HEIDENHAIN

User's Manual

PROFINET

Interface for Encoders

English (en)
6/2014

Content

List of tables **5**

List of figures **7**

1 Introduction **9**
- 1.1 About absolute encoders 9
- 1.2 About PROFINET technology 10
- 1.3 Encoder Profiles 12
- 1.4 References 13
- 1.5 Abbreviations 14

2 Installation **15**
- 2.1 Cables and standards 15
- 2.2 Connectors and pin configuration 16
- 2.3 Shielding concept of the encoder 17
- 2.4 MAC-address 17
- 2.5 LED indication 18

3 Configuration example **19**
- 3.1 Device description file installation (GSDML) 19
- 3.2 Setting encoder configuration 21
- 3.3 Setting encoder device name 24
- 3.4 Setting encoder parameters 28
- 3.5 Isochronous real time settings (RT Class 3) 31

4 PROFINET IO data description **35**
- 4.1 Encoder profile overview, PNO order no.3.162 35
- 4.2 Application Class definition 36
- 4.3 Standard signals 36
- 4.4 Standard telegrams 37
  - 4.4.1 Standard Telegram 81 37
  - 4.4.2 Standard Telegram 82 38
  - 4.4.3 Standard Telegram 83 39
  - 4.4.4 Standard Telegram 84 40
- 4.5 Manufacturer telegram 59001 41
- 4.6 Format of G1_XIST1 and G1_XIST2 42
- 4.7 Format of G1_XIST3 43
- 4.8 Control word 2 (STW2_ENC) 44
- 4.9 Status word 2 (ZSW2_ENC) 45
- 4.10 Control word (G1_STW) 46
- 4.11 Status word (G1_ZSW) 47
- 4.12 Real time communication 48

5 Alarms and warnings 50
5.1 Diagnostics and Alarms 50
5.2 Channel diagnostics 50
5.3 Sensor status word 51

6 Acyclic Parameter Data 52
6.1 Acyclic data exchange 52
6.2 Identification and Maintenance (I&M functions) 52
6.3 Base mode parameter access 53
6.3.1 General characteristics 53
6.3.2 Parameter requests and responses 53
6.3.3 Changing the preset value 53
6.3.4 Reading the preset value 54
6.4 Supported parameters 55
6.4.1 Parameter 922, read only 55
6.4.2 Parameter 925, read/write 55
6.4.3 Parameter 964, read only 55
6.4.4 Parameter 965, read only 55
6.4.5 Parameter 971, read/write 55
6.4.6 Parameter 974, read only 55
6.4.7 Parameter 975, read only 56
6.4.8 Parameter 979, read only 56
6.4.9 Parameter 980, read only 57
6.4.10 Parameter 61000, read/write 57
6.4.11 Parameter 61001, read only 57
6.4.12 Parameter 61002, read only 57
6.4.13 Parameter 61003, read only 57
6.4.14 Parameter 61004, read only 57
6.4.15 Parameter 65000 read/write 57
6.4.16 Parameter 65001, read only 58
6.4.17 Parameter 65002, read/write 58
6.4.18 Parameter 65003, read only 58
6.5 Example of reading and writing to a parameter 59
6.5.1 Used blocs 60

7 Functional description of the encoder 68
7.1 Code sequence 69
7.2 Class 4 functionality 69
7.3 G1_XIST1 Preset control 70
7.4 Scaling function control 70
7.5 Alarm channel control 71
7.6 Compatibility mode 72
7.7 Preset value 73
7.8 Scaling function parameters 74
7.8.1 Measuring units per revolution 74
7.8.2 Total measuring range 75
7.9 Maximum Master Sign-of-Life failures 79
7.10 Velocity measuring units 80
7.11 Encoder profile version 81
7.12 Operating time 81
7.13 Offset value 82
7.14 Acyclic data 83
7.14.1 PROFIdrive parameters 83
7.14.2 Encoder parameter numbers 84
7.14.3 Parameter 65000 and 65002- Preset value 85
7.14.4 Parameter 65001-Operating status 86
7.14.5 Parameter 65003- operating status 64 bit 89
7.14.6 Identification & Maintenance functions 90

8 Firmware upgrade 91
8.1 Firmware upgrade in a PROFINET network 92
8.2 Error handling 96
8.3 TFTP server installation 98

9 Encoder replacement using LLDP 100

10 Encoder state machine 106
10.1 Normal operation state 107
10.1.1 Profile version 4.x 107
10.1.2 Profile version 3.x 107
10.1.3 Profile version 3.x and 4.x 107
10.2 Parking state 107
10.3 Set/shift home position (Preset) 107
10.3.1 Preset depending on different telegrams 108
10.3.2 Absolute preset with negative value 108
10.4 Error state 108
10.5 Error acknowledgement 108
10.6 Start up 108

11 Frequently asked questions FAQ 109

List of tables

Table 1 Bus Connection ... 16
Table 2 Power supply connection ... 16
Table 3 Led indication ... 18
Table 4 GSDML file ... 19
Table 5 Standard signals ... 36
Table 6 Output data Telegram 81 ... 37
Table 7 Input data Telegram 81 ... 37
Table 8 Output data Telegram 82 ... 38
Table 9 Input data Telegram 82 ... 38
Table 10 Output data Telegram 83 ... 39
Table 11 Input data Telegram 83 ... 39
Table 12 Output data Telegram 84 ... 40
Table 13 Input data Telegram 84 ... 40
Table 14 Format of G1_XIST3 ... 43
Table 15 Control word 2 (STW2_ENC) ... 44
Table 16 Detailed assignment of control word 2 (STW2_ENC) ... 44
Table 17 Status word 2 (ZSW2_ENC) ... 45
Table 18 Detailed assignment of status word 2 (ZSW2_ENC) ... 45
Table 19 Control word (G1_STW) ... 46
Table 20 Status word (G1_ZSW) ... 47
Table 21 Channel diagnostics ... 50
Table 22 Sensor status word ... 51
Table 23 Changing the preset value ... 53
Table 24 Reading the preset value (request) ... 54
Table 25 Reading the preset value (response) ... 54
Table 26 Hardware components ... 59
Table 27 Software components ... 59
Table 28 Parameters of SFB52 ... 63
Table 29 Parameters of SFB53 ... 64
Table 30 Supported encoder functions ... 68
Table 31 Code sequence ... 69
Table 32 Class 4 functionality ... 69
Table 33 G1_XIST1 Preset control ... 70
Table 34 Scaling function control ... 70
Table 35 Alarm channel control ... 71
Table 36 Compatibility mode ... 72
Table 37 Compatibility mode overview ... 72
Table 38 Measuring units per revolution ... 74
Table 39 Maximum master Sign of life failures ... 79
Table 40 Velocity measuring units ... 80

List of tables

Table 41 Encoder profile 81
Table 42 Operating time 81
Table 43 Offset value 82
Table 44 Supported PROFIdrive parameters 83
Table 45 Encoder parameter numbers 84
Table 46 Parameter 65000, Preset value 85
Table 47 Parameter 65002, Preset value 64 bit 85
Table 48 Parameter 65001, Operating status 86
Table 49 Parameter 65001, Sub index 87
Table 50 Parameter 65001, Sub index 1 88
Table 51 Parameter 65003, Operating status 64 bit 89
Table 52 Parameter 65003, Sub index 89
Table 53 Identification & Maintenance 90

List of figures

Figure 1 Bus connectors 16
Figure 2 Power supply connector 16
Figure 3 Installation of GSDML file 20
Figure 4 Encoder configuration 21
Figure 5 Example of connected encoder 22
Figure 6 Telegram selection 23
Figure 7 Selected telegram 23
Figure 8 How to set encoder device name 24
Figure 9 Device name 24
Figure 10 Assign device name 25
Figure 11 Assign name 26
Figure 12 How to verify device name 26
Figure 13 Verify device name 27
Figure 14 Parameter Access point 28
Figure 15 Parameter data 29
Figure 16 Save and compile 29
Figure 17 Download settings 30
Figure 18 Open Interface properties 31
Figure 19 RT Class option 31
Figure 20 Interface properties 32
Figure 21 IO Cycle properties 32
Figure 22 Port settings 33
Figure 23 Topology settings 33
Figure 24 Domain management 34
Figure 25 Overview of encoder profiles 35
Figure 26 Absolute value in G1_XIST1 42
Figure 27 Absolute value in G1_XIST2 42
Figure 28 Real time Communication 48
Figure 29 Request data block, DB1 60
Figure 30 Response data block, DB2 60
Figure 31 Instance data block, DB3 61
Figure 32 Instance data block, DB 61
Figure 33 Organization block, OB1 62
Figure 34 Diagnostic address of slot 1 65
Figure 35 Variable table 66
Figure 36 Cyclic operation 76
Figure 37 Non cyclic operation, preset control enabled 77
Figure 38 Non cyclic operation, preset control disabled 78
Figure 39 Firmware upgrade startpage 92
Figure 40 Firmware upgrade settings 93

Figure 41 Firmware upgrade confirmation page 94
Figure 42 Firmware upgrade status page 95
Figure 43 SolarWinds TFTP server 98
Figure 44 SolarWinds TFTP server settings 99
Figure 45 LLDP Properties 100
Figure 46 LLDP Port configuration 101
Figure 47 LLDP Partner port settings 102
Figure 48 Open Topology editor 103
Figure 49 Topology editor 103
Figure 50 Edit Ethernet node 104
Figure 51 Factory reset 105
Figure 52 Factory set confirmation 105
Figure 53 Encoder state machine 106

1 Introduction

1.1 About absolute encoders

With an absolute encoder each angular position is assigned a coded position value generated by a code disc equipped with several parallel fine graduations tracks which are scanned individually. On single turn encoders, i.e. an encoder producing absolute positions within one revolution, the absolute position information repeats itself with every revolution. So called multi turn encoders can also distinguish between 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 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.

1.2 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 to fulfill the partly very high requirements of speed.

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 de-centralized 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 100ms
- 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 cycles times of less than 1ms

Interfacing the peripherals devices such as encoders is implemented by 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 data exchange 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 contains the automation program and 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 allow 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.

1.3 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 published by PI. Profiles are important for openness, interoperability and interchangeability, so that the end user can be sure that similar equipments from different vendors perform in a standardized way. HEIDENHAIN comply with the definitions in the encoder profile 3.162, version 4.1. 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 backed by the INTERBUS Club and, since 2003, is part of the IEC 61158 and IEC 61784 standards.

PROFIBUS User Organization
Haid-und-Nue Straβe 7
D 76131 Karlsruhe
Tel: +49 721 96 58 590
Fax: + 49 721 96 58 589
Web: www.profibus.com

1.4 References

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

Profile Drive Technology, PROFIdrive V4.1,
PROFIBUS International, Order No. 3.172

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

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

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

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

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

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

1.5 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

2 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.

2.1 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).

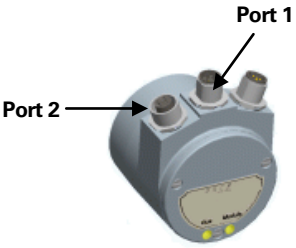
Only shielded cables and connecting elements are allowed in a PROFINET network. The individual components have to satisfy the requirements of Category 5 in accordance with IEC 11801. The entire transmission path has to meet the requirements of Class D in accordance with IEC 11801. Furthermore, PROFINET cables shall 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 on adherence to simple installation rules.

Transmission channels lengths are determined by the type of cable being used. The choice of cable is to be such that a transmission channel length of 100 meter 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.

2.2 Connectors and pin configuration

M12 connectors are used for connecting the bus lines to the encoder. The M12 connector used is a 4-pin female shielded D-coded version.

The correct arrangement of the bus connectors are specified as follows:



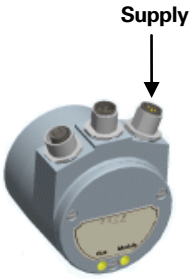
Signal	Function	Pin
Tx+	Transmission data +	1
Tx-	Transmission data -	3
Rx+	Receiver data +	2
Rx-	Receiver data -	4

Table 1 Bus Connection

Figure 1
Bus connectors

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

The M12 connector used for power supply of the encoder is constituted by a 4-pin male shielded A-coded version.
The correct arrangement of the power supply line is specified as follows:



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

Table 2 Power supply connection

Figure 2
Power supply connector

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

2.3 Shielding concept of the encoder

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, electric 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 make up the system. Data cabling is considered as a passive system and cannot be tested for EMC compliance individually. Nevertheless, cabling and connection elements for PROFINET supports 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 shall 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.

2.4 MAC-address

PROFINET IO field devices are addressed using MAC addresses and IP addresses. All field devices have a unique MAC address. The MAC address is constituted by a 6 byte Ethernet address for each individual station and is unique worldwide. The MAC address consists of two parts, the first 3 bytes represents the manufacturer-specific ID and the last 3 bytes represents a consecutive number. The MAC address of the encoder is printed on the encoder label for commissioning purposes.

2.5 LED indication

The following table defines diagnostic indications shown by the encoders 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 - Master not availble/ 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	- Slave 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	

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

Table 3 Led indication

3 Configuration example

This chapter will illustrate how to setup and configure a PROFINET encoder for working in RT Class 1 mode. In the following examples SIMOTION SCOUT V.4.1.5.6 and D435 motion controller is used. Please refer to the manufacturer of the configuration tool if other configuration tools are being used.

3.1 Device description file installation (GSDML)

In order to start using an absolute encoder with PROFINET interface, a device description file needs to be downloaded and imported to the configuration software. The device description file is called a **G**eneric **S**tation **D**escription **M**arkup **L**anguage file and contains the necessary implementation parameters needed for a PROFINET IO device.

The GSDML file can be downloaded from www.heidenhain.com

GSDML file
GSDML-V2.2-JH-PROFINET-Encoder-xxxxxxxx.xml

Table 4 GSDML file

Installation of GSDML-files

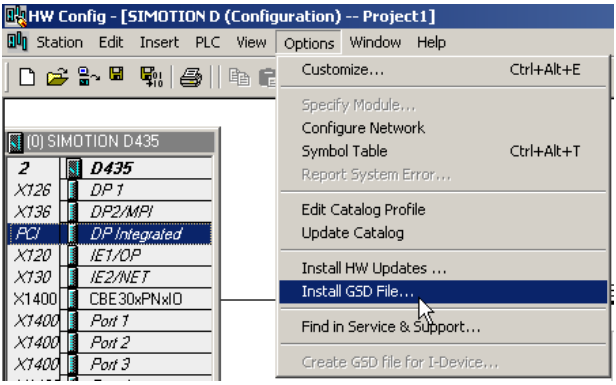


Figure 3 Installation of GSDML file

1. Select Options -> Install GSD File and click the Browse button to navigate to the location of the GSD 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.heidenhain.com.

2. Select the GSD file and click the Installbutton to start installing the selected GSD file.

3.2 Setting encoder configuration

When the GSD file has been installed the supported encoder types can be found in the HW Configuration under PROFINET IO->Additional Field Devices->Encoders->JH Group PROFINET Encoders. Select either multi turn 25 bit or single turn 13 bit encoder, dependent on the type of encoder to be configured. Drag and drop the encoder onto the PROFINET IO system as shown in the picture below. In the example below one 25 bit multiturn encoder was chosen. If more than one encoder shall be configured, then the following steps need to be done once for each device.

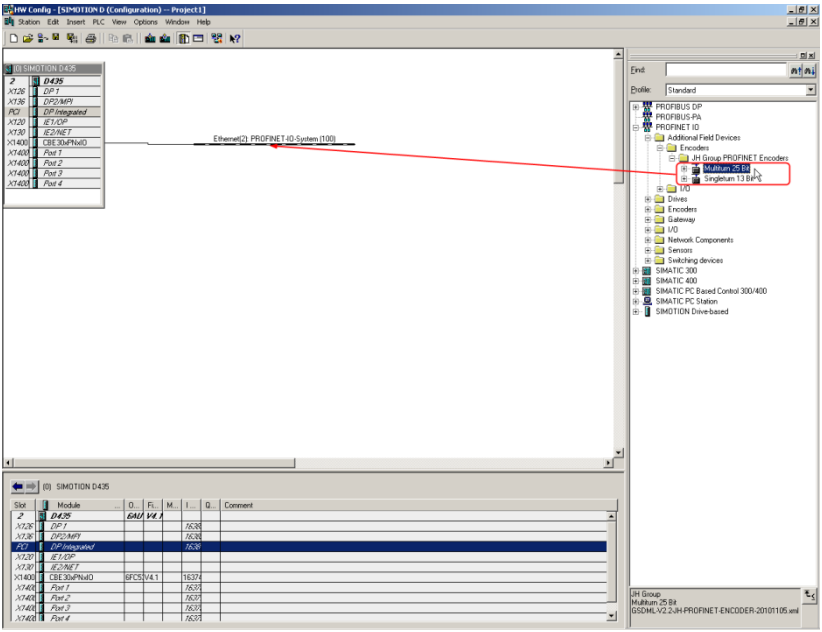


Figure 4 Encoder configuration

When correctly done, the encoder will appear on the PROFINET IO system as shown in figure 5 below.

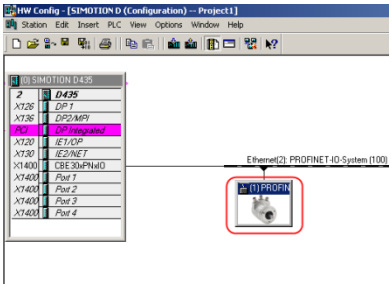


Figure 5 Example of connected encoder

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 for the multi-turn 25 bit encoder can be found under Multiturn 25 Bit -> EO Multiturn. In the example below standard telegram 81 is used. Drag and drop the telegram onto slot 1, sub slot 2 as shown in the figure 6 below. For more information regarding the different telegrams refer to chapter 4.4.

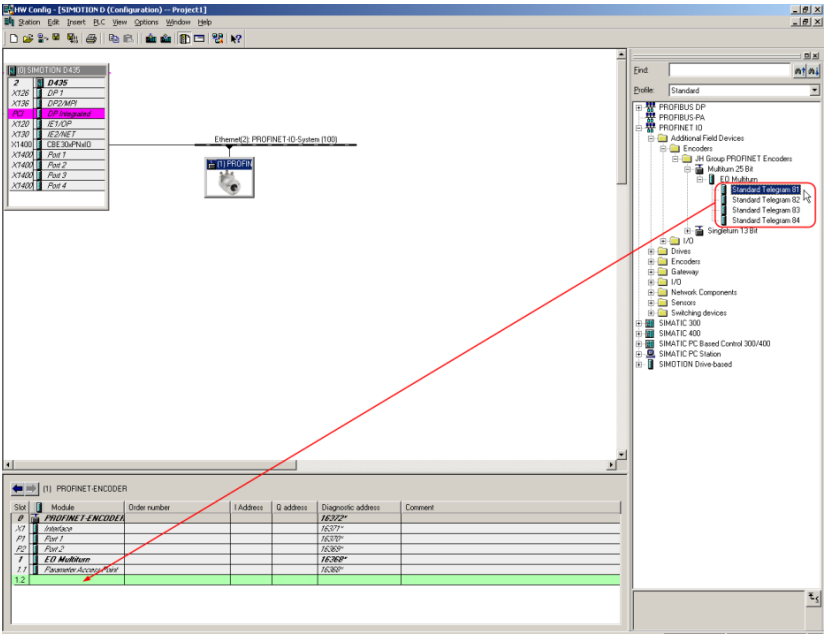


Figure 6 Telegram selection

The Standard Telegram 81 will appear on slot 1 sub slot 2 according to figure 7 below.

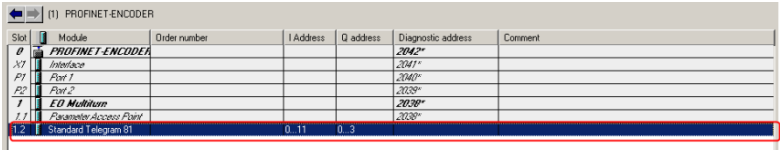


Figure 7 Selected telegram

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

3.3 Setting encoder device name

In a PROFINET network all IO devices needs to have a unique device name. The encoders are delivered without any device name preset from the factory. To set the encoder device name, double click on the encoder icon to open the Properties window.

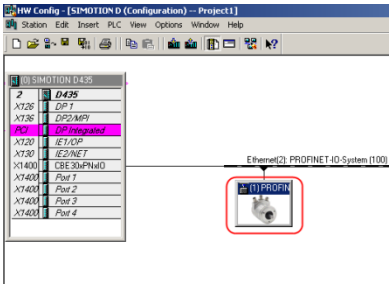


Figure 8 How to set encoder device name

In the Properties window, enter an appropriate device name in the Device name field.

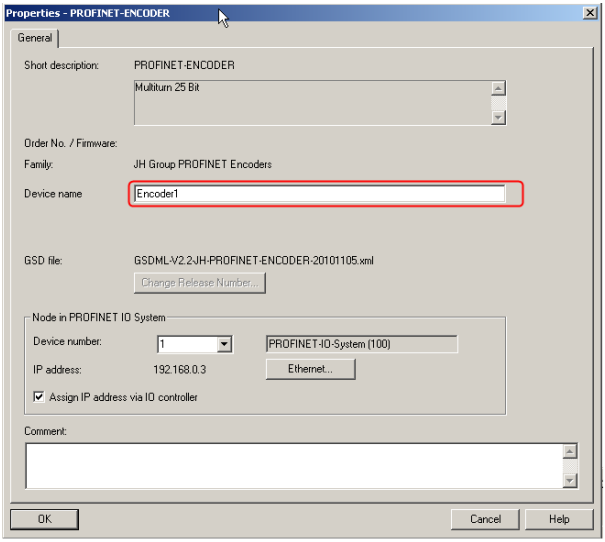


Figure 9 Device name

Make sure that the checkbox Assign IP address via IO controller is checked if the IP address for the encoder should be assign via the IO controller.

Then select PLC-> Ethernet->Assign Device Name to open the Assign device name window.

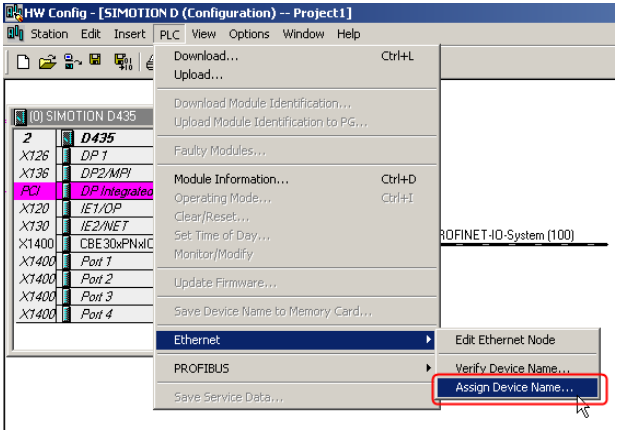


Figure 10 Assign device name

Choose the device on which the device name should be changed and then click on the Assign name button to adopt the changes and then click on the Close button. The MAC address of the encoder is written on the encoder label.

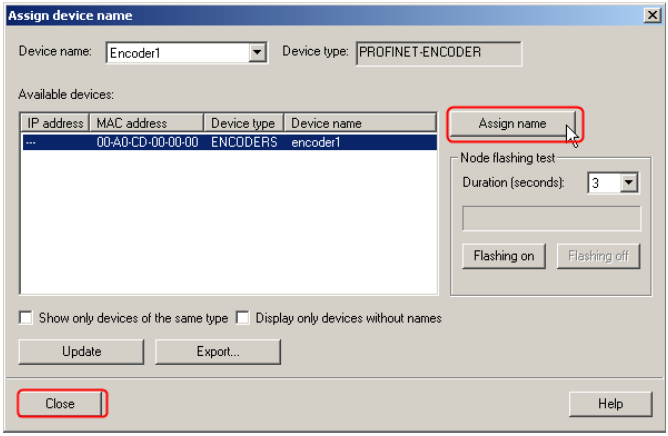


Figure 11 Assign name

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

After changing device name, it is recommended to verify that the performed change has been done. This is done by opening the Verify Device Name window found under PLC->Ethernet->Verify Device Name.

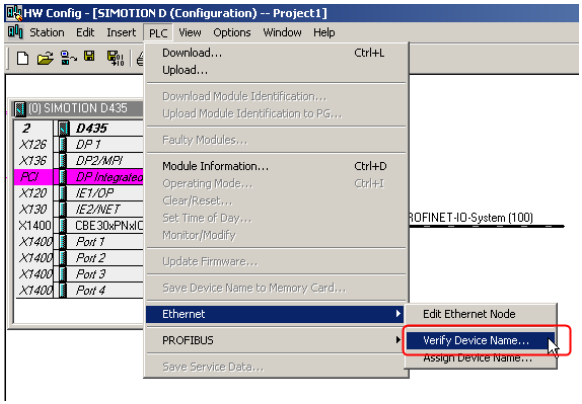


Figure 12 How to verify device name

In the Verify Device Name window, verify that the Device name has changed and the status is OK as shown in the example according to figure 13 below.

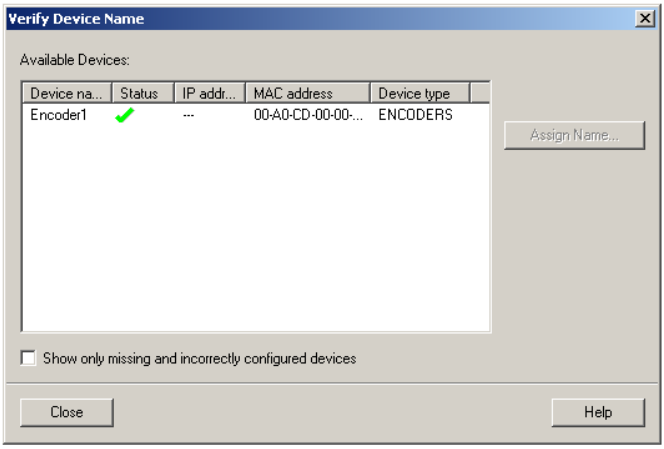


Figure 13 Verify device name

3.4 Setting encoder parameters

This chapter describes how to change the user parameters in the encoder.

To set the encoder user parameters double click on the Parameter Access point field located under slot 1.1 as shown in figure 14, to open the Properties window.

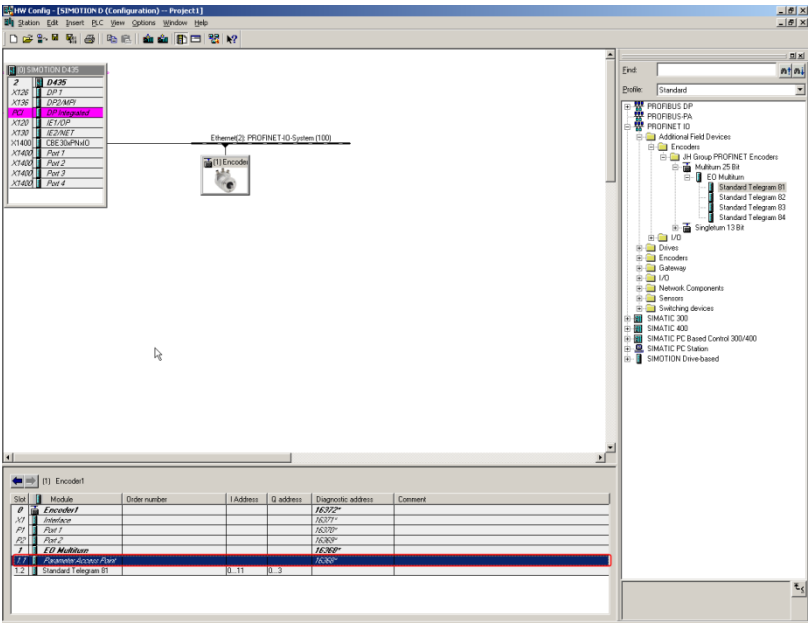


Figure 14 Parameter Access point

In the Properties window, choose the Parameters" tab. To set the parameter data, 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 7.

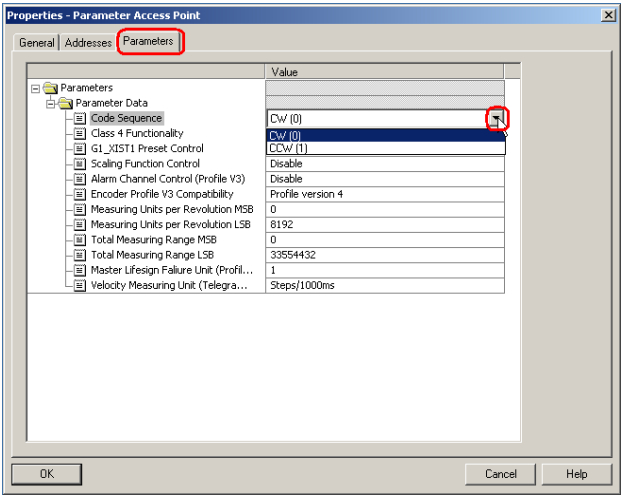


Figure 15 Parameter data

When the configuration and parameterization of the device has been done, the settings need to be saved and compiled. This is done by clicking on the Save and Compile option under the Station tab.

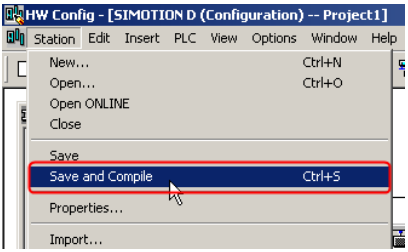


Figure 16 Save and compile

Then the settings need to be downloaded to the IO-controller. This is done by clicking on the Download option under the PLC Tab.

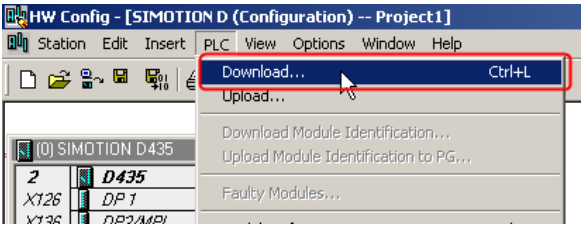


Figure 17 Download settings

3.5 Isochronous real time settings (RT Class 3)

This example is intended to illustrate the commissioning of a PROFINET encoder in isochronous operation. In the example below STEP 7 v5.4 SP5 and SIMOTION D435 motion controller is used. The basic principal for configuration and parameterization of the encoder is the same as described in chapter 3.2-3.4.

To set the IRT settings of the encoder, double click on the Interface field located under slot 0, sub slot X1 to open the Properties window.

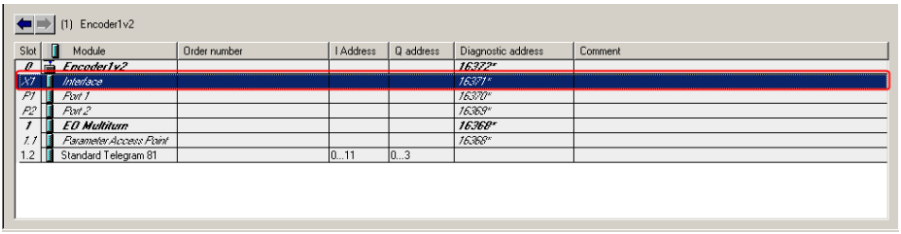


Figure 18 Open Interface properties

Under the Synchronization tab change the value for the Parameter RT Class to IRT and the IRT option parameter to High Performance according to the picture below.

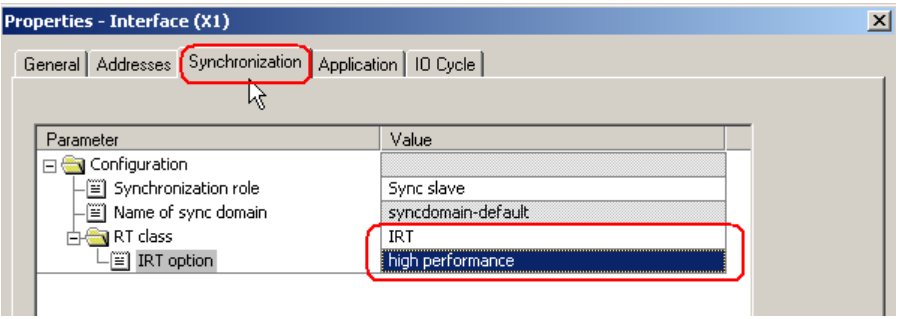


Figure 19 RT Class option

Under the Application tab check the box for Operate IO device/application in isochronous mode.

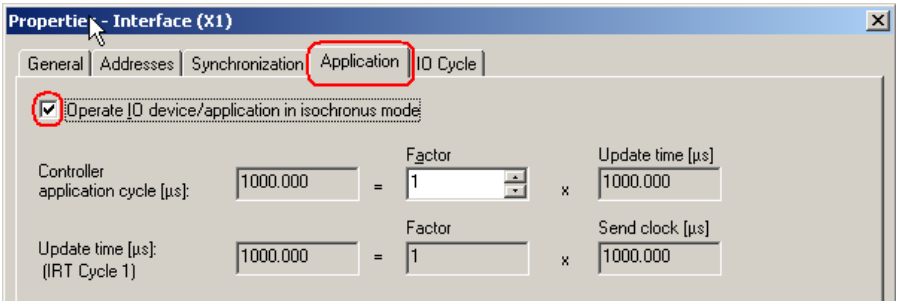


Figure 20 Interface properties

Under the IO Cycle tab change the Update Time Mode to fixed factor.

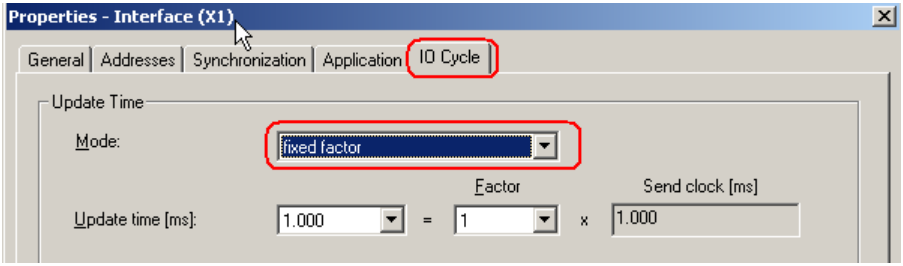


Figure 21 IO Cycle properties

Before the encoder can operate in IRT mode it is necessary to set from which port of the encoder the connection to the network has been done.

To set the topology double click on the port from which the encoder is connected to the network. This is either slot 0 sub slot P1 or slot 0 sub slot P2. In the example in figure 22 below Port 1 is used on the encoder. For port description of the encoder see chapter 2.2 Connectors and pin configuration.

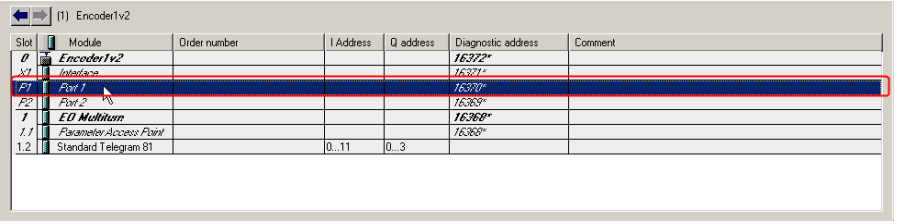


Figure 22 Port settings

Under the Topology tab change the Partner port to the used port of your IO controller.

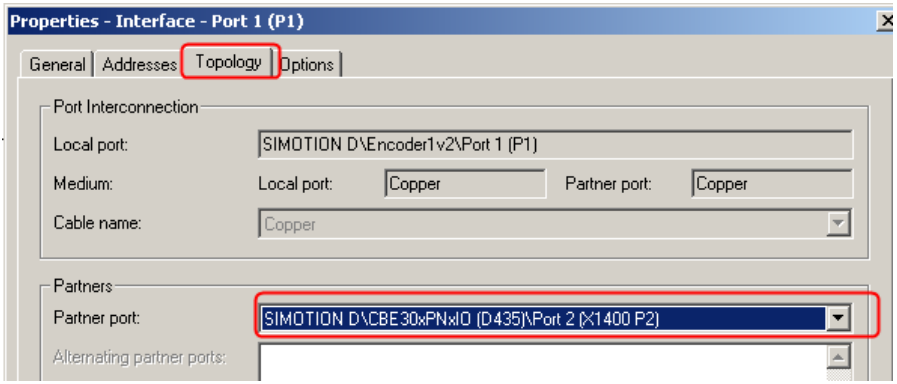


Figure 23 Topology settings

When the above steps have been performed, it is recommended to verify that the setting for the encoder and the IO controller is correct. This is done by opening the Domain management Window found under Edit->PROFINET IO.

Verify that the RT Class is set to IRT and that the IRT option is set to High performance.

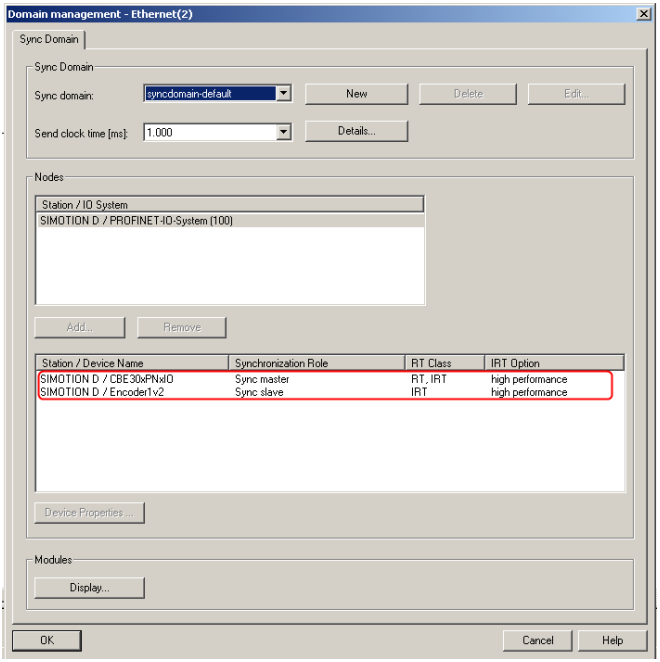


Figure 24 Domain management

The encoder is now prepared for operating in IRT mode.

4 PROFINET IO data description

4.1 Encoder profile overview, PNO order no.3.162

This manual is related to encoders that fulfills the demands and functionality according to encoder profile V4.1 (PNO no 3.162). The operating functions for encoders according to this profile are divided into two application classes, named Class 3 and Class 4. For an overview of the different encoder profile for PROFIBUS and PROFINET and the related standards, see figure 25 below.

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

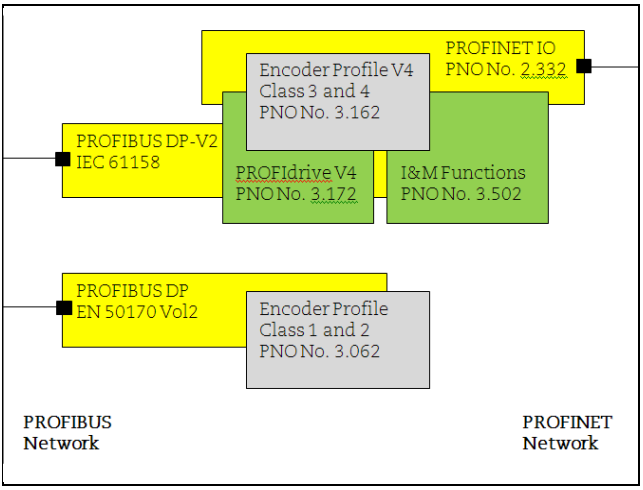


Figure 25 Overview of encoder profiles

4.2 Application Class definition

The PROFINET encoders can be configured as a class 3 or class 4 PROFINET IO device according to the encoder profile V.4.1 (PNO no 3.162). A Class 4 configured encoder fully supports all functionality according to the encoder profile V4.1.

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

CLASS 4 Encoder with scaling, Preset and base mode parameter access. Isochronous mode **is** supported.

4.3 Standard signals

Table 5 below describes the standard signals that are used to configure the IO data. The signals are described in the chapters that follow.

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

Table 5 Standard signals

4.4 Standard telegrams

Configuration of PROFINET encoders 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. The following standard telegrams are supported.

4.4.1 Standard Telegram 81

Standard telegram 81 uses 4 bytes for output data from the IO controller to the encoder 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 (G1_STW).

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2_ENC		G1_STW	

Table 6 Output data Telegram 81

Input data to the IO controller:
2 bytes Status word 2(ZSW2_ENC).
2 bytes Status word (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 7 Input data Telegram 81

4.4.2 Standard Telegram 82

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

Output data from the IO controller:
2 bytes Control word 2 (STW2_ENC).
2 bytes Control word (G1_STW).

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2_EN		G1_STW	

Table 8 Output data Telegram 82

Input data to the IO controller:
2 bytes Status word 2(ZSW2_ENC).
2 bytes Status word (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 9 Input data Telegram 82

4.4.3 Standard Telegram 83

Standard telegram 83 uses 4 bytes for output data from the controller to the encoder and 16 bytes of input data from the encoder to the controller.

Output data from the IO controller:
2 bytes Control word 2 (STW2_ENC).
2 bytes Control word (G1_STW).

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2_ENC		G1_STW	

Table 10 Output data Telegram 83

Input data to the IO controller:
2 bytes Status word 2(ZSW2_ENC).
2 bytes Status word (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 11 Input data Telegram 83

4.4.4 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.

Output data from the IO controller:
2 bytes Control word 2 (STW2_ENC).
2 bytes Control word (G1_STW).

IO Data (word)	1		2	
Byte	0	1	2	3
Set point	STW2_ENC		G1_STW	

Table 12 Output data Telegram 84

Input data to the IO controller:
2 bytes Status word 2(ZSW2_ENC).
2 bytes Status word (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 13 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.

4.5 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 encoder 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 14 Output data from IO-controller to encoder

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(MSB)	1	2	3(LSB)	4(MSB)	5	6	7(LSB)
Actual value	Position value 32 bit Unsigned in				Velocity value 32 bit Signed int			

Table 15 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 59001.

4.6 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:
25 bit multi turn absolute encoder (8192 steps per revolution, 4096 distinguishable revolutions)

M = Multi turn value (Distinguishable revolutions)
S = Single turn value (number of steps per revolutions)

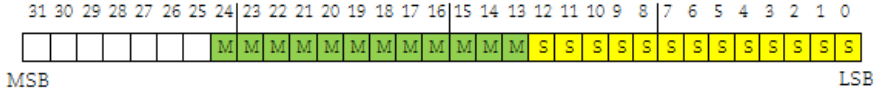


Figure 26 Absolute value in G1_XIST1

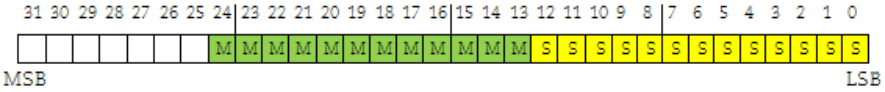


Figure 27 Absolute value in G1_XIST2

4.7 Format of G1_XIST3

G1_XIST3 is a 64 bit position value which 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	1	2	3	4
Format	64 bit position value			

Table 16 Format of G1_XIST3

4.8 Control word 2 (STW2_ENC)

The control word 2 (STW2_ENC) is referred to as the master sign of life and it includes the fault buffer handling and Control by PLC mechanism from PROFIdrive STW1 and the Controller Sign-Of-Life mechanism from PROFIdrive STW2. This signal is mandatory for controlling the clock synchronization.

Bit	Function
0..6	Reserved
7	Fault Acknowledge
8,9	Reserved
10	Control by PLC
11	Reserved
12..15	Controller Sign-of-life

Table 17 Control word 2 (STW2_ENC)

Bit	Value	Significance	Comments
7	1	Fault Acknowledge (0->1)	The fault signal is acknowledged with a positive edge. The encoder reaction to a fault depends on the type of fault.
	0	No significance	
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		Controller Sign-Of-Life	

Table 18 Detailed assignment of control word 2 (STW2_ENC)

4.9 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 fault buffer handling and Control by PLC mechanism from PROFIdrive ZSW1 and the Slave Sign-Of-Life mechanism from PROFIdrive ZSW2. This signal is mandatory for controlling the clock synchronization.

Bit	Function
0..2	Reserved
3	Fault present/No fault
4..8	Reserved
9	Control requested
10,11	Reserved
12..15	Encoder Sign-of-life

Table 19 Status word 2 (ZSW2_ENC)

Bit	Value	Significance	Comments
3	1	Fault Present	Unacknowledged faults or currently not acknowledged faults (fault messages) are present (in the buffer). The fault reaction is fault-specific and device-specific. The acknowledging of a fault may only be successful, if the fault cause has disappeared or has been removed before. If the fault has been removed the encoder returns to operation. The related fault numbers are in the fault buffer.
	0	No Fault	
9	1	Control requested	The automation system is requested to assume control.
	0	No Control requested	Control by automation system is not possible, only possible at the device or by another interface.
12..15		Encoder Sign-Of-Life	

Table 20 Detailed assignment of status word 2 (ZSW2_ENC)

4.10 Control word (G1_STW)

The control word controls the functionality of major encoder functions.

Bit	Function
0..7	Function requests: Reference mark search, measurement on the fly
8..10	Reserved (without effect)
11	Home position mode 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 21 Control word (G1_STW)

Note: If the sensor parking is activated (bit 14 = 1) the encoder is still on the bus with the slave sign of life active and the encoder error and diagnostics switched off.

4.11 Status word (G1_ZSW)

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

Bit	Function
0..7	Function status: Reference mark search, measurement on the fly
8	Probe 1 deflected
9	Probe 2 deflected position mode (Preset)
10	Reserved, set to zero
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 error

Table 22 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.

4.12 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 or Real Time channel is used for process data transfer and alarms.
Real-time data are treated with a higher priority than data sent over the open channel. RT communications overrides the open channel to handle the data exchange with programmable Controllers.

The third channel, Isochronous Real Time (IRT) is the high performance, high speed channel used for demanding motion Control applications. IRT data are treated with a higher priority than RT data sent over the RT channel.

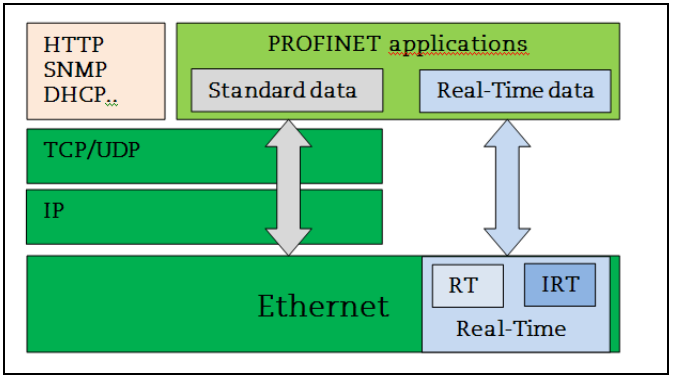


Figure 28 Real time Communication

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

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

5 Alarms and warnings

5.1 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 failure occurs which effects the position value. Alarms can be reset (deleted) when all encoder parameters are within the specified value ranges and the position value is correct.

5.2 Channel diagnostics

The encoder 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	0x900A	The encoder fails to read the correct position value
Memory error	0x9000	The encoder fails to read stored offset or preset values from the non volatile memory
Commissioning diagnostics	0x9011	User parameter data assignment error

Table 23 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 go to stop.

5.3 Sensor status word

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 encoder fails to read the correct position value
Memory error	0x1001	The encoder 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 the controller's life sign was exceeded.

Table 24 Sensor status word

6 Acyclic Parameter Data

6.1 Acyclic data exchange

In addition to the cyclic data exchange, the PROFINET encoder 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:

- Reading of diagnostic
- Reading of I&M functions
- Reading of PROFIdrive parameters

6.2 Identification and Maintenance (I&M functions)

Encoders 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.

According to the PROFINET specification all IO devices must at least support the following I&M functions:

- Order ID
- MAC address
- Hardware Version
- Software Version
- Product type
- Manufacturer ID

For more information regarding additional I&M functions supported by the encoder, refer to chapter 7.14.6.

6.3 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).

6.3.1 General characteristics

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

6.3.2 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.

6.3.3 Changing the preset value

Table 23 below shows the structure of a change value request.

Write of Preset value, parameter 65000 Parameter request		
Request reference	0x00	
Request ID	0x02	0x02 →Change value, 0x01→read 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 25 Changing the preset value

6.3.4 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 26 Reading the preset value (request)

Read of Preset value, parameter 65000 Parameter response		
Request reference	0x00	mirrored
Response 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 27 Reading the preset value (response)

6.4 Supported parameters

6.4.1 Parameter 922, read only

922→ unsigned int, presents which telegram is used. Telegram 81,82,83, 84 or 59001 is possible.

6.4.2 Parameter 925, read/write

925→ unsigned int, maximum allowed MLS (Master sign-of-life) error. Parameter 925 may be used to set a maximum on how many consecutive Sign-of-life failures may occur.

6.4.3 Parameter 964, read only

964→unsigned int

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] = 201→Software version
964[3] = 2009→Software year
964[4] = 2805→ Software day and month
964[5] = 1→ Number of drive objects (DO)

6.4.4 Parameter 965, read only

965→OctetString 2

965[0] =0x3D→Encoder profile number
965[1] = 31 or 41 →Encoder profile version, set by customer (user_parameters)

6.4.5 Parameter 971, read/write

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

6.4.6 Parameter 974, read only

974→unsigned int

974[0] = 96→Max array length supported by parameter channel.
974[1] = 1→Numbers of multi parameters, 1 = no support of multi parameters.
974[2] = 1000→max time to process parameter request, n x 10 ms.

6.4.7 Parameter 975, read only

975→unsigned int

975[0] = Manufacturer Id, Set in the production.
975[1] = 7011→DO type
975[2] = 201→Software version
975[3] = 2009→Software year
975[4] = 2805→Software day and month
975[5] = 0x0005→ PROFIdrive DO type class 5 = encoder interface
975[6] = 0x8000→ PROFIdrive SUB class 1, Encoder application class 4 supported.
975[7] = 0x0001→Drive object Id (DO ID).

6.4.8 Parameter 979, read only

979→unsigned long

979[0] = 0x00005111→ Number of index describing encoder, Numbers of described encoders, Version of parameter structure

979[1] = 0x80000000→ Sensor type
Bit 31 = 1 if configuration and parameterization is OK
Bit 0 = 0 Rotary encoder, Bit 0 = 1 linear encoder
Bit 1 = 0 always set to 0
Bit 2 = 0 →32 bit data, Bit 2 = 1 →64 bit data

979[2] = 8192 → Encoder scaled resolution
979[3] = 0 →Shift factor for G1_XIST1 always set to 0.
979[4] = 0 →Shift factor for G1_XIST2 always set to 0.
979[5] = 1 or 4096 →Singleturn = 1, Multiturn = 4096
979[6] = 0
979[7] = 0
979[8] = 0
979[9] = 0
979[10] = 0

6.4.9 Parameter 980, read only

This parameter shows the supported parameters

980→unsigned int

980[0] = 922	980[9] = 61001
980[1] = 925	980[10] = 61002
980[2] = 964	980[11] = 61003
980[3] = 965	980[12] = 61004
980[4] = 971	980[13] = 65000
980[5] = 974	980[14] = 65001
980[6] = 975	980[15] = 65002
980[7] = 979	980[16] = 65003
980[8] = 61000	980[17] = 0

6.4.10 Parameter 61000, read/write

Name of station
61000 →OctetString, 240 octets

6.4.11 Parameter 61001, read only

IP of station
61001→unsigned long

6.4.12 Parameter 61002, read only

MAC of station
61002→OctetString, 6 octets

6.4.13 Parameter 61003, read only

Default gateway of station
61003→ unsigned long

6.4.14 Parameter 61004, read only

Subnet mask of station
61004→ unsigned long

6.4.15 Parameter 65000 read/write

Used with telegram 81-83.
65000→ signed long, preset value 32 bit.

6.4.16 Parameter 65001, read only

Used with telegram 81-84 and 59001
65001→ unsigned long

65001[0] = 0x000C0101 →Header, Version of parameter structure and numbers of index describing the encoder. 12 index and version 1.01

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

65001[2] = Alarm
65001[3] = Supported alarms
65001[4] = Warning
65001[5] = Warnings supported
65001[6] = 0x00000401→ Encoder profile version. Always set to this value.

65001[7] = Operating time
65001[8] = Offset value
65001[9] = Singleturn value, scaled value
65001[10] = Total measuring length, scaled value (Linear = 1)

65001[11] = Velocity unit
- step/10 ms
- step/100 ms
- step/1000 ms
- RPM

6.4.17 Parameter 65002, read/write

Used with telegram 84
65002→ signed long long, Preset value 64 bit.

6.4.18 Parameter 65003, read only

Used with telegram 84
65003→ unsigned long long,

65003[0] = 0x000000000040101→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] = Singleturn value 64 bit, scaled value
65003[3] = total measuring range in measuring units 64 bit, scaled value (Linear =1)

6.5 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		
IO controller	SIEMENS S7-F CPU	CPU 315F-2PN/DP
IO Device	PROFINET encoder	

Table 28 Hardware components

Software components	
SIMATIC STEP 7	V5.4 + SP5
GSDML file for PROFINET encoder	GSDML-V2.2-JH-PROFINET-Encoder-xxxxxxxx.xml

Table 29 Software components

6.5.1 Used blocs

Write record block SFB53 WRREC
Read record block SFB52 RDREC
Instance data blocks DB3 and DB4
Request data block DB1
Response data block DB2
Organization blocks OB1, OB82 and OB86

SFB52
SFB52 is standard S7 block for reading parameters.

SFB53
SFB53 is standard S7 block for writing parameters.

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 29 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 30 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 31 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 32 Instance data block, DB

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 33 Organization block, OB1

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

Table 30 Parameters of SFB52

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

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

Table 31 Parameters of SFB53

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

Diagnostic address of slot 1

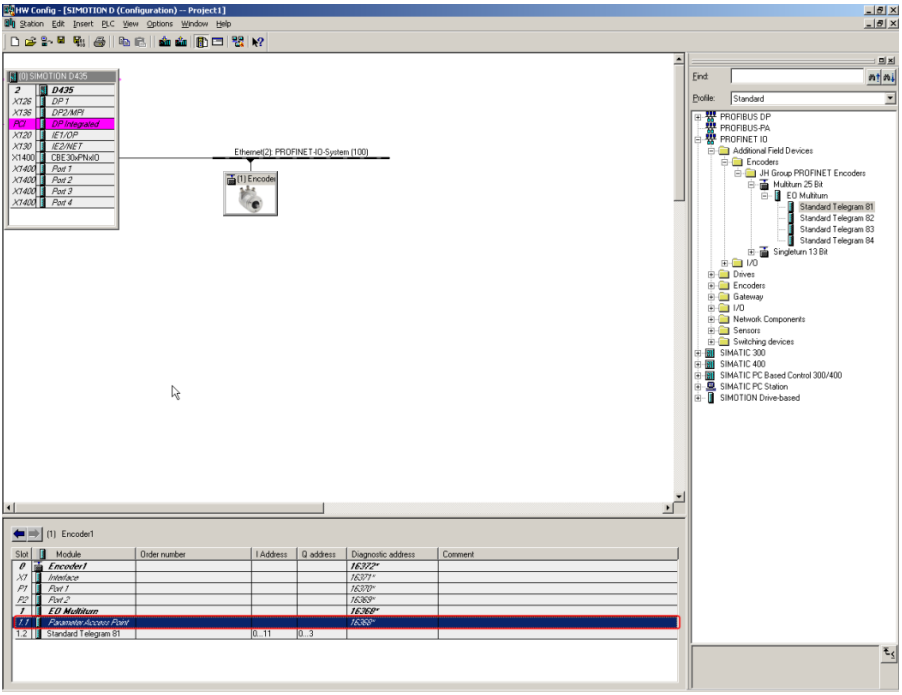


Figure 34 Diagnostic address of slot 1

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 35 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).

7 Functional description of the encoder

This chapter describes the functions that have been implemented in PROFINET encoders from HEIDENHAIN. The table below shows the supported functions in the PROFINET encoder.

Function
Code sequence
Class 4 functionality
G1_XIST1 Preset control
Scaling function control
Alarm channel control
Compatibility mode
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
Maximum Master Sign of Life failures
Velocity measuring unit
Encoder Profile version
Operating time
Offset value
Offset value 64 bit

Table 32 Supported encoder functions

7.1 Code sequence

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

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

Table 33 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.

7.2 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 34 Class 4 functionality

7.3 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 35 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.

7.4 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 36 Scaling function control

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

7.5 Alarm channel control

This parameter enables or disables the encoder 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 switch on	1
Disable	No profile specific diagnosis (default)	0

Table 37 Alarm channel control

Note: This parameter is only supported in compatibility mode.

7.6 Compatibility mode

This parameter defines if the encoder 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	Value
Enable	Compatibility with encoder Profile V3.1	0
Disable	No backward compatibility (default)	1

Table 38 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
User parameter Maximum Master Sign of Life failures	Supported	Not supported, one Sign of Life failure tolerated, 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)

Table 39 Compatibility mode overview

7.7 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. The preset function is controlled by bits in the control word (G1_STW) and acknowledged by a bit in the status word (G1_ZSW). 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. The preset function is controlled by bits in the control and status words (G1_STW and G1_ZSW) and bit in the operating parameters. The preset value is used when a preset is requested by bit 12 in the control word (G1_STW).

7.8 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.

7.8.1 Measuring units per revolution

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

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 40 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.

7.8.2 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 is higher than 31 bit, telegram 84 and acyclic encoder parameter 65002 and 65003 must be used. In this case the 64 bit values are used and the 32 bit values are set to zero (0) by the encoder.

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)

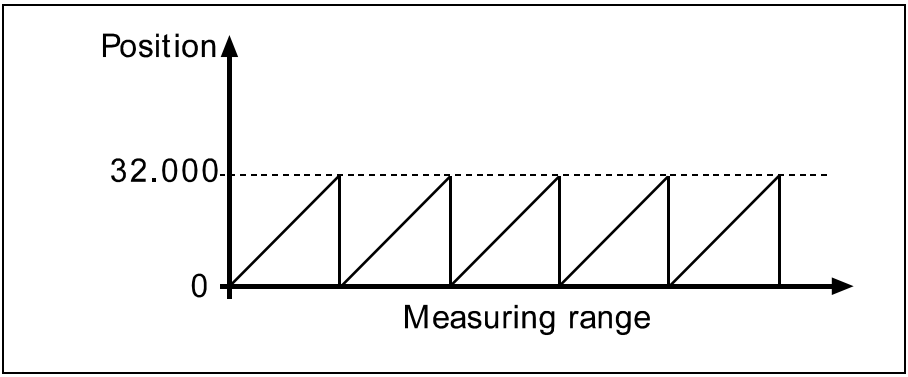


Figure 36 Cyclic operation

B. Non-cyclic operation
If the desired total measuring range is **not** equal to the specified single turn resolution * 2^X (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)

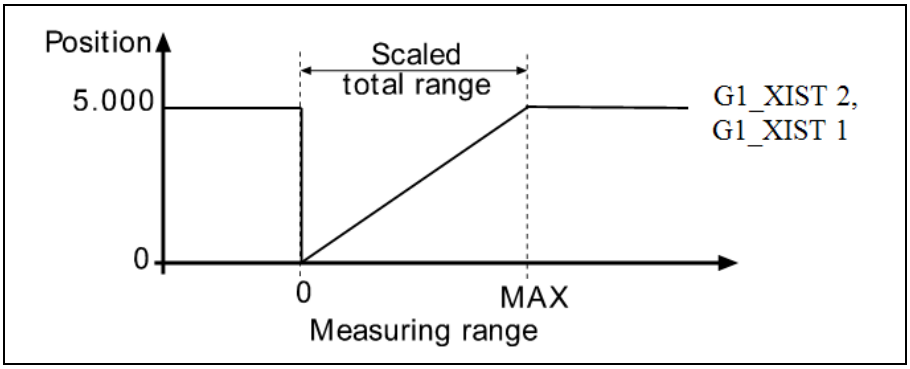


Figure 37 Non cyclic operation, preset control enabled

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 position 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)

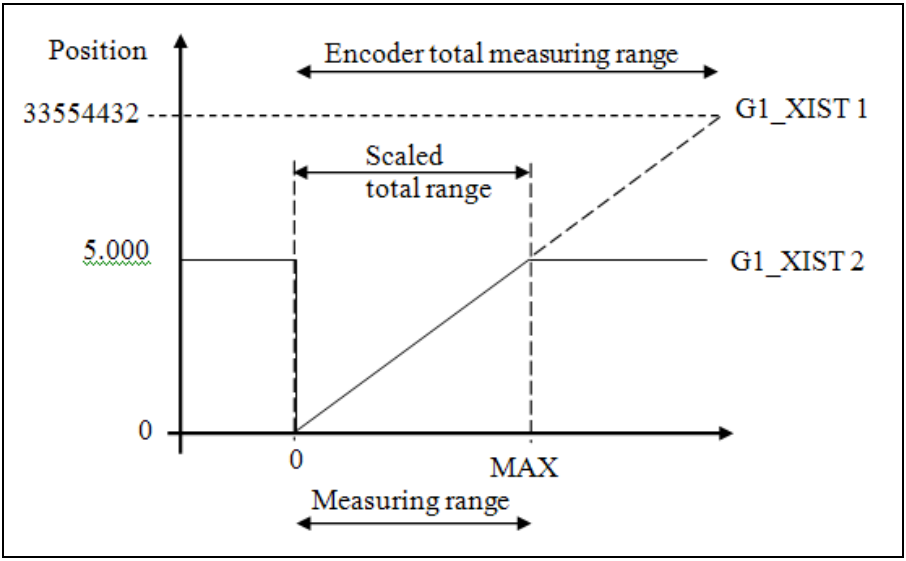


Figure 38 Non cyclic operation, preset control disabled

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}

$$2^{36} = 68719476736 = 0x\ \underbrace{00\ 00\ 00\ 10}_{\text{MSB: 4 byte=32 bit}}\ \underbrace{00\ 00\ 00\ 00}_{\text{LSB: 4 byte=32 bit}}$$

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**

7.9 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 masters life sign.	1...255

Table 41 Maximum master Sign of life failures

Note: This parameter is only supported in compatibility mode.

7.10 Velocity measuring units

This parameter defines the coding of the velocity measuring units used to configure the signals NIST_A and NIST_B. Standard telegram 81 has no velocity information included and the encoder does not use the velocity unit information in this case. Telegram 82,83,84 and 59001 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	Value
Steps/s	0
Steps/100ms	1
Steps/10ms	2
RPM	3

Table 42 Velocity measuring units

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 2^{25} single turn resolution and a 2^{12} multi turn resolution, the maximum single turn value for velocity calculations will be 2^{19}. 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 2^{19}.

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

Note: If scaling has been set on the device the velocity calculation is based on the scaled position value. Consequently the accuracy of the velocity value is dependent of the scaling set to the device.

7.11 Encoder profile version

The encoder Profile Version is the version of the encoder profile document implemented in the encoder. 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 43 Encoder profile

7.12 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 44 Operating time

7.13 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 encoder 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 45 Offset value

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

7.14 Acyclic data

The PROFINET encoder support the following acyclic data exchange functions.

7.14.1 PROFIdrive parameters

The encoder profile V4.1 (PNO no. 3.162) has adopted certain standard PROFIdrive parameter. 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	Device identification	Array[n] Unsigned 16	R
965	Encoder Profile number	Octet string 2	R
971	Transfer to non volatile memory	Unsigned 16	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 46 Supported PROFIdrive parameters

7.14.2 Encoder parameter numbers

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

PNU (Prm.no)	Significance	Data type	Read/Write
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
65003	Operating status 64 bit	Array [n] Integer 64	R

Table 47 Encoder parameter numbers

7.14.3 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
Validity range	Profile specific
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 reloaded at each start up if stored.

Table 48 Parameter 65000, Preset value

PNU	65002
Significance	Preset value
Data type	Integer 64
Access	Read and write
Validity range	Profile specific
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 reloaded at each start up if stored.

Table 49 Parameter 65002, Preset value 64 bit

7.14.4 Parameter 65001-Operating status

This parameter structure is a read only structure where information on the Encoder operating status can be found. It is a complement to the PROFIdrive parameter 979 described in the Profile for Drive Technology, PROFIdrive V4.1, Order nr 3.172 available from PROFIBUS and PROFINET International.

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

Table 50 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 measuring unit

Table 51 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	Compatibility mode
6...7	Reserved for the Encoder manufacturer
8..31	Reserved for future use

Table 52 Parameter 65001, Sub index 1

7.14.5 Parameter 65003- operating status 64 bit

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

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

Table 53 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 54 Parameter 65003, Sub index

7.14.6 Identification & Maintenance functions

In addition to the PROFIdrive parameter 964, Device Identification, I&M functions are supported by the encoder. 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	Encoder part number
SERIAL_NUMBER	16	Encoder serial number
HARDWARE_REVISION	2	Not used
SOFTWARE_REVISION	4	Software revision
REVISION_COUNTER	2	Not used
PROFILE_ID	2	Encoder Profile number
PROFILE_SPECIFIC_TYPE	2	Type of encoder,
IM_VERSION	2	Version of the I&M profile
IM_SUPPORTED	2	Value = 0 means support of I&M

Table 55 Identification & Maintenance

8 Firmware upgrade

The encoder supports a firmware upgrade function. The firmware upgrade function is developed to offer the possibility to upgrade the encoders in the future.

Before the upgrade of the encoder can start, the following tools are needed:

- A running TFTP server
- A WEB browser (Internet Explorer, Firefox, Opera etc.)

The encoder itself puts no restrictions on what TFTP server to use. The customer can choose to use any TFTP servers.

Firmware upgrade in a PROFINET network.

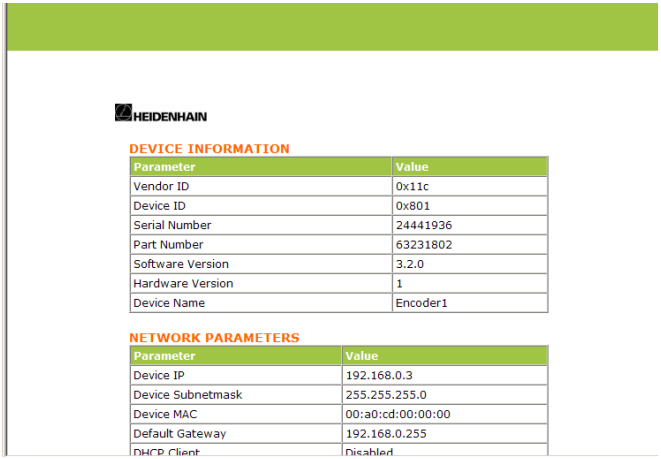
- This is when the encoder is connected to a PROFINET network. The encoder will be provided with an IP address from the PROFINET IO controller (with DCP).

8.1 Firmware upgrade in a PROFINET network

The following prerequisites have to be fulfilled in order to upgrade the encoder in a PROFINET network:

- The encoder should be attached to the network.
- The encoder must have a valid Device name and a valid IP address (assigned with DCP).
- A TFTP server should be enabled on the LAN where the encoder is attached. See chapter 8.4 for an example how to set up a TFTP server.

Once the encoder has been assign a valid IP address it should be accessible on the network. Enter the encoders IP address in the WEB browser to open the Firmware upgrade page.


HEIDENHAIN

DEVICE INFORMATION

Parameter	Value
Vendor ID	0x11c
Device ID	0x801
Serial Number	24441936
Part Number	63231802
Software Version	3.2.0
Hardware Version	1
Device Name	Encoder1

NETWORK PARAMETERS

Parameter	Value
Device IP	192.168.0.3
Device Subnetmask	255.255.255.0
Device MAC	00:a0:cd:00:00:00
Default Gateway	192.168.0.255
DHCP Client	Disabled

Figure 39 Firmware upgrade startpage

When accessing the encoder with the web browser it will display a number of parameters. In the firmware upgrade section of the page, enter the following information:

- Server IP address - Enter the IP address to the TFTP server on the LAN
- Firmware filename - Enter the full file name of the new firmware file supplied by the TFTP server
- Date - Enter the current date for the upgrade. This is stored as part of the Upgrade History. The format is yyyy-mm-dd. E.g. 2010-11-15.

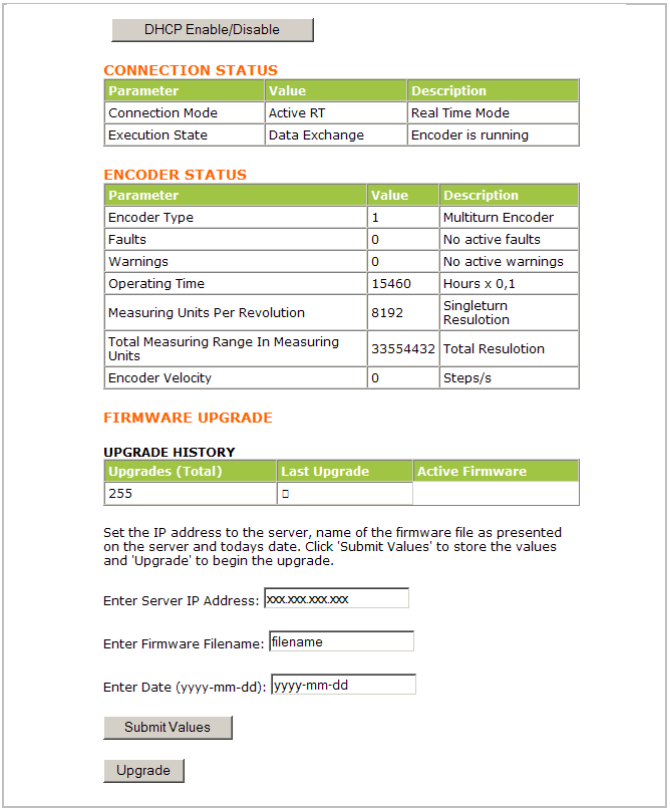


Figure 40 Firmware upgrade settings

The parameters are set by clicking the Submit Values button. After clicking the Submit Values button, update the page in the web browser. To start the upgrade, click on the Upgrade button.

A confirmation page is displayed where the upgrade has to be confirmed before the device starts the actual firmware upgrade process. The Continue button needs to be clicked in order to start the upgrade sequence.

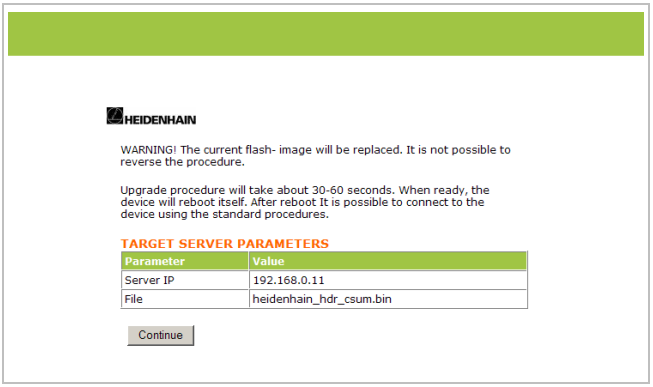


Figure 41 Firmware upgrade confirmation page

During upgrade a progress page is displayed. Depending upon the choice of web browser, the auto generated progress page will take some time to be displayed. However, the progress web page should always be displayed when the upgrade is finished. If no errors occur during upgrade the encoder will automatically reboot itself and connect to the PROFINET IO-controller with the new firmware.

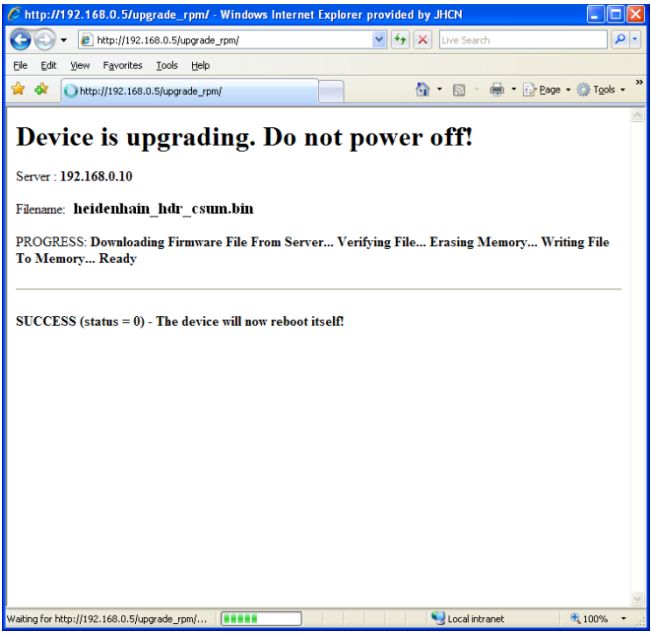


Figure 42 Firmware upgrade status page

During the upgrade, both the bus status LED and the device status LED will be flashing green. If an error occurs both LEDS will be flashing red.

If the upgrade fails check the error code displayed on the progress page. The error codes are described in chapter 8.3.

8.2 Error handling

This chapter will list all the possible error codes that can occur during an upgrade error. The error code will be visible on the feedback webpage. If an error occurs the device will **not reboot** itself automatically. Instead it will wait upon user action. This is to allow the user to take the next step. E.g. the user might want to check some parameters before rebooting or try to run the upgrade procedure again.

Failed to download firmware file from server
Error code: -2

The user should verify the IP address and the image filename. If any of them is incorrect the user should go back and submit the correct parameters at the main html page (index.html). If the parameters are correct the user should verify that the TFTP server is running on the host computer and that the TFTP server settings are correct.

Host not responding/No contact with host computer
Error code: -3

The user should verify that the host computer is connected to the encoder. The ping command can be used for this purpose. If connected, go back to upgrade.html and click Confirm to try and upgrade again.

Checksum Error/File image error
Error code: -4

Calculated checksum doesn't match the one supplied by the image file. The most likely cause for this problem is that there was an error when downloading the file to the encoder. Go back to upgrade.html and press Confirm and try again.

Flash Erase/Write Error
Error code: -5

The image might be corrupt. Flash Erase or Write failed. If this error occurs the device can still start with its failsafe image. It will be displayed by the Execution State parameter on the web Page.

File Size Error
Error Code: -6

The firmware file is too big to be written to flash.

Insufficient Memory
Error Code: -7

There is not enough memory available to store the firmware file image.

Invalid Firmware File
Error Code: -8

Firmware file is not supported for this hardware.

8.3 TFTP server installation

The TFTP server used in this example is a freeware TFTP server for Windows NT/XP/Vista platforms and it can be downloaded from www.solarwinds.com.

Unzip the installation file and double click on the SolarWinds-TFTP-Server.exe file to start the installation. Follow the instructions on the screen to complete the installation.

Create a folder on C:\ named TFTP_Root (if it not already exists). Copy or Move the new firmware file used to the C:\TFTP_Root directory.

Start the SolarWinds TFTP server and click on the File->Configure tab to open up the Configure window.

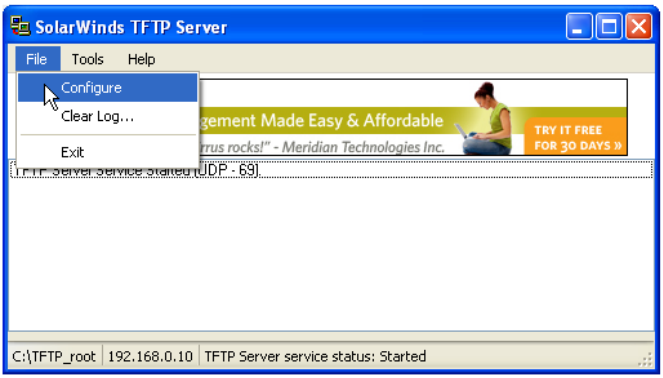


Figure 43 SolarWinds TFTP server

In the Configure window:

- Make sure that the correct network interface is selected in the Used NIC selection menu. I.e. it is the network interface which is connected to the encoder network.
- Set up the path to the TFTP root directory. I.e. the TFTP-Root directory created under C:\.
- Leave the other parameters with their default values.
- Click Start to start the TFTP server service in Windows.

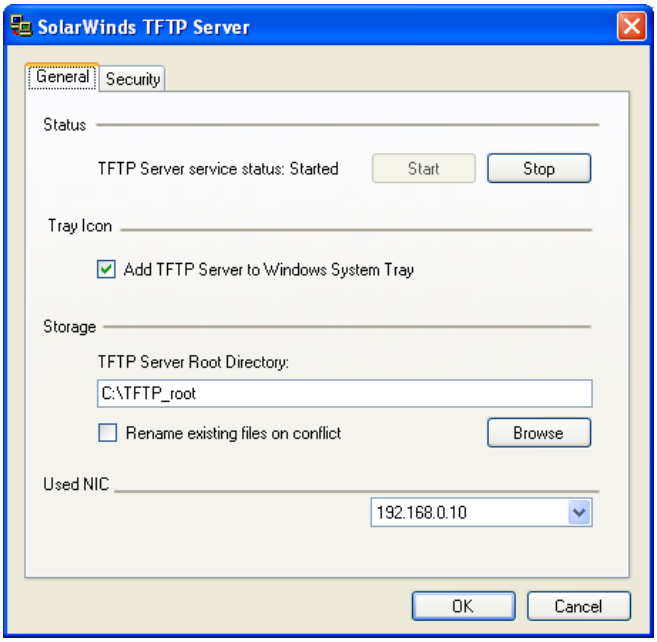


Figure 44 SolarWinds TFTP server settings

Note: The server will listen to port 69. Verify that there is no firewall blocking the port for incoming/outgoing requests. Disable any firewall temporarily if communication problems occur.

9 Encoder replacement using LLDP

The encoder supports 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.8

Follow the instruction below to exchange an IO device using LLDP:
Select properties of the PN-IO controllers interface module and enable Support device replacement without exchangeable medium.

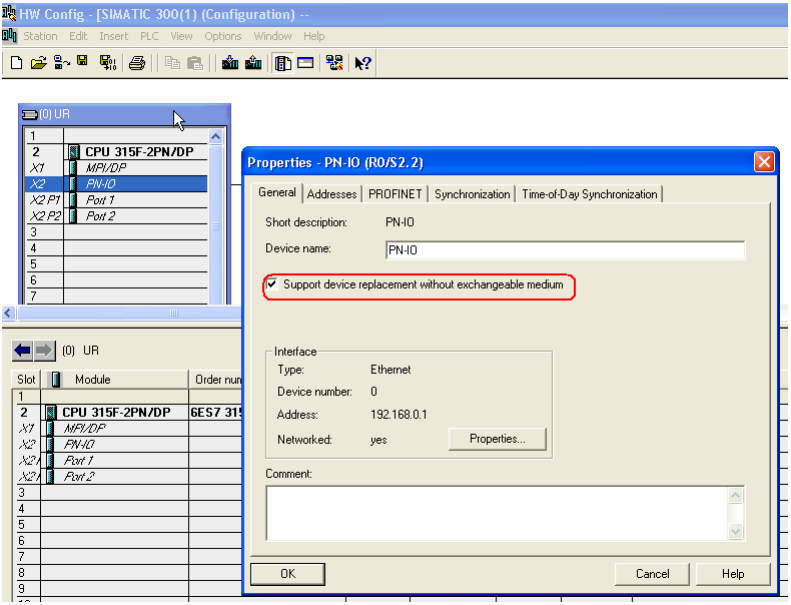


Figure 45 LLDP Properties

Configure the topology of the system for all connected ports.

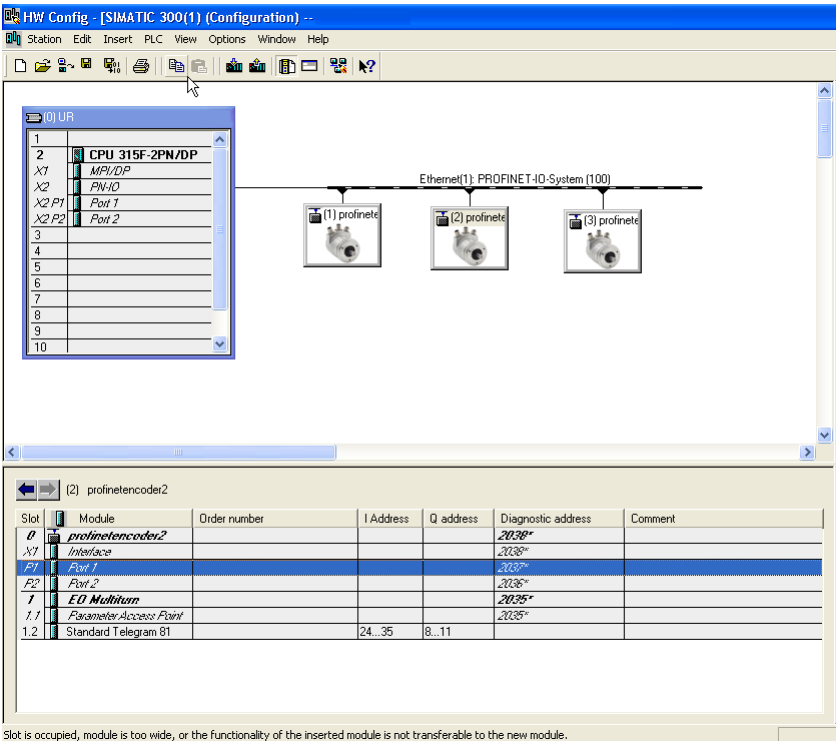


Figure 46 LLDP Port configuration

In the properties window, select the corresponding partner port.

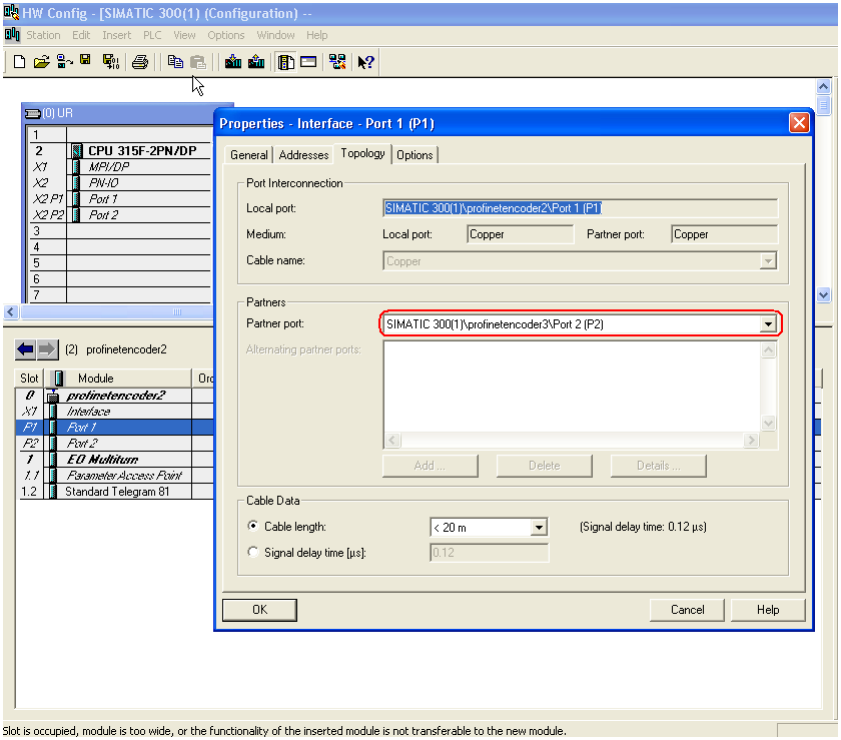


Figure 47 LLDP Partner port settings

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

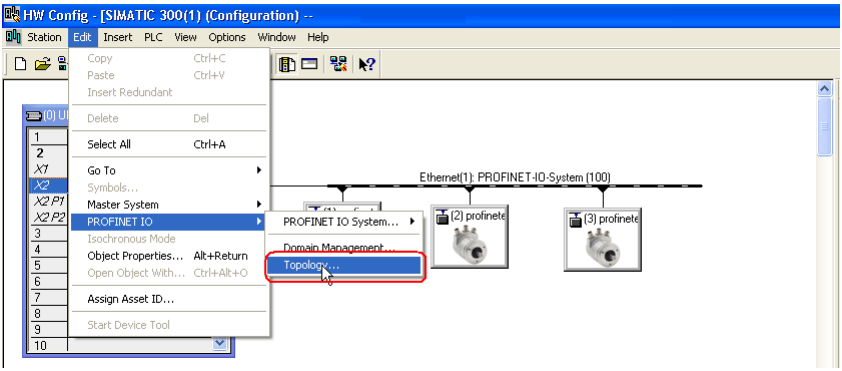


Figure 48 Open Topology editor

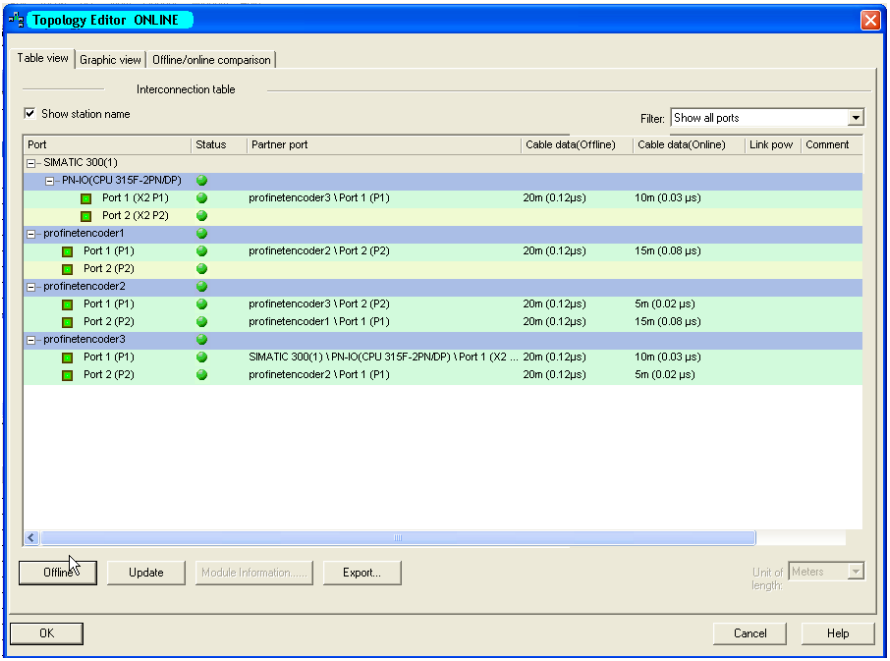


Figure 49 Topology editor

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.

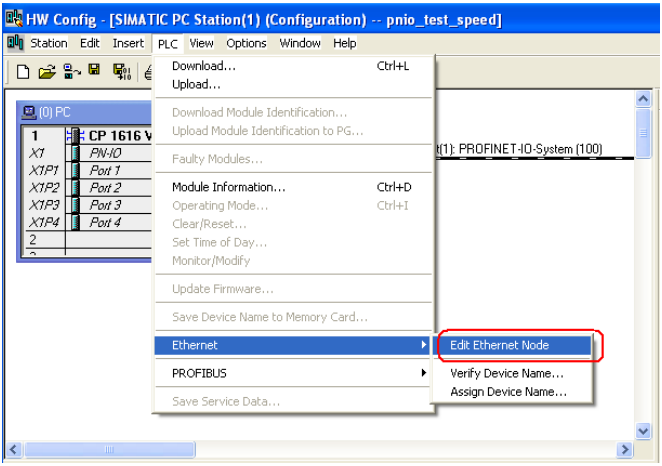


Figure 50 Edit Ethernet node

Enter the encoder´s MAC-adress and then click on the Reset button. The MAC-adress of the encoder is written on the encoder label.

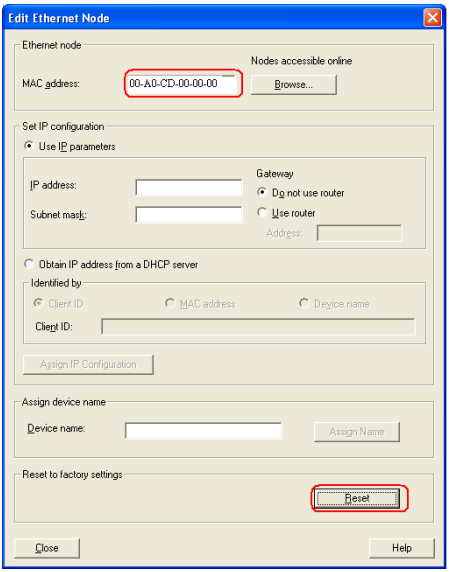


Figure 51 Factory reset

Click yes in the confirmation window to reset the encoder to its factory settings.

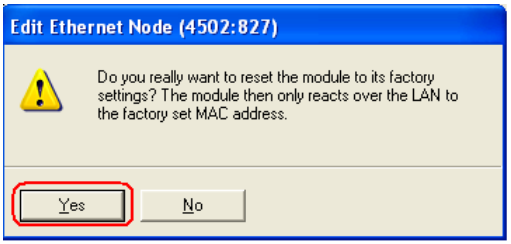
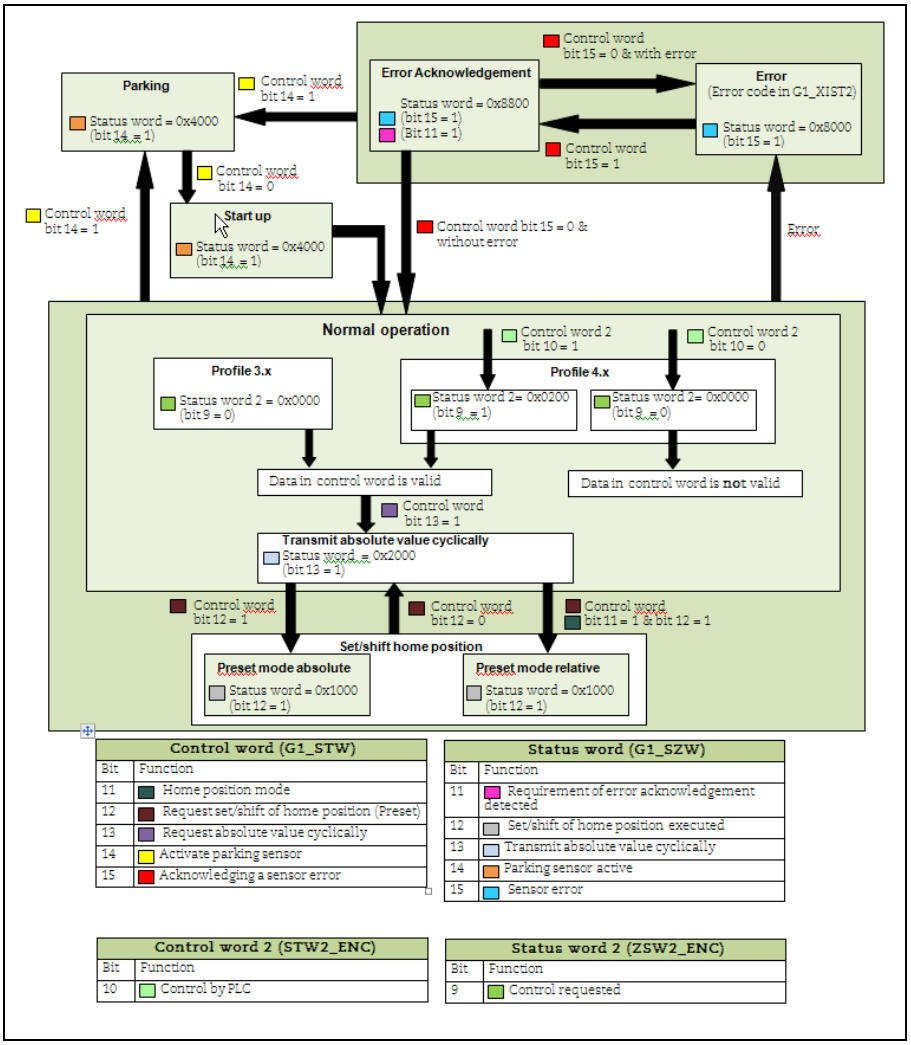


Figure 52 Factory set confirmation

10 Encoder state machine



Control word (G1_STW)	
Bit	Function
11	Home position mode
12	Request set/shift of home position (Preset)
13	Request absolute value cyclically
14	Activate parking sensor
15	Acknowledging a sensor error

Status word (G1_SZW)	
Bit	Function
11	Requirement of error acknowledgement detected
12	Set/shift of home position executed
13	Transmit absolute value cyclically
14	Parking sensor active
15	Sensor error

Control word 2 (STW2_ENC)	
Bit	Function
10	Control by PLC

Status word 2 (ZSW2_ENC)	
Bit	Function
9	Control requested

Figure 53 Encoder state machine

10.1 Normal operation state

10.1.1 Profile version 4.x

If using encoder complying with encoder profile v4.1, 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 encoder firmware.

10.1.2 Profile version 3.x

If using encoders 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.

10.1.3 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.

10.2 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.

10.3 Set/shift home position (Preset)

The Set/shift home position is initiated when Control word 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 in G1_XIST2.

10.3.1 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 encoder parameter 65002 Preset value 64 bit is used in this case, an error message will be returned. With telegram 81-83 the operating status must be read by encoder parameter 65001 Operating status 32 bit.

With telegram 84, the acyclic encoder parameter 65002 Preset value 64 bit shall be used to set a preset value (<=64 bit) for the encoder. If the acyclic encoder parameter 65000 Preset value 32 bit is used in this case, an error message will be returned. With telegram 84 the operating status must be read by encoder parameter 65003 Operating status 64 bit.

10.3.2 Absolute preset with negative value

Preset data sent with acyclic encoder 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 encoder parameter 65000 or 65002) is used while trying to initiate an absolute preset.

10.4 Error state

This state is reached when an error has occurred. The encoder can enter this state from both the normal operation state and the set/shift home position state. If an error occurs, the Status word bit 15 Sensor error is set, and the error code is displayed in G1_XIST2 instead of the position value.

10.5 Error acknowledgement

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

10.6 Start up

This state is only reached when Control word bit 14 Activate parking sensor are cleared (=0). Once the Control word bit 14 are cleared, it takes about 500ms before the Status word bit 14 Parking sensor active are 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.

11 Frequently asked questions FAQ

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).

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.

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Germany
☏ +49 8669 31-0
FAX +49 8669 5061
E-mail: info@heidenhain.de

Technical support FAX +49 8669 32-1000
Measuring systems ☏ +49 8669 31-3104
E-mail: service.ms-support@heidenhain.de
TNC support ☏ +49 8669 31-3101
E-mail: service.nc-support@heidenhain.de
NC programming ☏ +49 8669 31-3103
E-mail: service.nc-pgm@heidenhain.de
PLC programming ☏ +49 8669 31-3102
E-mail: service.plc@heidenhain.de
Lathe controls ☏ +49 8669 31-3105
E-mail: service.lathe-support@heidenhain.de

www.heidenhain.de

772084-22 · Ver02 · 6/2014 · PDF