LEINE LINDE

PROFINET

FOR 900 SERIES ENCODERS

MANUAL / USERS GUIDE

PROFINET®

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LEINE LINDE

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1 Introduction

Thank you for choosing this device produced by the Swedish encoder manufacturer Leine Linde. In your hands, you have a state of the art component that is ready to be used in the utmost demanding environments. This manual describes the installation procedures and configuration of absolute encoders with PROFINET interface. 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 PROFINET encoders within the following series.

PSE 901	PHE 901
PSE 903	PHE 903
PSE 921	PHE 921
PSE 923	PHE 923

Leine Linde is a company that often customizes the product to fit individual customer requirements. Such customized products may therefore not be fully compliant with the descriptions in this product manual. Customized encoder devices are indicated by their type label, and marked 99X – where the "9" digit in the second position indicates that the device has some customized parameters. Encoder series with the following name and type plate information may therefore have deviating functional performance.

PSE 991
PSE 993
PHE 991
PHE 993

If your product is of the type mentioned above, contact Leine Linde to obtain the product's complete functional description.

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 value. By internally dividing the difference in position with a small delta time an accurate speed value 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 up to 1 ms cycle times.
- IRT (Isochronous Real-Time) for PROFINET IO applications in drive systems with cycle times of less than 1 ms. **Note! IRT is not supported by the 900 series PROFINET encoders**

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 Encoder Profiles

Profiles are pre-defined configurations of the functions and features available from PROFINET 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. The encoder device profile describing encoder functionality and additional information about PROFINET can be ordered from PROFIBUS User Organization, PNO.

PROFINET is generally defined by PROFIBUS & PROFINET International (PI) and is backed by the INTERBUS Club. Since 2003, it has been part of the IEC 61158 and IEC 61784 standards.

PROFIBUS User Organization

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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 Inter-national, 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

3.2 Abbreviations

PI	PROFIBUS and PROFINET International
IO	Input/Output
DO	Drive Object
DU	Drive Unit
AR	Application Relation
CR	Communication Relation
MLS	Master Sign-of-Life
RT	Real Time Ethernet

IRT	Isochronous Real Time Ethernet
IsoM	Isochronous Mode
LLDP	Link Layer Discovery Protocol
GSD	General Station Description
GSDML	General Station Description Markup Language
UDP	User Datagram Protocol
TCP	Transmission Control Protocol
IP	Internet Protocol
DHCP	Dynamic Host Configuration Protocol
TFTP	Trivial File Transfer Protocol
MAC	Media Access Control
I&M	Identification & Maintenance
MSW	Most Significant Word (upper part of Unsigned64)
LSW	Least Significant Word (Lower part of Unsigned64)
RPM	Revolutions Per Minute
MRP	Media Redundancy Protocol
DCP	Discovery and Configuration Protocol
OB	Organizational Block

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.
  - Choose configuration, single-turn or multi-turn.
  - Choose telegram
  - Configure the IP-address settings and give the device a unique device name.
  - Configure the encoder module parameters
  - Compile and download the configuration

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

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

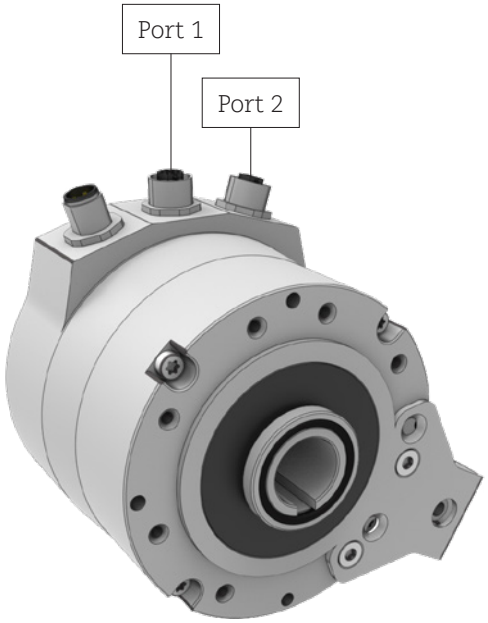


Figure 1 Encoder port 1 and 2

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

Table 1 Bus connection

Note: The encoder provides integrated switch functionality between the two M12 connectors used for PROFINET communication.

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

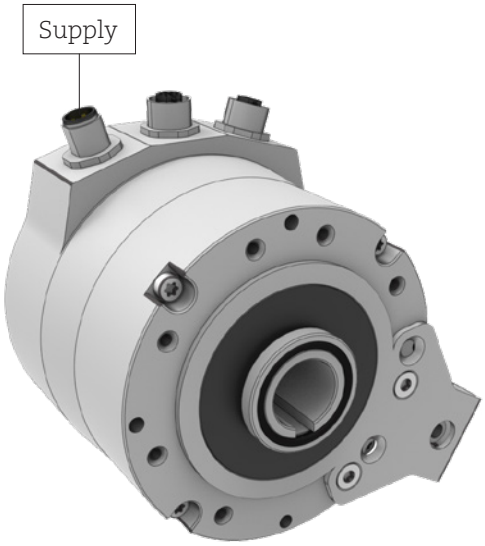


Figure 2 Encoder power supply

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

Table 2 Power supply connection

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 worldwide. 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, the MAC address is always printed on the encoder label for commissioning purposes. See picture.

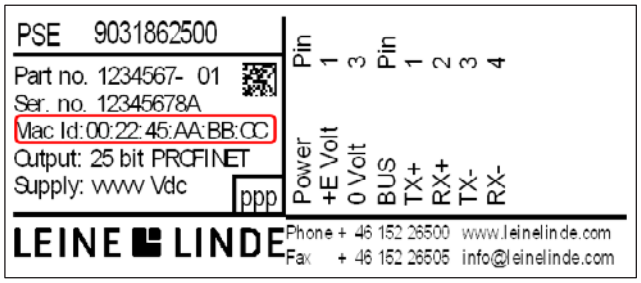


Figure 3 MAC-adress

One other identification mark on the label is the Change index used in upgraded versions of the firmware in order to identify the version of the firmware. The Change index is a letter that is added behind the serial number as in the picture below.

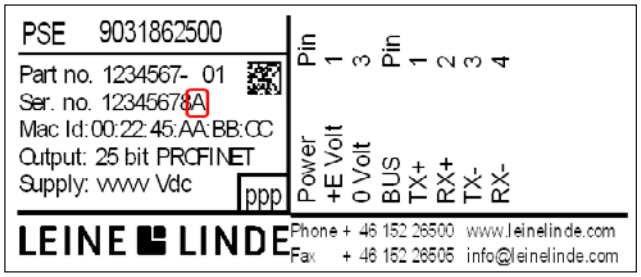


Figure 4 Change index

4.6 LED indication

The following table defines diagnostic indications shown by the encoder's two bi-colored 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*	Blinking green	Firmware upgrade in process	
Blinking red*	Blinking red	Failure during firmware upgrade	
Red	Red	Missing EnDat encoder; No bus communication	– No connection to EnDat encoder
Green	Orange	Warning present	– Command not supported

*) The Blinking frequency is 0.5 Hz. Minimal indication time is 3 seconds.

Table 3 LED indication

5 Configuration example with TIA-portal

This chapter will illustrate how to setup and configure a PROFINET multi-turn encoder with the TIA-portal. In the following example, *Totally Integrated Automation Portal version V13 SP1 and Step 7 Basic Version V13 SP1* was used. Please refer to the manufacturer of the configuration tool if other configuration tools are being used.

5.1 Installation of GSDML files

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

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

GSDML file	
Encoder	GSDML-V2.35-LL-PROFINET-PxE-900-xxxxxxxx.xml

Table 4 GSDML file

Installation of GSDML-file

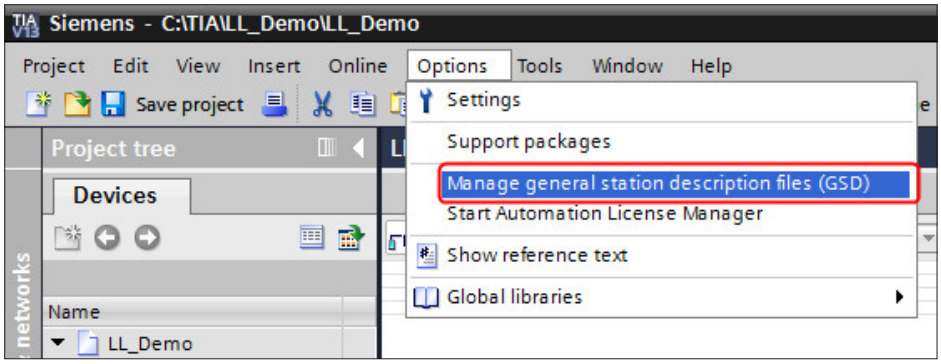


Figure 5 GSDML installation

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.

5.2 Setting the encoder configuration

When the GSDML file has been installed the supported encoder types can be found in the “HW catalog” under *Other Field Devices->PROFINET IO-> Encoders->LEINE LINDE->LEINE LINDE PROFINET Encoders*. Select either multi-turn encoders or single-turn encoders depending on the type of encoder to be configured. Drag and drop the device as shown in the picture below. In the example in figure 29 below, a multi-turn encoder was chosen. If more than one encoder shall be configured, then the following steps need to be done once for each device.

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

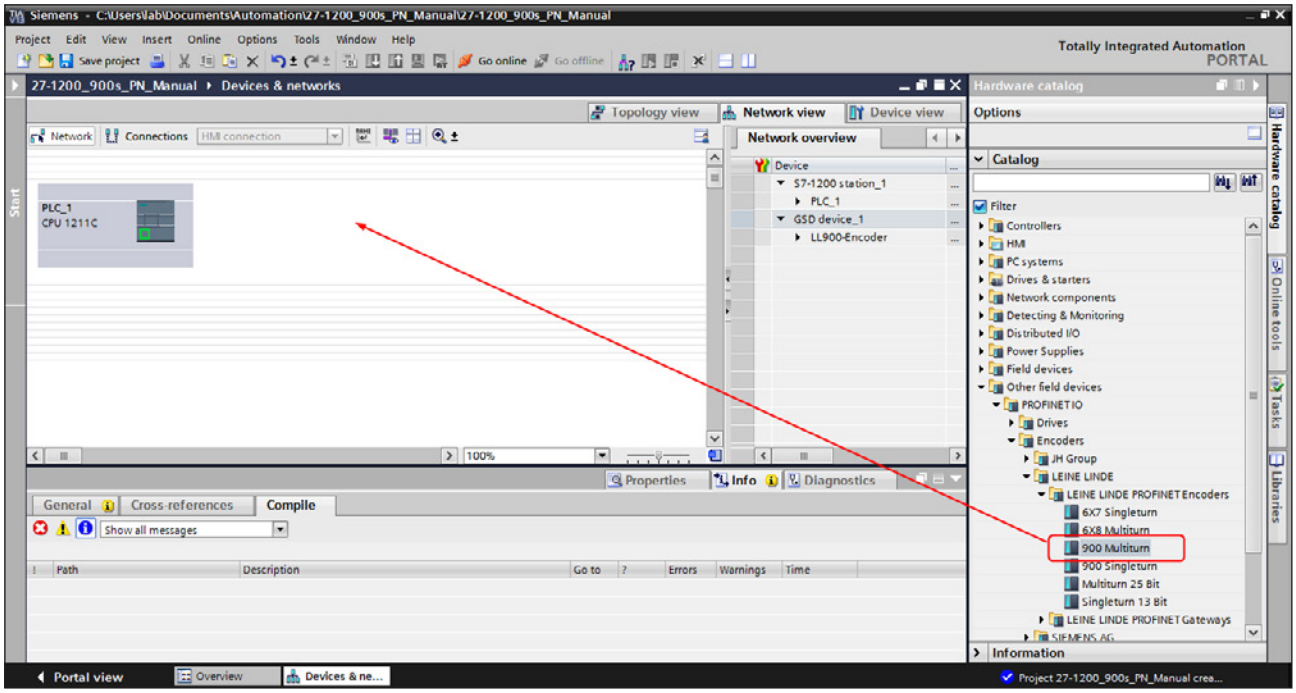


Figure 6 Setting up the encoder configuration

The next step will be to choose the data length and the type of data that should be sent to and from the IO controller. This is done by choosing different telegrams. Available telegrams can be found in the “Hardware catalog” in the “Device” view. Expand the “Module” folder in the catalogue tree and double-click on “EO Multiturn”. That will open up the “Submodules” folder. Double-click on the telegram to be used. For more information regarding the different telegrams refer to chapter sections 6.4 - 6.14.

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

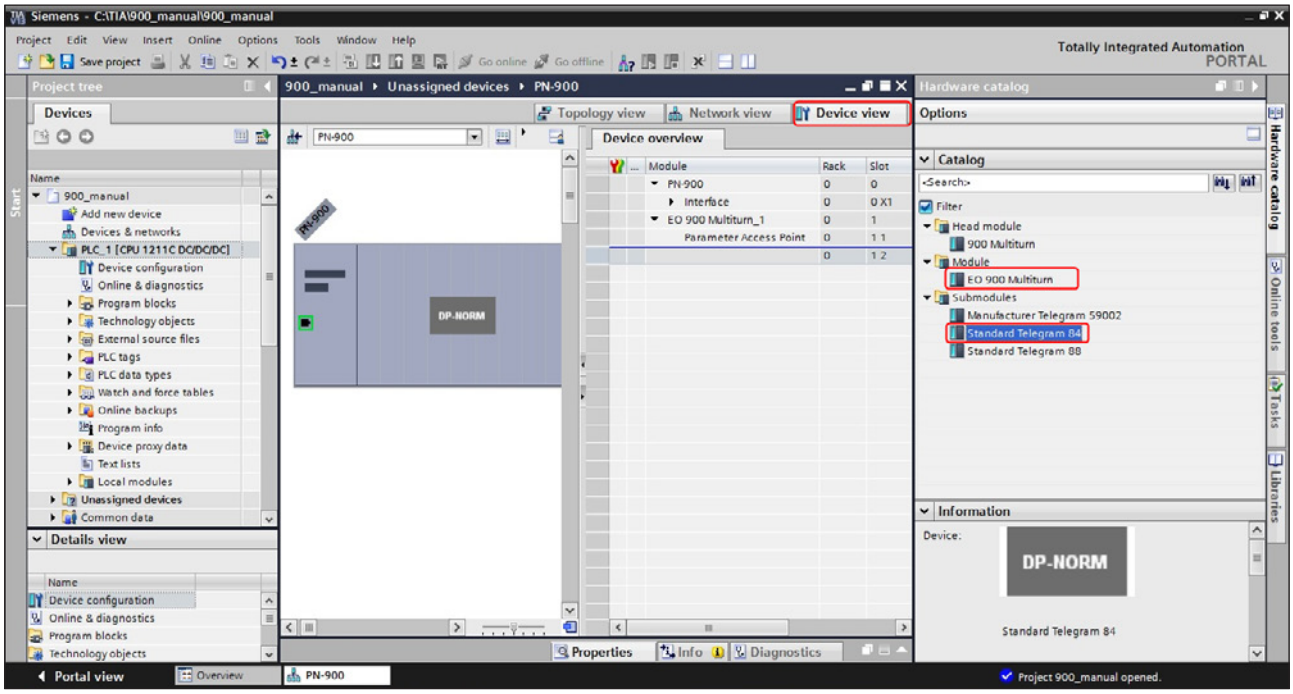


Figure 7 Telegram selection

5.3 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.

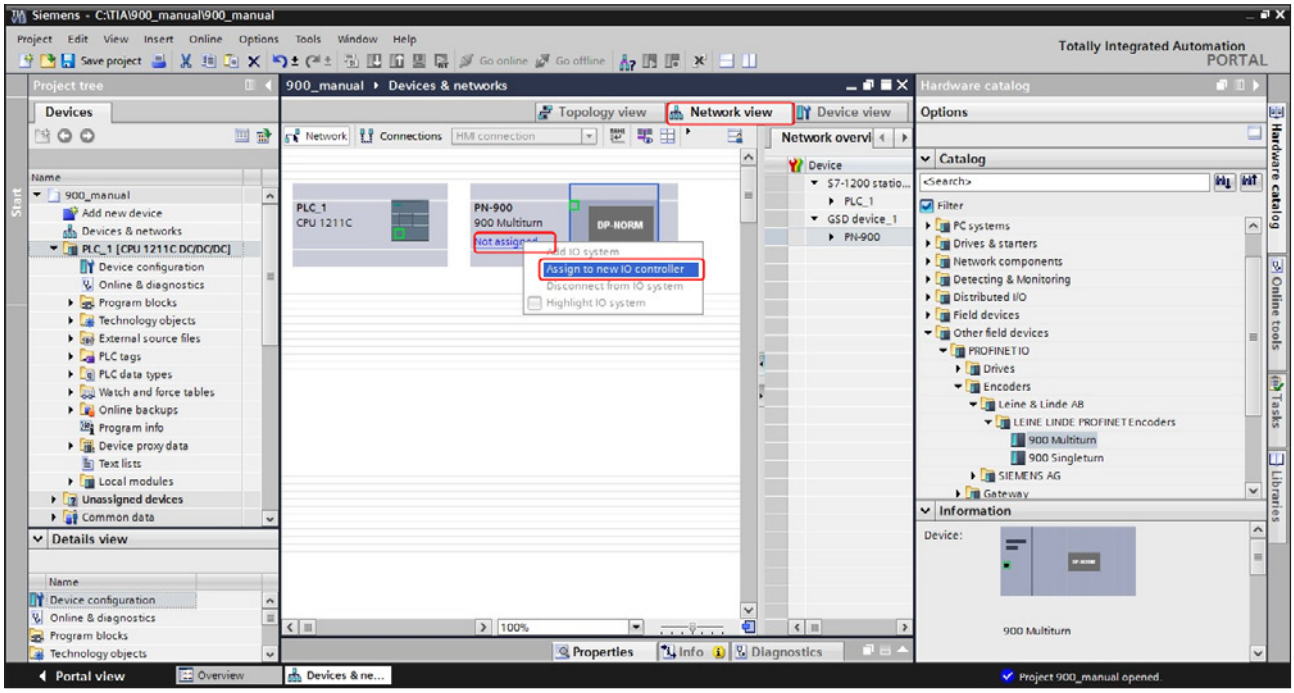


Figure 8 Assign IO controller

5.4 Setting encoder IP-address and encoder device name

In a PROFINET network all IO devices needs to have a unique IP-address and device name.
In the “Network” view, click on the “PROFINET ENCODER” device. Then click on the “Properties” tab for the “PN-900”. The setting for the IP-address and device name can be found under the General tab -> 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.

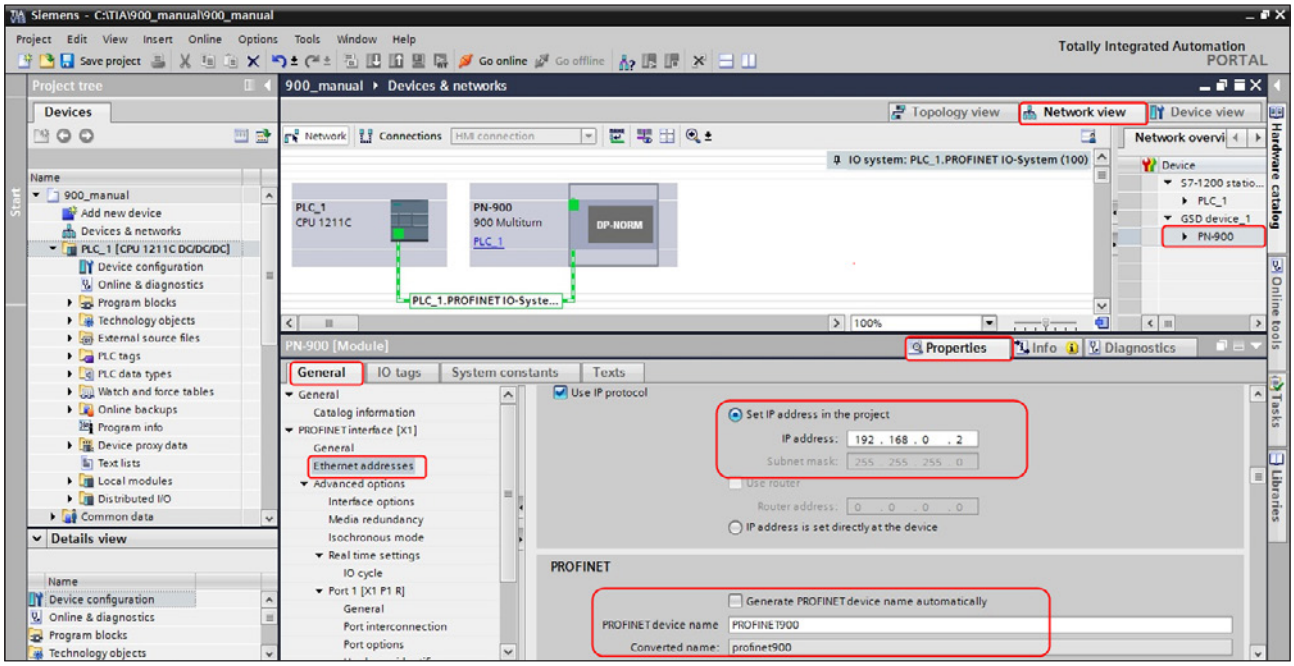


Figure 9 IP-address and device name settings

5.5 Assigning device name

To assign the device name to the device, right-click on the “PN-900” device, then click on “Assign device name” or click on the “Assign device name” icon.

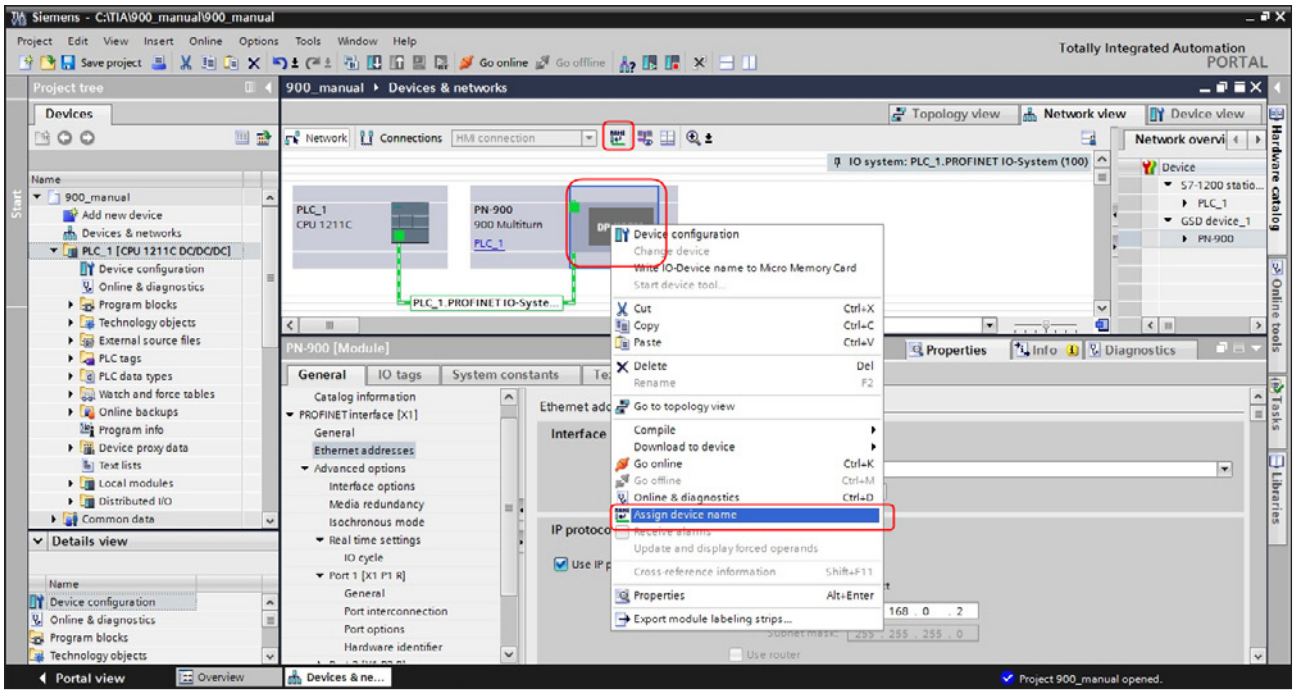


Figure 10 Assigning device name

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.
Then choose the PROFINET device name from the drop down list and click the “Assign name” button.

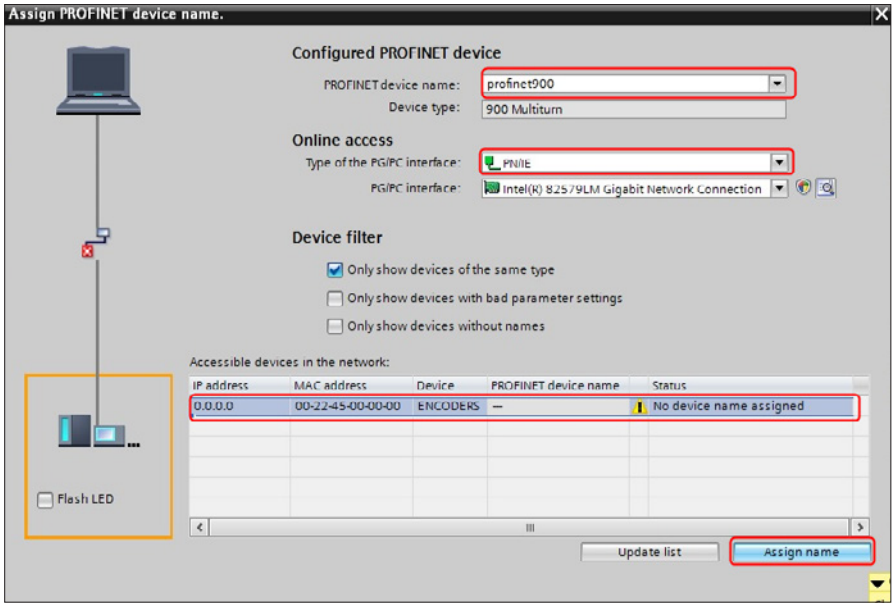


Figure 11 Assign PROFINET device name

If the assigning of the name went well, this will be indicated with a status “OK”.

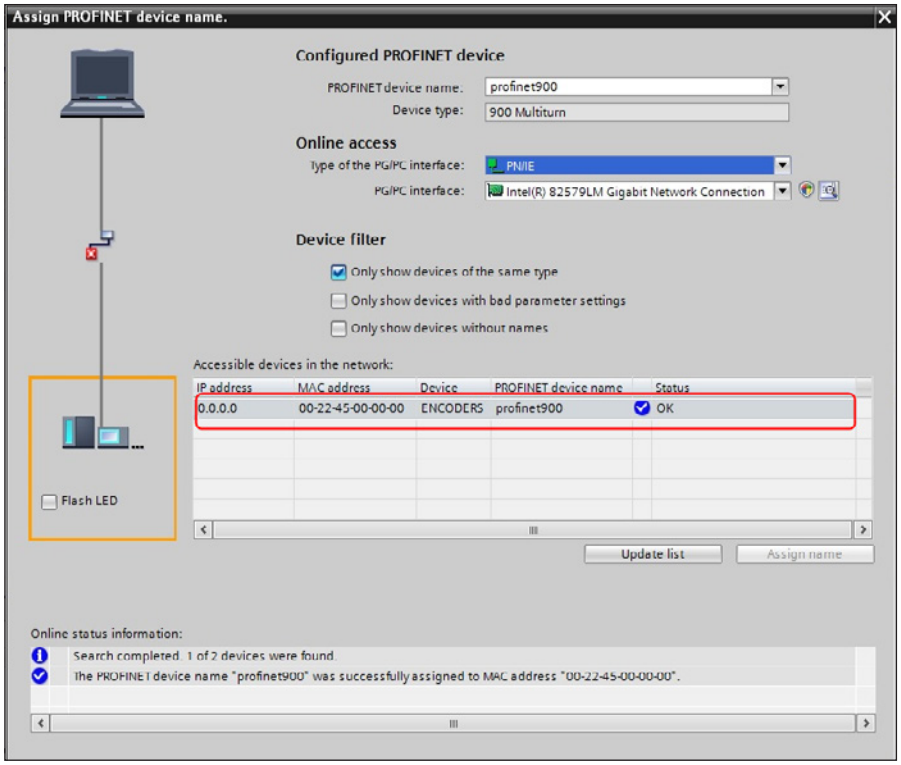


Figure 12 Assign name OK

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

5.6 Setting encoder parameters

This chapter describes how to change the module parameters in the encoder.
To set the encoder user parameters, click on the “Parameter Access Point” under the “Device” view. Then click Properties->General-> Module parameters.

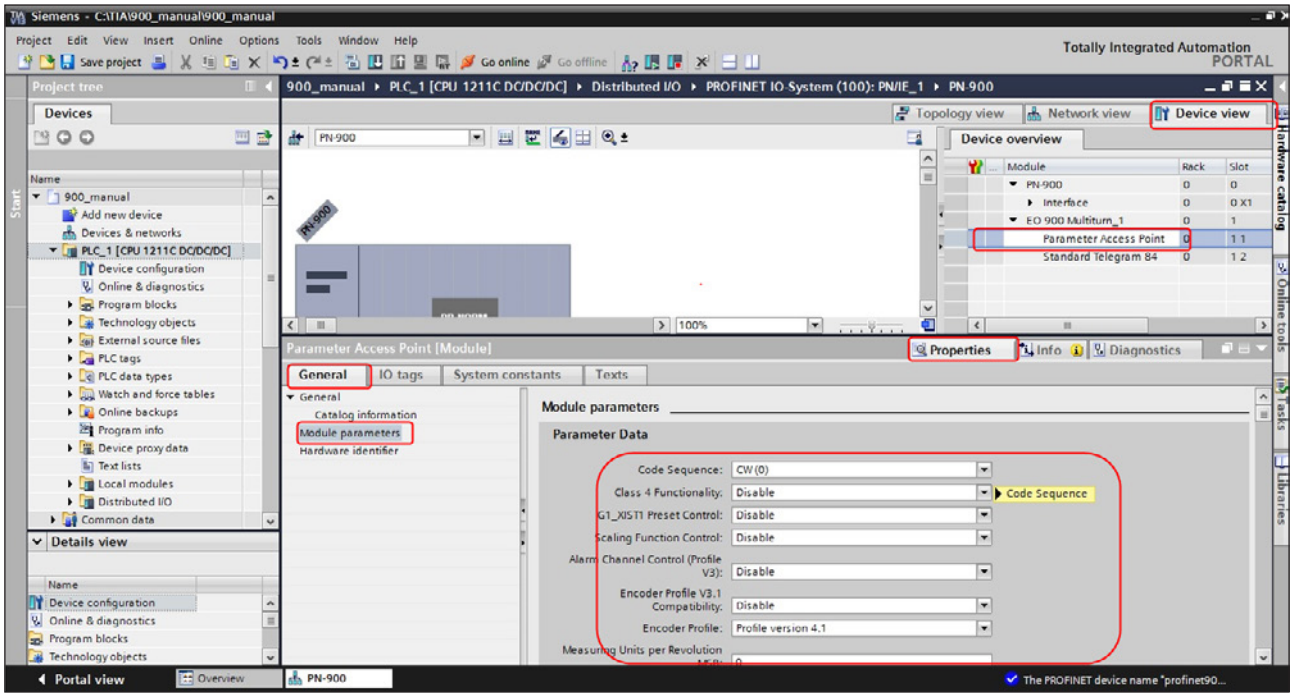


Figure 13 Setting encoder parameters

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 parameter data, see chapter 8.

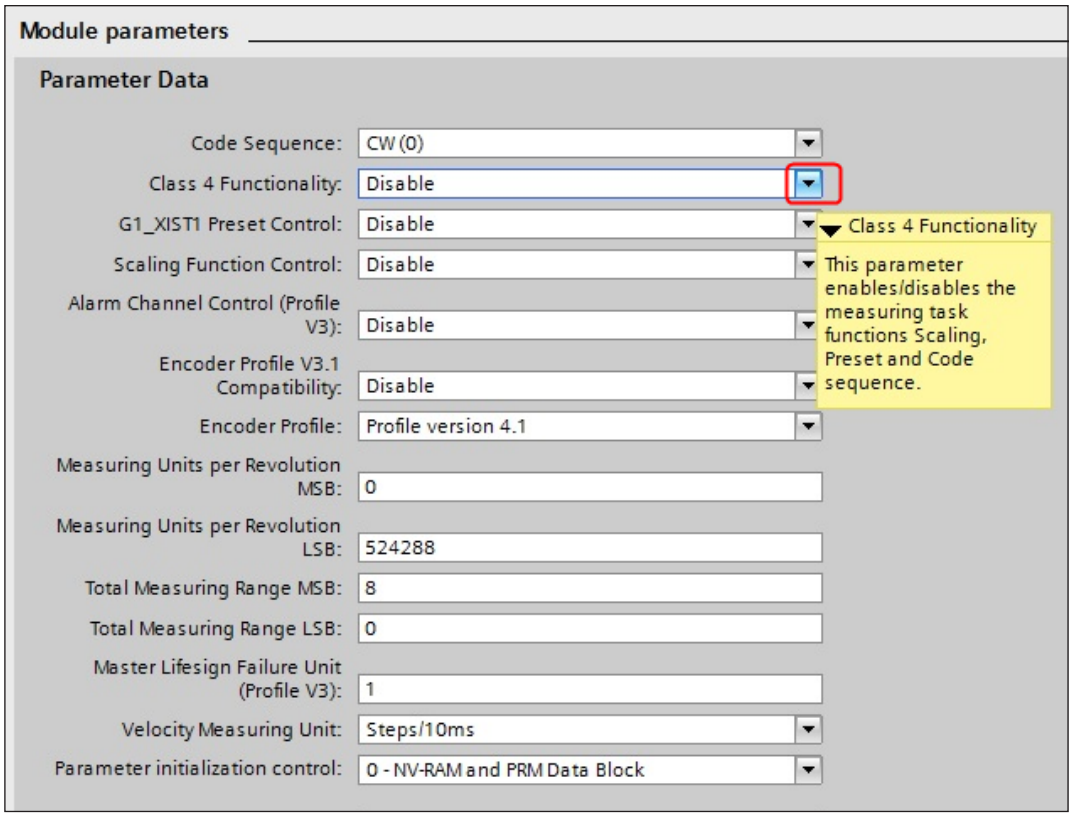


Figure 14 Example of parameter data

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

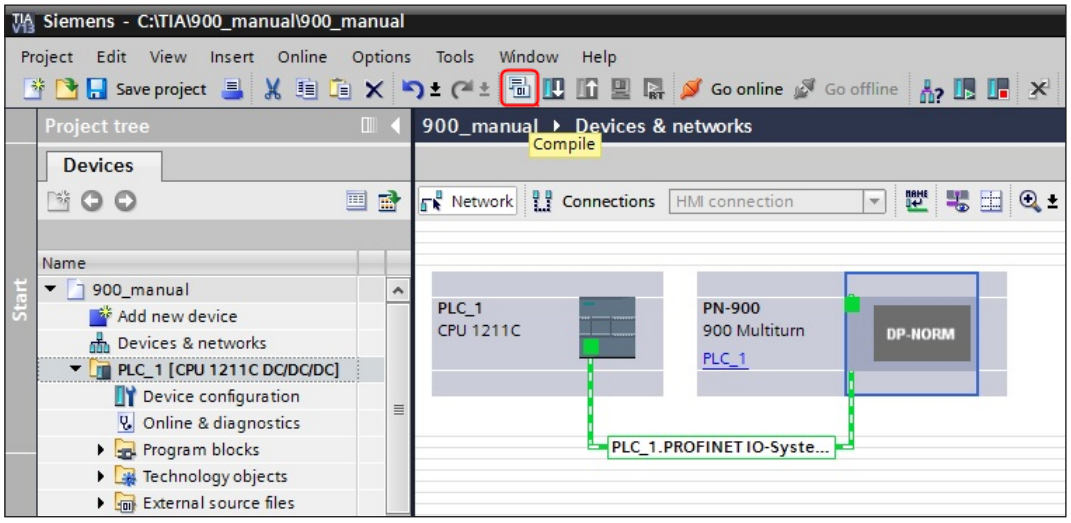


Figure 15 Compile

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

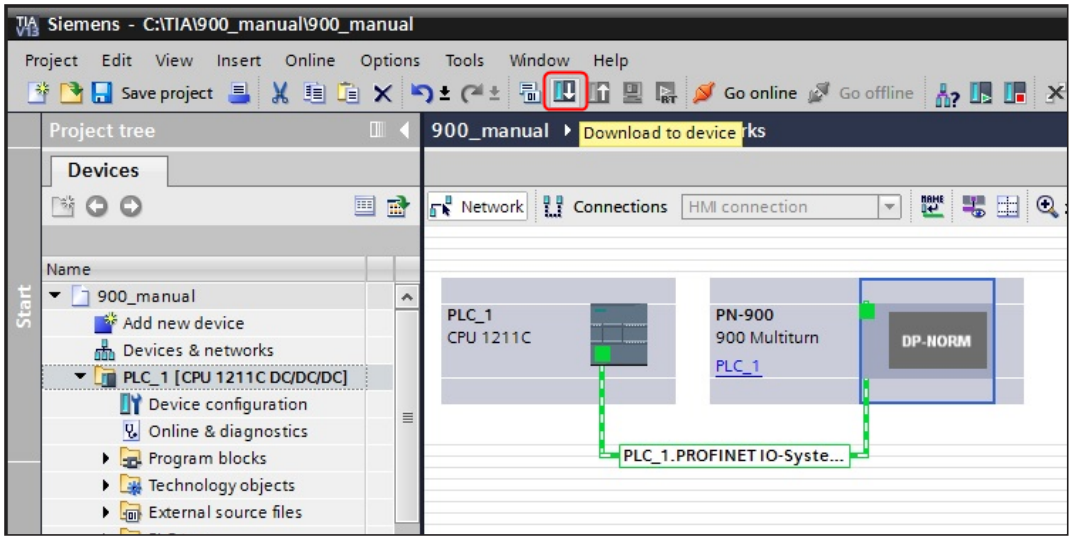


Figure 16 Download settings

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.
If everything went well, both the Module and Bus LED shall turn to green.

6 PROFINET IO data description

6.1 Encoder profile overview, PNO order no. 3.162

This manual relates to encoders that fulfill the demands and functionality according to Encoder profile V4.2 (PNO no 3.162). The operating functions for devices according to this profile are divided into four encoder application classes, named Class 1, Class 2, Class 3 and Class 4. For an overview of the different encoder profiles for PROFIBUS and PROFINET and the related standards, see the picture below.

For further information regarding the device functionality, refer to the device profile. The profile and PROFINET technical information can be ordered at PNO in Karlsruhe, Germany (www.profinet.com).

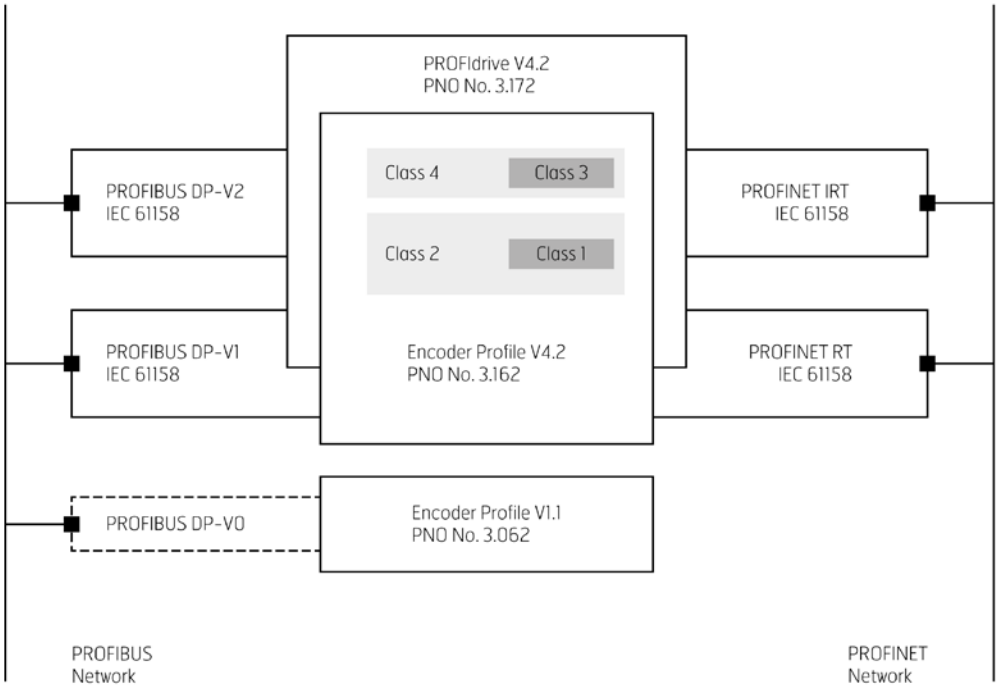


Figure 17 Overview of encoder profiles

6.2 Application Class definition

The PROFINET devices can be configured as a class 1, 2, 3 or class 4 PROFINET IO device according to the Encoder profile V.4.2.

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 base mode parameter access, preset functionality, velocity value and scaling functionality. Isochronous mode is not supported. Inherited from old PROFIBUS profile for DP-V0. Specially dedicated to General motion application.

CLASS 3 Device with base mode parameter access and limited parameterization of the functionality. Isochronous mode is not supported.

CLASS 4 Device with scaling, preset and base mode parameter access. Isochronous mode is supported. **Note! IRT is not supported by the 900 series PROFINET encoder**

6.3 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 6.

Significance	Abbreviation	Length (bits)	Data type
Velocity value A	NIST A	16	Signed
Velocity value B	NIST B	32	Signed
Control word	G1 STW	16	Unsigned
Status word	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

Table 5 Standard specific signals

6.4 Standard and manufacturer-specific telegrams

Configuration of PROFINET devices 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. 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 PROFINET 900 series encoders support the standard and manufacturer-specific telegrams according to the table below.

Telegram	Absolute encoder
Standard Telegram 81	Supported
Standard Telegram 82	Supported
Standard Telegram 83	Supported
Standard Telegram 84	Supported
Standard Telegram 86	Supported
Standard Telegram 87	Supported

Telegram	Absolute encoder
Standard Telegram 88	Supported
Standard Telegram 89	Supported
Manufacturer Telegram 59001	Supported
Manufacturer Telegram 59002	Supported

Table 6 Supported telegrams

6.5 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 7 Output data Telegram 81

Input data to the IO controller:
2 bytes Status word 2 (ZSW2 ENC).
2 bytes Status 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 8 Input data Telegram 81

6.6 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 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		G1 STW	

Table 9 Output data Telegram 82

Input data to the IO controller:
2 bytes Status word 2 (ZSW2 ENC).
2 bytes Status 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 10 Input data Telegram 82

Note: Avoid using telegram 82. Telegram 82 uses only a 16 bit velocity value and an overflow of the speed value is likely to occur.

6.7 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 11 Output data Telegram 83

Input data to the IO controller:
2 bytes Status word 2 (ZSW2 ENC).
2 bytes Status 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 12 Input data Telegram 83

6.8 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 13 Output data Telegram 84

Input data to the IO controller:
2 bytes Status word 2 (ZSW2 ENC)
2 bytes Status 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 XIST3								G1 XIST2				NIST B			

Table 14 Input 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.

6.9 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 and status words.

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

Table 15 Output data Telegram 86

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

Table 16 Input data Telegram 86

6.10 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.

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

Table 17 Output data Telegram 87

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

Table 18 Input data Telegram 87

6.11 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.

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

Table 19 Output data Telegram 88

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 20 Input data Telegram 88

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

6.12 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).

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

Table 21 Output data Telegram 89

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 22 Input data Telegram 89

6.13 Manufacturer Telegram 59001

The Manufacturer Telegram 59001 is a simplified telegram 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.

The preset function can be used to set the actual position of the encoder to any entered value within the working range of the encoder. If scaling is active and has been done on the device it is only possible to enter a preset value within the working range of the encoder.

The preset is activated when the most significant bit (bit 31) is set to 1. The actual preset value should be entered in the following bits according to below.

IO Data (word)	1			2	
Byte	0		1	2	3
Bits	31(MSB)	30-24	23-16	15-8	7-0(LSB)
	Preset control bit	Preset value < total resolution			

Table 23 Output data Telegram 59001

The Manufacturer Telegram 59001 input data consist of a 4 bytes position data value and a 4 byte velocity value as shown below. The velocity value uses the format that is defined in the Velocity measuring unit.

IO Data (word)	1		2		3		4	
Byte	0	1	2	3	4	5	6	7
Actual value	Position value 32 bit Unsigned int				Velocity value 32 bit Signed int			

Table 24 Input data Telegram 59001

Note: User parameter Class 4 functionality and G1 XIST1 Preset control, must be activated in order to activate the preset in Manufacturer Telegram 59001.

6.14 Manufacturer Telegram 59002

The manufacturer telegram 59002 is a simplified telegram 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.

The preset function can be used to set the actual position of the encoder to any entered value within the working range of the encoder. If scaling is active and has been done on the encoder it is only possible to enter a preset value within the scaled working range of the encoder.

The preset is activated when the Most significant Bit (bit 63) is set to 1. The actual preset value should be entered in the other following bits according to below.

Byte	0	1		2	3	4	5	6	7
Bits	63 (MSB)	62-56	55-48	47-40	39-32	31-24	23-16	15-8	7-0
	Preset control bit	Preset value < total resolution							

Table 25 Output data from IO-controller to encoder

The manufacturer telegram 59002 input data consist of an 8 byte position value and a 4 byte velocity value as shown below. The velocity value uses the format that is defined in the Velocity measuring unit.

IO Data (word)	0		1		2		3		4		5	
Byte	0 (MSB)	1	2	3	4	5	6	7 (LSB)	8 (MSB)	9	10	11 (LSB)
Actual value	Position value 64 Bit Unsigned int								Velocity value 32 Bit Signed int			

Table 26 Input data from encoder to IO-controller

Note: User parameter Class 4 functionality and G1_XIST1 Preset control must be activated in order to activate the preset in manufacturer telegram 59002.

6.15 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.

Example with absolute rotary encoder:
25-bit multi-turn absolute encoder (8,192 steps per revolution, 4,096 distinguishable revolutions).
M = Multi-turn value (distinguishable revolutions)
S = Single-turn value (number of steps per revolution)

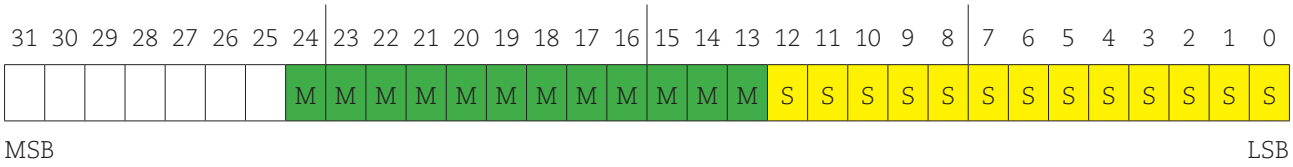


Figure 18 Absolute value in G1 XIST1

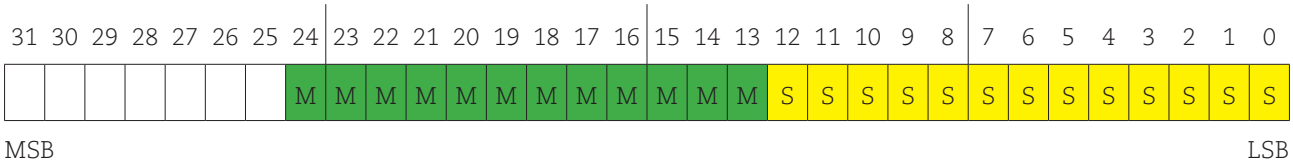


Figure 19 Absolute value in G1 XIST2

6.16 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			

Table 27 Format of G1 XIST3

6.17 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	7-0(LSB)
	Preset control bit	Preset value < total resolution			

Table 28 G1 XIST1 PRESET B

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

6.18 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	
Byte	0	1	2	3
	PRESET value			

Table 29 G1 XIST1 PRESET B1

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

6.19 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 30 G1 XIST1 PRESET C

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

6.20 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	Not supported
8, 9	Reserved
10	Control by PLC
11	Reserved
12...15	Controller Sign-of-Life

Table 31 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
10	1	Control by PLC	Control via interface, EO IO Data is valid.
	0	No Control by PLC	EO IO Data not valid, except Sign-of-Life
12...15	0 to 15	Controller Sign-of-Life	Received if isochronous operation is activated

Table 32 Detailed assignment of Control word 2 (STW2 ENC)

6.21 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 33 Status word 2 (ZSW2 ENC)

Bit	Value	Significance	Comments
0	1	Preset Acknowledge 0->1	The preset value was set as new position value.
	0	Idle	The encoder position offset value was stored in the encoder and the encoder is now ready for a new Preset operation.

Bit	Value	Significance	Comments
1	1	G1 XISTx position value is valid	This bit shows if there is a valid position value in the corresponding XISTx of a Class 1 or class 2 Telegram. This bit is only used for Telegram 89.
	0	G1 XISTx position value is invalid	This bit is only used for Telegram 89.
2	1	NISTx speed value is valid	This bit shows if there is a valid speed value in the corresponding NISTx of a Class 1 or class 2 Telegram. This bit is only used for Telegram 89.
	0	NISTx speed value is invalid	This bit is only used for Telegram 89.
3	1	Fault Present	At least one fault is present. The position value should be considered invalid.
	0	No Fault	
7	1	Warning Present	At least one warning is present. One or more critical limits are reach but all encoder functionality is still operable.
	0	No Warning	
9	1	Control requested	The automation system is requested to assume control.
	0	No Control requested	Control by the automation system is not possible.
12...15	0 to 15	Encoder Sign-of-Life	Send if isochronous operation is activated.

Table 34 Detailed assignment of Status word 2 (ZSW2 ENC)

6.22 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 35 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.

6.23 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
15	Sensor fault

Table 36 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.

6.24 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.
Note! IRT is not supported by the 900 series PROFINET encoders

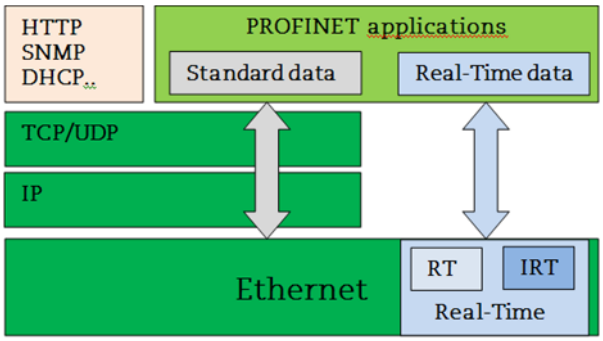


Figure 20 Real-time communication

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

REAL-TIME, RT CLASS 2

- Synchronized and unsynchronized data transmission
- Special switches supporting IRT is needed
- Typical application area: Factory automation

ISOCHRONOUS REAL-TIME, RT CLASS 3
Note! IRT is not supported by the 900 series PROFINET encoders

The isochronous operation mode is used when real-time positioning with high-performance is required. The basic principal is that all PROFINET 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

7 Alarms and warnings

7.1 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 position value. Alarms can be reset (deleted) once all encoder parameters are within the specified value ranges and the position value is correct.

7.2 Channel diagnostics

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

Supported channel diagnostic	Diagnostic data record	Description
Position error (hardware and signal quality)	0x9100	The device fails to read the correct position value
Memory error	0x9116	The device fails to read stored offset or preset values from the non-volatile memory
Commissioning diagnostics	0x9105	User parameter data assignment error
Master´s Sign-of-Life fault	0x910B	A master Sign-of-Life evaluation error was detected
Command not supported	0x910F	The activation of a non-supported function was detected

Table 37 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 (SFB54 RALRM for STEP 7). 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.

7.2.1 Extended channel diagnostics

The below table shows the manufacturer specific error types implemented.

Error code	Description
0x7FFF	Checksum incorrect
0x7FFE	Encoder missing (communication error)

Error code	Description
0x7FFD	Light source error
0x7FFC	Signal amplitude error
0x7FFB	Position error
0x7FFA	Overvoltage error
0x7FF9	Undervoltage error
0x7FF8	Overcurrent error
0x7FF7	Battery error
0x7FF6	Error value unknown

Table 38 Manufacturer-specific error types

7.3 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	0x0F02	The number of permissible failures of the controller's life sign was exceeded.

Table 39 Error codes in G1 XIST 2

8 Acyclic Parameter Data

8.1 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

8.2 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:

4. MAC address
5. Hardware Version
6. Software Version
7. Product type
8. Manufacturer ID

For more information regarding additional I&M functions supported by the encoder, refer to chapter 9.17.9.

8.3 Base Mode Parameter access

The PROFIdrive parameters and the encoder parameter 65000 can be accessed by the Acyclic Data Exchange service using the Base Mode parameter access local (Record Data Object 0xB02E).

8.3.1 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.

8.3.2 Parameter requests and responses

Request header:
Request ID, DO-ID and number of parameters of the access.

Parameter address:
One address for each parameter, if several parameters are accessed.

Parameter value:
If the Request ID is 0x02 (change value) the value is set in the request and if the Request ID is 0x01 (request value), the value appears in the reply.

8.3.3 Changing the preset value

The table below shows the structure of a change value request.

Write of Preset value, parameter 65000 Parameter request		
Request reference	0x00	
Request ID	0x02	0x02 → Write value
DO-ID (axis)	0x01	Drive Object ID
No. of parameters	0x01	
Attribute	0x10	0x10 → Value
No. of elements	0x00	
Parameter number	0xFDE8	Parameter 65000
Sub index	0x0000	
Format	0x04	Data type integer 32
Number of values	0x01	

Table 40 Changing the preset value

Note: Preset value should only be changed during standstill.

8.3.4 Reading the preset value

The tables below show the structure of a read value request.

Read of Preset value, parameter 65000 Parameter request		
Request reference	0x00	
Request ID	0x01	0x01 → read value
DO-ID (axis)	0x01	Drive Object ID
No. of parameters	0x01	0x01 Read one parameter
Attribute	0x10	0x10 → Value
No. of elements	0x00	
Parameter number	0xFDE8	Parameter 65000
Sub index	0x0000	

Table 41 Reading the preset value (request)

Read of Preset value, parameter 65000 Parameter request		
Request reference	0x00	Mirrored
Request ID	0x01	0x01 → read value
DO-ID (axis)	0x01	Mirrored
No. of parameters	0x01	
Format	0x04	0x04= Data type unsigned 32
No. of values	0x01	
Values or errors	0x00, 0x00, 0x00, 0x64	Preset value 100

Table 42 Reading the preset value (response)

8.4 Supported parameters

8.4.1 Parameter 922, read only

922 → unsigned16, presents which telegram is used. Telegram 81, 82, 83, 84, 86, 87, 88, 89, 59001 or 59002 is possible.

8.4.2 Parameter 925, read/write

925 → unsigned16, Number of Controller Sign-of-Life failures which will be tolerated

8.4.3 Parameter 964, read only

964 → Array unsigned32, 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)

8.4.4 Parameter 965, read only

965 → OctetString 2

965[0] = 0x3D → Profile number
965[1] = 31, 41 or 42 → Profile version, set by customer (module_parameters)

8.4.5 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.

8.4.6 Parameter 972, read/write

972 → unsigned16, Reset encoder device

Note: Only supported in Encoder profile V4.2 mode

8.4.7 Parameter 974, read only

974 → Array unsigned16, BMP access service identification

974[0] = Max block length
974[1] = Max number of parameter requests per multi-parameter request
974[2] = Max latency per request, (n x 10 ms)

8.4.8 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).

8.4.9 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

8.4.10 Parameter 980, read only

This parameter shows the supported parameters
980 → Array unsigned16

Note: Supported parameters depend on encoder profile configuration

8.4.11 Parameter 60000, read/write

Velocity reference value
60000 → Float 32
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.

8.4.12 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

8.4.13 Parameter 61000, read/write

Name of station
61000 → OctetString, 240 octets

8.4.14 Parameter 61001, read/write

IP of station
61001 → OctetString

8.4.15 Parameter 61002, read only

MAC of station
61002 → OctetString, 6 octets

8.4.16 Parameter 61003, read only

Default gateway of station
61003 → OctetString

8.4.17 Parameter 61004, read only

Subnet mask of station
61004 → OctetString

8.4.18 Parameter 65000, read/write

Preset value 32 bit.
65000 → Integer32

8.4.19 Parameter 65001, read only

65001 → Array Integer32, 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
65001[13] = Measuring units per revolution 64 bit (MSW)
65001[14] = Measuring units per revolution 64 bit (LSW)
65001[15] = Total measuring range in measuring units 64 bit (MSW)
65001[16] = Total measuring range in measuring units 64 bit (LSW)
65001[17] = Offset value 64 bit (MSW)
65001[18] = Offset value 64 bit (LSW)

8.4.20 Parameter 65002, read/write

Preset value 64 bit
65002 → Integer64

8.4.21 Parameter 65003, read only

Operating status 64 bit
65003 → Array integer64
65003[0] = 0x0000000000040101 → Header Version of parameter structure and numbers of index describing encoder. 4 index and version 1.01
65003[1] = Offset value 64 bit
65003[2] = Measuring units per revolution 64 bit
65003[3] = Total measuring range in measuring units 64 bit, (Linear =1)

Note: Only supported in Encoder profile V4.1 mode

8.4.22 Parameter 65004, read/write

Function control
65004 → Unsigned32

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

8.4.23 Parameter 65005, read/write

Parameter control
65005 → Unsigned16

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

8.4.24 Parameter 65006, read/write

Measuring units per revolution
65006 → Unsigned32

Note: Only supported in Encoder profile V4.2 mode

8.4.25 Parameter 65007, read/write

Total Measuring range in measuring units
65007 → Unsigned32

Note: Only supported in Encoder profile V4.2 mode

8.4.26 Parameter 65008, read/write

Measuring units per revolution 64 bit
65008 → Unsigned64

Note: Only supported in Encoder profile V4.2 mode

8.4.27 Parameter 65009, read/write

Total Measuring range in measuring units 64bit
65009 → Unsigned64

Note: Only supported in Encoder profile V4.2 mode

8.5 Example of reading and writing to a parameter

This is an example of S7 blocks used for reading and writing to parameter 65000 (preset value).
Experience with S7 programming and Statement List programming language STL is required.

Hardware components		
Controller	SIEMENS S7-F CPU	CPU 315F-2PN/DP
IO Device	PROFINET encoder	

Table 43 Hardware components

Software components	
SIMATIC STEP 7	V5.4 + SP5
GSDML file for PROFINET encoder	

Table 44 Software components

8.5.1 Used blocks

Request data block DB1
Response data block DB2
Instance data blocks DB3 and DB4
Organization blocks OB1
Read record block SFB52 RDREC
Write record block SFB53 WRREC

DB1
DB1 is the request data block.

Address	Name	Type	Initial value	Actual value	Comment
0.0	Request_reference	BYTE	B#16#1	B#16#01	request number
1.0	Request_ID	BYTE	B#16#2	B#16#02	request parameter = 1; change parameter = 2
2.0	Axis	BYTE	B#16#0	B#16#00	Axis addressing for multi-axis drives
3.0	No_of_parameters	BYTE	B#16#1	B#16#01	write 1 parameters
4.0	Attribute_parameter_01	BYTE	B#16#10	B#16#10	write value
5.0	No_of_elements_01	BYTE	B#16#1	B#16#01	number of elements 1
6.0	parameter_number_01	WORD	W#16#FDE8	W#16#FDE8	parameter 65000 (Preset value 32)
8.0	Subindex_01	WORD	W#16#0	W#16#0000	subindex
10.0	Data_type	BYTE	B#16#4	B#16#04	data type integer 32
11.0	No_of_values	BYTE	B#16#1	B#16#01	Number of values = number of elements
12.0	Value	DINT	L#0	L#33554176	Value Of 65000

Figure 21 Request data block, DB1

DB2
DB2 is the response data block.

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Request_reference_mirror	BYTE	B#16#0	request number mirrored
+1.0	Response_ID	BYTE	B#16#0	request parameter
+2.0	DOID_mirrored	BYTE	B#16#0	Axis mirrored
+3.0	No_of_parameters	BYTE	B#16#0	response about number of parameter
+4.0	Format_parameter_1	BYTE	B#16#0	response about parameter 1 format
+5.0	No_of_values_parameter_1	BYTE	B#16#0	response about number of value of parameter 1
+6.0	parameter_number_01	DWORD	DW#16#0	Read value p65000
=10.0		END_STRUCT		

Figure 22 Response data block, DB2

DB3
DB3 is the instance data block of SFB52

DB3 -- PN_WR_RD_PRESET_LL\SIMATIC 300(1)\CPU 315F-2PN/DP

	Address	Declaration	Name	Type	Initial value	Actual value
1	0.0	in	REQ	BOOL	FALSE	FALSE
2	2.0	in	ID	DWORD	DW#16#0	DW#16#0
3	6.0	in	INDEX	INT	0	0
4	8.0	in	MLEN	INT	0	0
5	10.0	out	VALID	BOOL	FALSE	FALSE
6	10.1	out	BUSY	BOOL	FALSE	FALSE
7	10.2	out	ERROR	BOOL	FALSE	FALSE
8	12.0	out	STATUS	DWORD	DW#16#0	DW#16#0
9	16.0	out	LEN	INT	0	0
10	18.0	in_out	RECORD	ANY	P#P 0.0 VOID 0	P#P 0.0 VOID 0

Figure 23 Instance data block, DB3

DB4
DB4 is the instance data block of SFB53

DB4 -- PN_WR_RD_PRESET_LL\SIMATIC 300(1)\CPU 315F-2PN/DP

	Address	Declaration	Name	Type	Initial value	Actual value
1	0.0	in	REQ	BOOL	FALSE	FALSE
2	2.0	in	ID	DWORD	DW#16#0	DW#16#0
3	6.0	in	INDEX	INT	0	0
4	8.0	in	LEN	INT	0	0
5	10.0	out	DONE	BOOL	FALSE	FALSE
6	10.1	out	BUSY	BOOL	FALSE	FALSE
7	10.2	out	ERROR	BOOL	FALSE	FALSE
8	12.0	out	STATUS	DWORD	DW#16#0	DW#16#0
9	16.0	in_out	RECORD	ANY	P#P 0.0 VOID 0	P#P 0.0 VOID 0

Figure 24 Instance data block, DB4

OB1
OB1 controls the read and write operation.

```
OB1 : "Main Program Sweep (Cycle)"
In network 1 and network 2 the user will see how to generate the request /
response DB for writing/reading p65000 using S7 standard function blocks
SFB53/53
easy handled by the VAT_1 vaiable table.

Network 1: Write request
With the SFB53 "WRREC" (write record) you transfer a data record with the
number INDEX to a DP slave device component defined by ID.

      A     M      8.4
      AN    M      8.1
      AN    M      8.3
      AN    M      8.2
      S     M      8.0
      L     W#16#B02E
      T     #INDEX


      CALL  "WRREC" , "InstanceDB_SFB53"    SFB53 / DB4        -- Write a Process Data Record
       REQ   :=M8.0
       ID    :=DW#16#7F7
       INDEX :=#INDEX
       LEN   :=16
       DONE  :=M14.0
       BUSY  :=M8.1
       ERROR :=M14.2
       STATUS:=MD10
       RECORD:=P#DB1.DBX0.0 BYTE 16



      A     M      8.1
      R     M      8.0

Network 2 : Read request
With the SFB52 "RDREC" (read record) you read a data record with the number
INDEX from a component.

      A     M      8.4
      AN    M      8.1
      AN    M      8.3
      AN    M      8.0
      S     M      8.2


      CALL  "RDREC" , "InstanceDB_SFB52"    SFB52 / DB3        -- Read a Process Data Record
       REQ   :=M8.2
       ID    :=DW#16#7F7
       INDEX :=#INDEX
       MLEN  :=10
       VALID :=M16.0
       BUSY  :=M8.3
       ERROR :=M16.2
       STATUS:=MD18
       LEN   :=MW22
       RECORD:=P#DB2.DBX0.0 BYTE 10



      A     M      8.3
      R     M      8.2
```

Figure 25 Organization block, OB1

SFB52
SFB52 is standard S7 block for reading parameters.

Parameters of SFB52

Parameter	Declaration	Data type	Description
REQ	INPUT	BOOL	REQ=1 Enables data transfer
ID	INPUT	DWORD	Logical address of the PROFINET IO module or sub module (PAP-module address 2039)
INDEX*	INPUT	INT	Record number
MLEN*	INPUT	INT	Maximum length of the record information in bytes
VALID	OUTPUT	BOOL	New record has been received and is valid.
BUSY	OUTPUT	BOOL	Busy=1 during the read operation
ERROR	OUTPUT	BOOL	Error=1 read error
STATUS	OUTPUT	DWORD	Block status or error code
LEN*	OUTPUT	INT	Length of record information
RECORD	IN_OUT	ANY	Target area for the record

*) Negative values are interpreted as 16-bit unsigned integers.

Table 45 Parameters of SFB52

SFB53

SFB53 is standard S7 block for writing parameters.

Parameters of SFB53

Parameter	Declaration	Data type	Description
REQ	INPUT	BOOL	REQ=1 Enables data transfer
ID	INPUT	DWORD	Logical address of the PROFINET IO module or sub module (PAP-module address 2039)
INDEX*	INPUT	INT	Record number
LEN*	INPUT	INT	Length of the record information in bytes
DONE	OUTPUT	BOOL	Data record was transferred
BUSY	OUTPUT	BOOL	Busy=1 during the write operation
ERROR	OUTPUT	BOOL	Error=1 write error
STATUS	OUTPUT	DWORD	Block status or error code
RECORD	IN_OUT	ANY	Data record

*) Negative values are interpreted as 16-bit unsigned integers.

Table 46 Parameters of SFB53

Diagnostic address

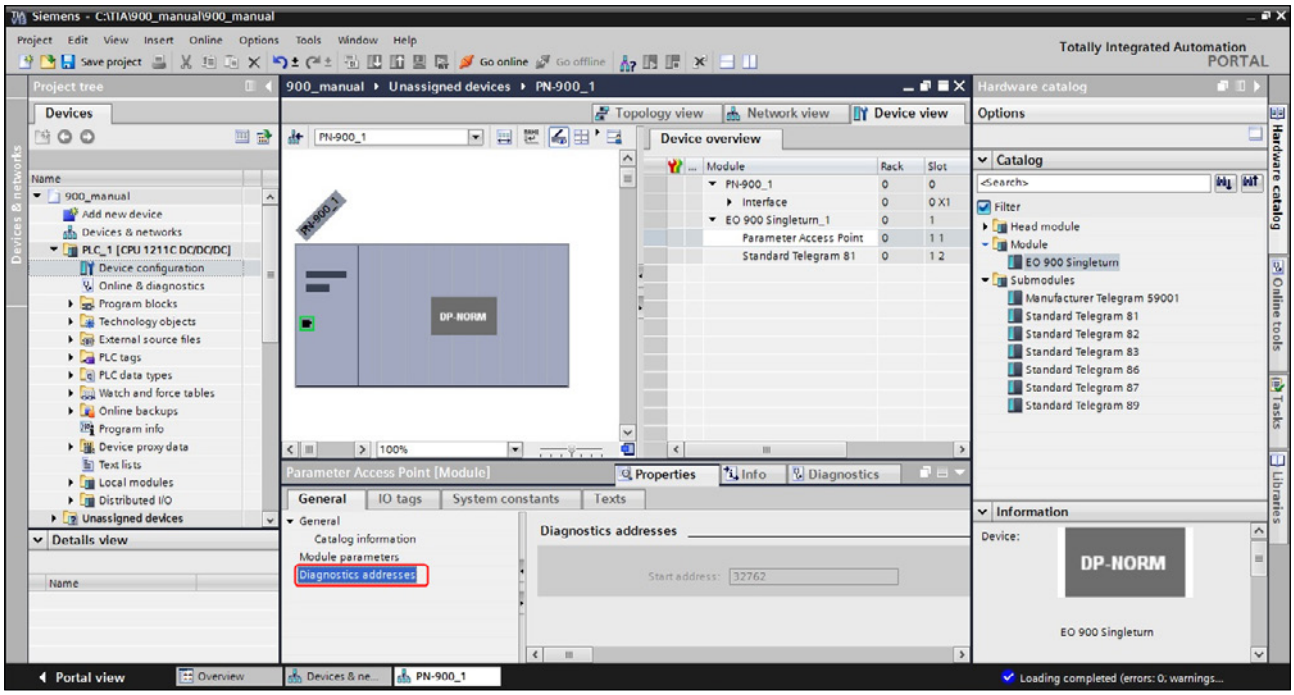


Figure 26 Diagnostic address of slot 1

Variable table

With the variable table the user can monitor and modify variables.

	Address	Symbol	Symbol comment	Display format	Status value	Modify value
1	// Enable parameter write/read 1=enabled					
2	M 8.4			BOOL	false	
3						
4	// The flag M8.1 shows if writing is not yet completed (BUSY = 1: The write process is not yet terminated)					
5	M 8.1			BOOL	false	
6	// ERROR = 1: A write error has occurred					
7	M 14.2			BOOL	false	
8	// Write block status or error information					
9	MD 10			HEX	DW#16#00700000	
10						
11	// The flag M8.3 shows if reading is not yet completed (BUSY = 1: The read process is not yet terminated)					
12	M 8.3			BOOL	false	
13	// ERROR = 1: A read error has occured					
14	M 16.2			BOOL	false	
15	// Read block status or error information					
16	MD 18			HEX	DW#16#00700000	
17						
18	// Position and control/status words					
19	PIW 2			HEX	W#16#0000	
20	PQW 2			HEX		W#16#1000
21	PIW 1			HEX	W#16#0000	
22	PQW 1			HEX		W#16#0400
23						
24	PID 4			HEX	DW#16#0001877E	
25	PID 8			HEX	DW#16#0001877E	
26						
27						
28						
29	// Write parameters:					
30	DB1.DBB 1	"Request_DB".Request_ID	request parameter = 1; change parameter = 2	HEX	B#16#02	
31	DB1.DBD 12	"Request_DB".Value	Write value 65000	HEX	DW#16#12345678	DW#16#12345678
32	DB2.DBD 6	"Respons_DB".parameter_number_01	Read value p65000	HEX	DW#16#00000000	
33						

Figure 27 Variable table

To change the value of parameter 65000 with the variable table perform the following steps:

1. Enable monitoring by clicking the “Monitor variable” button.
2. Write 02hex to address DB1.DBB 1 by entering B#16#02 in the “Modify value” column.
3. Write the new preset value in hexadecimal to address DB1.DBD 12 by entering the value in the “Modify value” column. (Ex.DW#16#000001F4)
4. Click the “Modify variable” button. The status value of DB1.DBB 12 should now contain the new value.
5. Run the program – right-click on “M8.4” and click “Modify address to 1” to run the program. Then stop the program by right-click and click “Modify address to 0”.
6. The status value of DB2.DBD 6 should now have been changed to the new preset value.
7. Change the value in DB1.DBB 1 to 01hex (B#16#01#) and click “Modify variable”.
8. To set the encoder to the new preset value bit 12 in control word must be set to 1. This is done by writing 1000hex (W#16#1000) to address PQW 2. Then click the button “Modify variable” to make the preset of the encoder.
9. The encoder can now at any time be set to the preset value by setting bit 12 in Control word (G1 STW).

9 Functional description of the device

The table below shows the supported functions in the PROFINET encoder.

Function	Encoder
Code sequence	√
Class 4 functionality	√
G1 XIST1 Preset control	√
Scaling function control	√
Alarm channel control	√
Encoder profile V3.1 compatibility	√
Encoder profile	√
Encoder type	√
Preset value	√
Preset value 64 bit	√
Measuring units per revolution/Measuring step	√
Total measuring range	√
Measuring units per revolution 64 bit	√
Total measuring range 64 bit	√
Velocity reference value	√
Maximum Master Sign-of-Life errors	√
Velocity measuring unit	√
Encoder profile version	√
Operating time	√
Offset value	√
Offset value 64 bit	√
Acyclic data	√

Table 47 Supported functions

9.1 Code sequence

Rotary encoder:
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).

Linear encoder:
The code sequence defines the direction count of the absolute position value. The code sequence is by default set to increase (CW) when the scale is traversed towards the right (viewed from ID-label side).

Attribute	Meaning	Value
CW	Rotary encoder: 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 48 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.

9.2 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 49 Class 4 functionality

9.3 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 50 G1 XIST1 Preset control

Note: This parameter is disabled by setting the value to 1.

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

9.4 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 51 Scaling function control

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

9.5 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 52 Alarm channel control

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

9.6 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 backward-compatibility

Table 53 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)	41(V4.1)/42(V4.2)

Table 54 Compatibility mode overview

9.7 Encoder profile

This parameter defines if the encoder functionality shall be according to Encoder profile 3.162 V4.1 or Encoder profile 3.162 V4.2.

Attribute	Meaning	Value
Profile version V4.1	Functionality according to Profile V4.1	0
Profile version V4.2	Functionality according to Profile V4.2	1

Table 55 Encoder profile

9.8 Encoder type

The parameter 65001 subindex 1 bit 6 defines if the encoder is a rotary or linear encoder.

Attribute	Meaning	Value
Rotary encoder	Encoder resolution is measured in number of increments per turn	0
Linear encoder	Encoder resolution is measured in number nm per increment	1

Table 56 Encoder type

9.9 Preset value

The preset value function enables adaptation of the position value from the encoder to a known mechanical reference point of the system. The preset function sets the actual position of the encoder to zero (= default value) or to the selected preset value. Depending on the telegram used, the preset function is either controlled by bits in the Control word or by a preset trigger bit in Control word 2 (STW2 ENC) or directly set in the output data with some telegrams. A preset value can be set more than once and it can be stored to the non-volatile memory using PROFIdrive parameter 971.

The preset function has an absolute and a relative operating mode selectable by bit 11 in the Control word (G1 STW). Bit 11 and bit 12 in the Control word controls the preset in the following way.

Normal operating mode: Bit 12 = 0
In this mode, the encoder will make no change in the output value.

Preset mode absolute: Bit 11 =0, Bit 12 = 1
In this mode, the encoder reads the current position value and calculates an internal offset value from the preset value and the current position value. The position value is then shifted with the calculated offset value to get a position value equal to the preset value. No preset will be made if a negative preset value is used while trying to initiate an absolute preset.

Preset mode relative: Bit 11 =1, Bit 12 = 1
In this mode the position value is shifted by the preset value, which could be a negative or a positive value set by encoder parameter 65000 or 65002.

The steps below should be followed by the IO-controller when modifying the Preset value parameters:

1. Read the requested Preset value parameter and check if the returned value meets the application requirements. If not, proceed with the following steps.
2. Write the Preset value into the individual parameter.
3. Store the value in the non-volatile memory by PROFIdrive parameter 971 if the value should be valid also after the next power on sequence.

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

Note: The number of possible preset cycles is unlimited.

Note: If scaling is used the preset function shall be used after the scaling function to ensure that the preset value is entered in the current measuring unit.

Note: There is no preset activated when the preset value is written to the encoder. How the preset is controlled depends on the telegram used.

Note: Preset can also be done with encoder specific Parameter 65000 or 65002 (64bit).

9.10 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 securely stored in the IO-controller and are reloaded into the encoder at each power-up.

9.10.1 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.

Example:
For a 13-bit encoder with a single-turn resolution of 13 bits, the permissible value range for "Measuring units per revolution" is between 2^0 and 2^{13} (8192).

Parameter	Meaning	Data type
Measuring units per revolution	The single-turn resolution in measuring steps	Unsigned 32
Measuring units per revolution 64 bit	The single-turn resolution in measuring steps for encoders with a resolution exceeding 32 bits.	Unsigned 64

Table 57 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.

9.10.2 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.

Example:
The total measuring range for a 25 bit multi-turn encoder with a 13 bit single-turn and a 12 bit multi-turn resolution is between 2^0 and 2^{25} (33 554 432).

The total measuring range is calculated as below:

Measuring units per revolution x Total measuring range
= 8192 (2^{13}) x 4096 (2^{12})
= 33554432
If the total measuring range for the encoder is higher than 31 bit, telegram 84 or telegram 88 shall be used.
The device has two different operating modes, depending on the specified measuring range. When the device receives a parameter message, it checks the scaling parameters if a binary scaling can be used. If binary scaling can be used, the device selects operating mode A (see following explanation). If not, operating mode B is selected.

A. Cyclic operation (binary scaling)
Cyclic operation is used when operating with 2^X number of turns (2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096... number of turns). If the desired total measuring range is equal to the specified single-turn resolution * 2^X (where x<= 12) the encoder operates in endless cyclic operation (0 - max - 0 -max). If the position value increases above the maximum value by rotating the encoder shaft, the encoder continues from 0.

Example of a cyclic scaling:
Measuring units per revolution = 1 000
Total measuring range = 32 000
(2^5 = number of revolutions 32)

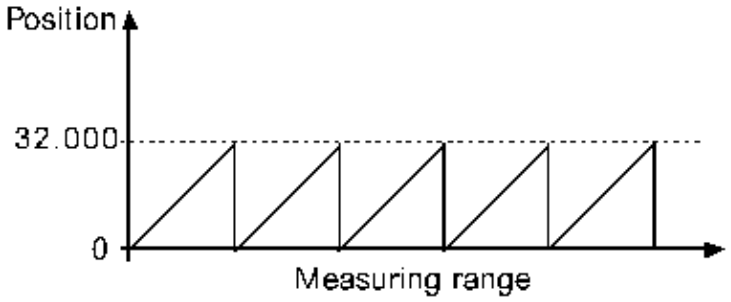


Figure 28 Cyclic operation

B. Non-cyclic operation
If the desired total measuring range is not equal to the specified single-turn resolution * 2X (where x<= 12) the encoder operates in non-cyclic operation. The non-cyclic operation is affected by the parameter G1 XIST1 Preset control as described below.

G1 XIST1 Preset control = Enabled
If the position value increases or decreases outside the maximum value or below 0 with the parameter G1 XIST1 Preset control enabled, the device outputs the maximum position value within the scaled total range for both position values G1 XIST1 and G1 XIST2.

Example of non-cyclic scaling with G1 XIST1 Preset control enabled:
Measuring units per revolution = 100
Total measuring range = 5000
(number of revolutions 50)

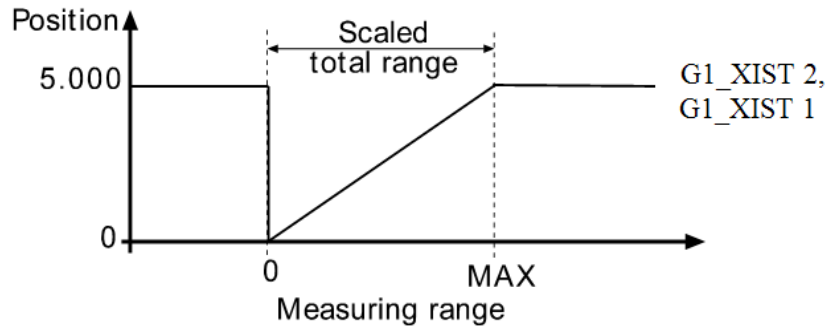


Figure 29 Non cyclic operation, preset control enabled

G1 XIST1 Preset control = Disabled
With the parameter G1 XIST1 disabled, and if the position value increases or decreases outside the maximum value or below 0, the device will output the maximum position value within the scaled total range for the posi-

tion value G1 XIST2. The position value G1 XIST1 is not limited to the scaled total range. For the position value G1 XIST1, the device will continue to output a scaled position value within the encoder's total measuring range (up to 33554432 positions for a 25 bit encoder).

Example of non-cyclic scaling with G1 XIST1 Preset control disabled:
Measuring units per revolution = 100
Total measuring range = 5000 (number of revolutions 50)

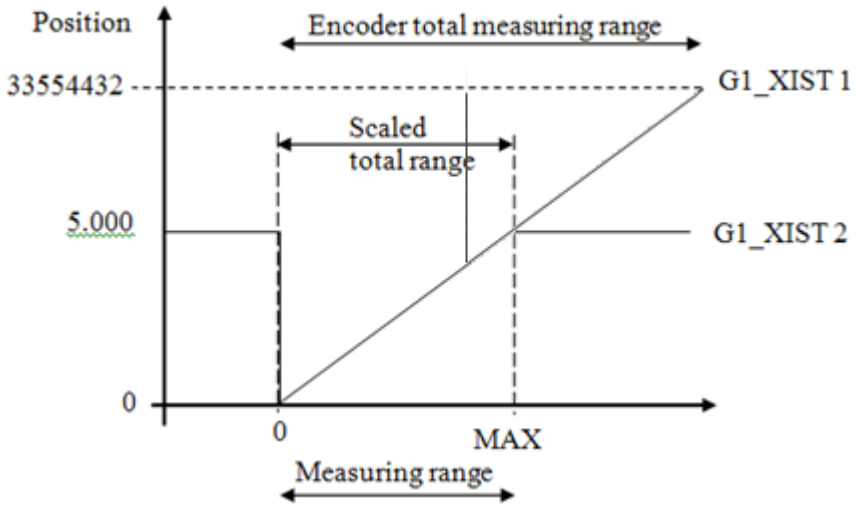


Figure 30 Non-cyclic operation, preset control disabled

Handling 64 bit data
Siemens hardware configuration tool does not support 64 bit data type, so when writing larger numbers than 32 bit into the configuration tool, this needs to be done according to below:

Example:
Total measuring range in measuring units = 2^{36}

MSB LSB
2^{36} = 68719476736 = 0x 00 00 00 10 00 00 00 00
4 byte = 32 bit 4 byte = 32 bit

Take the 4 least significant bytes above and convert to decimal:
→ 0x00 00 00 00 = **0** = Total measuring range LSB

Then take the 4 most significant bytes above and convert to decimal:
→ 0x00 00 00 10 = **16** = Total measuring range MSB

In the configuration software enter the decimal values:
Total measuring range LSB = **0**
Total measuring range MSB = **16**

9.11 Velocity reference value

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

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

9.12 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

Table 58 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.

9.13 Velocity measuring units

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 and manufacturer specific telegram 59001 and 59002 includes velocity output and needs a declaration of the velocity measuring unit.

Parameter	Meaning	Value
Velocity measuring units	Definition of the units for the encoder velocity output value	See below
Velocity measuring units for encoder		**Value**
Steps/s		0
Steps/100 ms		1
Steps/10 ms		2
RPM		3
N2/N4 normalized		8

Table 59 Velocity measuring units for encoders

The velocity calculations are made with a maximum of 19 bits resolution. If the resolution is higher than 2^{19}, the value used for velocity calculations is automatically reduced to 2^{19}.

Example:
For a 37 bit multi-turn encoder with a 225 single-turn resolution and a 212 multi-turn resolution, the maximum single-turn value for velocity calculations will be 219. For a single-turn encoder the maximum resolution can be up to 31 bit, but the value used for velocity calculations will in this case also be 219.

Note: In case of the steps/s unit, an average is made over 200 ms and the value is multiplied by 5.

Note: Avoid using telegram 82. Telegram 82 uses only a 16 bit velocity value and an overflow of the speed value is likely to occur.

9.14 Encoder profile version

The Encoder Profile Version is the version of the encoder profile document implemented in the device.
This parameter is not affected by the Compatibility mode settings.

Bits	Meaning
0...7	Profile Version, least significant number, (value range: 0-99), decimal coding
8...15	Profile Version, most significant number, (value range: 0-99), decimal coding
16...31	Reserved

Table 60 Encoder profile

9.15 Operating time

The operating time monitor stores the operating time for the device in operating hours. The operating time is saved every six minutes in the non-volatile memory in the device. This happens as long as the device is powered on.

If the operating time function is not used the operating time value is set to the maximum value (0xFFFF FFFF).

Parameter	Meaning	Data type
Operating time	The accumulated power on time	Unsigned 32

Table 61 Operating time

9.16 Offset value

The offset value is calculated in the preset function and shifts the position value with the calculated value. The offset value is stored in a non-volatile memory and can be read from the device at any time. The data type for the offset value is a 32 bit or 64 bit binary value with sign, whereby the offset value range is equal to the measuring range of the device.

The preset function is used after the scaling function. This means that the offset value is indicated according to the scaled resolution of the device.

Parameter	Meaning	Data type
Offset value	The offset value for encoders with a measuring range of maximum 32 bits	Integer 32
Offset value 64 bit	The offset value for encoders with a measuring range exceeding 32 bits	Integer 64

Table 62 Offset value

Note: The offset value is read only and cannot be modified by a parameter write access.

9.17 Acyclic data

The devices supports the following acyclic data exchange functions: write parameter, read parameter.

9.17.1 PROFIdrive parameters

The following PROFIdrive parameters are supported:

PNU (Prm.no)	Significance	Data type	Read/Write
922	Telegram selection	Unsigned 16	R
925	Number of Controller Sign-of-Life failures which may be tolerated.	Unsigned 16	R/W
964	Drive Unit identification	Array[n] Unsigned 16	R
965	Profile identification number	Octet string 2	R
971	Transfer to non-volatile memory	Unsigned 16	W
972	Reset encoder device Note: Only available when the encoder is configured according to Encoder profile 4.2.	Unsigned 16	R/W
974	Base Mode Parameter Access service identification	Array[n] Unsigned 16	R
975	Encoder object identification	Array[n] Unsigned 16	R
979	Sensor format	Array[n] Unsigned 32	R
980	List of supported parameters	Array[n] Unsigned 16	R

Table 63 Supported PROFIdrive parameters

9.17.2 Encoder parameter numbers

The table below specifies the device specific parameter that is supported.

PNU (Prm.no)	Significance	Data type	Read/Write
60000	N2/N4 Velocity reference value	Float 32	R/W
60001	Velocity value normalization	Unsigned 16	R/W
61000	Name of station	Octet String [240]	R
61001	IP of station	Unsigned 32	R
61002	MAC of station	Octet String[6]	R
61003	Default gateway of station	Unsigned 32	R
61004	Subnet Mask Of Station	Unsigned 32	R
65000	Preset value	Integer 32	R/W
65001	Operating status	Array [n] Integer 32	R
65002	Preset value 64 bit	Integer 64	R/W
Additional parameters available when the encoder is configured according to the Encoder profile V.4.1. (See chapter 9.7 Encoder Profile)			
65003	Operating status 64 bit	Array [n] Integer 64	R

Table 64 Device specific parameter

9.17.3 Parameter 65000 and 65002 – Preset value

The parameter 65000 and 65002 sets the value for the preset function. The parameter 65002 should be used if the preset value exceeds 32 bits.

PNU	65000
Significance	Preset value
Data type	Integer 32
Access	Read and write
Explanation	The preset value sets the value for the preset function. The preset value can be stored in the non-volatile memory by PROFIdrive parameter 971 and will be re-loaded at each start-up if stored.

Table 65 Parameter 65000, Preset value

PNU	65002
Significance	Preset value
Data type	Integer 64
Access	Read and write
Explanation	The preset value sets the value for the preset function. The preset value can be stored in the non-volatile memory by PROFIdrive parameter 971 and will be re-loaded at each start-up if stored.

Table 66 Parameter 65002, Preset value 64 bit

9.17.4 Parameter 65001 – Operating status

This parameter structure is a read only structure where information on the device operating status can be found. It is a complement to the PROFIdrive parameter 979 described in the Profile for Drive Technology.

PNU	65001
Significance	Encoder Operating Status
Data type	Array[n] Integer 32
Access	Read
Explanation	The operating status displays the status of the encoder.

Table 67 Parameter 65001, Operating status

Sub index	Meaning
0	Header
1	Operating status
2	Faults
3	Supported Faults
4	Warnings
5	Supported warnings
6	Encoder profile version
7	Operating time
8	Offset value
9	Measuring units per revolution
10	Total measuring range in measuring units
11	Velocity value normalization

Sub index	Meaning
Sub-indices 12..18 are only available when the encoder is configured according to the Encoder profile version V.4.2. (See chapter 9.7 Encoder profile)	
12	Velocity reference value
13	Measuring units per revolution 64bit MSW
14	Measuring units per revolution 64bit LSW
15	Total measuring range in measuring units 64 bit MSW
16	Total measuring range in measuring units 64 bit LSW
17	Offset value 64 bit MSW
18	Offset value 64 bit LSW

Table 68 Parameter 65001, Sub index

Sub index 1: Operating status
In sub index 1 the status of different encoder functions can be read out. The mapping of the respective functions is according to the table below.

Bits	Definition
0	Code sequence
1	Class 4 functionality
2	G1 XIST1 Preset control
3	Scaling function control
4	Alarm channel control
5	V3.1 Compatibility mode
6	Encoder type
7...27	Reserved for future use
28...31	Reserved for manufacturer

Table 69 Parameter 65001, Sub index 1

9.17.5 Device specific parameter 65003 – Operating status 64-bit

The parameter 65003 is only available when the encoder is configured according to Encoder profile V4.1. (See chapter 9.7 Encoder profile).

Parameter 65003 is a read only parameter where information on the 64 bit parameter values can be found.

PNU	65003
Significance	Operating Status 64 bit
Data type	Array[n] Integer 64
Access	Read
Explanation	The status of operating parameters with 64 bit length.

Table 70 Parameter 65003, Operating status 64 bit

Sub index	Meaning
0	Header
1	Offset value 64 bit
2	Measuring units per revolution 64 bit
3	Total measuring range in measuring units 64 bit

Table 71 Parameter 65003

9.17.6 Parameter 65004 Function control

The setting of the Function control parameter permits or locks the encoder-related functionalities. For more detailed information about the bit definition refer to chapter 9.1-9.9.

PNU	65004
Significance	Function control
Data type	Unsigned 32
Access	Read/write
Explanation	This parameter configures position acquisition related functionality

Table 72 Parameter 65004, Function control

Bits	Definition
0	Code sequence
1	Class 4 functionality
2	G1 XIST1 Preset control
3	Scaling function control
4	Alarm channel control

Bits	Definition
5	V3.1 Compatibility mode
6	Encoder type
7...31	Reserved

Table 73 Parameter 65004 Bit definition

9.17.7 Parameter 65005 Parameter control

The parameter 65005 controls the run-up initialisation of the encoder parameters and the online write access on the encoder parameters via the BMP parameter channel.

PNU	65005
Significance	Parameter control
Data type	Unsigned 16
Access	Read/write
Explanation	This parameter configures all available parameter initialization and access functionality

Table 74 Parameter 65005 Parameter control

Bits	Definition
0-1	Parameter initialization control
2-4	Parameter write protect
5	Parameter 65005 write protect
6	Reset control write protect
7...15	Reserved

Table 75 Parameter 65005 bit definition

Bit	Value	Attribute	Comments
0-1	0	PRM	Initialisation of parameter set out of PRM Data Block enabledIni
	1	NV-RAM	Only initialization via internal NV-RAM
2-4	0	Write all	Write/read access to all parameters
	1	Read only	Read access to all parameters. (Parameter 971, 972 and 65005 excluded)

Bit	Value	Attribute	Comments
5	0	Write all	Write/read access to 65005 and 971
	1	Read only	Read access to 65005 and 971
6	0	Write all	Reset control via 972 enabled
	1	Read only	Reset control via 972 disabled
7...15	Reserved		

Table 76 Parameter 65005 detailed bit definition

9.17.8 Parameter 65006-65009 Scaling function

With these parameters the encoder's internal numerical value is converted by software to change the resolution of the encoder.

Parameter	Meaning	Data type
65006	Measuring units per revolution/Measuring step: The single-turn resolution in measuring steps	Unsigned 32
65007	Total measuring range in measuring units: The total absolute measuring range in measuring steps	Unsigned 32
65008	Measuring units per revolution 64 bit: The single-turn resolution for rotary encoders with a resolution exceeding 32 bits per revolution	Unsigned 64
65009	Total measuring range in measuring units 64bit: The total absolute measuring range for encoders with a range exceeding 32 bits	Unsigned 64

Table 77 Parameters 65006-65009 Scaling function

9.17.9 Identification & Maintenance functions (I&M function)

In addition to the PROFIdrive parameter 964, Device Identification, I&M functions are supported by the devices. The I&M functions can be accessed with record index 0xAFF0-0xAFF4.
The following I&M functions are supported:

I&M Parameter	Octets	Comment
Header		
Manufacturer specific	10	Not used
I&M Block		
MANUFACTURER_ID	2	Manufacturer Id
ORDER_ID	20	Part number

I&M Parameter	Octets	Comment
SERIAL_NUMBER	16	Serial number
HARDWARE_REVISION	2	Hardware revision
SOFTWARE_REVISION	4	Software revision
REVISION_COUNTER	2	Not used
PROFILE_ID	2	Profile number
PROFILE_SPECIFIC_TYPE	2	Type of device
IM_VERSION	2	Versions of the I&M profile
IM_SUPPORTED	2	Value = 0 means support of I&M

Table 78 Identification & Maintenance

10 Firmware upgrade

The Leine Linde encoders support a firmware upgrade function. The firmware upgrade function has been developed to offer the possibility to upgrade the device to the latest released firmware. For more information regarding the firmware upgrade function, please contact Leine Linde.

The update is performed with a PC software with an interface as figure below. The PC software is available from Leine Linde. The below procedure for firmware upgrade is only valid for encoders with change index A or later. For more information about change index, refer to chapter 4.5.

Note: Please contact Leine Linde for firmware upgrade of older encoders, without change index.

The following steps shall be followed to perform a firmware upgrade:

1. Make sure that you have the firmware upgrade PC software and a valid *.bin firmware file.
2. Make sure that the device has a valid IP-address set.
3. Connect the device to the PC where the Firmware upgrade tool is located.
4. Click on the “Open file” tab and browse to the location of the firmware *.bin file.
5. Enter the IP-address of the encoder in the IP-address field.
6. Click on the “Update” button.
7. Once the update is finished this is indicated in the status field with the text “Firmware updated successfully”.

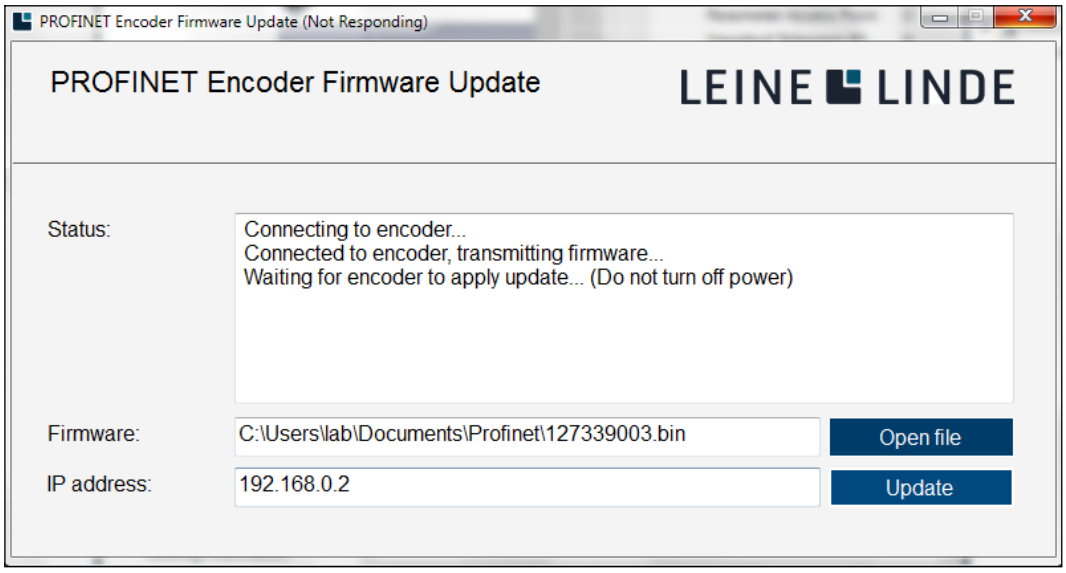


Figure 31 Firmware upgrade PC software running

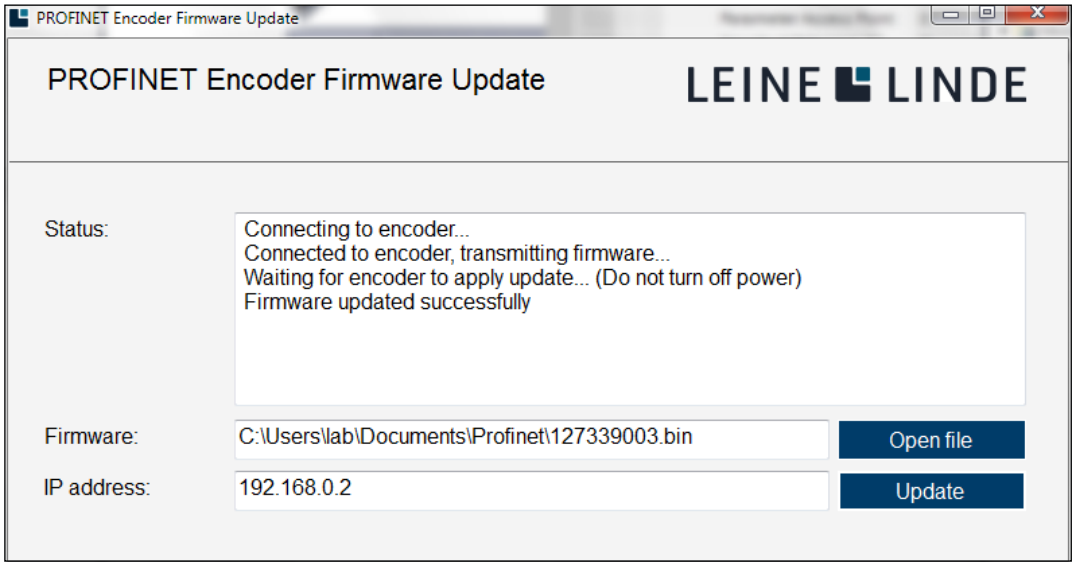


Figure 32 Firmware upgrade PC software completed

11 Media Redundancy Protocol (MRP)

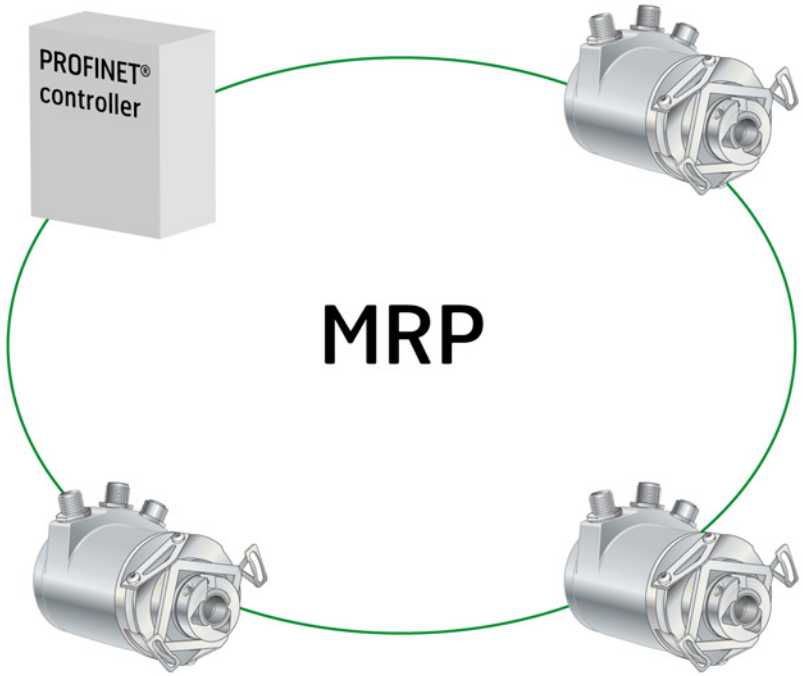


Figure 33 MRP

Ring redundancy is supported by the Leine Linde encoder through the Media Redundancy Protocol (MRP). 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.

12 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”.

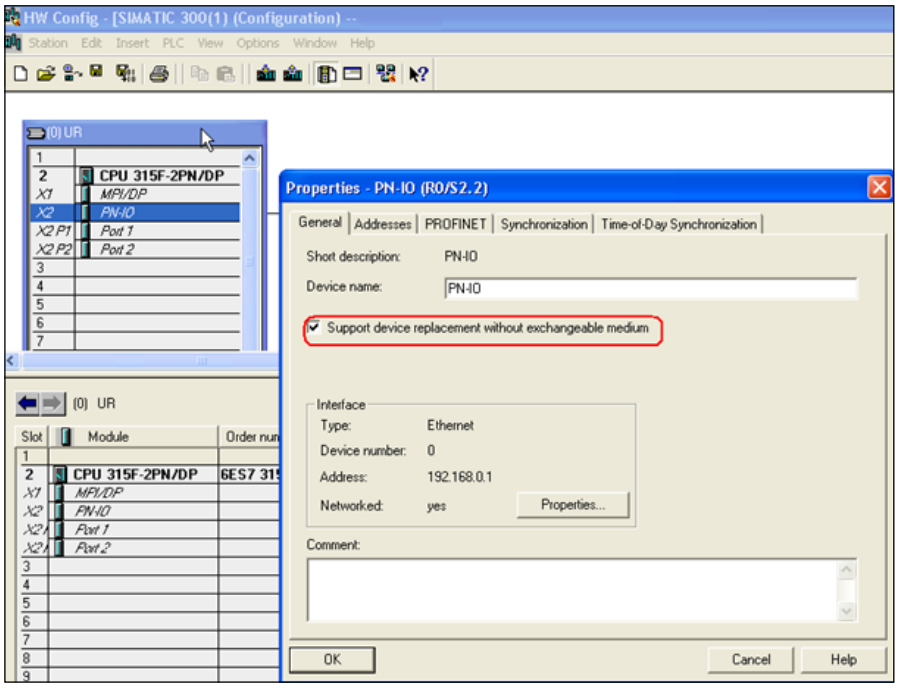


Figure 34 LLDP Properties

Configure the topology of the system for all connected ports.

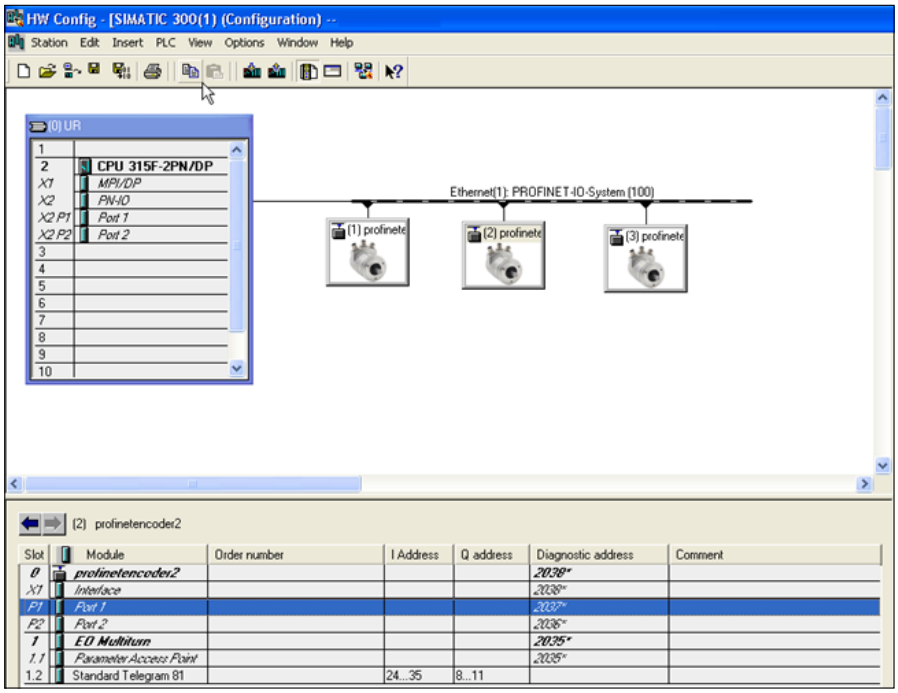


Figure 35 LLDP Port configuration

In the “Properties” window, select the corresponding partner port.

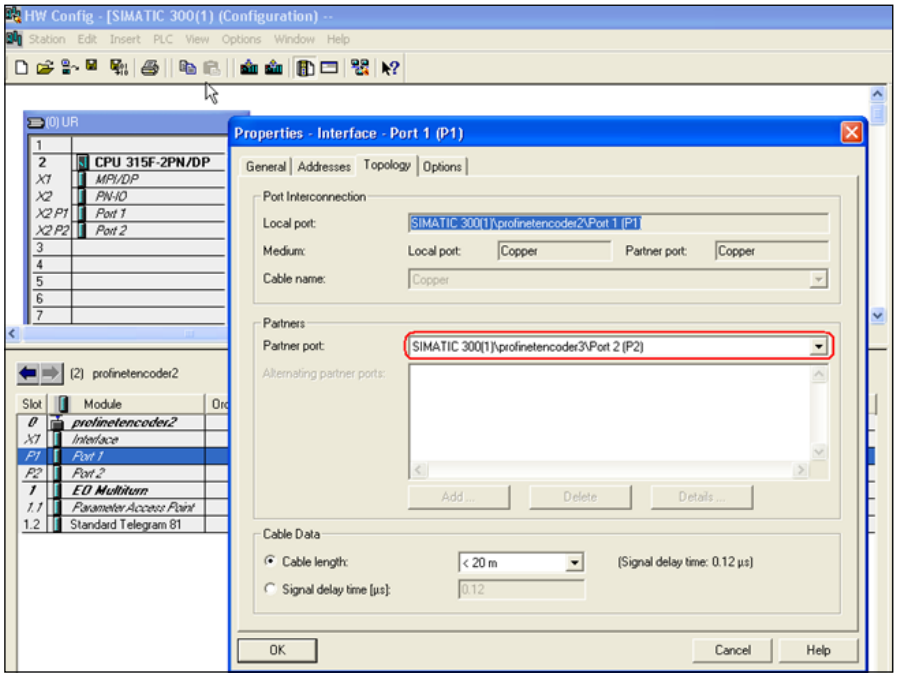


Figure 36 LLDP Partner port settings

Then select Edit -> PROFINET IO -> Topology to open the “Topology editor”.

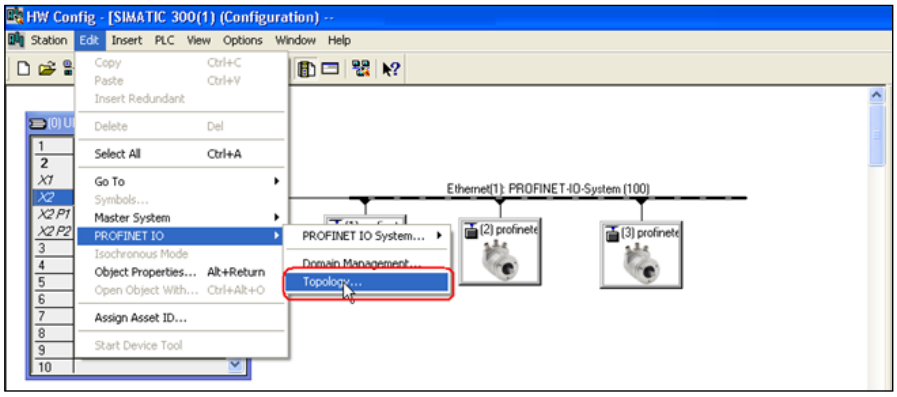


Figure 37 Open Topology editor

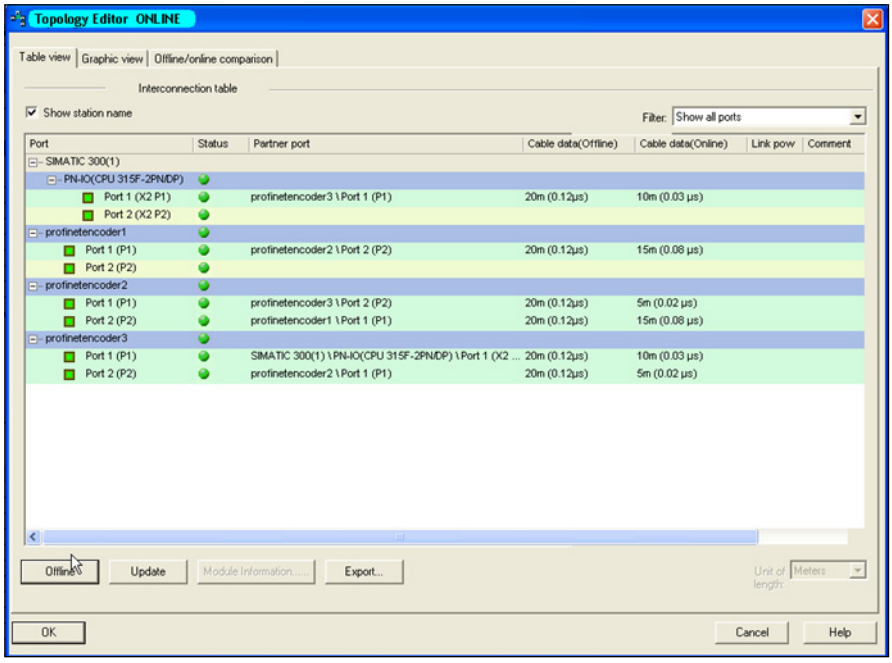


Figure 38 Topology editor

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.

To manually do a factory set of the encoder, follow the steps below:

Select PLC -> Ethernet -> Edit Ethernet Node.

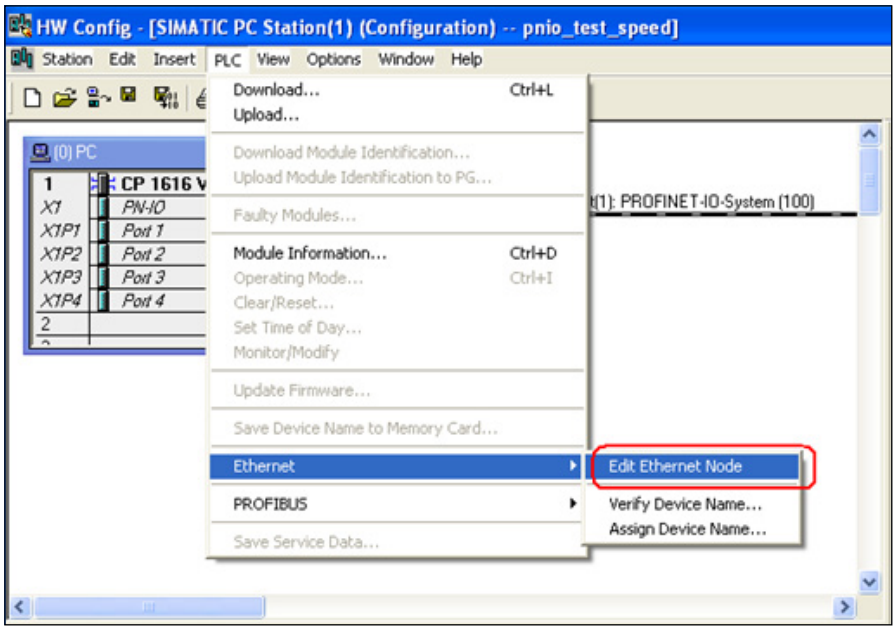


Figure 39 Edit Ethernet node

Enter the device's MAC-address and then click on the "Reset" button. The MAC-address of the device is written on the label of the device.

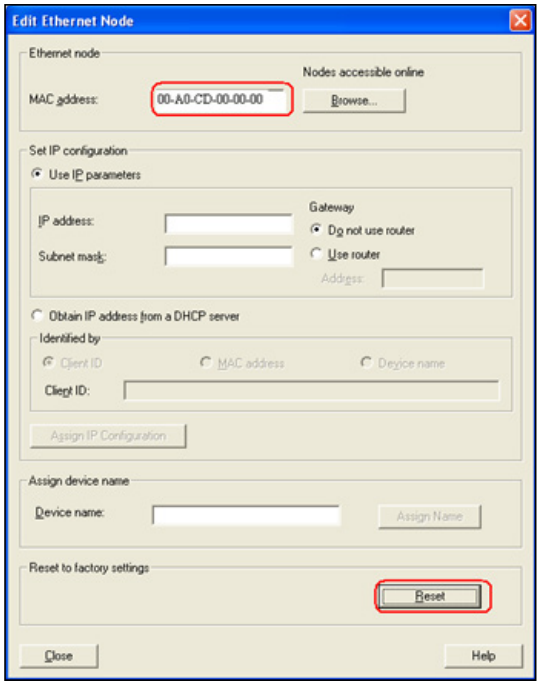


Figure 40 Factory reset

Click “Reset” under “Reset to factory settings”, and then “Yes” in the confirmation window to reset the encoder to its factory settings.

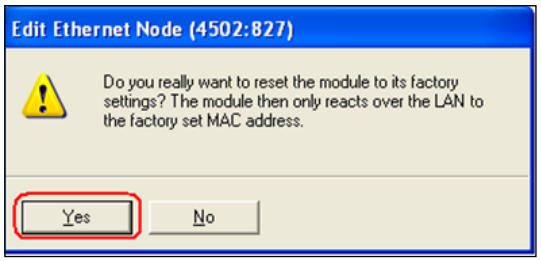


Figure 41 Factory set configuration

13 Encoder state description

13.1 Normal Operation state

13.1.1 Profile version 4.x

If using devices complying with Encoder profile V4.1 or V4.2, then bit 10 Control by PLC in Control word 2 needs to be set before the data in Control word is valid. If not set, Control word is not used by the device firmware. See chapter 9.7 for more information about encoder profiles.

13.1.2 Profile version 3.x

If using devices complying with Encoder profile 3.x, the data in Control word is always valid and bit 9 Control requested in Status word 2 is always cleared.

13.1.3 Profile version 3.x and 4.x

When using Telegram 81-83 and Control word bit 13 Request absolute value cyclically is set, then Status word bit 13 Transmit absolute value cyclically is set. Status word bit 13 is cleared (bit 13=0) when Control word bit 13 is cleared. Status word bit 13 is always cleared when using Telegram 84, due to the fact that no absolute value is sent in G1 XIST2.

13.2 Parking state

This state can be reached from any other state. The position value in G1 XIST1, G1 XIST2 and G1 XIST3 are set to zero. Errors are cleared and alarms are disabled in parking mode. The parking mode is activated by setting bit 14 in Control word (G1 STW).

13.3 Set/shift home position (Preset)

The Set/shift home position is initiated when Control word (G1 STW) bit 12 Request set/shift of home position is set. In this case the Status word bit 12 Set/shift of home position executed is set to 1. In order to initiate a set/shift home position Class 4 functionality must be enabled otherwise there will be an error message in G1 XIST2 and the encoder Module LED will turn orange indicating a warning.

13.3.1 Preset depending on different telegrams

When using standard Telegram 81-83 the acyclic encoder parameter 65000 Preset value 32 bit shall be used to set a preset value (<=32 bit) for the encoder. If the acyclic parameter 65002 Preset value 64 bit is used in this case, an error message will be returned. When using Telegram 86, 87, and 89, the PRESET value is set directly in the output data.

With Telegram 84, the acyclic parameter 65002 Preset value 64 bit shall be used to set a preset value (<=64 bit) for the device. If the acyclic parameter 65000 Preset value 32 bit is used in this case, an error message will be returned.

When using Telegram 88 the preset value is set directly in the output data. The operating status is read by parameter 65001 Operating status and 65003 Operating status 64bit if using the encoder in Encoder profile V4.1. If using the encoder in Encoder profile V4.2 the operating status is read by parameter 65001.

13.3.2 Absolute preset with negative value

Preset data sent with acyclic parameter 65000 or 65002 are signed values. The relative preset mode uses signed preset values, but with the absolute preset mode no preset will be made if a negative preset value (set with parameter 65000 or 65002) is used while trying to initiate an absolute preset.

13.4 Error state

This state is reached when an error has occurred. The device can enter this state from both the normal operation state and the set/shift home position state. If an error occurs, the Status word (G1 ZSW) bit 15 “Sensor error” is set, and the error code is displayed in G1 XIST2 instead of the position value.

13.5 Error acknowledgement

This state is reached when an error has occurred, and Control word (G1 STW) bit 15 “Acknowledging a sensor error” has been set. The Status word bit 11 “Requirement of error acknowledgment detected” and Status word (G1 ZSW) bit 15 “Sensor error” are set to 1.

13.6 Start up

This state is only reached when Control word (G1 STW) bit 14 “Activate parking sensor” is cleared (=0). Once the Control word bit 14 is cleared, it takes about 500 ms before the Status word bit 14 “Parking sensor active” is set to zero (=0).The reason for the delay is that before the encoder goes to normal operation mode, an initializing of the encoder is made.

14 Troubleshooting

1. Problem:
   Preset, parking mode and error reset is not possible.

   Solution:
   The Control By PLC bit in Control Word 2 has to be set to 1 (Profile V4.1/V4.2).

2. Problem:
   The preset value is lost if the power supply is switched off.

   Solution:
   Parameter 971 has to be set to 1 in order to save the preset value into non-volatile memory.

15 Revision history

Revision	Date	Changes
Rev. 01	2017-01-03	First release
Rev. 02	2020-06-15	Added functionality according to profile 4.2
Rev 03	2025-10-17	Editorial corrections

Table 79 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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