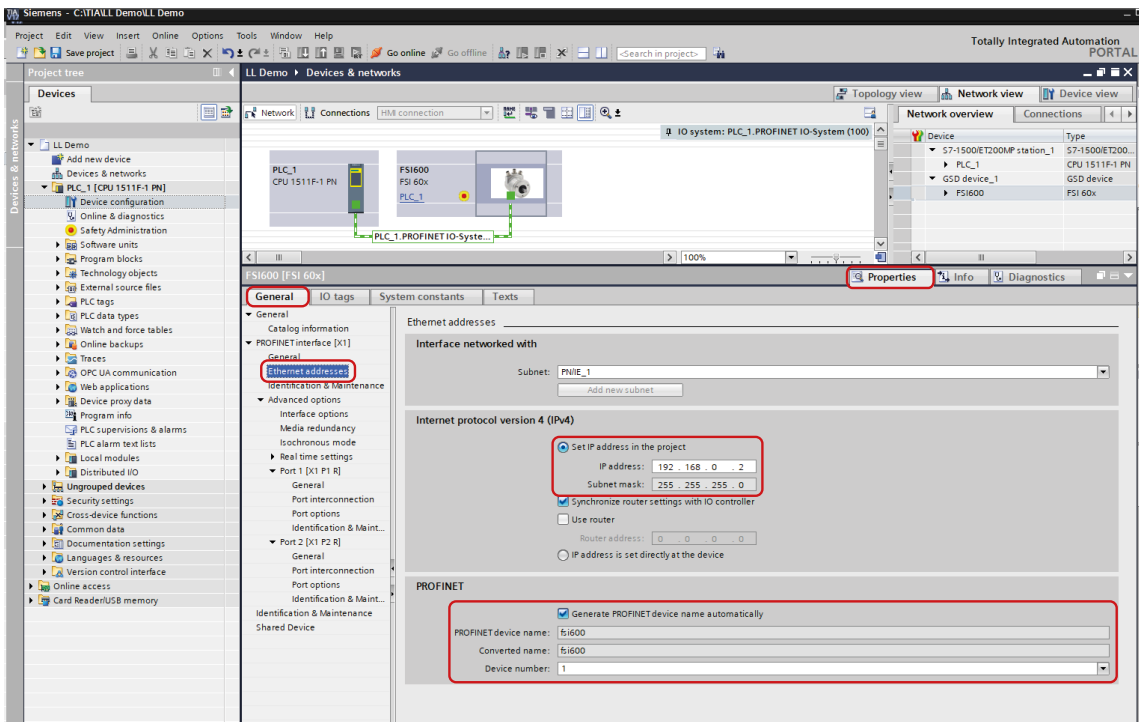


Figure 12 IP-address and device name settings

5.6 Assign device name

To assign the device name to the device, right-click on the “PROFINET ENCODER” device, then click on *Assign device name* or click on the *Assign device name* icon.

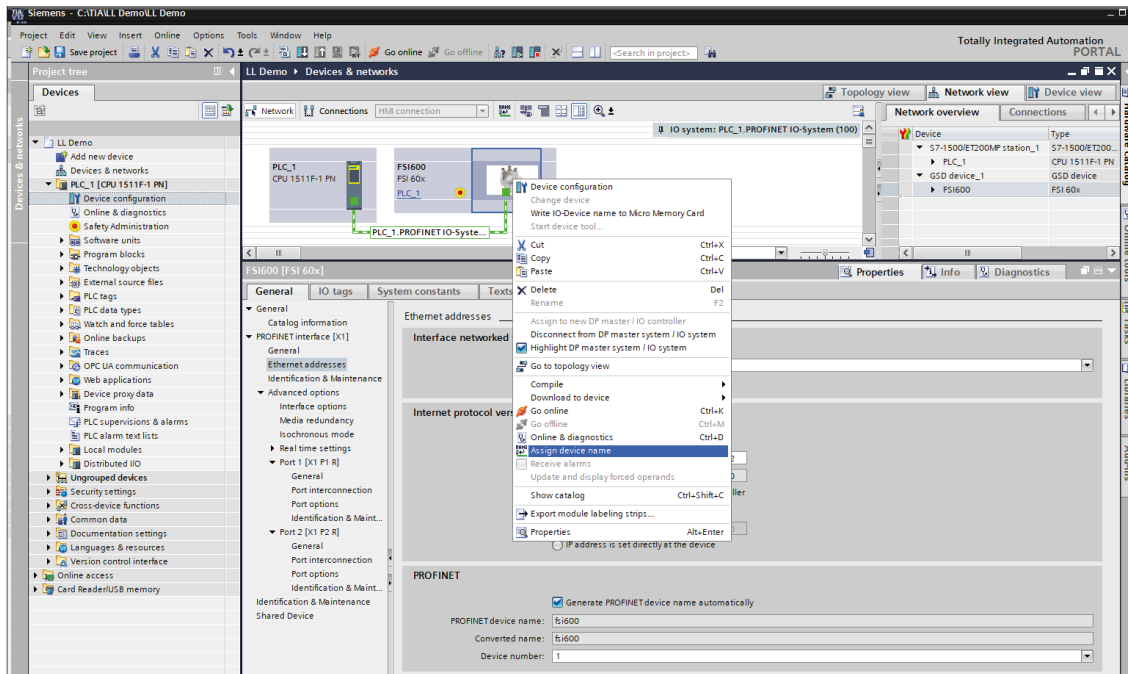


Figure 13 Assigning device name

The *Assign PROFINET device name* window will then open. Under the *Online access field* choose *PN/IE* as the type of *PG/PC interface*. Then click on the *Update* list button to update the list. The encoder should now be available in the list. Choose the device to be configured with the help of the MAC address. The MAC address for the device is written on the device label (see section 4.5). Then choose the PROFINET device name from the drop down list and click the *Assign name* button.

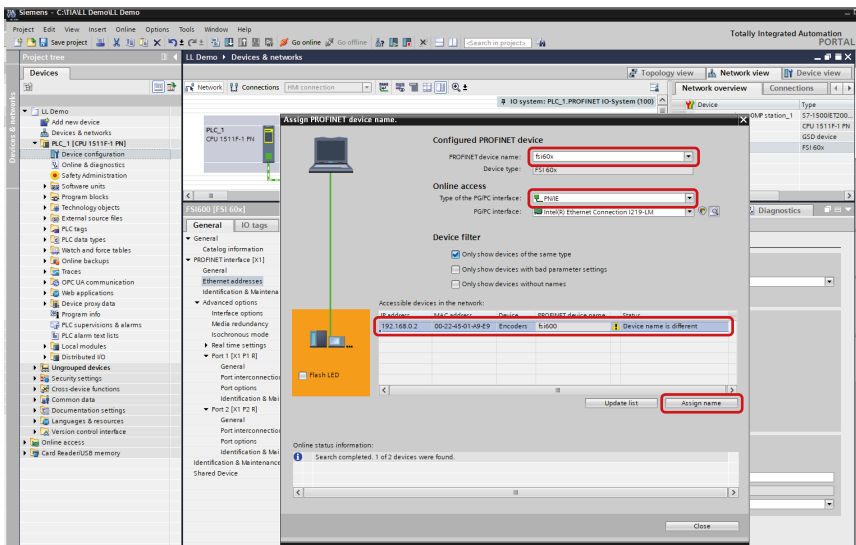


Figure 14 Assigning device name

If the assigning of the name went well, this will be indicated with a status OK as in Figure 15 below.

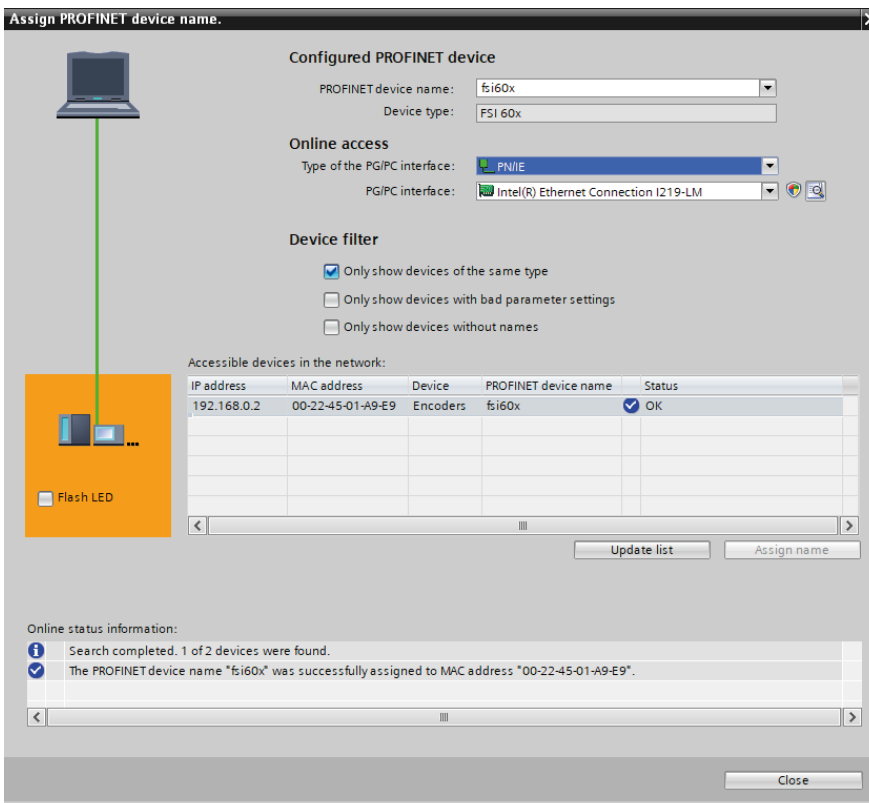


Figure 15 Assigned device name OK

Note: All connected devices need to be assigned a unique device name

5.7 Setting PROFINET parameters

This chapter describes how to change the module parameters for the standard PROFINET telegrams/modules (not safety) in the encoder configuration. To set the encoder user parameters, click on *Parameter Access Point* under the *Device* view. Then click *Properties->General->Module parameters*.

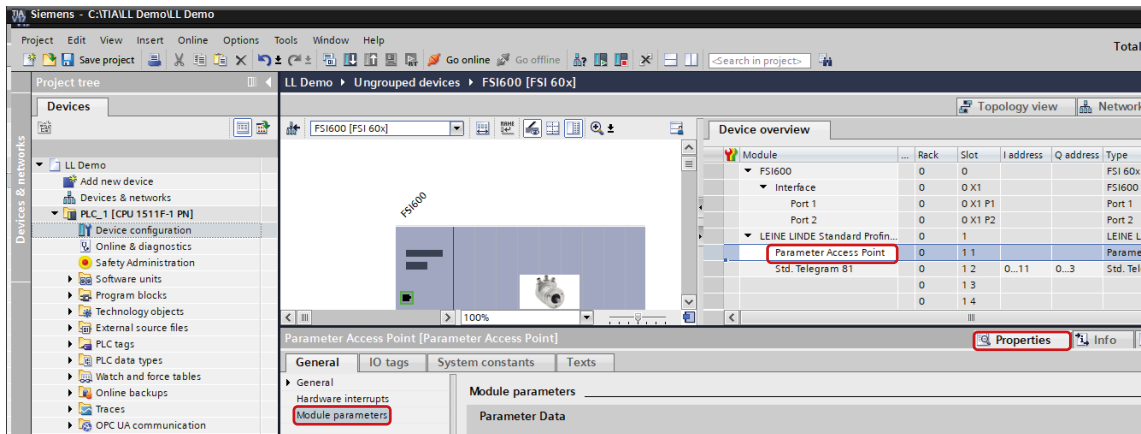


Figure 16 Setting PROFINET parameters of the encoder

The *Module parameters* window will open. Change the value of the different parameters by clicking on the drop-down list in the *Value* field for the respective parameter. For more information regarding parameters, see chapter 7.3.

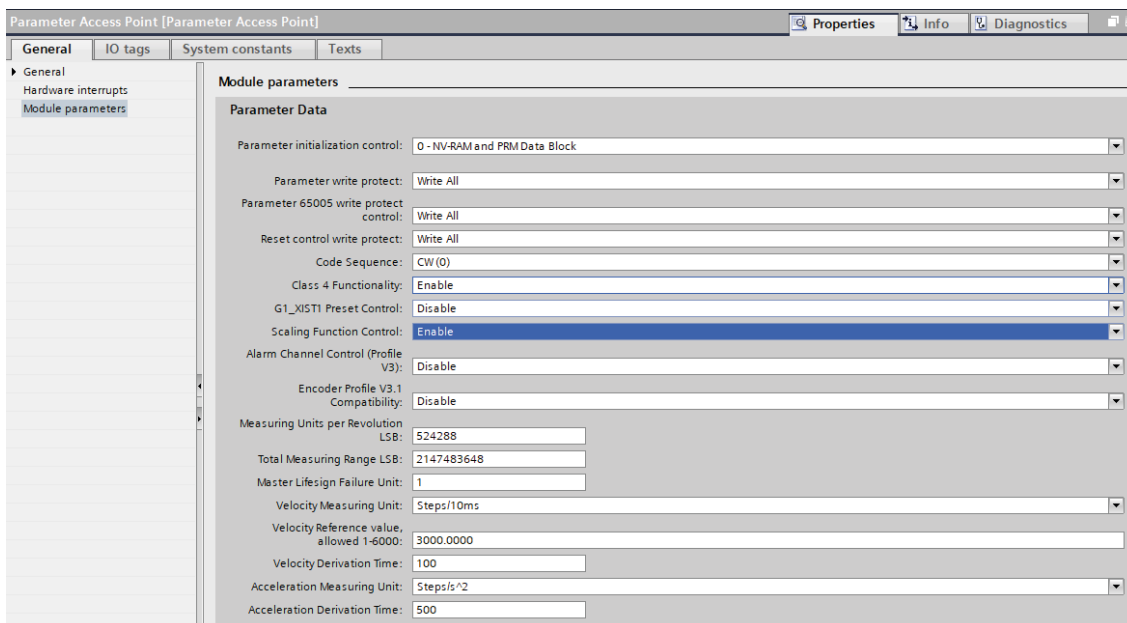


Figure 17 Example of parameter data

5.8 Settings of PLC

To set up communication with PROFIsafe protocol an F-CPU is needed. In order to run it failsafe some settings of the F-CPU is needed or recommended to be done when you set up a new project, please refer to relevant instruction from the manufacturer. In this section a short example is shown on what to think of.

F-capability of the F-CPU must be activated by checking the box in Figure 18.

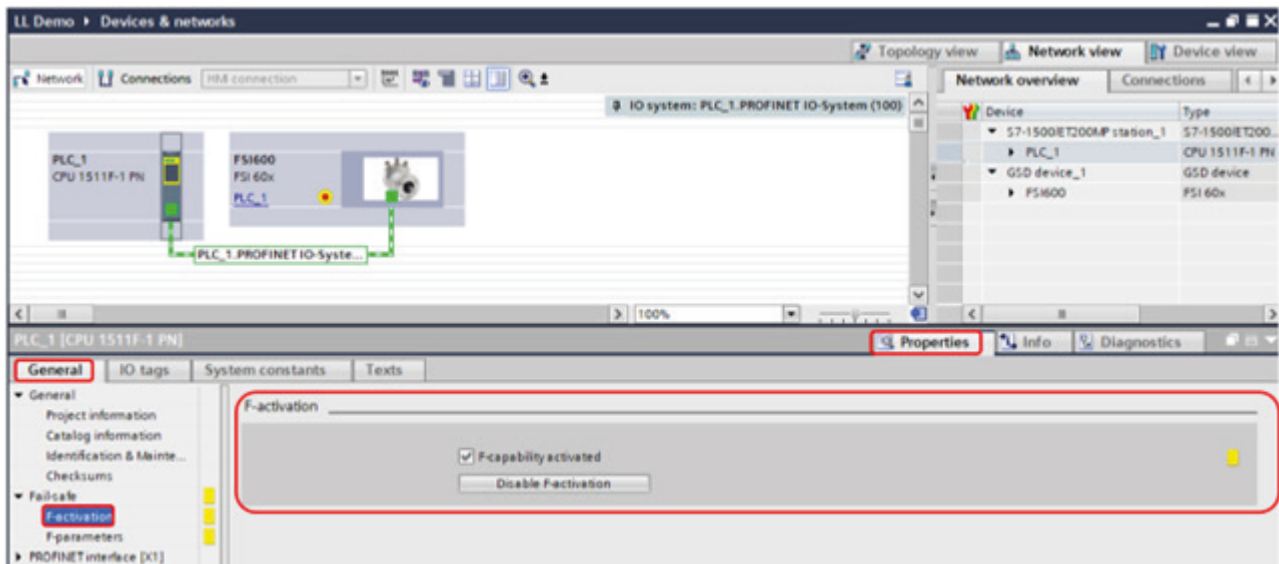


Figure 18 F-capability must be activated in the F-CPU

The access level of the F-CPU must be selected, depending on the circumstances in the specific application it can vary. In below example *Full access (no protection)* is selected, and hence a mandatory access password is needed to be entered (recommended as minimum) to access the fail-safe functions in the program.

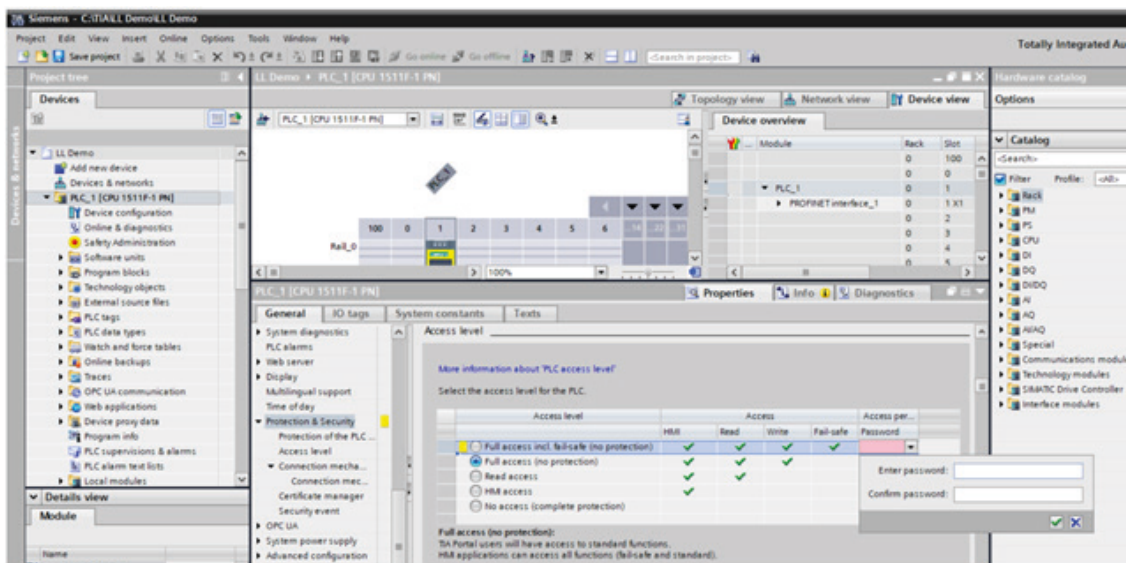


Figure 19 Select the access level of the PLC and enter a password

Another password could be set to protect the offline program in TIA portal from editing. This password can be set through *Safety Administration->Access protection*, visible in Figure 20 below.

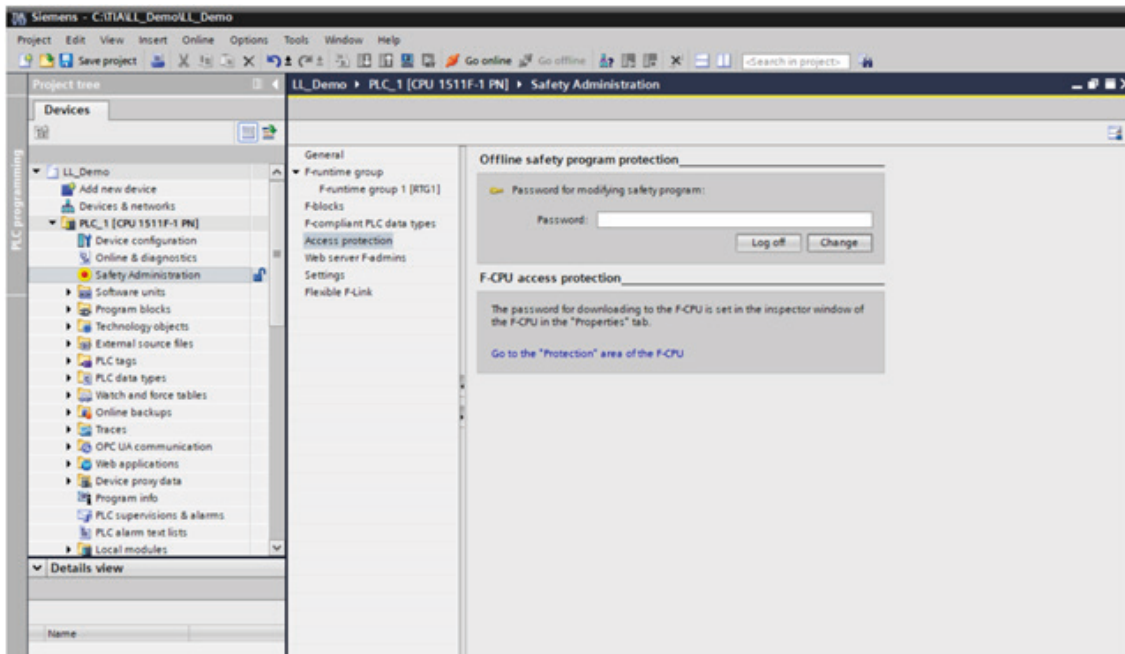


Figure 20 Offline access protection of safety program

It is also optional to add a password for confidential PLC configuration data, under *Protection & Security->Protection of the PLC configuration data*. The password need to be entered during download of the data to the PLC if it is added to the program.

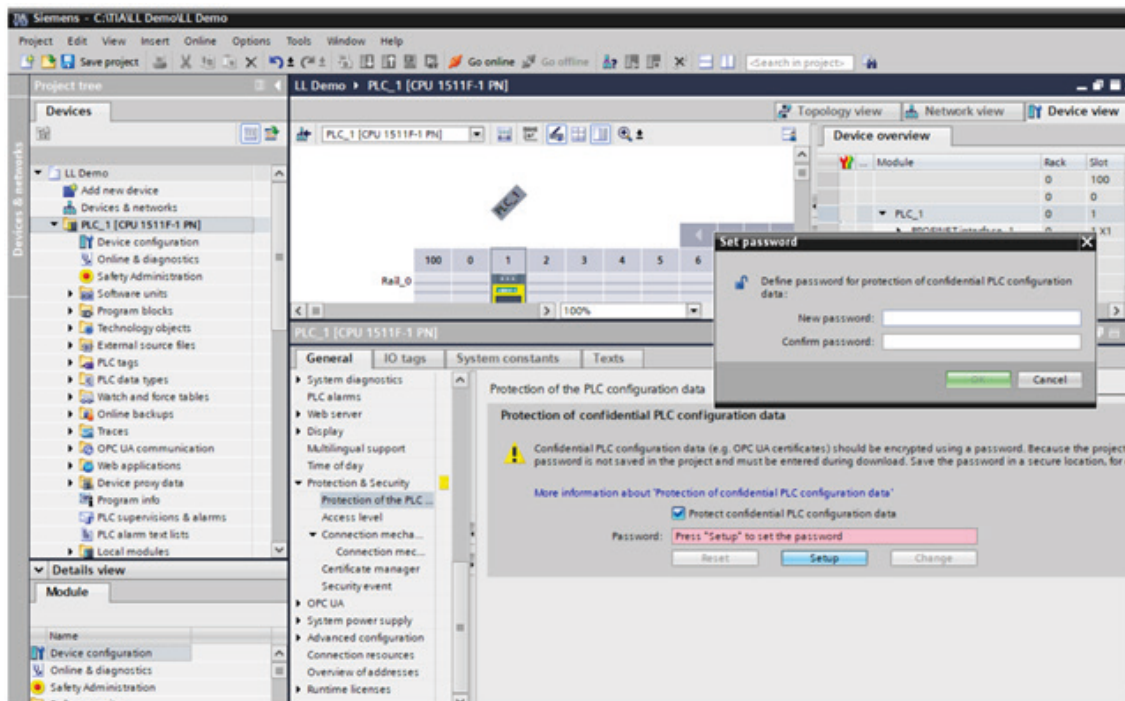


Figure 21 Password for Protection of the PLC configuration data

The F_Source_Add of the PLC can be changed under Fail-safe->F-destination address range for PROFIsafe address type 1. Under Central F-source address the address is assigned. The F_Source_Add need to be unique on the network and not equal to any F_Dest_Add in the network.

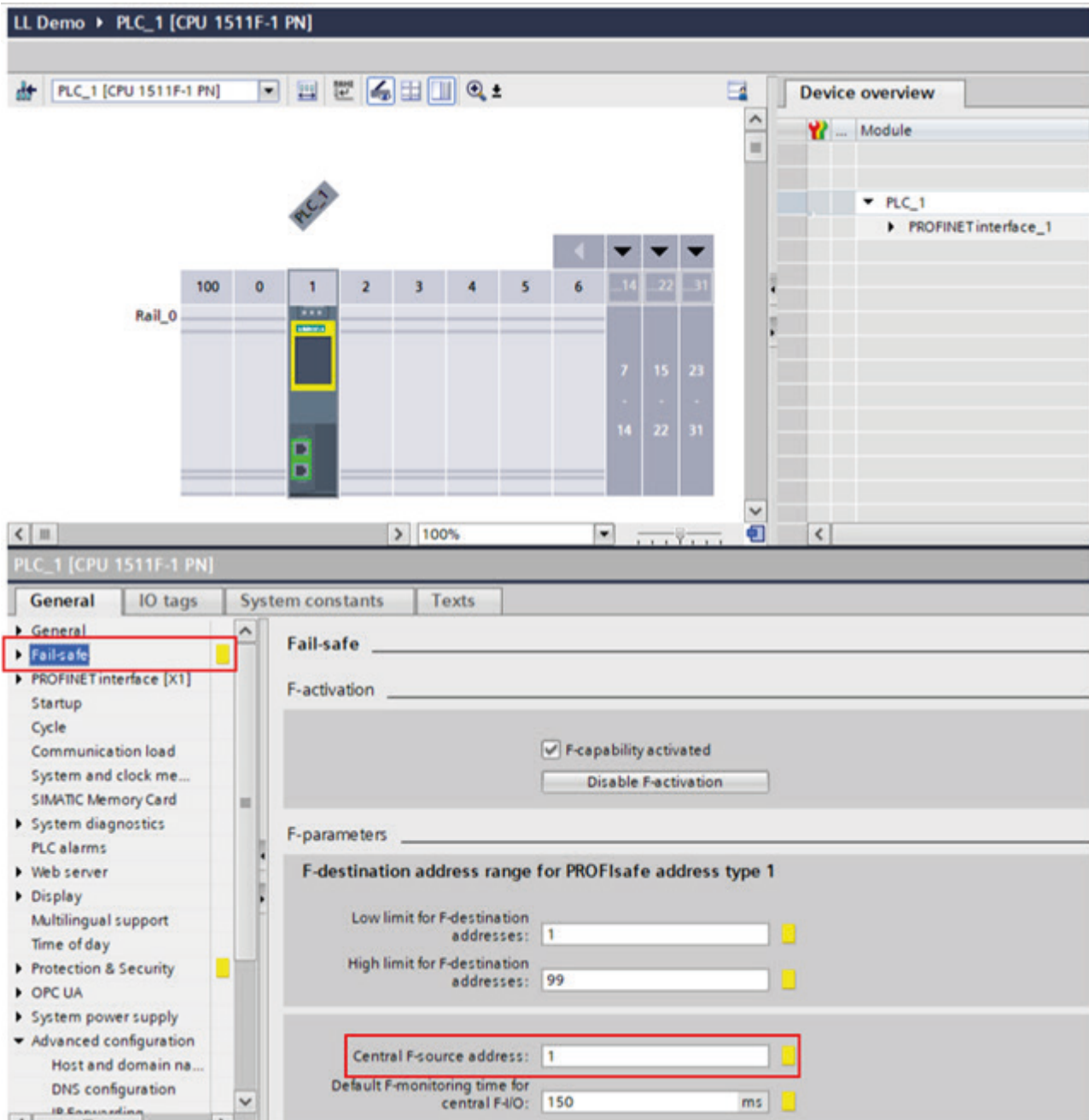


Figure 22 Change F_Source_Add in PLC

5.9 Setting F-parameters and iParameters

For the PROFIsafe protocol the F-parameters and the iParameters (individual failsafe parameters) can be adjusted for the device.

The iParameters are found in the Device view of the encoder. The Parameter Access Point for the failsafe module (indicated by yellow flag) in the Device overview window must be selected. Under Properties->General->Module parameters the iParameters are visible. The iParameters are device specific and can all be adjusted for the application. Detailed information of the specific iParameters are found in chapter 7.1.

From the sum of the iParameters the F-parameter iParCRC is generated. The generation of iParCRC must occur outside the configuration program. The iParCRC can be calculated by the Leine Linde webserver (see chapter 11.4).

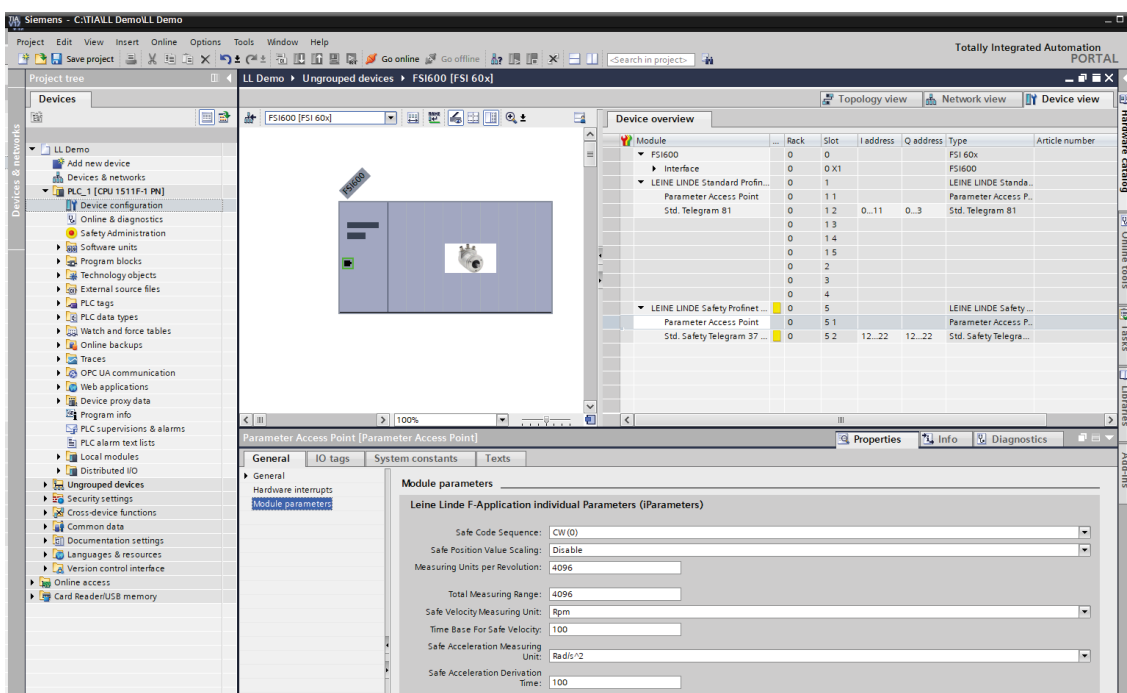


Figure 23 Setting iParameters of the encoder

The F-parameters include information of the PROFIsafe layer to adapt some functions and double check that the configuration is correct (by CRCs). Some F-parameters are programmed into the hardware and cannot be changed for the device (marked in grey), while the ones with white background could be edited by the user. F_Dest_Add are defined in the Leine Linde Webserver (Chapter 11.3). For information about the specific F-parameters see chapter 7.2.

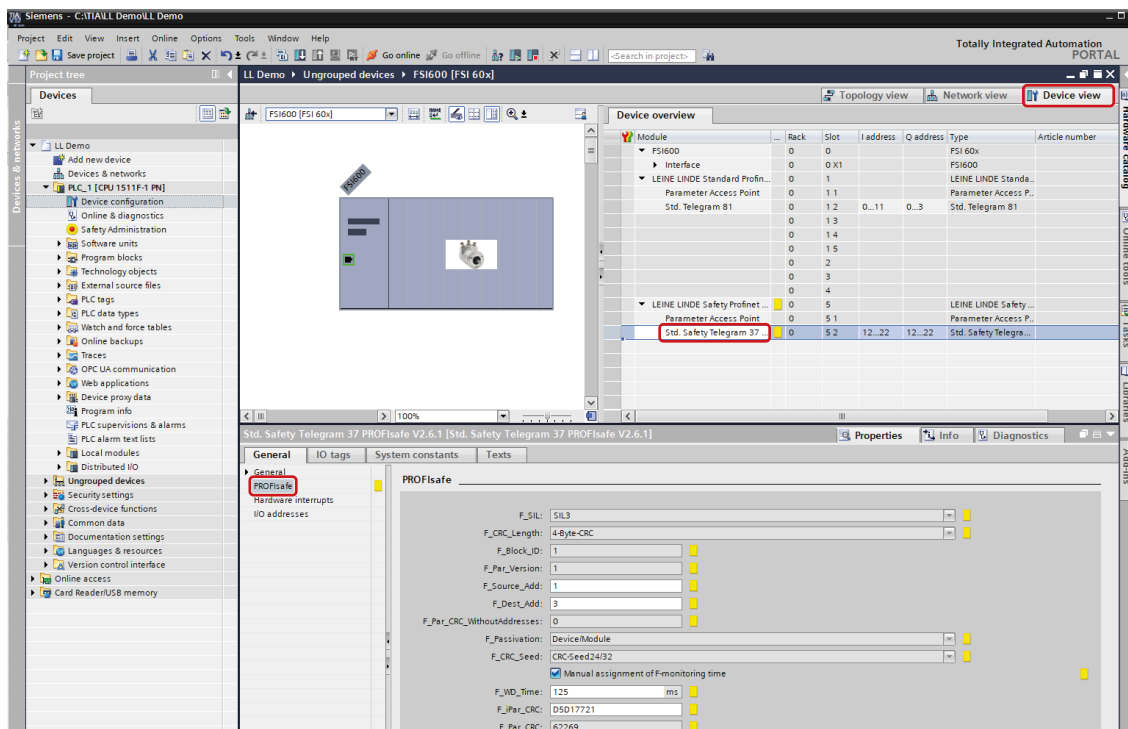


Figure 24 F-parameters for the safety program

Note: The F-parameter **F_iPar_CRC** has to be entered as a hexadecimal number and **F_Dest_Add** $\neq$ **F_Source_Add**. The **F_Source_Add** and **F_Dest_Add** also need to be unique in the network.

5.10 Go online with the project

When the configuration and parameterization of the device has been finalized, the settings needs to be compiled before they can be downloaded to the IO controller. This is done by clicking on the **Compile** button.

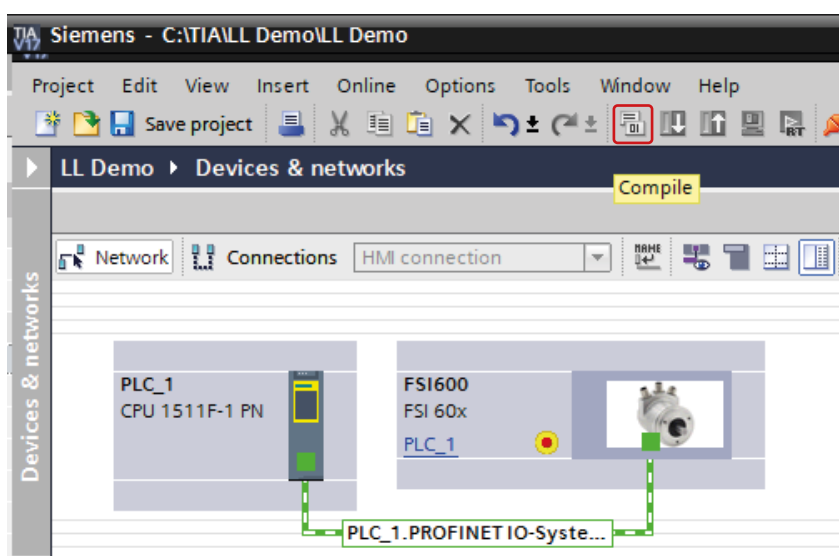


Figure 25 Compile the program

Then download the settings to the IO controller by clicking on the **Download** button.

In the extended **Download to device** window, select your interface/subnet (PN/IE_1) and click on the **Start search** button. Then choose the IO controller and click on the **Load** button.

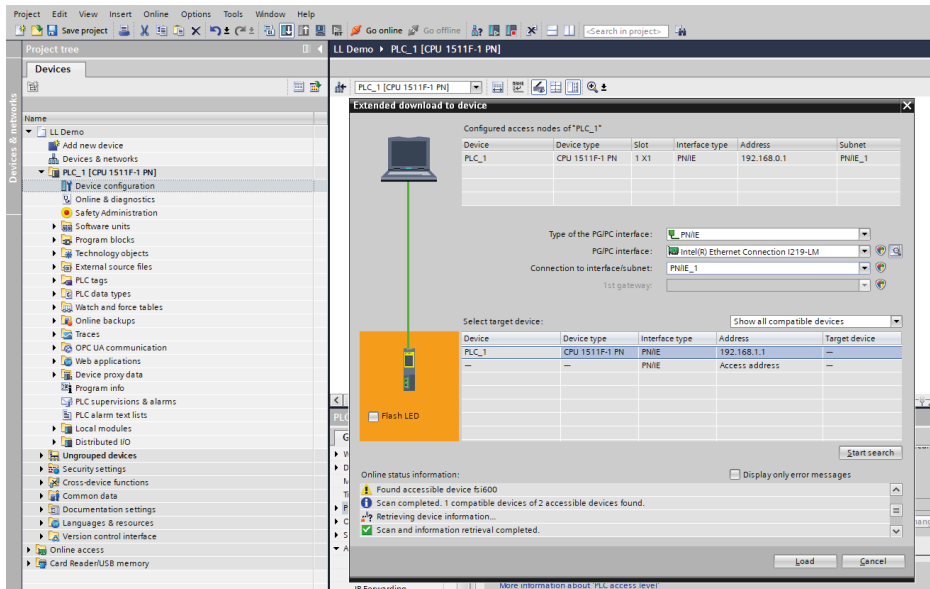


Figure 26 Download configuration to device

Now the **Load preview** window will open. In this example you have to select **Stop all** in the drop down menu for **Stop modules** and enter the password to gain full access (including fail-safe access) from the PLC. Then press **Load**, followed by **Finish** and the program is downloaded to the IO controller. If everything went well, both the Module and Bus LED shall turn to green. Now you can go online in the program by pressing the **Go online** button.

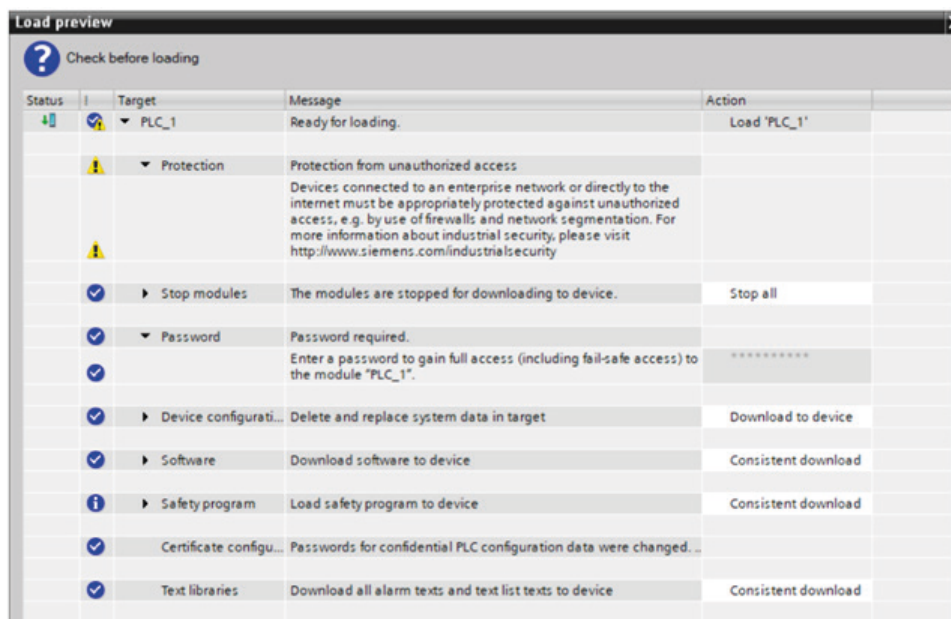


Figure 27 Load preview, download the configuration to the IO device.

The password have been entered and all modules are stopped.

After a download of a safety program an operator acknowledgement is needed to release the unit from safe state and deliver safety related data.

It is required to start the CPU after download (see below Figure) in order to put PLC in run mode.

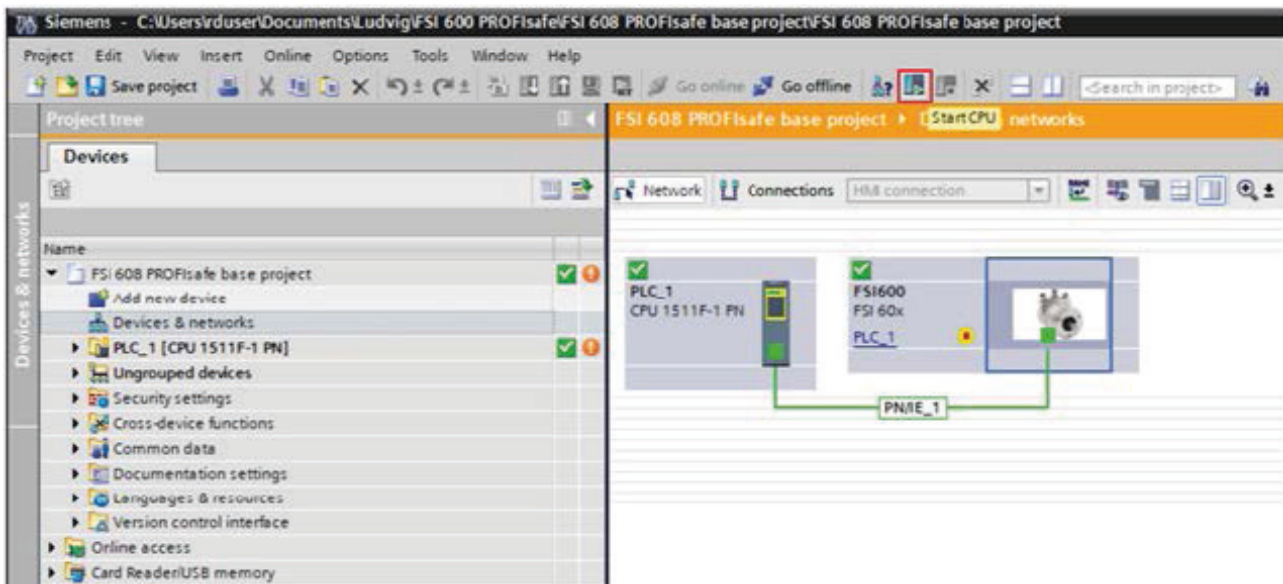


Figure 28 Start CPU in order to put PLC in run mode

5.11 Access safe position and safe speed data

This is a short intuitive example on how to access the safe position and safe speed values in the PROFIsafe protocol. When the safety program is created it will automatically generate an F-Runtime group. The F-Runtime group consist of

- F-Organization Block FOB_RTG1 (OB123)
- F-Function Block Main_Safety_RTG1 (FB1)
- F-Data Block Main_Safety_RTG1_DB (DB1)

You can find the F-Runtime group under safety administration. The default settings, seen in Figure 29, are used in this example

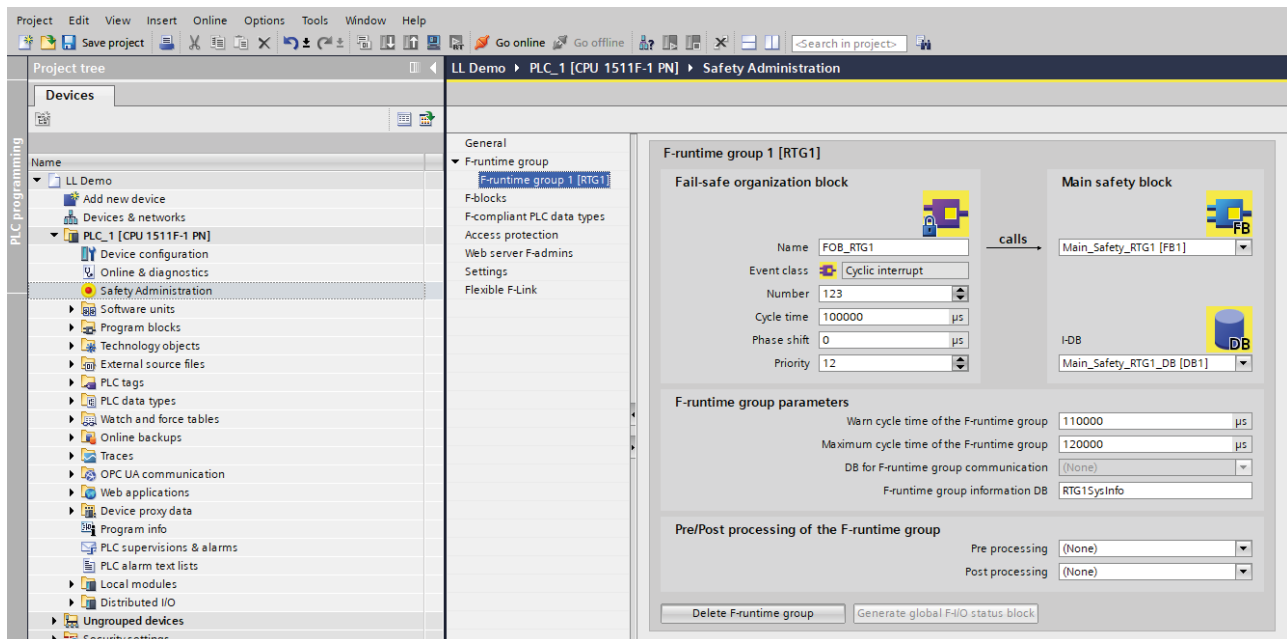


Figure 29 F-Runtime group handling safety program blocks, automatically generated for a safety program

Right click on *Main_Safety_RTG1 (FB1)* in the project tree under *PLC_1->Program blocks*. The programming language is here changed to *FBD* (Function block diagram). Both ladder and FBD are allowed to use for safety programming.

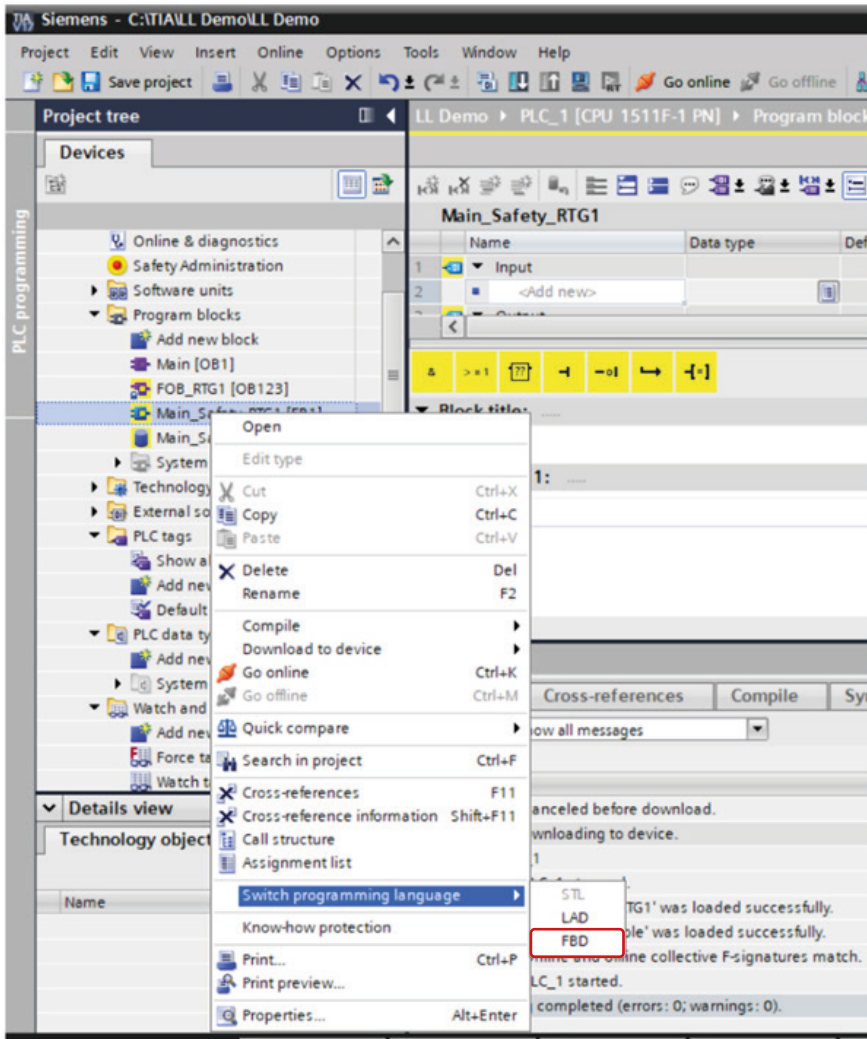


Figure 30 Switch programming language to FBD

Double click on **Main_Safety_RTG1 (FB1)** and add the assignment block as in below figure under Network 1. The assignment block is coupling the signal **ACK_REI** from the measuring data "F00012_STD_SafetyTelegram-36PROF.ACK_REI" to the memory bit **M0.0**. The **ACK_REI** (Acknowledge reintegration) signal need to have value **TRUE (1)** for the IO controller to receive safety data.

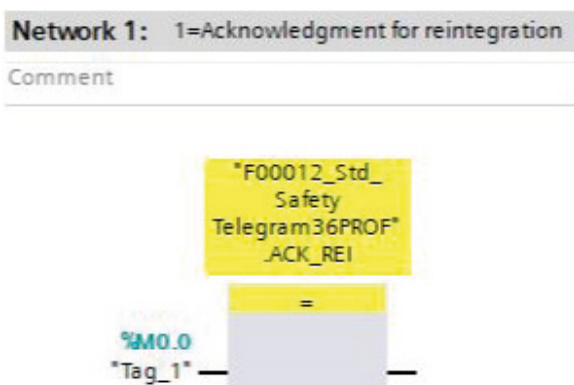


Figure 31 Add an assignment block for ACK_REI signal to Network 1 in Main_Safety_RTG1 (FB1)

The tags safe speed, safe position, speed, position and Tag_1 with corresponding addresses (according to telegram 36) are added to a tag table seen in below figure.

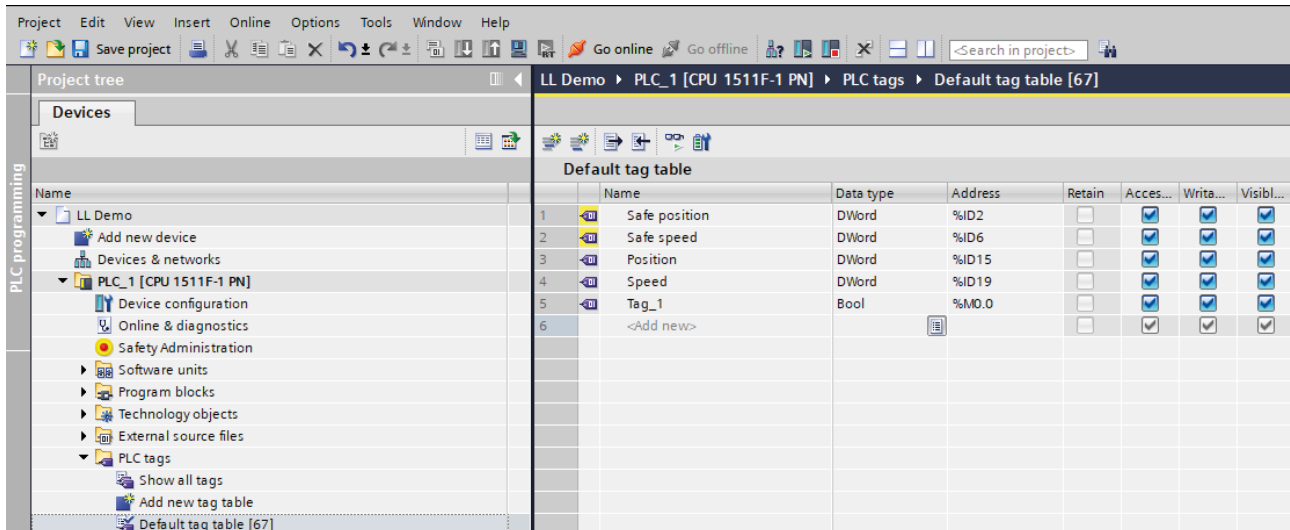


Figure 32 Tags for data of telegram 36 created. The yellow tags indicate failsafe data.

The values for the tags can be monitored in a watch table as in Figure 31 below. When going online Tag_1 need to be changed from FALSE->TRUE in order to monitor the safe data from the PROFIsafe protocol. In this example the tags *Position* and *Speed* were also included, these are referring to standard (non safety) telegram data from PROFINET.

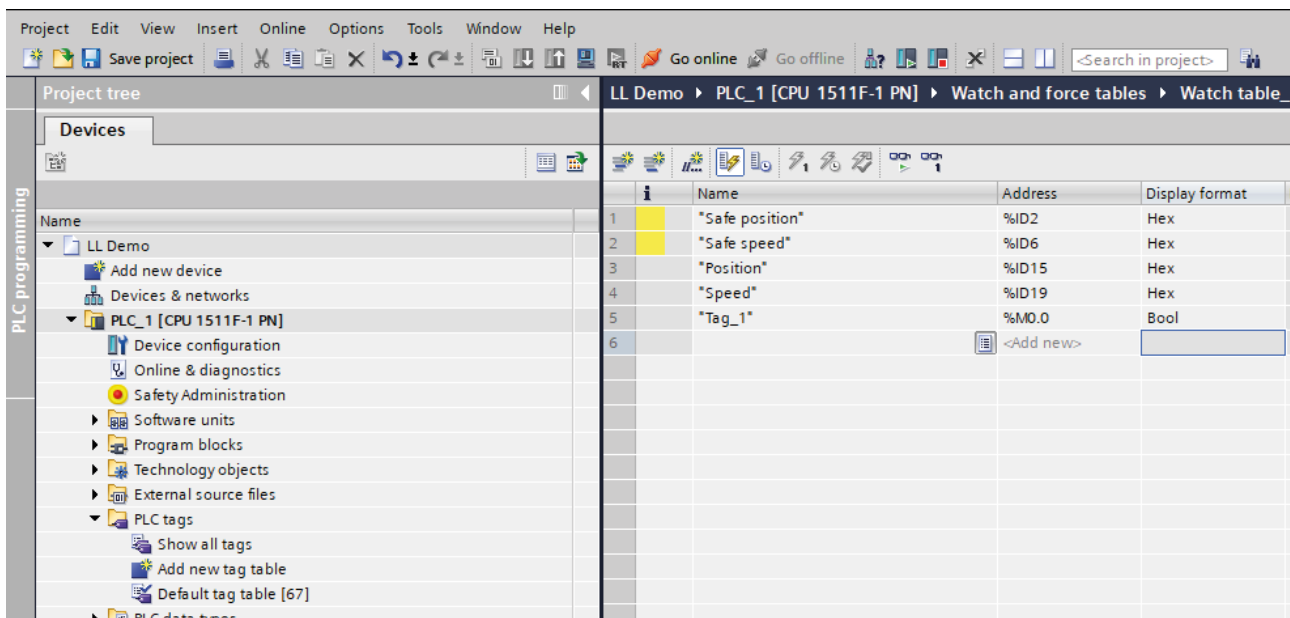


Figure 33 Monitor safe values from the PROFIsafe and PROFINET communication in a watch table.

For further documentation and help refer to manual for the SIMATIC-1500 and TIA-portal.

6 Parameters

Parametrization of an absolute encoder is carried out using acyclic PROFINET communication. For the PROFIsafe over PROFINET interface one can divide the parameters in to three categories: iParameters, F-parameters and PROFINET parameters. The iParameters are the set of individual failsafe parameters that are specific for the device and manufacturer. The iParameters are defined in the GSDML file and need to be verified with a special signature through the F-parameter F_iParCRC. The F-parameters are the general (minimum) failsafe parameters needed to be supported by the device for PROFIsafe communication. With PROFINET parameters here is referred to all parameters that are non-safety relevant.

6.1 iParameters

The iParameters are defined in the GSDML file. The necessary GSDML-file can be downloaded from www.leineline.com.

iParameter	Allowed values	Default value	Note
Safe code sequence	0, 1	0	0 = CW, 1 = CCW
Safe position value scaling	0, 1	0	0 = safe scaling disabled 1 = safe scaling enabled
Safe measuring units per revolution	2-524288	524288	
Total safe measuring range	2-2147483648	2147483648	
Safe velocity measuring unit	0-3	3	0 = Steps/1000ms 1 = Steps/100ms 2 = Steps/10ms 3 = rpm
Safe velocity derivation time	1-1000	100	Values in ms
Safe acceleration measuring unit	0, 1	1	0 = steps/s ² 1 = rad/s ²
Safe acceleration derivation time	100-1000	100	Values in ms

Table 4 List of all iParameters for the device

6.1.1 Safe code sequence

Defines the direction for an increasing position value, looking at shaft.

0 = Clockwise (CW) rotation increasing position

1 = Counter-clockwise (CCW) rotation increasing position

6.1.2 Safe position value scaling

The safe scaling function converts the encoder's physical safe absolute position value by means of software in order to change the measuring range of the encoder. The parameters *Safe measuring units per revolution* (see 6.1.3) and *Total safe measuring range* (see 6.1.4) are the safe scaling parameters set by the corresponding iParameters. Safe scaling is active only if the control bit for the iParameter *Safe position value scaling* is set to 1 (Enabled). When the safe scaling control bit is set to 0, the safe scaling function is disabled. Disabled scaling means that the encoder position will work in the full range. For a multiturn encoder the full safe position range is 0-2147483648 (31 bits).

Note: Safe position value scaling are not affecting scaling of the standard (non-safe) position value.

6.1.3 Safe measuring units per revolution

This parameter sets the safe single-turn measuring range of the encoder. In other words it is the number of measuring steps during one revolution of the encoder shaft.

Example: For an encoder with 19-bit single-turn resolution, the permissible value range for "Safe measuring units per revolution" is between 2-524288 for one revolution.

Note: After downloading new (safe) scaling parameters, a (safe) preset must be performed to set the encoder starting point to (safe) absolute position 0 or to any required starting position within the (safe) scaled operating range.

6.1.4 Total safe measuring range

This parameter sets the total safe measuring range of the encoder. The total safe measuring range is calculated by multiplying the safe single-turn measuring range with the number of safe distinguishable revolutions.

Example:

The total measuring range for a 31 bit encoder is between 2 and 2^{31} (2147483648). The total safe measuring range is calculated as below: Safe measuring units per revolution x Total safe measuring range = 524288 x 4096 = 2147483648. The device has one operating mode for scaling, which is called free scaling.

Safe free scaling:

(Safe) free scaling means that the measuring range of the encoder can be set to any desired number within the limitation of the encoder's maximum total measuring range. The encoder will then work in cyclic operation, which means that the encoder counts from 0 to maximum set value and then starts over from 0 again (0-max-0-max-0...) until it reaches the maximum total measuring range.

Example of safe free scaling:

Safe measuring units per revolution = 1000 steps

Total safe measuring range = 3000 steps (Safe measuring units per revolution x 3 revolutions)

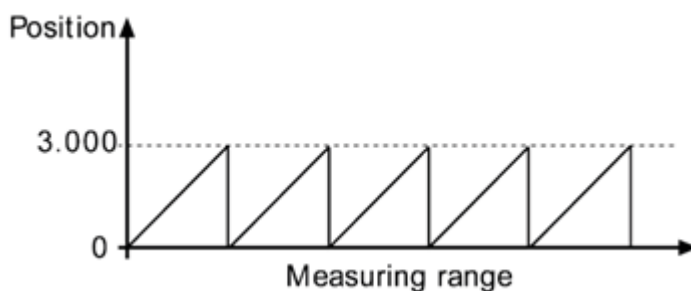


Figure 34 Safe free scaling

Note: After downloading new (safe) scaling parameters, a (safe) preset must be performed to set the encoder starting point to (safe) absolute position 0 or to any required starting position within the (safe) scaled operating range.

6.1.5 Safe velocity measuring unit

The units for the safe velocity can be set according to following units:

Value	Unit
0	Steps/s
1	Steps/100ms
2	Steps/10ms
3	RPM (Revolutions per minute)

where 3 (RPM) is the default value of the iParameter. Steps for the safe speed units (Steps/s, Steps/100ms, Steps/10ms) refers to the maximum number of safe position steps over one revolution.

Note: If safe scaling is activated the velocity units including steps are scaled accordingly

6.1.6 Time base for safe velocity

The parameter indicates the integration time to calculate the safe velocity.

Long integration times is suitable for high-resolution measurements at low speeds. While low integration times is beneficial in applications for high velocities and high dynamics, with sudden changes. The default value for the iParameter is 100 ms. The update time of the safe velocity data is affected with increased integration time.

6.1.7 Safe acceleration measuring unit

The units for the safe acceleration can be set according to following units:

Value	Unit
0	Steps/s ²
1	Rad/s ²

where 1 (Rad/s²) is the default value of the iParameter. Steps for the safe acceleration unit (Steps/s²) refers to the maximum number of safe position steps over one revolution.

Note: If safe scaling is activated the acceleration unit including steps is scaled accordingly

6.1.8 Time base for safe acceleration

The parameter indicates the integration time to calculate the safe acceleration value. The default value for the iParameter is 100 ms. The update time of the safe acceleration data is affected with increased integration time.

6.2 F-parameters

F-Parameter	Settable	Description
F_SIL	No	1 = SIL3 (default)
F_CRC_Length	No	CRC signature length, 0 = 3-byte-CRC (default) 1 = 4-byte-CRC

F-Parameter	Settable	Description
F_Block_ID	No	
F_Par_Version	No	
F_Source_Add	Yes	Source address, default = 1 Range: 1-0xFFFFE
F_Dest_Add	Yes	Destination address, default = 1 Range: 1-0xFFFFE
F_Passivation	No	
F_CRC_Seed	No	
F_WD_Time	Yes	Watchdog time, default = 125 ms, Range: 10-10000 ms
F_iPar_CRC	Yes	CRC of iParameters, default = 0x7F51C55D Range: 1-0xFFFFFFFF (FSCP test mode is not supported)
F_Par_CRC	No	CRC of F-Parameters, default = 0x4987 Range: 0-0xFFFF

Table 5 List of all F-parameters for the device

6.2.1 F_SIL

The parameter F_SIL specifies what safety integrity level the user can expect from the F-Device.

6.2.2 F_CRC_Length

The parameter F_CRC_Length specifies the length of the CRC signature. Default value is 3-byte-CRC (PROFIsafe V2.4). 4-byte-CRC is for PROFIsafe V2.6.1.

6.2.3 F_Block_ID

Since the measuring system supports device-specific safety parameters (iParameters) this parameter is preconfigured with the value "1 = generate F_iPar_CRC" and cannot be changed.

6.2.4 F_Par_Version

The parameter identifies the PROFIsafe version "V2-Mode" implemented in the measuring system. This value is predefined and cannot be changed.

6.2.5 F_Source_Add / F_Dest_Add

The parameter F_Source_Add defines a unique source address within the network. In previous example with Siemens S7-1500 it is automatically assigned a source address with standard value 1. The parameter F_Dest_Add defines a unique destination address within the network. The destination address is assigned to the encoder via LL Webserver (see chapter 11 for details). The parameter codename is constructed with the F_Source_Add and F_Dest_Add.

The device is a FSCP 3/1 Address Type 1: F-(Sub)Module which checks as Retentive Selection of the Codename the destination address only.

Note that F_Source_Add≠F_Dest_Add

6.2.6 F_Passivation

Defines passivation type. Fixed to module-granular passivation.

6.2.7 F_CRC_Seed

The parameter F_CRC_Seed specifies the length of the CRC signature. Default value is 3-byte-CRC (PROFIsafe V2.4). 4-byte-CRC is for PROFIsafe V2.6.1.

6.2.8 F_WD_Time

The parameter F_WD_Time is monitoring the so called Watchdog time of the measuring system. A valid safety telegram must arrive from the F-Host within this time otherwise the measuring system will be set to safe state. Default value is 125 ms.

6.2.9 F_iPar_CRC

The parameter F_iPar_CRC defines the checksum value, which is calculated from all iParameters of the device-specific part of the measuring system and ensures safe transmission of the iParameters. The calculation occurs in the LL webserver (see chapter 11). The checksum value calculated there must then be manually entered in the F-Host engineering tool.

6.2.10 F_Par_CRC

The F_Par_CRC parameter defines the checksum value, which is calculated from all F-Parameters of the measuring system and ensures safe transmission of the F-Parameters. F_PAR_CRC is generated automatically.

6.3 PROFINET IO parameters

Module parameters are standard acyclic PROFINET IO parameters that defines the encoder specific setup and configuration. The module parameters are read and written during run-up of the device. In table 6 the module parameters are listed. For other acyclic data that is read and written online over base mode parameter (BMP) access details can be found in chapter 9.

Parameter	Allowed values	Default value
Parameter initialization control	0-1	0 = PRM Data Block
Parameter write protect	0-1	0 = Write all
Parameter 65005 write protect control	0-1	0 = Write enabled
Reset control write protect	0-1	0 = Write enabled
Code sequence	0-1	0 = CW
Class 4 functionality	0-1	0 = Disable
G1_XIST preset control	0-1	1 = Disable
Scaling function control	0-1	0 = Disable
Alarm channel control (Profile V3)	0-1	0 = Disable
Encoder profile V3.1 compatibility	0-1	0 = Disable

Parameter	Allowed values	Default value
Measuring units per revolution LSB	2-524288	524288
Total measuring range LSB	2-2147483648	2147483648
Master lifesign failure unit	0-255	1
Velocity measuring unit	0-4	1 = Steps/100 ms
Velocity reference value	0-6000	3000 rpm
Velocity derivation time	1-1000 ms	100 ms
Acceleration measuring unit	0-1	0 = Steps/s ²
Acceleration derivation time	100-1000 ms	500 ms

Table 6 List of all PROFINET IO parameters of the device

6.3.1 Parameter initialization control

Select if the run-up initialization of encoder parameters are using data from PRM Data Block (0) or Only NV-RAM (1).

6.3.2 Parameter write protect

Select if the online access on parameters via acyclic communication service is read and write (0) or read only (1). It does not affect the write access to parameter 65 005 and 972, for these parameters the access control is defined separately.

6.3.3 Parameter 65005 write protect control

Defines if the online access on parameter 65 005 and 971 via acyclic communication service is read and write (0) or read only (1).

6.3.4 Reset control write protect

Defines if the online access on parameter 972 via acyclic communication service is read and write (0) or read only (1).

6.3.5 Code sequence

The code sequence defines whether the absolute position value should increase during clockwise or counter-clockwise rotation of the encoder shaft, seen from flange side. The code sequence is set by default to increase the absolute position value when the shaft is turned clockwise (0).

Attribute	Meaning	Value
CW	Increasing position values with clockwise rotation (seen from shaft side)	0
CCW	Increasing position values with counter-clockwise rotation (seen from shaft side)	1

Table 7 Code sequence

Note: The position value will be affected when the code sequence is changed during operation. It might be necessary to perform a preset after the code sequence has been changed.

6.3.6 Class 4 functionality

This parameter enables or disables the measuring task functions Scaling, Preset and Code sequence. If the function is enabled, scaling and code sequence control affects the position value in G1 XIST1, G1 XIST2 and G1 XIST3. A preset will in this case always affect G1 XIST2 and G1 XIST3 but if the parameter “G1 XIST1 Preset control” is disabled the preset will not affect the position value in G1 XIST1.

Attribute	Meaning	Value
Enable	Scaling/preset/code sequence control enabled	1
Disable	Scaling/preset/code sequence control disabled	0

Table 8 Class 4 functionality

6.3.7 G1 XIST1 Preset control

This parameter controls the effect of a preset on the G1 XIST1 actual value. If “Class 4 functionality” is activated and “G1 XIST1 Preset control” is disabled, the position value in G1 XIST1 will not be affected by a Preset.

Attribute	Meaning	Value
Enable	G1 XIST1 is affected by a preset command	0
Disable	Preset does not affect G1 XIST1	1

Table 9 G1 XIST1 Preset control

Note: There is no functionality of this parameter if the “Class 4 functionality” parameter is disabled.

6.3.8 Scaling function control

This parameter enables or disables the Scaling function of the encoder.

Attribute	Meaning	Value
Enable	Scaling function is enabled	1
Disable	Scaling function is disabled	0

Table 10 Scaling function control

Note: The parameter “Class 4 functionality” must be enabled to use this parameter.

6.3.9 Alarm channel control (Profile V3)

This parameter enables or disables the device-specific Alarm channel transferred as “Channel Related Diagnosis”. This functionality is used to limit the amount of data sent in isochronous mode.

If the value is zero (default value) only the communication related alarms are sent via the alarm channel.

If the value is one (1) also encoder profile specific faults and warnings are sent via the alarm channel.

Attribute	Meaning	Value
Enable	Profile specific diagnosis is switched on	1
Disable	No profile specific diagnosis (default)	0

Table 11 Scaling function control

Note: This parameter is only supported in Encoder profile V3.1 compatibility mode. In standard mode the profile-specific diagnosis is always active.

6.3.10 Encoder profile V3.1 Compatibility

This parameter defines if the device should run in a mode compatible to Version 3.1 of the Encoder profile. See below for an overview of functions affected when the compatibility mode is enabled.

Attribute	Meaning
Enable	Compatibility with Encoder profile V3.1
Disable	No profile specific diagnosis (default)

Table 12 Profile V3.1 compatibility mode

Function	Compatibility mode enabled (=0)	Compatibility mode disabled (=1)
Control by PLC (STW2 ENC)	Ignored, the control word (G1 STW) and the set point values are always valid. Control requested (ZSW2 ENC) is not supported and is set to 0.	Supported
Module parameter Maximum Master Sign of Life failures	Supported	Not supported in V4.1 mode. In V4.1 the value is fixed to 1. PROFIdrive P925 is optional to control the life sign monitoring
User parameter Alarm channel control	Supported	Not supported, the application alarm channel is active and controlled by a PROFIdrive parameter.
P965 Profile version	31 (V3.1)	42 (V4.2)

Table 13 Compatibility mode overview

6.3.11 Scaling function parameters

The scaling function converts the encoder's physical absolute position value by means of software in order to change the resolution of the encoder. The scaling parameters will only be activated if the parameter "Class 4

functionality" and "Scaling function control" are enabled. The permissible value range for the scaling is limited by the resolution of the encoder. The scaling parameters are either securely stored in the encoder or received by controller during start-up.

6.3.11.1 Measuring units per revolution

This parameter sets the single-turn resolution of the encoder. In other words it is the number of measuring steps during one revolution of the encoder shaft.

Parameter	Meaning	Data type
Measuring units per revolution	The single-turn resolution in measuring steps	Unsigned 32

Table 14 Measuring units per revolution

Note: After downloading new scaling parameters, the preset function must be used to set the encoder starting point to absolute position 0 or to any required starting position within the scaled operating range.

6.3.11.2 Total measuring range

This parameter sets the total measuring range of the encoder. The total measuring range is calculated by multiplying the single-turn resolution with the number of distinguishable revolutions (multi-turn resolution).

Example:

The total measuring range for a 31 bit multi-turn encoder with a 19 bit single-turn and a 12 bit multi-turn resolution is between 2^1 and 2^{31} (2147483648). The total measuring range is calculated as below: Measuring units per revolution x distinguishable revolutions = $524288 (2^{19}) \times 4096 (2^{12}) = 2147483648$. The device has one operating mode for scaling, which is called free scaling.

Free scaling:

Free scaling means that the resolution of the encoder can be set to any desired number within the limitation of the encoder's maximum total resolution. The encoder will then work in cyclic operation, which means that the encoder counts from 0 to maximum set value and then starts over from 0 again (0-max-0-max-0...) until it reaches the maximum total resolution.

Example of free scaling:

Measuring units per revolution = 1000 steps

Total measuring range = 3000 steps (Measuring units per revolution x 3 revolutions)

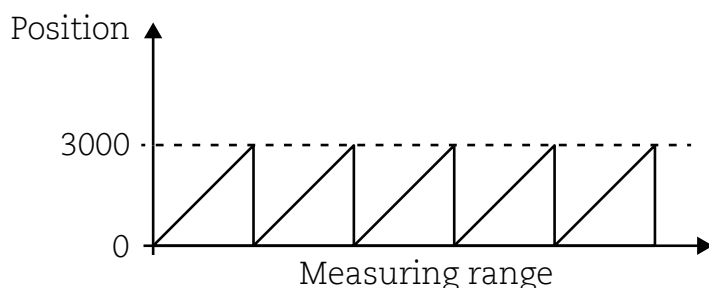


Figure 35 Free scaling

Note: After downloading new scaling parameters, a preset must be performed to set the encoder starting point to absolute position 0 or to any required starting position within the scaled operating range.

6.3.12 Maximum Master Sign-Of-Life failures

With this parameter, the number of allowed failures of the Master's Sign-Of-Life is defined. The default value is one (1).

Parameter	Meaning	Value
Maximum Master Sign-of-Life failures	The number of permissible failures of the master's life sign	0...255

Figure 36 Maximum Master Sign-of-Life failures

Note: This parameter is only supported in Encoder profile V3.1 or V4.2 mode. When using the encoder in V4.1 mode the value is fixed to 1.

6.3.13 Velocity measuring unit

This parameter defines the coding of the velocity measuring units used to configure the signals NIST A and NIST B. Telegrams 82, 83, 84, 86, 88, 89 includes velocity output and needs a declaration of the velocity measuring unit.

Velocity measuring units for encoder	Value
Steps/s	0
Steps/100 ms	1
Steps/10 ms	2
RPM	3
N2/N4 normalized	8

Figure 37 Velocity measuring units for encoders

6.3.14 Velocity reference value

The N2/N4 normalization will normalize the speed to a percentage of the "Velocity reference" where 0x0 = 0% and 0x4000 0000 (for N4 and 0x4000 for N2) = 100%. Possible values are -200% <= value <= 200%. The Velocity Reference is configured using parameter 60000 in RPM.

Example:

Velocity reference value= 3000 rpm

N2 value = Desired rpm / 3000 rpm * 0x4000

N4 value = Desired rpm / 3000 rpm * 0x40000000

Using 2000 rpm gives

Profinet N2 value 2000 rpm / 3000 rpm * 0x4000 = 10923

Profinet N4 value 2000 rpm / 3000 rpm * 0x40000000 = 715827883

Note: This parameter is only used when N2/N4 Normalization has been chosen as velocity measuring unit.

6.3.15 Velocity derivation time

The parameter indicates the derivation time to calculate the velocity in NIST A and NIST B. Long derivation times is suitable for high-resolution measurements at low speeds. While low integration times is beneficial in applications for high velocities and high dynamics, with sudden changes. The default value is 100 ms.

6.3.16 Acceleration measuring unit

The units for acceleration can be set according to following units:

Value	Unit
0	Steps/s ²
1	Rad/s ²

where 1 (Rad/s) is the default value.

6.3.17 Acceleration derivation time

The parameter indicates the derivation time to calculate the acceleration value. The default value is 100 ms.

7 PROFINET IO and PROFIsafe data description

7.1 Encoder profile overview

This manual relates to encoders that fulfill the demands and functionality according to Encoder profile V4.2 (PNO no 3.162), PROFIsafe V2.6.1 (Order no. 3.192) and PROFIsafe V2.4 (Order no. 3.192b). The operating functions for devices according to this profile are divided into four non-safety related encoder application classes, named Class 1, Class 2, Class 3 and Class 4 respectively two safety related, named Class S1 and Class S2 for PROFIsafe communication. For further information regarding the device functionality, refer to the device profile. The profiles, PROFINET and PROFIsafe technical information can be ordered at PNO in Karlsruhe, Germany (www.profinet.com).

7.2 Application class definition

The devices can be configured as a class 1, 2, 3 or class 4 PROFINET IO device according to the Encoder profile V4.2

CLASS 1	Standard encoder with preset functionality. Isochronous mode is not supported. Inherited from old PROFIBUS profile for DP-V0. Specially dedicated to General motion application.
CLASS 2	Standard encoder with preset functionality. Isochronous mode is not supported. Inherited from old PROFIBUS profile for DP-V0. Specially dedicated to General motion application.
CLASS 3	Standard encoder with base mode parameter access, preset functionality, velocity value and scaling functionality. Inherited from old PROFIBUS profile for DP-V0. Specially dedicated to General motion application. Isochronous mode is supported.
CLASS 4	Device with base mode parameter access and limited parameterization of the functionality. Isochronous mode is supported.

The devices can be configured as a class S1 or S2 PROFIsafe device according to the PROFIsafe profile V2.6.1 and V2.4.

CLASS S1	Standard Safety Encoder (safe position actual value) with preset functionality. Isochronous mode is not supported.
CLASS S2	Standard Safety Encoder (Class S1) with additional safe speed actual value. Isochronous mode is not supported.

7.3 Standard and manufacturer specific signals

The table below describes the standard and manufacturer specific window signals that are used to configure the IO data. The signals are described in the following sections of chapter 8.

Significance	Abbreviation	Length (bits)	Data type
Safety related standard signals			
Safe speed actual value	S NIST16	16	Signed

Significance	Abbreviation	Length (bits)	Data type
Safe position actual value	S XIST32	32	Signed
Safety control word 1	S STW1 ENC	16	Unsigned
Safety status word 1	S ZSW1 ENC	16	Unsigned
Safe position preset value	S PRESET32	32	Signed
Velocity value A	NIST A	16	Signed
Velocity value B	NIST B	32	Signed
Control word 1	G1 STW	16	Unsigned
Status word 1	G1 ZSW	16	Unsigned
Position value 1	G1 XIST1	32	Unsigned
Position value 2	G1 XIST2	32	Unsigned
Position value 3	G1 XIST3	64	Unsigned
Control word 2	STW2 ENC	16	Unsigned
Status word 2	ZSW2 ENC	16	Unsigned
Encoder preset control word 31 bit with trigger bit included	G1 XIST PRESET B	32	Unsigned
Encoder preset control word 32 bit	G1 XIST PRESET B1	32	Unsigned
Encoder preset control word 64 bit	G1 XIST PRESET C	64	Unsigned
Manufacturer specific safety related signals			
Safe speed actual value 32-bit	S NIST32	32	Signed
Safe acceleration actual value 16-bit	S ACC16	16	Signed
Safe acceleration actual value 32-bit	S ACC32	32	Signed
Manufacturer specific (non-safety related) signals			
Acceleration value	ACC B	32	Signed

Table 15 Standard and manufacturer specific signals

7.4 Standard and manufacturer specific telegrams

Configuration of PROFINET devices with PROFIsafe profile are made by choosing different telegram structures. The telegrams are used to specify the data length and which type of data that are sent to and from the IO

controller. For some of the telegrams the communication is exclusively with safe data and safe information according to PROFIsafe profile. A configuration error will occur if for example a 37 bits multi-turn encoder is used and has been configured with Telegram 81-83. A 37 bit encoder needs Telegram 84 which supports 64 bit position values. Leine Linde PROFIsafe encoders support the standard and manufacturer-specific telegrams according to the table below.

Telegram	Absolute encoder
Standard Telegram 36 (Safety)	Supported
Standard Telegram 37 (Safety)	Supported
Standard Telegram 81	Supported
Standard Telegram 82	Supported
Standard Telegram 83	Supported
Standard Telegram 84	Supported
Standard Telegram 86	Supported
Standard Telegram 87	Supported
Standard Telegram 88	Supported
Standard Telegram 89	Supported
Manufacturer specific safety telegram 58001	Supported
Manufacturer specific safety telegram 58003	Supported
Mfr 60600 Acceleration 32 bits	Supported

Table 16 Standard and manufacturer specific telegrams

7.5 Standard telegram 36 (Safety)

Standard Telegram 36 uses 6 bytes for output data from the IO controller to the device and 8 bytes of input data from the encoder to the IO-controller. All data is safety related.

Output data from the IO controller:

2 bytes F Control word 1 (S_STW1_ENC)

4 bytes F Preset value (S_PRESET32)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Set point	S STW1 ENC		S PRESET32			

Table 17 Output data Telegram 36

Input data to the IO controller:

2 bytes F Status word 1 (S_ZSW1_ENC)

2 bytes F Velocity value (S_NIST16)

4 bytes F Position value (S_XIST32)

IO Data (word)	1		2		3		4	
Byte	0	1	2	3	4	5	6	7
Actual value	S ZSW1 ENC		S NIST16		S XIST32			

Table 18 Output data Telegram 36

7.6 Standard telegram 37 (Safety)

Standard Telegram 37 uses 6 bytes for output data from the IO controller to the device and 6 bytes of input data from the encoder to the IO-controller. All data is safety related.

Output data from the IO controller:

2 bytes F Control word 1 (S_STW1_ENC)

4 bytes F Preset value (S_PRESET32)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Set point	S STW1 ENC		S PRESET32			

Table 19 Output data Telegram 37

Input data to the IO controller:

2 bytes F Status word 1 (S_ZSW1_ENC)

4 bytes F Position value (S_XIST32)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Actual value	S ZSW1 ENC		S XIST32			

Table 20 Input data Telegram 37

7.7 Standard telegram 81

Standard Telegram 81 uses 4 bytes for output data from the IO controller to the device and 12 bytes of input data from the encoder to the IO-controller.

Output data from the IO controller:

2 bytes Control word 2 (STW2 ENC)

2 bytes Control word 1 (G1 STW)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2 ENC		G1 STW	

Table 21 Output data Telegram 81

Input data from the IO controller:

2 bytes Status word 2 (ZSW2 ENC)

2 bytes Control word 1 (G1 ZSW)

4 bytes Position value 1 (G1 XIST1)

4 bytes Position value 2 (G1 XIST2)

IO Data (word)	1		2		3		4		5		6	
Byte	0	1	2	3	4	5	6	7	8	9	10	11
Actual value	ZSW2 ENC		G1 ZSW		G1 XIST1				G1 XIST2			

Table 22 Input data Telegram 81

7.8 Standard telegram 82

Standard Telegram 82 uses 4 bytes for output data from the IO controller to the device and 14 bytes of input data from the encoder to the IO-controller.

Output data from the IO controller:

2 bytes Control word 2 (STW2 ENC)

2 bytes Control word 1 (G1 STW)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2 ENC		G1 STW	

Table 23 Output data Telegram 82

Input data from the IO controller:

2 bytes Status word 2 (ZSW2 ENC)

2 bytes Control word 1 (G1 ZSW)

4 bytes Position value 1 (G1 XIST1)

4 bytes Position value 2 (G1 XIST2)

2 bytes Velocity value A (NIST A)

IO Data (word)	1		2		3		4		5		6		7	
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Actual value	ZSW2 ENC		G1 ZSW		G1 XIST1				G1 XIST2				NIST A	

Table 24 Input data Telegram 82

Note: Avoid using telegram 82 together with a 19 or 31 bit resolution encoder. Telegram 82 uses only a 16 bit velocity value and an overflow of the speed value is likely to occur.

7.9 Standard telegram 83

Standard Telegram 83 uses 4 bytes for output data from the controller to the device and 16 bytes of input data from the device to the controller

Output data from the IO controller:

2 bytes Control word 2 (STW2 ENC)

2 bytes Control word 1 (G1 STW)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2 ENC		G1 STW	

Table 25 Output data Telegram 83

Input data from the IO controller:

2 bytes Status word 2 (ZSW2 ENC)

2 bytes Control word 1 (G1 ZSW)

4 bytes Position value 1 (G1 XIST1)

4 bytes Position value 2 (G1 XIST2)

4 bytes Velocity value B (NIST B)

IO Data (word)	1		2		3		4		5		6		7		8	
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Actual value	ZSW2 ENC		G1 ZSW		G1 XIST1				G1 XIST2				NIST B			

Table 26 Input data Telegram 83

7.10 Standard telegram 84

Standard Telegram 84 uses 4 bytes for output data from the controller to the encoder and 20 bytes of input data from the encoder to the controller. Telegram 84 shall only be used for encoders with resolution higher than 32 bit.

Output data from the IO controller:

2 bytes Control word 2 (STW2 ENC)

2 bytes Control word 1 (G1 STW)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2 ENC		G1 STW	

Table 27 Output data Telegram 84

Input data from the IO controller:

2 bytes Status word 2 (ZSW2 ENC)

2 bytes Control word 1 (G1 ZSW)

8 bytes Position value 3 (G1 XIST3)

4 bytes Position value 2 (G1 XIST2)

4 bytes Velocity value B (NIST B)

IO Data (word)	1		2		3		4		5		6		7		8		9		10	
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Actual value	ZSW2 ENC		G1 ZSW		G1 XIST 3								G1 XIST2				NIST B			

Table 28 Output data Telegram 84

Note: In standard Telegram 84, G1 XIST2 is used to transfer error codes and optionally position values if the measuring length exceeds 64 bits.

7.11 Standard telegram 86

Standard Telegram 86 uses 4 bytes for output data from the controller to the encoder and 8 bytes of input data from the encoder to the controller. With Telegram 86 it is possible to get cyclic data transmission and also the possibility to do a preset via IO-data without the need of control word and status words.

Output data from the IO controller:

4 bytes Encoder preset control word 31 bit with trigger bit included (G1 XIST PRESET B)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	G1 XIST PRESET B			

Table 29 Output data Telegram 86

Input data from the IO controller:

2 bytes Control word 1 (G1 ZSW)

4 bytes Velocity value B (NIST B)

IO Data (word)	1		2		3		4	
Byte	0	1	2	3	4	5	6	7
Actual value	G1 XIST1				NIST B			

Table 30 Input data Telegram 86

7.12 Standard telegram 87

Standard Telegram 87 uses 4 bytes for output data from the controller to the encoder and 4 bytes of input data from the encoder to the controller. With Telegram 87 it is possible to get cyclic data transmission and also the possibility to do a preset via IO-data without the need of control word and status words.

Output data from the IO controller:

4 bytes Encoder preset control word 31 bit with trigger bit included (G1 XIST PRESET B)

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	G1 XIST PRESET B			

Table 31 Output data Telegram 87

Input data from the IO controller:

4 bytes Position value 1 (G1 XIST1)

IO Data (word)	1		2	
Byte	0	1	2	3
Actual value	G1 XIST1			

Table 32 Input data Telegram 87

7.13 Standard telegram 88

Standard Telegram 88 uses 8 bytes for output data from the controller to the encoder and 12 bytes of input data from the encoder to the controller. With Telegram 88 it is possible to get cyclic data transmission and also the possibility to do a preset via IO-data without the need of control word and status words.

Output data from the IO controller:

4 bytes Encoder preset control word 64 bit (G1 XIST PRESET C)

IO Data (word)	1		2		3		4	
Byte	0	1	2	3	4	5	6	7
Set point	G1 XIST PRESET C							

Table 33 Output data Telegram 88

Input data from the IO controller:

8 bytes Position value 3 (G1 XIST3)

4 bytes Velocity value B (NIST B)

IO Data (word)	1		2		3		4		5		6	
Byte	0	1	2	3	4	5	6	7	8	9	10	11
Actual value	G1 XIST3								NIST B			

Table 34 Input data Telegram 88

Note: Telegram 88 should only be used if the measuring range exceeds 32 bits.

7.14 Standard telegram 89

Standard Telegram 89 uses 6 bytes for output data from the controller to the encoder and 10 bytes of input data from the encoder to the controller. With Telegram 89 a preset is initiated by a trigger bit in Control word 2 (STW2 ENC).

Output data from the IO controller:

2 bytes Control word 2 (STW2 ENC)

4 bytes Encoder preset control word 31 bit with trigger bit included (G1 XIST PRESET B)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Set point	STW2 ENC		G1 PRESET B1			

Table 35 Output data Telegram 89

Input data from the IO controller:

2 bytes Status word 2 (ZSW2 ENC)

4 bytes Position value 1 (G1 XIST1)

4 bytes Velocity value B (NIST B)

IO Data (word)	1		2		3		4		5	
Byte	0	1	2	3	4	5	6	7	8	9
Actual value	ZSW2 ENC		G1 XIST1				NIST B			

Table 36 Output data Telegram 89

7.15 Manufacturer specific safety telegram 58001

Output data from the IO controller:

2 bytes F Control word 1 (S_STW1_ENC)

4 bytes F Preset value (S_PRESET32)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Set point	S STW1 ENC		S PRESET32			

Table 37 Output data Manufacturer specific safety telegram 58001

Input data from the IO controller:

2 bytes F Status word 1 (S_ZSW1_ENC)

2 bytes F Acceleration value (S_ACC16)

4 bytes F Position value (S_XIST32)

4 bytes F Velocity value (S_NIST32)

IO Data (word)	1		2		3		4		5		6	
Byte	0	1	2	3	4	5	6	7	8	9	10	11
Actual value	S ZSW1 ENC		S ACC16		S XIST32				S NIST32			

7.16 Manufacturer specific safety telegram 58003

Output data from the IO controller:

2 bytes F Control word 1 (S_STW1_ENC)

4 bytes F Preset value (S_PRESET32)

IO Data (word)	1		2		3	
Byte	0	1	2	3	4	5
Set point	S STW1 ENC		S PRESET32			

Table 38 Output data Manufacturer specific safety telegram 58003

Input data from the IO controller:

2 bytes F Status word 1 (S_ZSW1_ENC)

2 bytes F Velocity value (S_NIST16)

4 bytes F Position value (S_XIST32)

4 bytes F Acceleration value (S_ACC32)

IO Data (word)	1		2		3		4		5		6	
Byte	0	1	2	3	4	5	6	7	8	9	10	11
Actual value	S ZSW1 ENC		S NIST16		S XIST32				S ACC32			

Table 39 Input data Manufacturer specific safety telegram 58003

7.17 Mfr 60600 Acceleration 32 bits

IO Data (word)	1		2	
Byte	0	1	2	3
Actual value	ACC B			

Table 40 Format of ACC B

7.18 Format of G1 XIST1 and G1 XIST2

The G1 XIST1 and G1 XIST2 signals consist of the absolute position value in binary format. By default, the G1 XIST1 signal is equal to the G1 XIST2 signal. The format of the actual position values in G1 XIST1 and G1 XIST2 is shown below.

Format definition for G1 XIST1 and G1 XIST2:

- All values are presented in binary format.
- The shift factor is always zero (right-aligned value) for both G1 XIST1 and G1 XIST2.
- The setting in the encoder parameter data affects the position value in both G1 XIST1 and G1 XIST2.
- G1 XIST2 displays the error telegram instead of the position value if error occurs.

Format definition for G1 XIST1 and G1 XIST2:

31-bit multi-turn absolute encoder (524,288 steps per revolution, 4,096 distinguishable revolutions).

M = Multi-turn value (distinguishable revolutions)

S = Single-turn value (number of steps per revolution)

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	M	M	M	M	M	M	M	M	M	M	M	M	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	

MSB

LSB

Figure 38 Absolute value in G1 XIST1

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	M	M	M	M	M	M	M	M	M	M	M	M	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

MSB

LSB

Figure 39 Absolute value in G1 XIST2

7.19 Format of G1 XIST3

G1 XIST3 is a 64-bit position value that is used to support encoders with a resolution exceeding 32 bits. Format definition for G1 XIST3:

- Binary format.
- The actual position value is always right-aligned; a shifting factor is not used.
- The settings in the encoder parameter data affect the position value in G1 XIST3 if Class 4 is enabled.

IO Data (word)	1	2	3	4
Format	64 bit position value (Bit 63...0)			

Table 41 Format of G1 XIST3

7.20 Safe position actual value (S_XIST32)

The safety-related actual position value is transmitted with the signal S_XIST32 if no error occurred and the measuring system can supply a safe actual position value. The scaling of the safe position value is independent from the scaling of the non-safe position value and depends only on the encoder type and the parameterisation by the iParameters. The Safety status word S_ZSW1_ENC, bit 0 = 1 indicates that the safety-related position data in S_XIST32 is valid.

IO Data (word)	1	2
Format	32 bit safe position value (Bit 31...0)	

Table 42 Safe actual position value (S_XIST32)

7.21 Safe speed actual value (S_NIST16)

The safety-related actual speed value is transmitted with the signal S_NIST16 if no error occurred and the measuring system can supply a safe actual speed value. The scaling of the safe speed value is independent from the scaling of the non-safe speed value and depends only on the encoder type and the parameterisation by the iParameters. The Safety status word S_ZSW1_ENC, bit 1 = 1 indicates that the safety-related speed value in S_NIST16 is valid.

IO Data (word)	1
Format	16 bit safe speed value (Bit 15...0)

Table 43 Safe speed actual value (S_NIST16)

7.22 Safety control word 1 (S_STW1_ENC)

The safety control word S_STW1_ENC controls the safety-related measuring system functions.

Bit	Value	Function
0	0	Safe preset function disabled
	1	Safe preset function enabled
1...5		Reserved
6		Trigger of for setting of Preset value out of S_PRESET_32 as new safe actual value (0 -> 1)
7...15		Reserved

Table 44 Safety control word 1 (S_STW1_ENC)

Note: It is the responsibility of the user to check that the safe position is correct after a safe preset has been performed.

7.23 Safety status word 1 (S_ZSW1_ENC)

The safety status word S_ZSW1_ENC indicates the safety-related measuring system function states:

Bit	Value	Significance	Function
0	0	Safe Position valid	Safety related position is not valid for S_XIST32
	1		Safety related position is valid for S_XIST32
1	0	Safe Speed Valid	Safety related speed is not valid for S_NIST16 or S_NIST32
	1		Safety related speed is valid for S_NIST16 or S_NIST32
2	0	Safe Preset activation acknowledgement	Safe preset not activated in S_STW_ENC bit 0
	1		Safe preset activated in S_STW_ENC bit 0
3, 4			Reserved
5	0	Safe preset error	No preset error exists
	1		Preset error is present, see diagnostic data for more details. This error does not affect bit 7 (Safety fault present)
6		Safe preset acknowledgement of trigger	1: Acknowledgement that the current value in S_PRESET32 was implemented as the new value in S_XIST32
7	0	Internal event	No Safety fault present
	1		Safety Fault present
8...11			Reserved
12	0	Safe Acceleration valid	Safety related acceleration is not valid for S_ACC16 or S_ACC32
	1		Safety related acceleration is valid for S_ACC16 or S_ACC32
13	0	Safe Preset requested	No safe preset is requested
	1		Safe preset is requested to deliver safe position (e.g. after scaling)
14,15			Reserved

Table 45 Safety status word 1 (S_ZSW1_ENC)

7.24 Safety position preset value (S_PRESET32)

The 32 bit position value transmitted to S_XIST32 in case of a safe preset function is performed. To perform a safe preset the preset function have to be enabled (S_STW1_ENC, bit 0=1) and the preset trigger (S_STW1_ENC, bit 6) need to go from 0->1.

IO Data (word)	1	2	3	4
Format	Safe position preset value (bit 31...0)			

Table 46 Safe position preset value (S_PRESET32)

Note: The safe preset function should only be used at encoder standstill.

7.25 Sensor preset control word (G1 XIST1 PRESET B)

G1 XIST1 PRESET B is a 32 bit signal that includes a trigger bit for PRESET Control used for Telegram 86 and 87. The controller can transmit a preset value for the sensor via cyclic data telegram and activate this preset value by setting the trigger bit. As the trigger bit is transferred in the same signal as the preset value only a preset value of maximum 31 bit can be applied.

IO Data (word)	1		2	
Byte	0	1	2	3
Bits	31(MSB)	30-24	23-16	15-8
	Preset control bit		Preset value < total resolution	

Table 47 G1 XIST1 PRESET B

Note: The preset function should only be used at encoder standstill.

7.26 Sensor preset control word (G1 XIST1 PRESET B1)

G1 XIST1 PRESET B1 is a 32 bit signal used for Telegram 89. G1 XIST1 PRESET B1 can be used to transmit a preset value in full 32 bit length. The activation of the preset value is triggered by bit 0 in Control word 2 (STW2 ENC).

IO Data (word)	1	2
	PRESET value	

Table 48 G1 XIST1 PRESET B1

Note: The preset function should only be used at encoder standstill.

7.27 Sensor preset control word (G1 XIST1 PRESET C)

G1 XIST1 PRESET C is a 64 bit signal that includes a trigger bit for preset control used for Telegram 88. The controller can transmit a preset value for the sensor via cyclic data telegram and activate this preset value by setting the trigger bit. As the trigger bit is transferred in the same signal as the preset value, only a preset value of maximum 63 bit can be applied.

IO Data (word)	1	2	3	4
Bits	(MSB) Bit 63 Preset control	Bit 62...0 Preset value		

Table 49 G1 XIST1 PRESET C

Note: The preset function should only be used at encoder standstill.

7.28 Control word 2 (STW2 ENC)

The Control word 2 (STW2 ENC) is referred to as the Master Sign-of-Life and it includes the Control by PLC mechanism from PROFIdrive STW2.

Bit	Function
0	Preset trigger (Only for Telegram 89)
1...6	Reserved
7	Fault acknowledge
8, 9	Reserved
10	Control by PLC
11	Reserved
12...15	Controller Sign-of-Life

Table 50 Control word 2 (STW2 ENC)

Bit	Value	Significance	Comments
0	1	Preset trigger 0->1	Trigger for performing preset (For Telegram 89 only)
	0	Idle	Before starting a new preset operation the controller has to reset this bit
7	1	Acknowledge 0->1	The current fault situation in the fault buffer is acknowledged with a leading edge
	0	Idle	
10	1	Control by PLC	Control via interface, EO IO Data is valid.
	0	No Control by PLC	This bit is only used for Telegram 89.
12...15	0 to 15	Controller Sign-of-Life	Received if isochronous operation is activated.

Table 51 Detailed assignment of Control word 2 (STW2 ENC)

7.29 Status word 2 (ZSW2 ENC)

The Status word 2 (ZSW2 ENC) is referred to as the slave's Sign-of-Life and it includes the Control by PLC mechanism from PROFIdrive ZSW1 and the Slave Sign-of-Life mechanism from PROFIdrive ZSW2.

Bit	Function
0	PRESET acknowledge
1	G1 XISTx position value valid

2	NISTx speed value valid
3	Fault Present
4...6	Reserved
7	Warning Present
8	Reserved
9	Control requested
10, 11	Reserved
12...15	Encoder Sign-of-Life

Table 52 Status word 2 (ZSW2 ENC)

7.30 Control word (G1 STW)

The control word controls the functionality of major encoder functions.

Bit	Function
0...7	Not supported
8...10	Reserved
11	Home position mode(Preset)
12	Request set/shift of home position (Preset)
13	Request absolute value cyclically
14	Activate parking sensor
15	Acknowledging a sensor error

Table 53 Control word (G1 STW)

Note: If the sensor parking is activated (bit 14 = 1), the encoder remains on the bus with the Slave Sign-of-Life active and the encoder error and diagnostics switched off.

7.31 Status word (G1 ZSW)

The status word defines encoder states, acknowledgements, error messages of major encoder functions.

Bit	Function
0...7	Not supported
8...10	Reserved
11	Requirements of error acknowledgment detected
12	Set/shift of home position (Preset) executed
13	Transmit absolute value cyclically
14	Parking sensor active

Bit	Function
15	Sensor fault

Table 54 Status word (G1 ZSW)

Note: If bit 13 Transmit absolute value cyclically or bit 15 Sensor error is not set there is no valid value or error code transferred in G1 XIST2.

Note: Bit 13 Transmit absolute value cyclically cannot be set at the same time as bit 15 Sensor error as these bits are used to indicate either a valid position value transmission (bit 13) or the error code transmission (bit 15) in G1 XIST2.

7.32 Real-Time Communication

PROFINET IO uses three different communication channels to exchange data with programmable controllers and other devices. The non real-time channel, based on for example TCP (UDP)/IP, is used for parameterization, configuration and acyclic read/write operations. The RT (Real-Time) channel is used for process data transfer and alarms. Real-time data are treated with a higher priority than data sent over the open channel. RT communications overrides the open channel to handle the data exchange with programmable Controllers. The third channel, Isochronous Real-Time (IRT) is the high-performance, high-speed channel used for demanding motion control applications. IRT data are treated with a higher priority than RT data sent over the RT channel.

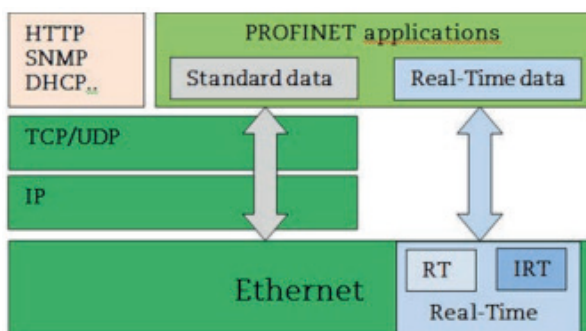


Figure 40 Real-time communication

PROFINET distinguishes between three real-time classes for transmission of time-critical process data. The three RT classes are:

REAL-TIME, RT CLASS 1

- Unsynchronized real-time communication
- Industrial standard switches can be used
- Typical application area: Factory automation

ISOCRONOUS REAL-TIME, RT CLASS 3

The isochronous operation mode is used when real-time positioning with high-performance is required. The basic principal is that all PROFIsafe devices on the net are clock synchronized with the controller using a global control broadcast enabling simultaneous data accusation from all devices with microsecond accuracy. The data exchange cycles for IRT are usually in the range of a few hundred microseconds up to a few milliseconds. The difference to real-time communication is essentially the high degree of determinism, so that the start of a bus cycle is maintained with high precision. The synchronization is monitored by "Sign-of-Life" messages in "Control word 2" (STW2 ENC) and "Status word 2" (ZSW2 ENC).

- Clock synchronized data transmission
- Special switches supporting IRT is needed
- IRT is required for example motion control applications

8 Alarms and warnings

8.1 Diagnostics and Alarms

Diagnostic data is always transferred acyclically using Record Data communications over the non real-time channel. An IO-Supervisor must specifically request the diagnostic or status data from the IO-device using RDO (Record Data Object) services.

Alarm data is transmitted from the IO-device to the IO-controller via the RT channel.

Alarm is generated by the encoder when a failure occurs that affects the process data. Alarms can be reset (deleted) once all encoder parameters are within the specified value ranges and the process data is valid.

8.2 Channel diagnostics

The device outputs a diagnostic interrupt to the CPU when it detects one of the supported channel diagnostics.

Supported channel diagnostic	Channel error value	Description
Position error (hardware and signal quality)	0x9100	The device fails to read the correct position value
Safety exception	0x9103	
Safety parameterisation	0x9104	
Commissioning diagnostics	0x9105	User parameter data assignment error
Commissioning invalid scaling	0x9106	
Communication	0x9108	
PROFIsafe	0x9109	
Synchronisation fault (isochronous operation only)	0x910A	
Master's Sign-of-Life fault	0x910B	A master Sign-of-Life evaluation error was detected
Undervoltage	0x9110	
Overvoltage	0x9111	
Short circuit	0x9112	
Overtemperature	0x9113	
Memory error	0x9116	The device fails to read stored offset or preset values from the non-volatile memory
Mismatch of safety destination address	0x0040	The F_Dest_Add is not same in encoder and user program
Safety destination address not valid	0x0041	

Safety source address not valid or mismatch	0x0042	
Safety watchdog time is 0 ms	0x0043	
Parameter "F_SIL" exceeds SIL from specific device application	0x0044	
Parameter "F_CRC_Length" does not match the generated values	0x0045	
Version of F-Parameter set incorrect	0x0046	
Data inconsistent in received F-Parameter Block (CRC1 error)	0x0047	
Device specific diagnosis information	0x0048	
Save iParameter watchdog time exceeded	0x0049	
Restore iParameter watchdog time exceeded	0x004A	
Inconsistent iParameters (iParCRC error)	0x004B	
Transmission error: data inconsistent (CRC2 error)	0x004C	
Transmission error: timeout (F_WD_Time and F_WD_TIME_2 elapsed)	0x004D	

Table 55 Channel diagnostics

In a SIMATIC STEP 7 system the operation system responds by calling a diagnostic OB. The OB number and start information provides the cause and location of the error. The error information can be read by calling a system Function block. Then the user can decide how the system should handle the error.

Note: If the called OB is not included in the program the CPU will cause CPU stop mode.

8.3 Error codes in G1 XIST 2

Diagnosis information can be obtained by monitoring of the Error bit in the Sensor Status word G1 ZSW (bit 15) and evaluation of the error code transmitted in G1 XIST2.

Supported diagnostic	Error code in G1 XIST2	Description
Sensor group error	0x0001	The device fails to read the correct position value

Memory error	0x1001	The device fails to read stored offset or preset values from the non-volatile memory
Command not supported	0x0F01	User parameter data assignment error or command error in commands words G1 STW and STW2 ENC
Master's Sign-of-Life fault (Only V3.1)	0x0F02	The number of permissible failures of the controller's life sign was exceeded

Table 56 Error codes in G1 XIST 2

9 Acyclic Parameter data

9.1 Acyclic data exchange

In addition to the cyclic data exchange, the PROFINET device also supports acyclic data exchange. The acyclic data exchange is transferred over the non real-time channel and is used to read out and write status information from and to the IO device. The acyclic data exchange is conducted in parallel to the cyclic data communication.

Example of acyclic data:

1. Reading of diagnostics
2. Reading of I&M functions
3. Reading of PROFIdrive parameters
4. Reading of Encoder profile parameters

9.2 Identification and Maintenance (I&M functions)

Devices according to the Encoder profile 3.162 also support I&M functionality. The main purpose of the I&M functions is to support the end user if the device is acting faulty or missing some of its functionality. The I&M functions could be seen as an electronic nameplate containing common information regarding the device and its manufacturer. The I&M parameters are accessed using the Record Data Object 0xAFF0.

Example of I&M functions:

1. MAC address
2. Hardware Version
3. Software Version
4. Product type
5. Manufacturer ID

9.3 Base Mode Parameter access

The PROFIdrive parameters and the encoder specific parameters can be accessed by the Acyclic Data Exchange service using the Base Mode parameter access local (Record Data Object 0xB02E). The parameters related to the PROFINET module are read from slot 1 and parameters related to the safety module slot 5. For more details see the example in section 9.5.

9.3.1 General characteristics

Acyclic parameters can be transmitted 1(single or up to 39 (multi) in one access. A parameter access can be up to 240 bytes long.

9.4 Supported parameters

Supported PNU parameters	Parameter number	Description
Telegram selection	922	Standard telegram selected
Number of Controller Sign-Of-Life failures which may be tolerated	925	Only in IRT mode
Fault buffer	944-952	PROFINET fault buffer
Drive Unit Identification	964	See PROFIdrive profile for details
Profile identification number	965	See PROFIdrive profile for details
Transfer into a non-volatile memory	971	
Drive reset	972	
EO identification	975	Encoder object identification
Sensor format	979	Format of encoder
Supported parameters	980	Lists the supported parameters of the encoder
Velocity derivation time	20000	
Acceleration unit	20001	
Acceleration derivation time	20002	
N2/N4 velocity reference value	60000	
Velocity value normalisation	60001	
Safety telegram selection	60022	Safety telegram selected
Safe speed value normalisation	60023	
Safety setpoint telegram	60024	
Safety actual value telegram	60025	
Safety fault buffer	60044-60052	PROFIsafe fault buffer
Name of station	61000	
IP of station	61001	
MAC of station	61002	
Default gateway of station	61003	
Subnet mask of station	61004	
Preset value	65000	
Operating status	65001	
Function control	65004	
Parameter control	65005	

Supported PNU parameters	Parameter number	Description
Measuring units per revolution	65006	
Total measuring range in measuring units	65007	
Operating time	65010	In units of 6 minutes
Safety operating status	65100	

Table 57 All supported PNU parameters

9.4.1 Parameter 922, read only

922 -> unsigned16, presents which telegram is used. Telegram 81, 82, 83, 84, 86, 87, 88 or 89 is possible.

9.4.2 Parameter 925, read/write

925 -> unsigned16, Number of Controller Sign-of-Life failures which will be tolerated (IRT only)

9.4.3 Parameter 944-952, read/write

944-952 -> PROFIdrive fault buffer (possibility for the user to read fault history)

9.4.4 Parameter 964, read only

964 -> Array unsigned16, Device identification

964[0] = Manufacturer Id. This is set during manufacturing of the encoder

964[1] = 0 -> DU Drive unit type, always set to 0.

964[2] = -> Software version

964[3] = -> Software year

964[4] = -> Software day and month

964[5] = 1 -> Number of drive objects (DO)

9.4.5 Parameter 965, read only

965 -> OctetString 2, Profile identification number

965[0] = 0x3D -> Profile number

965[1] = 31, 41 or 42 -> Profile version, selected by user in module parameters

9.4.6 Parameter 971, read/write

971 -> unsigned16, Stores the local parameter to a non-volatile memory. Preset value is saved when writing value 1 and is set to 0 by the device firmware when finished. This means that the preset value has been saved when reading back value 0.

9.4.7 Parameter 972, read/write

972 -> unsigned16, Reset encoder device

Note: Only supported in Encoder profile V4.2 mode

9.4.8 Parameter 975, read only

975 -> Array of Unsigned16, Encoder object identification

Subindex:

975[0] = Manufacturer Id, set in the production

975[1] = DO type

975[2] = Software version

975[3] = Software year

975[4] = Software day and month

975[5] = PROFIdrive DO type class

975[6] = PROFIdrive SUB class 1

975[7] = Drive object Id (DO ID)

9.4.9 Parameter 979, read only

979 -> Array unsigned32, Sensor format

Subindex:

979[0] = Header

979[1] = Sensor type

Bit 0 = 0 Rotary encoder, Bit 0 = 1 linear encoder

Bit 1 = 1 always set to 1

Bit 2 = 0 -> 32 bit data, Bit 2 = 1 -> 64 bit data

Bit 31 = 1 if configuration and parameterization is OK

979[2] = Sensor resolution

979[3] = Shift factor for G1 XIST1 always set to 0

979[4] = Shift factor for G1 XIST2 always set to 0

979[5] = Single-turn = 1, Multi-turn = 4096

979[6] = 0

979[7] = 0

979[8] = 0

979[9] = 0

979[10] = 0

9.4.10 Parameter 980, read only

This parameter shows the supported parameters

980 -> Array unsigned16

Note: Supported parameters depend on encoder profile configuration

9.4.11 Parameter 20000 read/write

20000 -> unsigned16, Velocity derivation time

9.4.12 Parameter 20001 read/write

20001 -> unsigned8, Acceleration unit

9.4.13 Parameter 20002 read/write

20002 -> unsigned16, Acceleration derivation time

9.4.14 Parameter 60000, read/write

60000 -> Float 32, Velocity reference value

The parameter 60000 sets the value for the velocity reference (100% value) for N2/N4 normalized speed actual values (NIST A, NIST B)

Note: Only supported in Encoder profile V4.2 mode.

Note: This parameter is only used together with parameter 60001 set to N2/N4 Normalized.

9.4.15 Parameter 60001, read/write

Velocity value normalization

60001 -> Unsigned 16

Value 0 = Steps/s

Value 1 = Steps/100 ms

Value 2 = Steps 10 ms

Value 3 = RPM

Value 4 = N2/N4 normalized

Note: Only supported in Encoder profile V4.2 mode

9.4.16 Parameter 60022, read only

60022 -> unsigned16, presents which safety telegram is used. Telegram 36, 37, 58001 or 58003 are possible.

Note: The parameter must be read from the safety module (slot 5).

9.4.17 Parameter 60023, read only

60023 -> Unsigned 16, Safe speed value normalization.

Value 0 = Steps/s

Value 1 = Steps/100 ms

Value 2 = Steps/10 ms

Value 3 = RPM

Note: The parameter must be read from the safety module (slot 5).

9.4.18 Parameter 60024, read only

60024 -> Octet String, Safety setpoint telegram. The safety setpoint (output data) of the selected safety telegram is displayed by one octet in each subindex.

Note: The parameter must be read from the safety module (slot 5).

9.4.19 Parameter 60025, read only

60025 -> Octet String, Safety actual value telegram. The safety actual value(input data) of the selected safety telegram is displayed by one octet in each subindex.

Note: The parameter must be read from the safety module (slot 5).

9.4.20 Parameter 60044-60052, read only

60044 -> Array unsigned32, Safety fault buffer (possibility for user to read fault history of safety module)

Note: The parameter must be read from the safety module (slot 5).

9.4.21 Parameter 61000, read only

61000 -> Octet String, Name of station

9.4.22 Parameter 61001, read only

61001 -> Octet String, IP of station (IP address)

9.4.23 Parameter 61002, read only

61002 -> Octet String, MAC of station (MAC address)

9.4.24 Parameter 61003, read only

61003 -> Octet String, Default gateway of station

9.4.25 Parameter 61004, read only

61004 -> Octet String, Subnet mask of station

9.4.26 Parameter 65000, read/write

65000 -> Integer32, Preset value

9.4.27 Parameter 65001, read only

65001 -> Array unsigned32, Operating status

65001[0] = 0x00120102 Header, Version of parameter structure and numbers of index describing the encoder. 19 index and version 1.2

65001[1] = Operating status (Bit 4 alarm channel control is always set with profile version 4.x)

65001[2] = Errors

65001[3] = Supported errors

65001[4] = Warnings

65001[5] = Supported warnings

65001[6] = Encoder profile version

65001[7] = Operating time

65001[8] = Offset value

65001[9] = Measuring units per revolution

65001[10] = Total measuring length in measuring units (Linear = 1)

65001[11] = Velocity value normalization

65001[12] = Velocity reference value

9.4.28 Parameter 65004, read/write

65004 -> Unsigned32, Function control

Bit 0 = Code sequence, (0=CW, 1=CCW)

Bit 1 = Class 4 functionality, (0=Disable, 1=Enable)

Bit 2 = G1 XIST1 Preset Control, (0=Enable, 1=Disable)

Bit 3 = Scaling function control, (0=Disable, 1=Enable)

Bit 4 = Alarm channel control, (0=Disable, 1=Enable)
Bit 5 = V3.1 Compatibility mode, (0=Compatibility mode enabled) (1=Compatibility mode Disabled)
Bit 6 = Encoder type, (0=Rotary, 1=Linear)
Bit 7-31 = Reserved

Note: Only supported in Encoder profile V4.2 mode

9.4.29 Parameter 65005, read/write

65005 -> Unsigned16, Parameter control
Bit 0-1 = Parameter Initialization control (0=PRM, 1=Non-volatile RAM)
Bit 2-4 = Parameter write protect (0=Write all, 1=Read only)
Bit 5 = Parameter 65005 write protect (0=Write all, 1=Read only)
Bit 6 = Reset control write protect (0=Write all, 1=Read only)
Bit 7-15 = Reserved

Note: Only supported in Encoder profile V4.2 mode

9.4.30 Parameter 65006, read/write

65006 -> Unsigned32, Measuring units per revolution

Note: Only supported in Encoder profile V4.2 mode

9.4.31 Parameter 65007, read/write

65007 -> Unsigned32, Total measuring range in measuring units

Note: Only supported in Encoder profile V4.2 mode

9.4.32 Parameter 65010, read only

65010 -> Unsigned32, Operating time in units of six minutes

9.4.33 Parameter 65100, read only

65100 -> Array unsigned32, Safety operating status
65001[0] = Version of parameter structure and numbers of index describing the encoder.
65001[1] = Operating status
65001[2] = Faults
65001[3] = Supported faults
65001[4] = Warnings
65001[5] = Supported warnings
65001[6] = Encoder profile version
65001[7] = Operating time
65001[8] = Offset value
65001[9] = Measuring units per revolution
65001[10] = Total measuring length in measuring units (Linear = 1)
65001[11] = Velocity value normalization

Note: The parameter must be read from the safety module (slot 5)

9.5 Example of reading and writing to a parameter

This is an example how to read and write to an acyclic parameter over the base mode parameter access (BMP) in the Tia Portal. Experience with PLC programming is required. For further references see Tia portal documentation.

Hardware components		
Controller	SIEMENS S7-F CPU	CPU 1511F-1
IO Device	PROFINET encoder (with PROFIsafe)	

Software components	
Tia Portal	V17 + Safety Advanced V17
GSDML file for PROFINET (PROFIsafe) encoder	

Table 58 Hardware and software components in this example

Click on “PLC data types” in the menu list to the left, click on “Add new data type”. Start by creating a new data type (record), here called “Data_record_PN_RD”, for reading a parameter with the variables according to below. All objects in the read record should have 0 as default values.

Data_record_PN_RD				
	Name	Data type	Default value	Comment
1	REQ_REF_MIRROR	Byte	16#0	Request number mirrored
2	RESPONSE_ID	Byte	16#0	Request parameter
3	AXIS	Byte	16#0	Axis mirrored
4	NO_PARAMS	Byte	16#0	Read back of number of parameter
5	DATA_TYPE_PARA1	Byte	16#0	Read back of data type of parameter
6	NO_VALUES_PARA1	Byte	16#0	Read back of number of values of parameter
7	PARA_VALUE	Word	16#0	Read the value of the parameter

Figure 41 Definition of variables for read record

Then create a second data record, here called “Data_record_PN_WR”, for writing the parameter to the record. In this example the below default values are used for the variables, but different values will be needed depending on what parameter is read (or written) and the size of the data. For more details consult Tia portal documentation.

Data_record_PN_WR				
	Name	Data type	Default value	Comment
1	REQ_REF	Byte	16#0	Request number
2	REQ_ID	Byte	16#2	Request parameter = 1, change parameter = 2
3	AXIS	Byte	16#0	Axis addressing for multi-axis drives
4	NO_PARAMS	Byte	16#1	Write 1 parameter
5	ATTRIBUTE_PARA	Byte	16#10	Write value
6	NO_ELEMS	Byte	16#1	Number of elements = 1
7	PARA_NO	Word	16#39A	Parameter number, e.g. 922
8	SUB_INDEX	Word	16#0	Subindex
9	DATA_TYPE	Byte	16#6	Data type, e.g. 6 = Unsigned 16
10	NO_VALUES	Byte	16#2	Number of values
11	VALUES	Word	16#0	Values of parameter

Figure 42 Definition of variables for writing the write record

Then create a new function block, here called “FB_AcyclicDataRDWR”, with the following networks created. RDREC and WRREC are pre-existing function blocks from the Tia portal library, for reading and writing of a record.

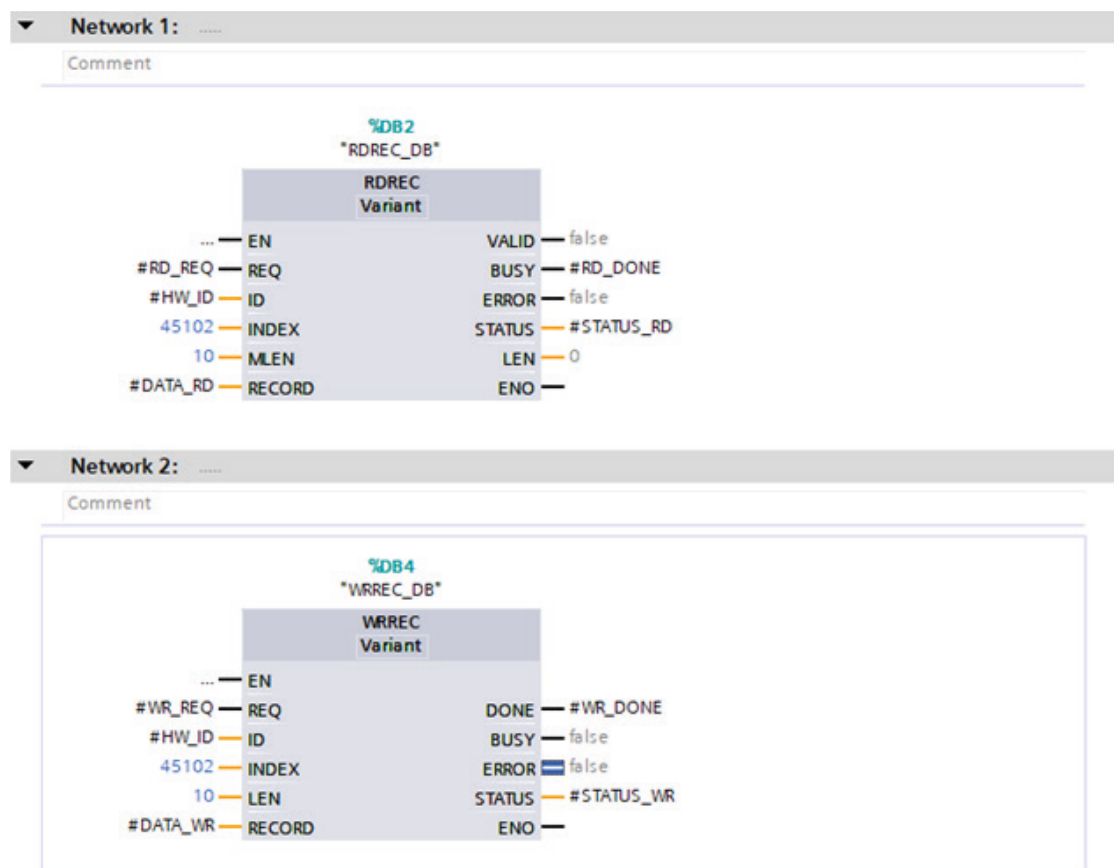


Figure 43 Networks added to FB_AcyclicDataRDWR with read and write blocks

With below variables defined in the function block of “FB_AcyclicDataRDWR”.

FB_AcyclicDataRDWR				
	Name	Data type	Default value	
1	▼ Input			
2	HW_ID	HW_IO	0	
3	WR_REQ	Bool	false	
4	WR_REQ2	Bool	false	
5	RD_REQ	Bool	false	
6	▼ Output			
7	STATUS_WR	DWord	16#0	
8	STATUS_RD	DWord	16#0	
9	WR_DONE	Bool	false	
10	RD_DONE	Bool	false	
11	▼ InOut			
12	DATA_WR	*Data_record_PN_WR*		
13	DATA_RD	*Data_record_PN_RD*		
14	▼ Static			
15	WRREC_DB	WRREC		
16	RDREC_DB	RDREC		
17	▼ Temp			
18	<Add new>			
19	▼ Constant			
20	<Add new>			

Figure 44 Variable definition of function block FB_AcyclicDataRDWR

Now create a data block, here called “ReqPNData” with the following variables:

ReqPNData				
	Name	Data type	Start value	Re
1	▼ Static			
2	READ_REQ	Bool	false	
3	WRITE_REQ	Bool	false	
4	HW_ID	HW_IO	0	
5	MLEN	UInt	0	
6	RECORD_WR	*Data_record_PN_WR*		
7	RECORD_RD	*Data_record_PN_RD*		
8	STATUS_RD	DWord	16#0	
9	STATUS_WR	DWord	16#0	
10	LEN	UInt	0	

Figure 45 Data block called “ReqPNData”

Now you need to add the FB_AcyclicDataRDWR function to the OB1 (Main) in order to call the function every cycle of the main program.

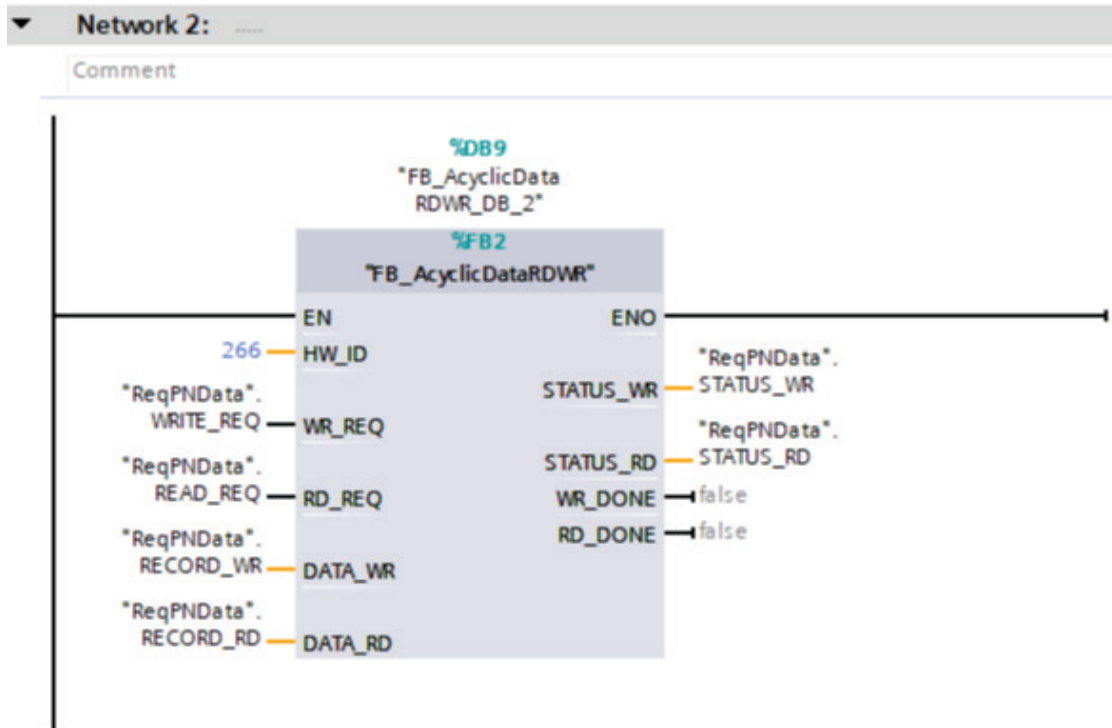


Figure 46 Calling the function block “FB_AcyclicDataRDWR”

The HW_ID here reference to the identity number for the Parameter Access Point of the module that will be read. You find it under “System constants” when selecting the Parameter Access Point for the PROFINET module. There is also a Parameter Access point for the PROFIsafe module, which will have a different hardware identity number. This number need to be used to read acyclic parameters from the PROFIsafe module.

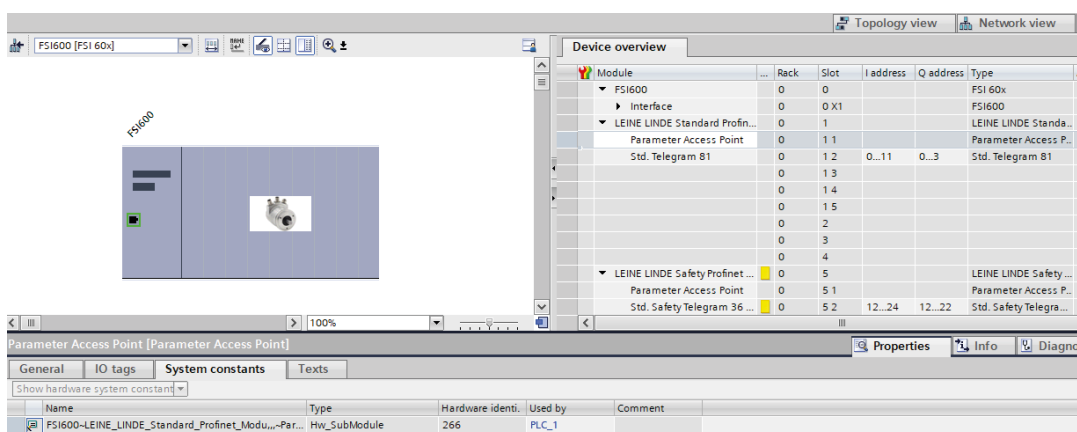


Figure 47 Finding the hardware identity number of the Parameter Access point of the PROFINET module

Now the data can be read in a watch table with below tags. In this example parameter 922 is read out, with a value of 81 (corresponding to Telegram 81).

	Name	Address	Display format	Monitor value	Modify value		Comment	Tag comment
1	// Enable write/read, 1=enable							
2	"Enable rdwr"	%M2.4	Bool	☒ TRUE	TRUE	☒		
3	// Write request (WRITE_REQ) 1=enable, REQ_ID=1 request value, REQ_ID=2 Change value							
4	"ReqPNDData".RECORD_WR.PARA_NO		DEC	922	922	☒		Parameter number, e.g. 922
5	"ReqPNDData".RECORD_WR.SUB_INDEX		Hex	16#0000	16#0000	☒		Subindex
6	"ReqPNDData".WRITE_REQ		Bool	☒ TRUE	TRUE	☒		
7	"ReqPNDData".RECORD_WR.REQ_ID		Hex	16#01	16#01	☒		Request parameter = 1, change parameter
8	"ReqPNDData".RECORD_WR.VALUES		Hex	16#0001	16#0001	☒		Value of parameter 922
9	"ReqPNDData".STATUS_WR		Hex	16#0070_0000		☐		
10	// Read request (READ_REQ) 1=enable							
11	"ReqPNDData".READ_REQ		Bool	☒ TRUE	TRUE	☒		
12	"ReqPNDData".STATUS_RD		Hex	16#0070_0100		☐		
13	// Read parameter value							
14	"ReqPNDData".RECORD_RD.PARA_VALUE		DEC	81		☐		Read the value of the parameter

Figure 48 Watch table with example to read parameter 922, which gives 81 (Telegram 81).

10 LL Webserver

10.1 Access and log in to LL Webserver

To connect to the LL webserver. Start with open up a web browser and write the IP-address of the encoder, for example:

- <http://169.254.15.76>

To log in and access your device, click on “Log in”

User name is “admin” and password is the serial number of the encoder, which can be found on the product label on the side of the product.

Note: The PC must be on the same subnet as the encoder in order to open the LL Webserver. Usage of the webserver during cyclic PROFIsafe/PROFINET communication can affect the system performance.

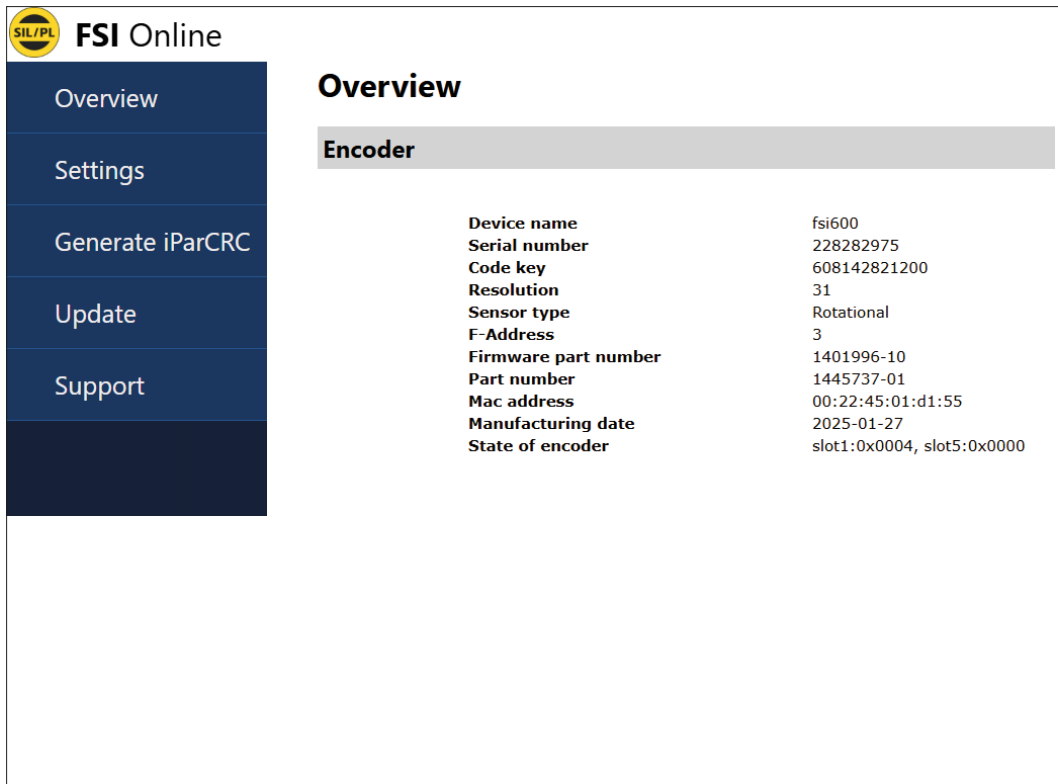
10.2 Overview

The first tab “Overview” is a general description of the connected FSI encoder. Status indication shows in green, “OK”, if the product is powered and connected.

- <http://169.254.15.76>

To log in and access your click on “Log in”

User name is “admin” and password is the serial number of the encoder, which can be found on the product label on the side of the product. Log in is not needed to access the overview page.



FSI Online

- Overview
- Settings
- Generate iParCRC
- Update
- Support

Overview

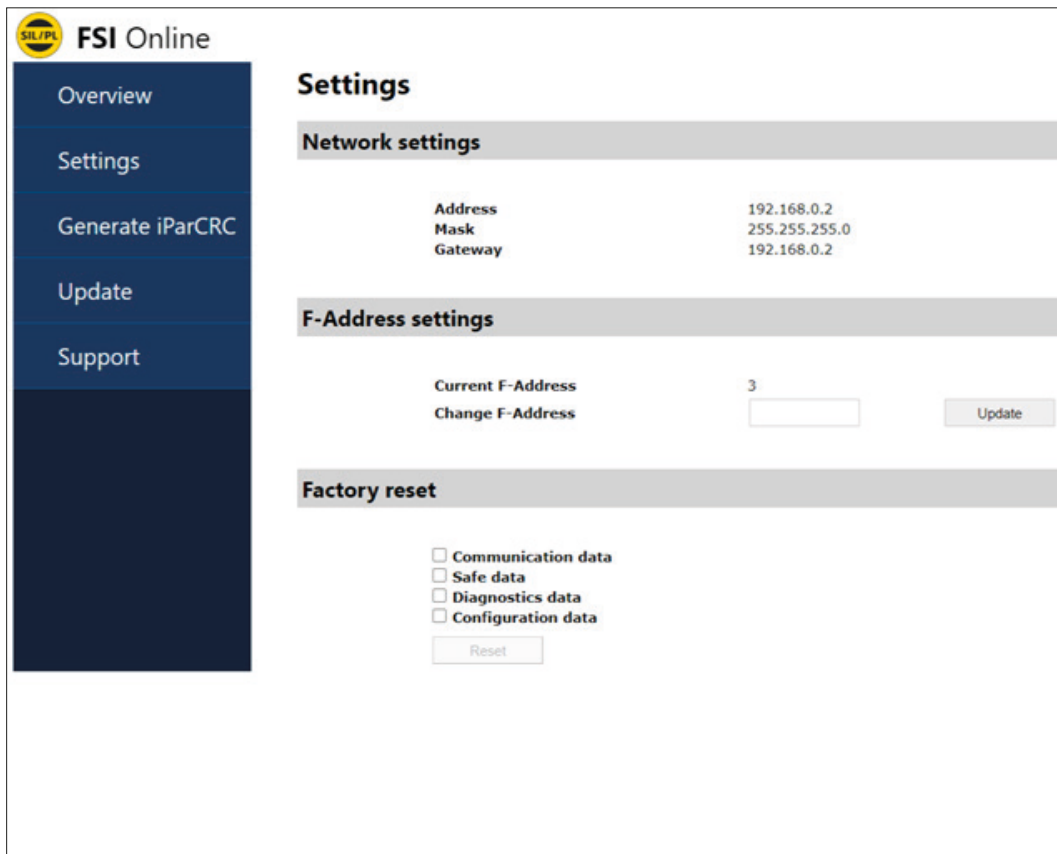
Encoder

Device name	fsi600
Serial number	228282975
Code key	608142821200
Resolution	31
Sensor type	Rotational
F-Address	3
Firmware part number	1401996-10
Part number	1445737-01
Mac address	00:22:45:01:d1:55
Manufacturing date	2025-01-27
State of encoder	slot1:0x0004, slot5:0x0000

Figure 49 FSI Online web server “Overview” tab

10.3 Settings

With the web interface the F_Dest_Address need to be assigned to the encoder under Change F-Address. The F_Dest_Address need to be unique on the network and not equal to any F_Source_Address in the network. Enter the desired F_Dest_Address under Change F-Address, then press Update. When the Current F-Address value have changed, the encoder is assigned with the new value. The destination address in the device need to be identical to the corresponding F-Parameter declaration in the configuration tool.



The screenshot shows the 'FSI Online' web interface. On the left is a dark blue sidebar with a menu containing 'Overview', 'Settings', 'Generate iParCRC', 'Update', and 'Support'. The 'Settings' tab is selected. The main content area is titled 'Settings' and contains three sections: 'Network settings', 'F-Address settings', and 'Factory reset'.
 The 'Network settings' section displays a table with the following values:
 Address: 192.168.0.2
 Mask: 255.255.255.0
 Gateway: 192.168.0.2
 The 'F-Address settings' section shows 'Current F-Address' as 3, and a 'Change F-Address' input field with an 'Update' button next to it.
 The 'Factory reset' section has four checkboxes: 'Communication data', 'Safe data', 'Diagnostics data', and 'Configuration data'. A 'Reset' button is located below these checkboxes.

Figure 50 Settings tab for F-Address assignment

There are four types of factory reset:

Communication data: Reset of IP-address and PROFINET device name

Safe data: Reset of F-Address

Diagnostics data: Clear the diagnostic log of the encoder.

Configuration data: Reset of encoder configuration data such as preset value, scaling, code sequence etc.

10.4 Generate iParCRC

In the tab “Generate iParCRC” the iParameters from the configuration need to be entered to generate a checksum. When the iParameters been added press “Generate iParCRC”. The checksum value should be used as F-parameter “iParCRC” to confirm a valid configuration of the iParameters.

FSI Online

- Overview
- Settings
- Generate iParCRC**
- Update
- Support

Generate iParCRC

iParameter (LL Profile)

Safe Code Sequence:	CW (0) ▾
Safe Position Value Scaling:	Disable ▾
Safe Measuring Units per Revolution:	4096
Safe Total Measuring Range:	16777216
Safe Velocity Measuring Unit:	Rpm ▾
Time Base For Safe Velocity:	100
Safe Acceleration Measuring Unit:	Rad/s ² ▾
Safe Acceleration Derivation Time:	100

iParCRC: e518cb70

Figure 51 Tab where the F-parameter “iParCRC” is generated, that is entered to the PLC program

10.5 Firmware update

In the next tab, Update, you can update or upgrade the firmware of the encoder. To update, press "Choose file" and select the update file. Note the file must come from Leine Linde.

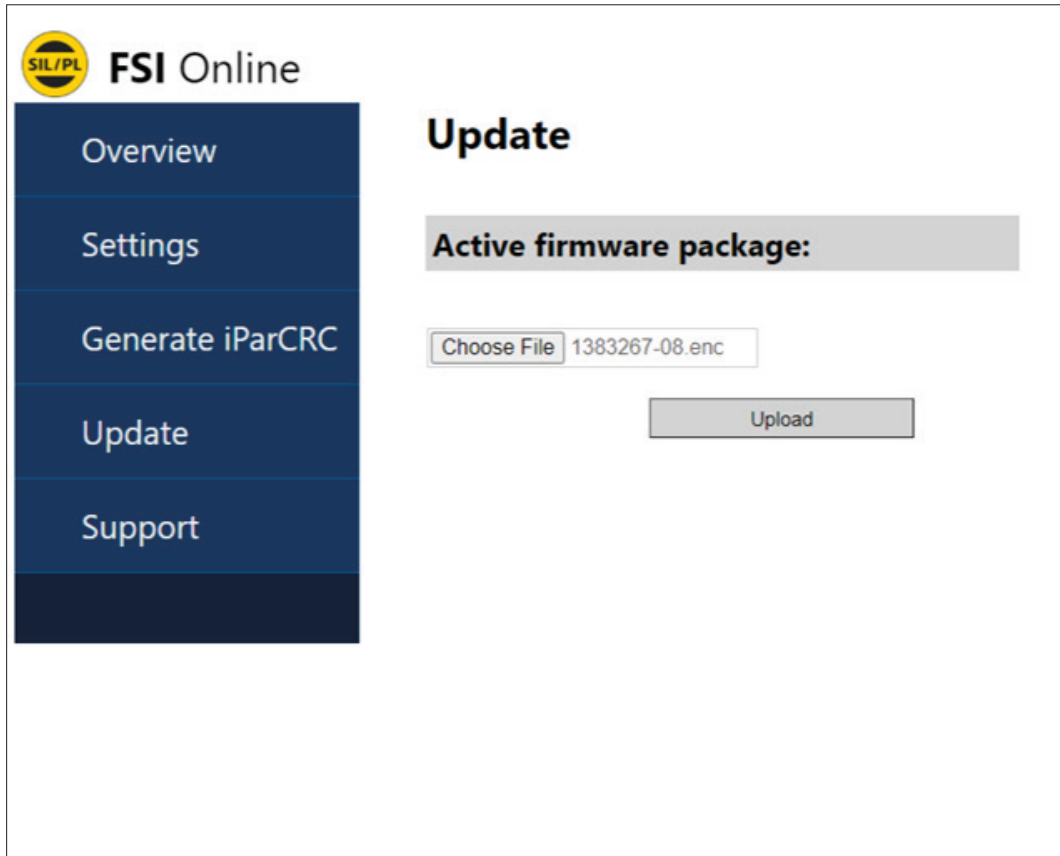


Figure 52 Select the update file

Press upload and then "Yes" in the pop-up window. Now the program will start to update the encoder. This can take several minutes and the time left is indicated by the progress bar. Do not remove the power during update.

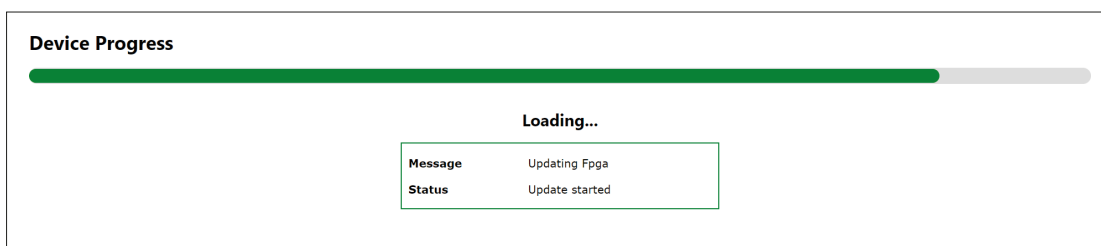


Figure 53 Progress bar to follow the update of the device

When the file transfer is done the user need to approve the update by cross-checking the data presented with correct data received from Leine Linde. If data is correct press Approve. Now the system will re-boot and re-start with the updated firmware. The new version number will be indicated in the Overview page.

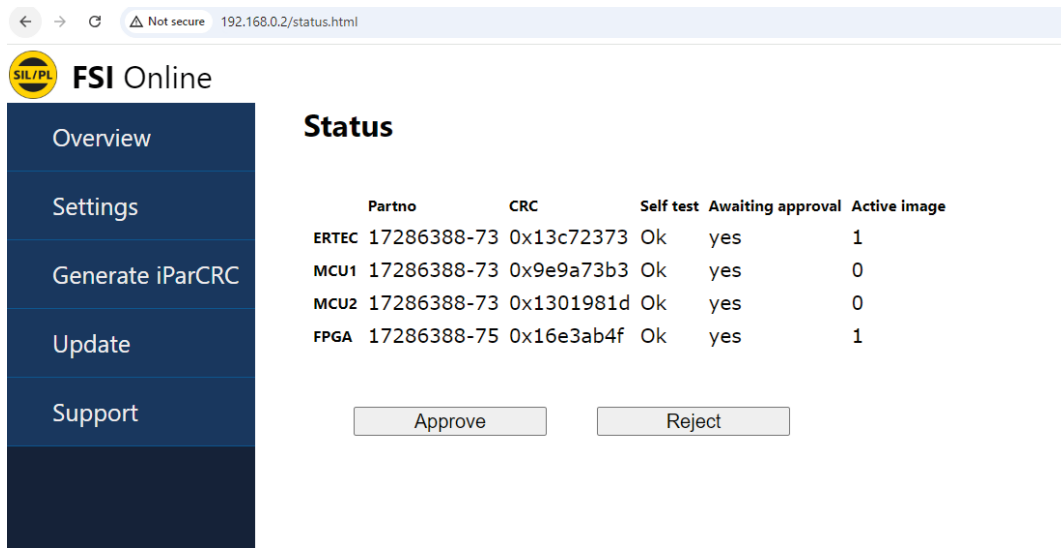


Figure 54 Approve the update

Note: If the update is rejected or interrupted the encoder will roll back to the previous installed firmware.

10.6 Support

In the support tab you can find contacts to Leine Linde and a “Diagnostic log” for the latest errors.

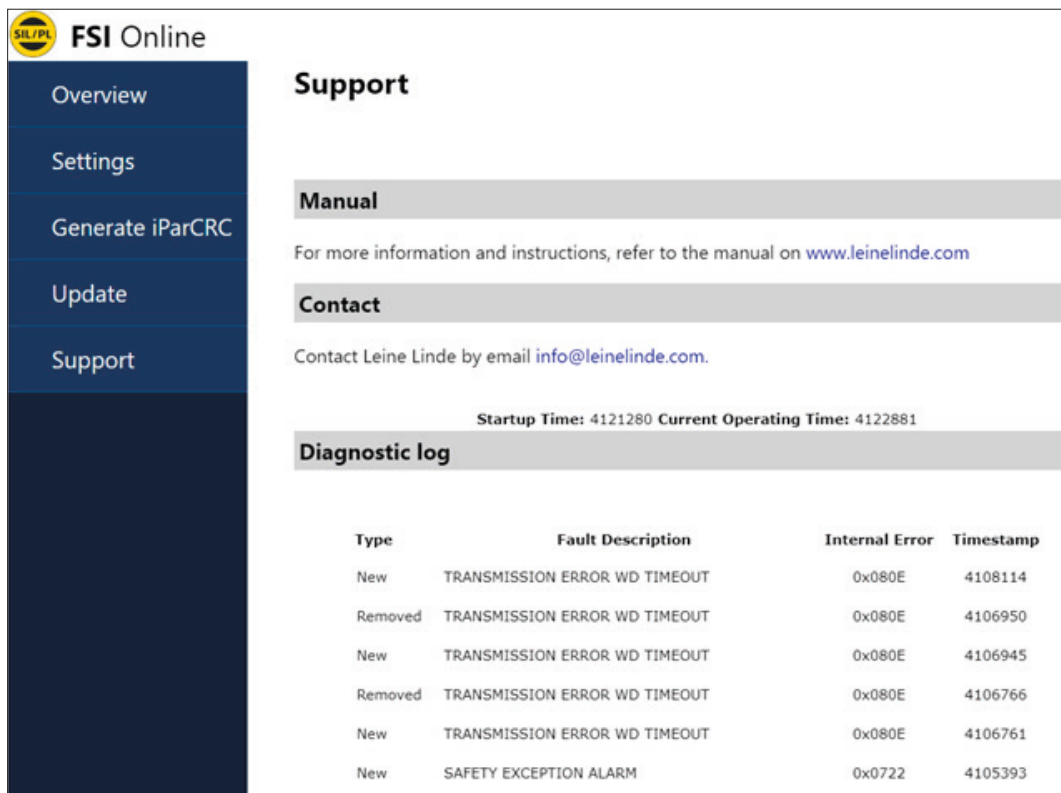


Figure 55 Support tab of the webserver

11 Isochronous Real-Time Settings (RT Class 3)

This example is intended to illustrate the commissioning of a PROFINET IO encoder in isochronous operation. In example below, the Totally Integrated Automation Portal V17 and a CPU 1511F-1 PN IO controller is used. Start by completing the configuration according to chapter 6.1-6.7 before continuing with the IRT settings as described in this section. This example is using “Technology objects” to set up the encoder for IRT communication, but it is also possible to use OB61 (Synchronous cycle), which is not described in this manual.

First go to “Technology objects” in the list menu to the left. Click on “Add new object” and now a window will open to select the type of technology object. Select “TO_ExternalEncoder”.

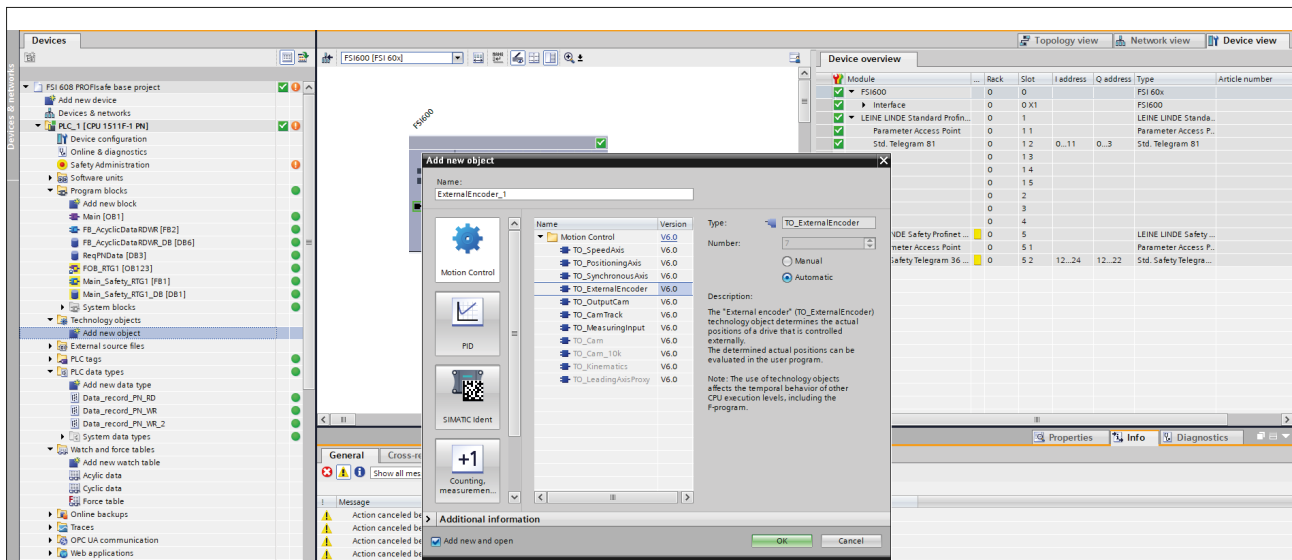


Figure 56 Add an External encoder as a Technology object.

Open the properties of the technology object select the PROFINET module, encoder type, telegram type (only Telegram 81 and 83 are available) and resolution, with examples in Figure 55 and 56.

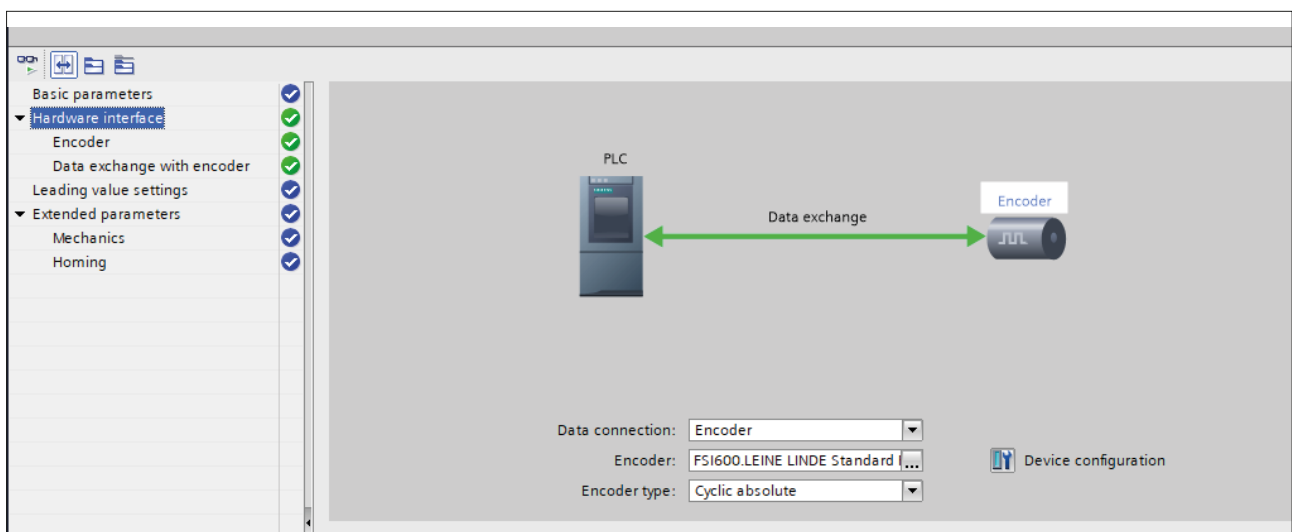


Figure 57 Settings of encoder configured as a technology object

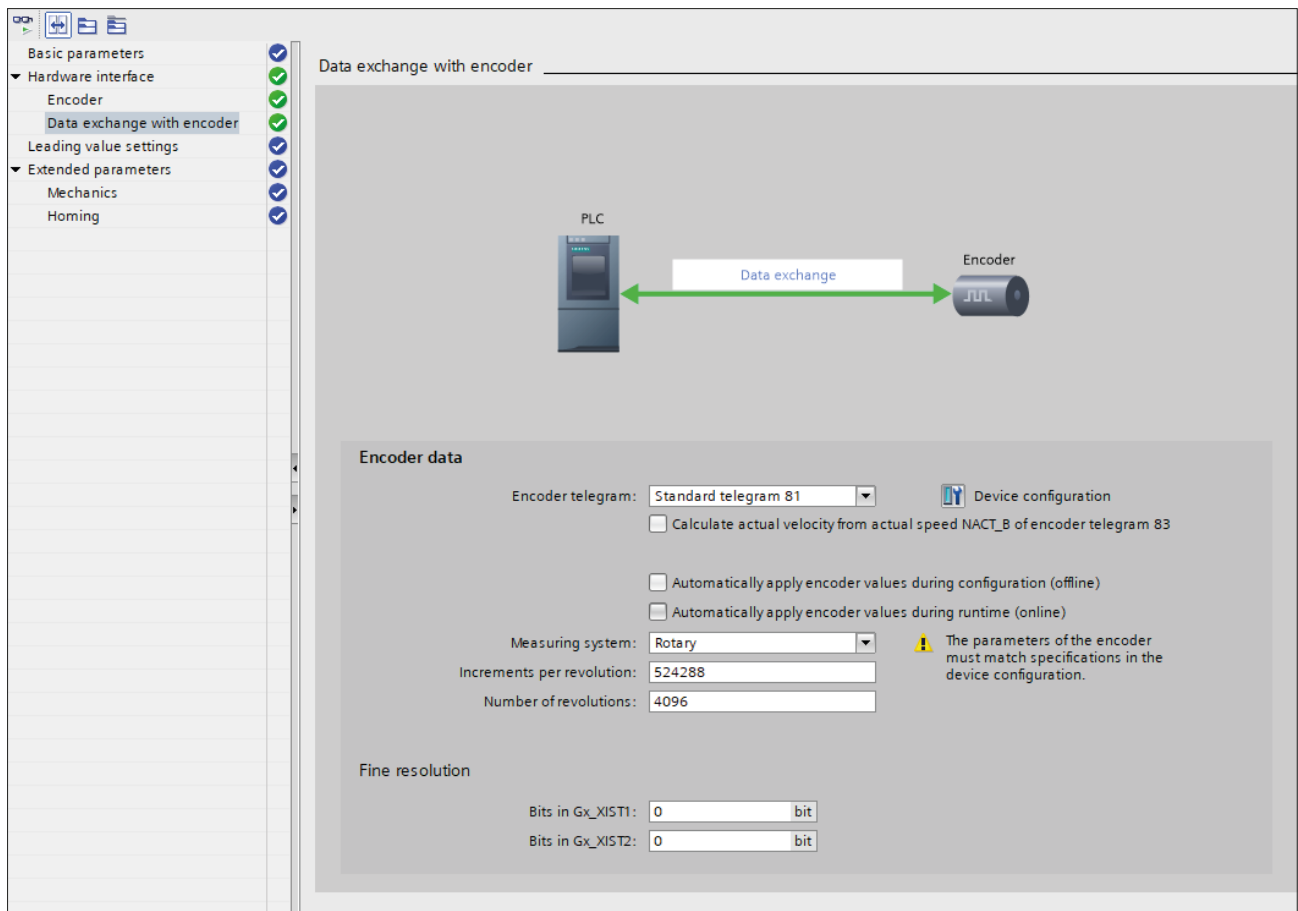


Figure 58 Data exchange of encoder configured as a technology object

Now go to the Topology view and connect the ports in the program exactly as they are connected between the encoder and PLC.

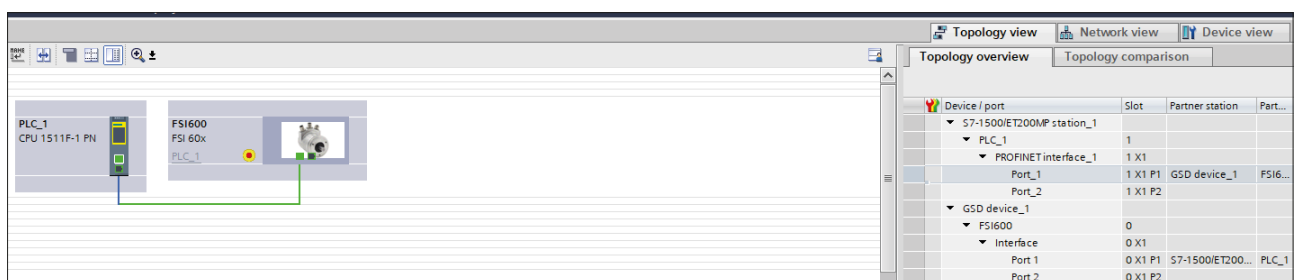


Figure 59 Define the ports connected for the controller and encoder to use it in IRT mode. Port 1 (PLC) and Port 1 (Encoder) are connected in this example.

To activate the IRT settings of the encoder, go to Properties->Isochronous mode. Select "isochronous mode" and the cyclic data you want to transfer in IRT mode (in this example Telegram 81 in Slot 1 2).

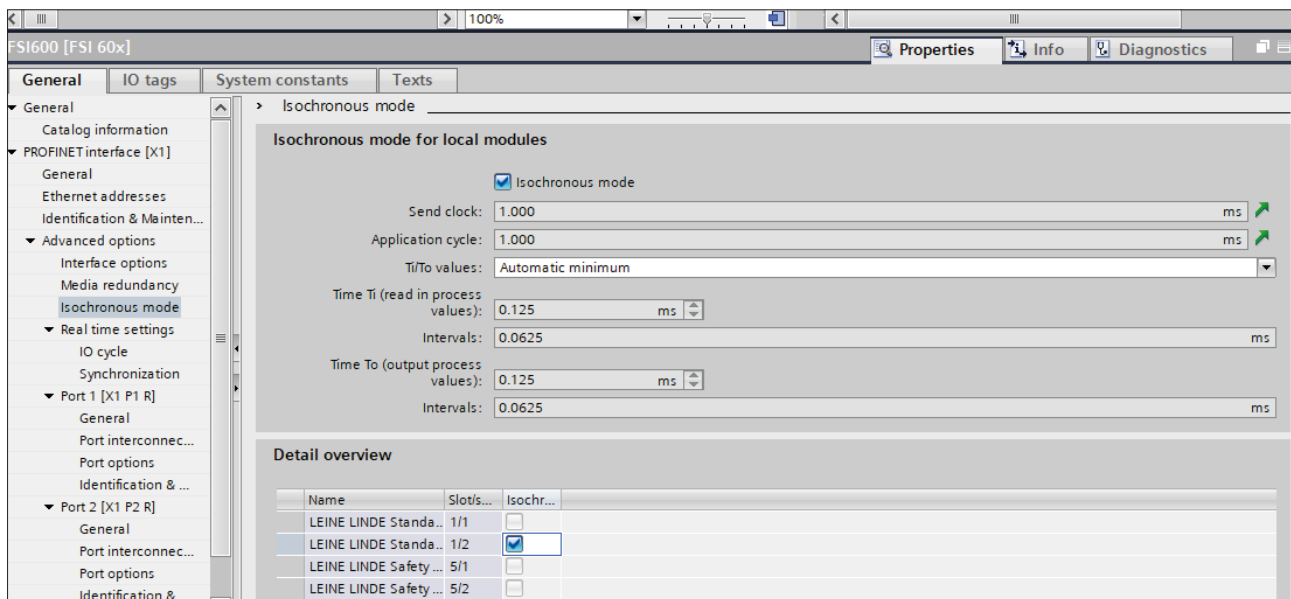


Figure 60 Settings in Isochronous mode of the encoder

Then go to the tab “Real time settings”. Select IRT under “Synchronization”. The watchdog time (for the IRT communication) can also be adjusted here.

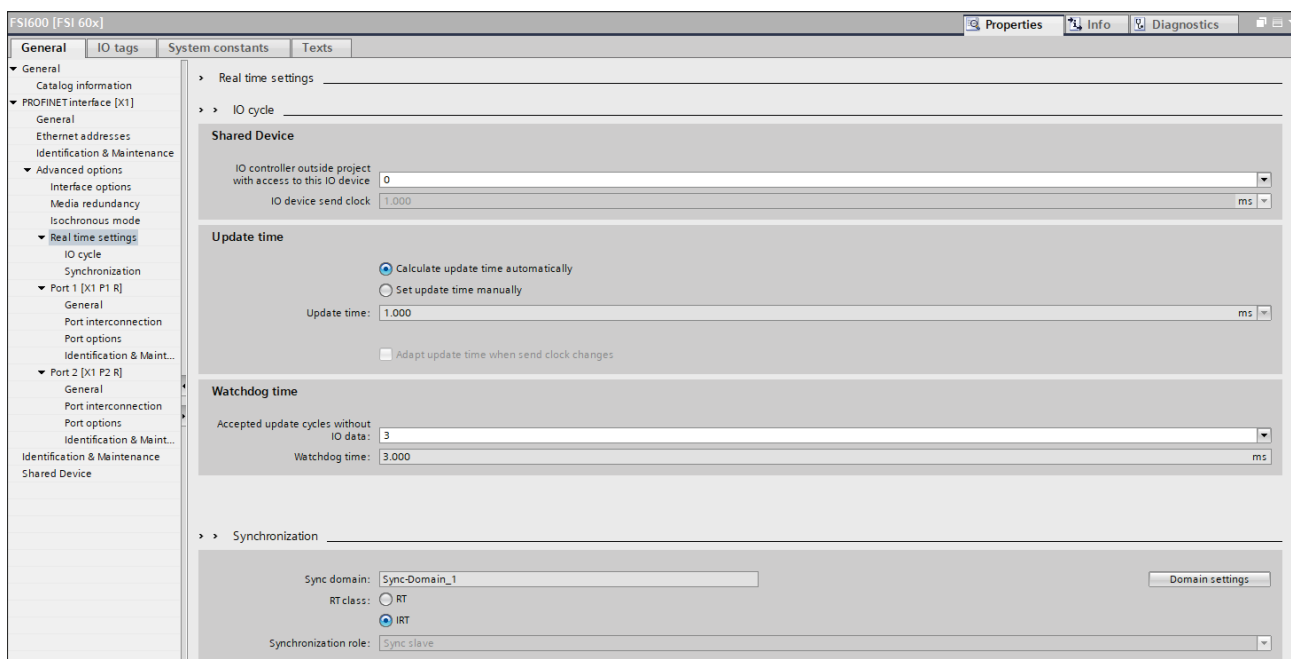


Figure 61 Real time settings of the encoder

Then click on the telegram used in the PROFINET module, in this example Standard Telegram 81, and use the following settings for the I/O addresses

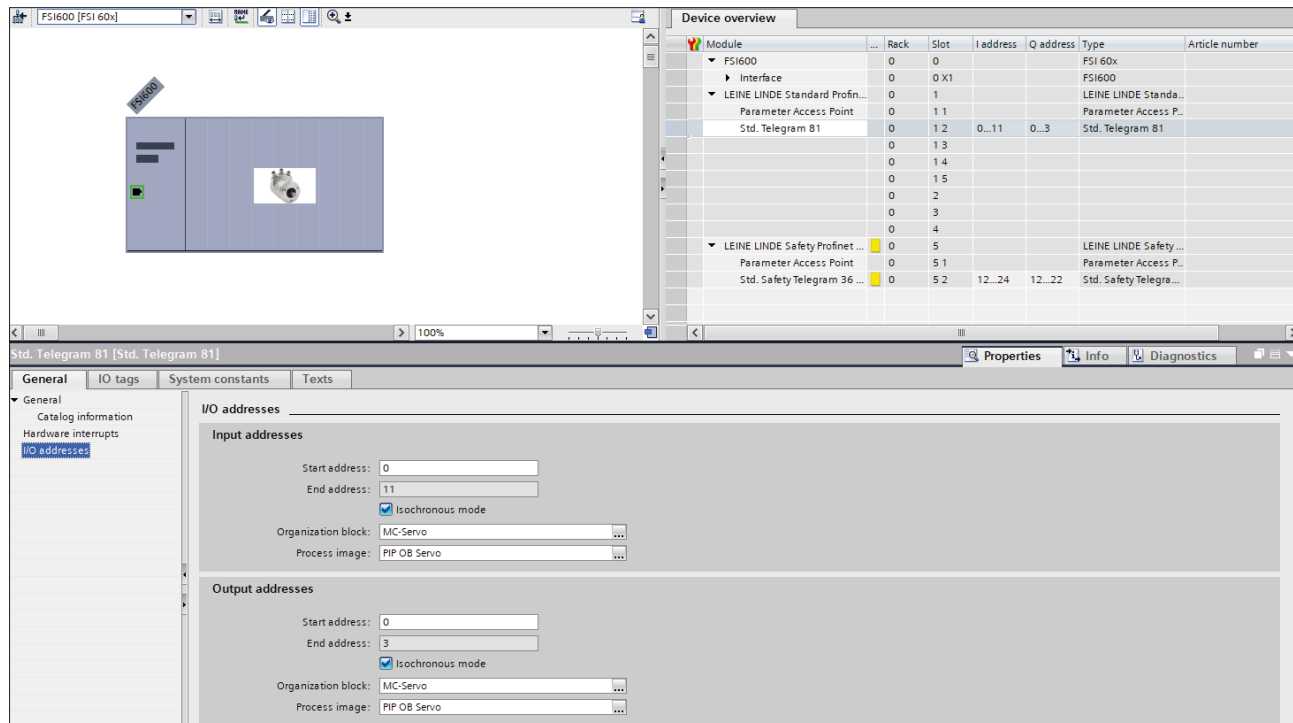


Figure 62 I/O addresses of the encoder in isochronous mode

Then click on the button “Domain settings” and have the check-box “Make “high performance” possible” activated.

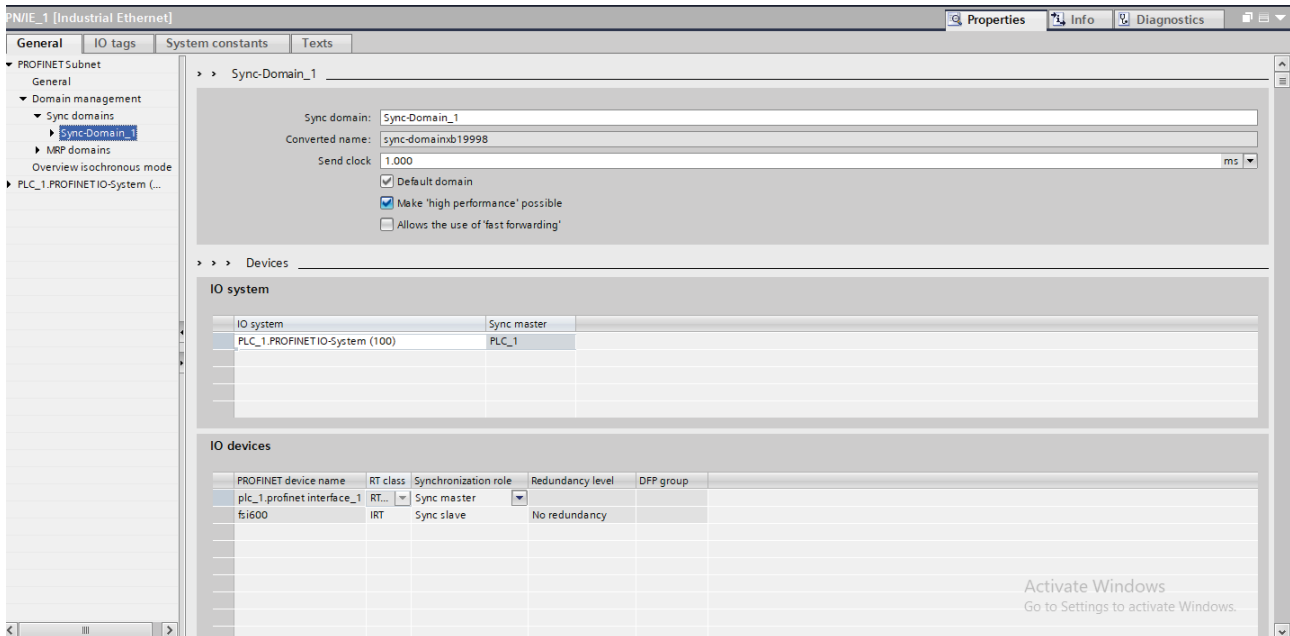


Figure 63 Select “Make “high performance” possible” in the Sync domain used for the communication.

Now the user should compile the program. Now the two organization blocks MC-Servo [OB91] and MC-Interpolator [OB92] will be generated by the program. In order to access the I/O data the organization blocks MC-PreServo [OB67] and MC-PostServo [OB95] can be used.

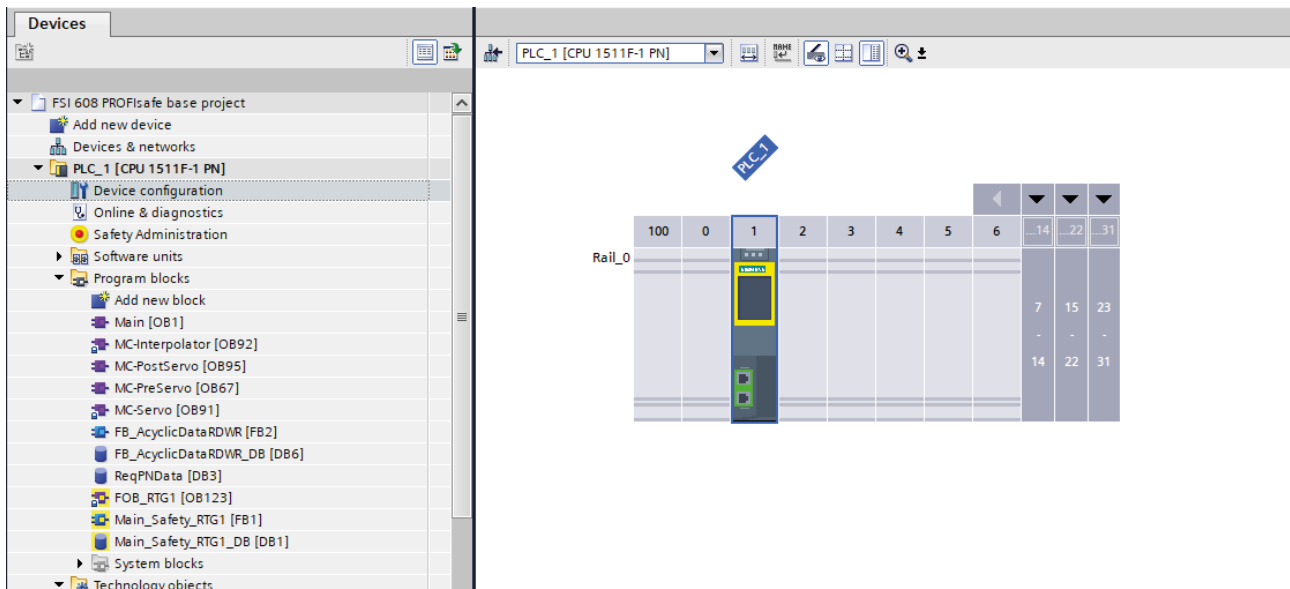
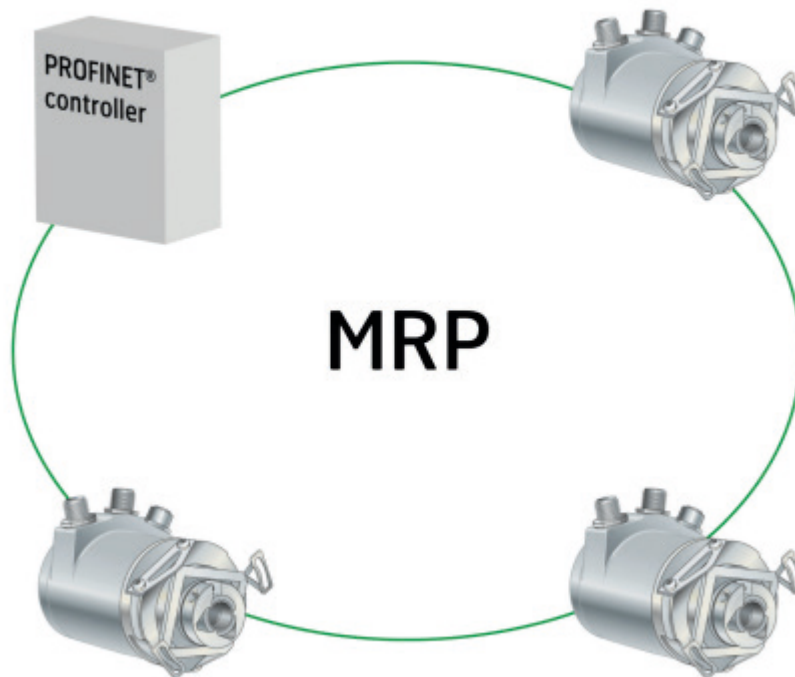


Figure 64 Organization blocks used to access the encoder as a technology object

Download the program and the encoder is now prepared to communicate in IRT mode as a technology object.

12 Media Redundancy Protocol



Ring redundancy is supported by the Leine Linde encoder through the Media Redundancy Protocol (MRP) and Media Redundancy Planned Duplication (MRP-D). The ring is managed by a Media Redundancy Manager and all the other devices on the network act as Media Redundancy Clients. The Media Redundancy Manager is responsible for issuing test frames for testing the network and for re-configuring the network in the event of a ring failure due to a non-functioning device or a broken cable.

If for example a cable or slave is damaged in the network the Media Redundancy Manager detects this through the failure of the test frames that is sent out. Additionally, the Media Redundancy Clients will communicate failure messages back to the manager if a failure is detected on its forwarding port.

Once a failure is detected, the Media Redundancy Manager will send out reconfiguration instructions to all clients on both ports. The manager will then begin sending data traffic out on both ports so that the messages reaches all clients. The total time for this process is about 200 ms.

If the application is running in IRT mode then MRP-D is automatically used if media redundancy protocol is activated. MRP-D transmits two equal frames to the receiver in opposite direction around the ring, in case of a failure the frame still arrives at the receiver destination. Hence MRP-D ensures constant non-stop connectivity with an instantaneous recovery.

Note: To use MRP or MRP-D all nodes/devices in the ring needs to support MRP respectively MRP-D.

Note: It is not possible to configure a redundancy ring with MRP-D if not all devices are running in IRT mode.

13 Device replacement using LLDP

The devices support Link Layer Discovery Protocol (LLDP). LLDP is essentially a neighbor discovery protocol used by network devices for advertising of their identity, capabilities and interconnections. In a PROFINET network all IO devices are recognized by their device name. Sometimes an IO device needs to be replaced in an automation system, and this is when LLDP is useful. Using LLDP, the neighbor relations between the individual IO device and the IO controller are analyzed and stored on the IO controller. If an IO device has been replaced, the IO controller will recognize this and will redefine the device name.

Below is an example on how to exchange an IO device using LLDP:

Select “Properties” of the PN-IO controllers interface module and enable “Support device replacement without exchangeable medium”.

Verify that the offline topology matches the online topology. After the above has been verified it is possible to replace any IO device if the ports are reconnected in the same way and the new device is set to factory reset.

Note: The safety related address will not be transferred over LLDP, it needs to be configured manually when replacing an encoder.

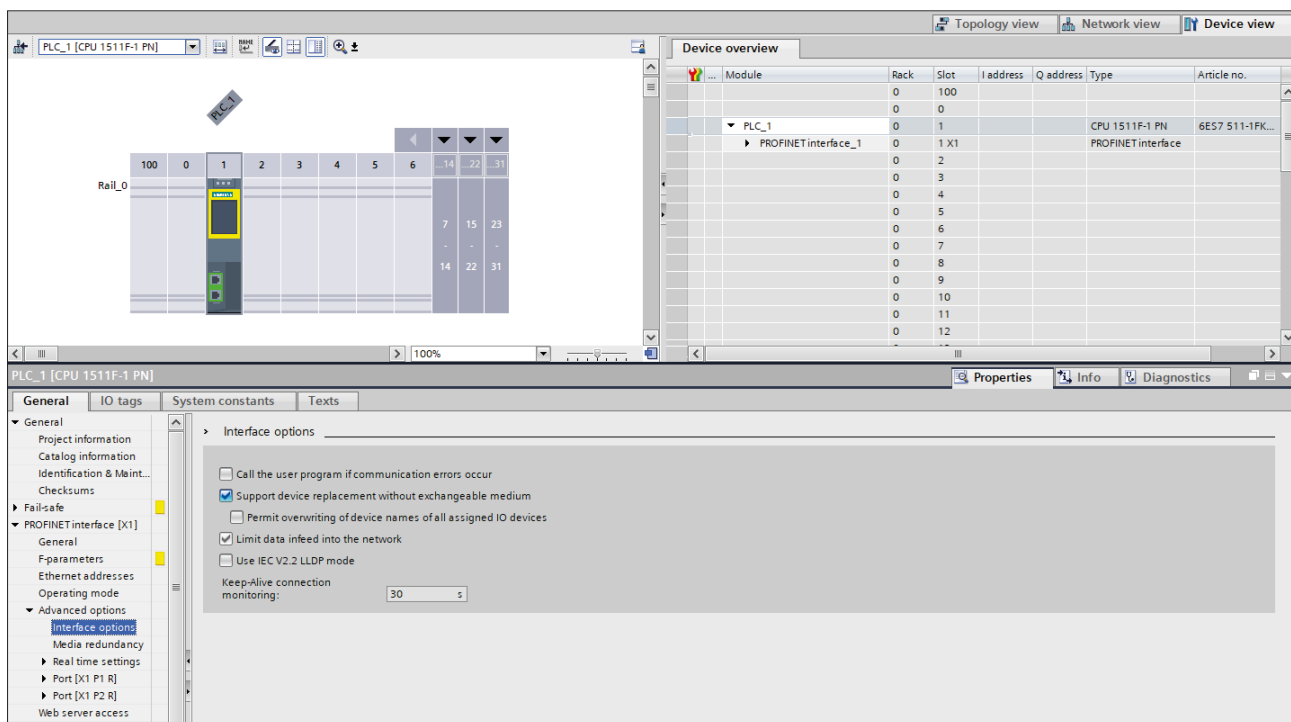


Figure 65 LLDP Properties

Then open the Topology view and configure the topology for all connected ports.

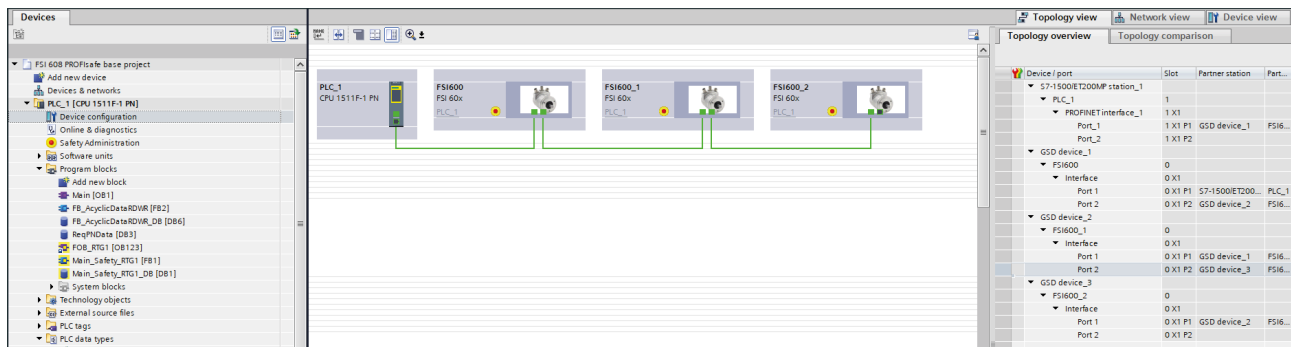


Figure 66 Port configuration in Topology view

Verify that the offline topology matches the online topology

After the above has been verified it is possible to replace any Profinet IO device if the ports are reconnected in the same way and the new device is set to factory reset.

To manually do a factory reset of a PROFINET encoder: right-click on the encoder in device view and select "Online and Diagnostics". Then go to Functions->Reset to factory settings and press Reset button. Note that the F_Dest_Addr is not reset while performing a factory reset over PROFINET.

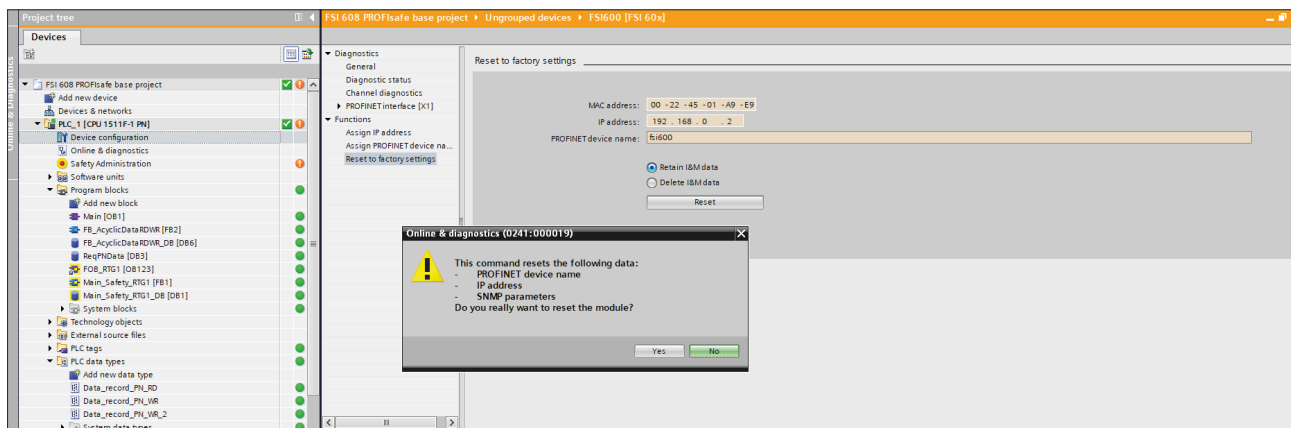


Figure 67 Factory reset of PROFINET

14 Revision history

Revision	Date	Changes
Rev. 01	2025-05-21	First release

Table 59 Revision history



The best encoders and sensors are those you never have to think about. Those that simply do their job – year after year. Leine Linde develops and manufactures customized encoder and sensor solutions for demanding environments, advanced measuring systems for accurate feedback of speed, position or strain.

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