SIEMENS

# SIMOTION/SIMATIC

# MC-ENCODER Absolute encoder with PROFINET IO

Operating Instructions



| Valid for | firmware version |
|---|---|
| SIMOTION | 4.2 |
| Product version MC-ENCODER | 1.0 |


11/2010

6SN1197-0AB11-0BP0

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| --- |
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| --- |
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| --- |
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# Preface

An overview of the SIMOTION documentation can be found in a separate list of references.

This documentation is included as electronic documentation in the scope of delivery of SIMOTION SCOUT. It comprises 10 documentation packages.

The following documentation packages are available for SIMOTION V4.2:

- SIMOTION Engineering System
- SIMOTION System and Function Descriptions
- SIMOTION Service and Diagnostics
- SIMOTION IT
- SIMOTION Programming
- SIMOTION Programming - References
- SIMOTION C
- SIMOTION P
- SIMOTION D
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# Table of contents

# Introduction 1

This manual describes the implementation and configuration of the absolute rotary encoder (MC-ENCODER) with PROFINET interface.

The device fulfills the requirements of a

- PROFINET IO device with RT (real time) or
- IRT (isochronous real time) classification and
- Encoder profile V4.1 Class 3 and Class 4

**Note**

Encoders are for installation on industrial machinery only (acc. Standard NFPA 79 in USA).

## 1.1 Absolute encoder

The basic principle of an absolute encoder is the optical sampling of a transparent code disk which is attached to the drive shaft.

The absolute encoder has a maximum resolution of 8.192 steps per revolution (13 bits).

The multiturn version can sense up to 16.384 revolutions (14 bits).

Therefore the highest resulting resolution is 27 bits = $2^{27}$.

The standard singleturn version has a resolution of 13 bits.

The standard multiturn version has a resolution of 27 bits.

## 1.2 PROFINET technology

PROFINET is an Industrial Ethernet standard merging plant automation with other enterprise IT resources. It provides comparable functionality to PROFIBUS with techniques used by engineering, IT, and management personnel.

Established IT standards are employed as basis of communication: TCP, UDP, IP. XML is used as description language for IO-Device profiles (GSDML files).

PROFINET can be used in two ways:

- PROFINET IO, similar to PROFIBUS DP as a distributed I/O system and
- PROFINET CBA as a modular component-based system for larger systems.

### Scalable communication

PROFINET offers scalable communication for different applications in industrial automation:

- PROFINET NRT (non real time) is suitable for non-time-critical process automation with clock rates of roughly 100 msec.
- PROFINET RT (real time) offers a communication channel with optimized performance (10 msec clock rate) for most factory automation tasks.
- PROFINET IRT (isochronous real time) employs special communication hardware to enable clock rates of less than 1 msec and a jitter precision of less than 1 µsec. This channel is mainly used for motion control applications.

PROFINET IO views the distributed I/O in a similar way to PROFIBUS DP. IO controllers (e. g. PLCs) run an automation program, IO devices (e.g. absolute encoders) are remotely assigned field IO devices, and IO supervisors (e.g. programming devices) are used for commissioning and diagnostics.

PROFINET IO is engineered similar to PROFIBUS. The fieldbuses (i. e. Ethernet topologies) are assigned to the control systems during configuration. The IO-device is configured in the actual system based on the contents of its GSDML file.

After engineering has been completed, the installer loads the data for the expansion into the IO controller (PLC) and the IO controller exchanges data with the IO device.

An IO device is addressed within PROFINET (and also possibly by external IT components) using its IP address.

Data can be exchanged between the IO controller and the IO device (and vice versa) cyclically (for process data). Apart from this, parameter data can be exchanged acyclically when engineering the IO device or by using PLC programming blocks.

### Further information

For further information about the function principle of operation or setting-up a PROFINET network, please refer to http://www.profibus.com/technology/profinet.

## 1.3 Encoder profile

### Introduction

The PI encoder profile defines a standard application interface for absolute encoders connected to PROFIBUS and PROFINET. In the encoder profiles, a distinction is made between 4 user classes (class 1 to 4) of absolute encoders.

### Classes 3 and 4

The encoder classes 3 and 4 contain a complete encoder channel according to PROFIdrive as well as the PROFIdrive parameter channel to access encoder parameters online. Correspondingly, encoders are generally used for clock-synchronous (isochronous) applications and as an equivalent to an encoder used on a PROFIdrive drive.

The absolute encoder MC-ENCODER is used on PROFINET IO via telegrams 81, 82, 83 and 84 as Class 3 or 4.

The MC-ENCODER can be operated with clock synchronism (IRT) or without clock synchronism (RT).

### Classes 1 und 2

Encoder classes 1 and 2 are intended for applications involving position encoders connected to PLC control systems without clock synchronization.

The MC-ENCODER is used via telegram 860 as class 1 or 2.

### Configuration

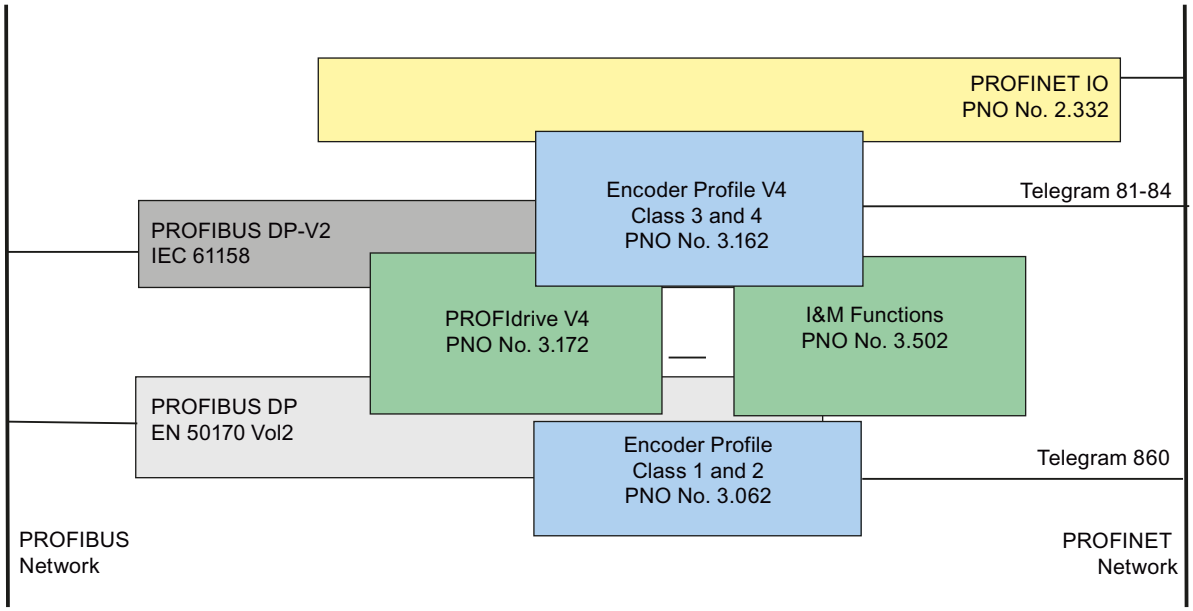



Figure 1-1 Overview of the relevant standards documents and assignment to the particular technologies

## 1.4 Features of the MC-ENCODER

The MC-ENCODER is a Class 4 absolute encoder and therefore also supports all of the functions of a Class 3 absolute encoder.

In addition, the MC-ENCODER can also be used in applications via telegram 860, where functions according to Class 1 and Class 2 are required.

The basic functions include:

- Communication interface PROFINET IO V2.2
- Neighbor detection
- Engineering identification call

- Support of encoder profile V4.1 (Class 3, Class 4)
- Support of encoder profile telegrams 81, 82, 83 and 84
- Support of vendor-specific telegram 860 (for Class 1, Class 2 applications)
- Support of PROFIdrive BMP parameter channel
- Integrated velocity calculation with selectable velocity filters and scaling
- Integrated round axis (endless shaft) functionality
- Integrated bootloader for encoder firmware upgrade

## 1.5 Encoder functions

The following table provides you with an overview of the functions supported by MC-ENCODER in the particular application classes.

Table 1- 1 Overview of the functions

| Function | Telegram 860<br>Class 1, Class 2 | Telegram 81 - 84<br>Class 3, Class 4 |
|---|---|---|
| Code sequence | ✓ | ✓ |
| Round axis (endless shaft) | ✓ | ✓ |
| Class 3 functionality | - | ✓ |
| Class 4 functionality | - | ✓ |
| Scaling function | ✓ | ✓ |
| G1_XIST1 preset control | - | ✓ |
| G1_XIST1 offset control | - | ✓ |
| Telegram 860 preset control | ✓ | - |
| Preset value 64 bit | - | - |
| Velocity signal 16 bit | - | ✓ |
| Velocity signal 32 bit | ✓ | ✓ |
| Velocity filter | ✓ | ✓ |
| Configurable velocity measuring unit | ✓ | ✓ |
| Sign-of-life supervision | - | ✓ |
| Configurable controller sign-of-life supervision | - | ✓ |
| Operation time | - | - |
| PROFIdrive fault buffer | - | - |
| Alarm channel diagnostics | >V1.0 | >V1.0 |

# Installing

# 2

## 2.1 Electrical connection

The encoder is connected using a 4 pin M12 connector for the power supply and two 4 pin, D-coded M12 connectors for Ethernet.

The encoder uses a second D-coded connector and provides integrated switch functionality. The mounting description is provided on or in the connector packaging.

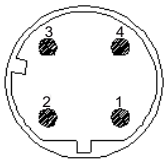
Adapters for field wiring can be ordered.

Refer to chapter: Accessories

or

Refer to catalog: "SIMOTION & SINAMICS PM 21", Part 7: Measuring systems

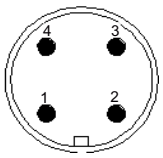
### Ethernet connector




| Pin number | Signal |
|---|---|
| 1 | Tx + |
| 2 | Rx + |
| 3 | Tx - |
| 4 | Rx - |

Figure 2-1 4 pin female, D-coded

### Connector power supply




| Pin number | Signal |
|---|---|
| 1 | US (10 - 30 V DC) |
| 2 | N.C. |
| 3 | GND (0 V) |
| 4 | N.C. |

Figure 2-2 4 pin male, A-coded

## 2.2 Ethernet cables

Table 2- 1 RJ45 - M12 crossover

| Signal | RJ45 Pin | M12 Pin |
|---|---|---|
| Tx + | 1 | 2 |
| Tx - | 2 | 4 |
| Rx + | 3 | 1 |
| Rx - | 6 | 3 |

Table 2- 2 M12 - M12 crossover

| Signal | M12 Pin | M12 Pin |
|---|---|---|
| Tx + | 1 | 1 |
| Tx - | 2 | 2 |
| Rx + | 3 | 3 |
| Rx - | 4 | 4 |

Table 2- 3 RJ45 - M12 crossover

| Signal | RJ45 Pin | M12 straight |
|---|---|---|
| Tx + | 1 | 1 |
| Tx - | 2 | 2 |
| Rx + | 3 | 3 |
| Rx - | 6 | 4 |

## 2.3 Diagnostic LEDs

Table 2- 4 Diagnostic LED

| LED | Color | Description for LED = on |
|---|---|---|
| Active1 | Yellow | Incoming and outgoing data traffic via port 1 |
| Link1* | Green | Link to another Ethernet component via port 1 |
| Active2 | Yellow | Incoming and outgoing data traffic via port 2 |
| Link2* | Green | Link to another Ethernet component for port 2 |
| Stat1 | Green | Status 2, see chapter Status LED indication (Page 15) |
| Stat2 | Red | Status 2, see chapter Status LED indication (Page 15) |
| * Flashes with 2 Hz if engineering identification call is activated and link connection is available | | |

## 2.4 Status LED indication

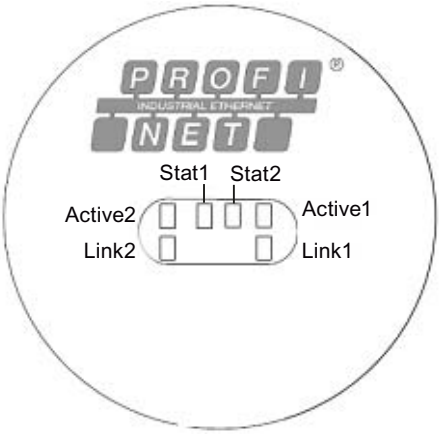



Figure 2-3 LED indication

Table 2- 5 Status LED indication

| Status 1<br>Green | Status 2<br>Red (bus failure) | Meaning | Cause |
|---|---|---|---|
| Off | Off | No power | |
| On | On | No connection to a controller<br>Criteria: no data exchange | • Bus disconnected<br>• IO-controller not available<br>• IO-controller switched off |
| On | Blinking * | • Parameterization fault, no data exchange<br>• Criteria: data communication correct. However, the IO-device did not switch to the data exchange mode | • IO-device not configured yet or wrong configuration<br>• Wrong station address assigned (but not outside the permitted range)<br>• Actual configuration of the IO-device differs from the nominal configuration |
| On | Off | Mode: Data exchange<br>IO-device and operation ok | |
| * The blinking frequency is 0.5 Hz. Minimum indication time is 3 sec. | | | |

## 2.5 Instructions for mechanical installation and electrical connection of the encoder

The following points should be observed during the installation and electrical connection of the encoder.

- Do not drop the angular encoder or subject it to excessive vibration. The encoder is a precision device.
- Do not open the angular encoder housing. If the device is opened and closed again, it can be damaged and dirt may enter the unit.
- The shaft of a full shaft encoder must be connected with the shaft of the suitable measuring object via a shaft coupling. This coupling is used to dampen vibration and imbalance on the encoder shaft and to avoid inadmissibly high forces. Suitable couplings are available from Siemens.
  Additional data is provided in the Catalog: "SIMOTION & SINAMICS PM 21", Part 7: Measuring systems.
- Although Siemens absolute encoders are rugged, when used in harsh ambient conditions, they should be protected against damage using suitable protective measures. The encoder should not be used as handles or steps.
- Only qualified personnel shall commission and operate these devices. These are personnel who are authorized to commission, ground and tag devices, systems and circuits according to the current state of safety technology.
- It is not permissible to make any electrical changes to the encoder.
- Route the connecting cable to the angular encoder at a considerable distance or completely separated from power cables with their associated noise. Completely shielded cables must be used for reliable data transfer and good grounding must be provided. Cabling, establishing and interrupting electrical connections may only be carried-out when the equipment is in a no-voltage condition. Short-circuits, voltage spikes etc. can result in malfunctions and uncontrolled states which can even include severe personnel injury and material damage.
- The encoder must be connected to PE through a large surface area. If the flange does not have a good electrical connection to the machine – i.e. if a plastic mounting device was used – then use e.g. a 30cm long and 2cm wide copper strap to establish the PE connection

Before powering-up the system, check all of the electrical connections. Connections, which are not correct, can cause the system to malfunction. Faulty connections can result in severe personnel injury and material damage.

# Cyclic Data Exchange

# 3

Setpoints and actual values to the absolute encoder are cyclically exchanged using standard telegrams, refer to the Telegrams (Page 25). The standard telegrams comprise a fixed compilation of signals, refer to the Signal list for cyclic data transmission (Page 17).

The structure of the telegrams as well as the content of the signals contained in them are provided in this documentation:

### Literature

Encoder profil

Additional literature (Page 76) [1]

PROFIdrive standard

Additional literature (Page 76) [2]

## 3.1 Signal list for cyclic data transmission

Table 3- 1 Signal list

| Signal | Significance | PROFIdrive signal No. | Data type |
|---|---|---|---|
| STW2_ENC | Encoder control word | 80 | U16 |
| ZSW2_ENC | Encoder status word | 81 | U16 |
| NIST_A | Velocity value A | 6 | I16 |
| NIST_B | Velocity value B | 8 | I32 |
| G1_STW | Sensor control word | 9 | U16 |
| G1_ZSW | Sensor status word | 10 | U16 |
| G1_XIST1 | Sensor position actual value 1 | 11 | U32 |
| G1_XIST2 | Sensor position actual value 2 | 12 | U32 |
| G1_XIST3 | Sensor position actual value 3 | 39 | U64 |
| G1_XIST_PRESET_A | Sensor position preset control word 32 bit | 238 | U32 |

## 3.2 Format of actual position values G1_X

The signals G1_XIST1 and G1_XIST2 represent the actual position values. For the MC-ENCODER the format for both signals is right aligned and fixed. See table G1_XIST1 (Page 18), G1_XIST2 (Page 19) below.

As the MC-ENCODER is a gray-coded absolute encoder, in G1_XIST it permanently supplies the absolute value – and G1_XIST2 supplies no additional value regarding the absolute value. If you directly access the position actual value in telegrams 81 - 84 from the user program, then you read out the position actual value from G1_XIST1 and you only use G2_XIST2 to read out the error code in the case of an error.

---

**Note**

The MC-ENCODER is using fixed shift factors for XIST1 and XIST2. There is no possibility to configure the shift factor. The shift factors are always zero and can be read out of parameter 979 by the controller or a supervisor:

- P979, Subindex 3 (Shift factor for G1_XIST1) = 0
- P979, Subindex 4 (Shift factor for G1_XIST2) = 0

---

### 3.2.1 G1_XIST1

The position value representing the current position value is right aligned (shift factor 0) according to table " Absolute value in G1_XIST1". After starting the encoder ("station come" and ZSW2_ENC bit 9 = 1 and G1_ZSW bit 14 = 0) the G1_XIST1 shows the absolute position value of the encoder. For a singleturn encoder, the bits "S" show the absolute value within one revolution, for the multiturn encoder also the current multiturn information (bits 13 to 26) are shown. If the absolute encoder is operational and is rotated beyond the absolute range (singleturn: up to bit 12, multiturn: up to bit 26), then the encoder continues to count electronically beyond these bits up until overflow is reached at bit 31. After the reset/new start of the absolute encoder, from the position actual value, only the value limited to the maximum possible absolute resolution of the absolute encoder is displayed in XIST1, (bits 0 - 12 or 0 - 26).

Table 3- 2 Absolute value in G1_XIST1

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

M = distinguishable revolutions (multiturn value)

S = pulses (singleturn steps per revolution)

### 3.2.2 G1_XIST2

The signal G1_XIST2 is a multiplex from the absolute position actual value and error code. If the encoder channel is not in an error state (G1_ZSW bit 15 = 0), then in G1_XIST2 the actual absolute value of the absolute encoder is transferred.

If the absolute encoder is operational and rotated beyond the absolute range, then the position value in G1_XIST2 is not counted electronically any further. This means that the range of the position actual value is limited according to Table "Absolute value in G1_XIST2 for singleturn encoder" or Table "Absolute value in G1_XIST2 for multiturn encoder" corresponding to the absolute encoder type being used.

Table 3- 3 Absolute value in G1_XIST2 for singleturn encoder

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

S = pulses (singleturn steps per revolution)

Table 3- 4 Absolute value in G1_XIST2 for multiturn encoder

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

S = pulses (singleturn steps per revolution)

M = distinguishable revolutions (multiturn value)

If the encoder channel is in the error state (G1_ZSW bit 15 = 0), then in G1_XIST2 the error code is transferred corresponding to the Table "Error Code G1_XIST2" in G1_XIST2. The encoder channel remains in the error state until the cause of the error has been resolved, and the error state was acknowledged using the encoder control word (G1_STW bit 15 = 0 → 1 edge).

Table 3- 5 Error code G1_XIST2

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

E = error code

Table 3- 6 List of error codes in G1_XIST2

| Error code | Error | Error description |
|---|---|---|
| 0x001 | Sensor group error | Error in the processing of the sensor signal which causes an invalid Gx_XIST (e.g. electronic malfunction or invalid sensor signal). |
| 0xF01 | Command not supported | Optional command (in G1_STW) not supported. |
| 0xF02 | Controller sign-of-life failure | The number of permissible failures of the masters sign-of-life was exceeded. |
| 0xF04 | Synchronization fault | The number of permissible failures for the bus cycle sign signal was exceeded. |

### 3.2.3 G1_XIST3

The function and bit assignment of signal G1_XIST3 is identical to signal G1_XIST1 (Page 18) only with a 64 bit signal word.

Bit 32 up to bit 63 contain the multiturn information "M".

Signal G1_XIST3 can be beneficial, for example, if you wish to count the position actual value in the encoder directly electronically with 64 bit in order to eliminate having to perform a modulus calculation in the user program when the 32 bit position actual value overflows in G1_XIST1.

### 3.2.4 G1_XIST_PRESET_A

Using the G1_XIST_PRESET_A signal, the controller can enter a preset value for the MC-ENCODER via the cyclic data telegram, and activate this using the trigger bit. As the trigger bit is transferred in the same signal, in this case, only a preset value of maximum 31 bits can be entered.

The structure of the G1_XIST_PRESET_A signal is shown in the subsequent table "Absolute value in G1_XIST_PRESET".

With the 1 → 0 edge of the trigger bit, the actual preset value (bits 0 - 30) is accepted as actual value in G1_XIST1. When this preset value is accepted, then this is also retentively saved automatically. The reason for this is that absolute value set using a preset is also kept after a reset/new start of the absolute encoder.

If a preset has not been set, then set trigger bit 31 to the standard value of 0.

**Note**

The speed of the encoder shaft at the time that the preset value is set should be as low as possible or zero. As a consequence, the influence of the communication dead times on the preset value that has been set are kept as low as possible.

Table 3- 7 Absolute value in G1_XIST_PRESET_A

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

P = preset value (31 bit) for G1_XIST1 in the format/resolution of G1_XIST1

T = trigger bit to control the transfer of the preset value

## 3.3 Format of actual velocity values NIST

The velocity value, which is transferred in NIST_A or in NIST_B is a speed actual value calculated by the absolute encoder from the equidistant position sensing. By calculating the speed actual value at the absolute encoder in real-time, the controller can also be provided a high accuracy velocity signal without isochronous communication (without PROFINET IRT). In addition, you can utilize parameterizable filtering for the velocity signal in NIST_x.

The normalization of the value in NIST_x can be parameterized.

The following parameterization options exist:

- Increments / s
- Increments / 100 ms
- Increments / 10 ms
- Revolutions/ minute
- N2 / N4 normalization:
  Velocity normalization (scaling) as used in PROFIdrive telegrams. The velocity actual value in NIST is a percentage of the reference value.
  The reference value can also be programmed. In addition, the controller can read out the parameterized or active reference value via parameter p2000. Adapt the reference value to the particular application in order to optimally utilize the value range.
  - for N2, 4000 hex corresponds to a value of 100 % of the reference value
  - for N4, 4000 0000 hex corresponds to a value of 100 % of the reference value
  - the value range extends from -200 % up to +200 %.
    MSB = 1 is a negative sign
    MSB = 0 is a positive sign

**Note**

If the expected velocity value does not appear in signal NIST_x, then check the selected normalization or scaling for NIST.

Standard setting:

- NIST_A = N2
- NIST_B = N4

## 3.4 Encoder control word (STW2_ENC)

Signal STW2_ENC is used in telegrams 81 - 84.

The signal transfers the sign-of-life from the controller to MC-ENCODER. Further, in STW2_ENC, the controller must set bit 10 (control by PLC) to 1, in order to signal to the devices that the cyclic data are valid.

The Table "Bit assignment of STW2_ENC" shows the bit assignment of the STW2_ENC signal.

**Note**

If, in STW2_ENC, the controller does not set bit 10 to 1, then MC_ENCODER does not respond to the commands in G1_STW.

For clock cycle synchronous (isochronous) applications, the sign-of-life (sign-of-life counter) is used to monitor the correct synchronization of the controller processes to the sampling process in the absolute encoder.

The sign-of-life counter is a 4-bit counter. The controller application starts the sign-of-life with any value between 1 and 15. The controller increases the counter in every cycle of the controller application.

Valid values for the controller sign-of-life are 1 to 15, "0" indicates an error and is left out in normal operation.

Table 3- 8 Bit assignment of STW2_ENC

| Bit | Value | Significance | Comments |
|---|---|---|---|
| 10 | 1 | Control by PLC | Control via interface, data is valid. |
| | 0 | No control by PLC | Data is not valid, except sign-of-life bits. |
| 12 ... 15 | | Controller sign-of-life | Sending continuous counting value from 1 to 15. |

## 3.5 Encoder status word (ZSW2_ENC)

Signal ZSW2_ENC is used in telegrams 81 – 84 to transfer the sign-of-life from the MC-ENCODER to the controller. Further, in ZSW2_ENC, the controller must evaluate bit 9 (control requested) in order to evaluate whether the cyclic data sent from the MC-ENCODER are valid, and the MC-ENCODER is ready to accept control commands.

The table "Bit assignment of ZSW2_ENC" indicates the bit assignment of the ZSW2_ENC signal.

**Note**

If, in ZSW2_ENC, bit 9 is not 1 then the information in G1_ZSW and G1_XIST_x is invalid and the MC-ENCODER does not respond to commands in the G1_STW.

For clock cycle synchronous applications, the sign-of-life (sign-of-life counter) is used to check the correct synchronization of the controller processes to the sampling process in the MC-ENCODER.

The sign-of-life counter is a 4-bit counter. The IO-device application starts the sign-of-life with any value between 1 and 15 after successful synchronization to the controller. The counter is increased by the IO-device in every data cycle.

Valid values for the IO-device sign-of-life are 1 to 15, "0" indicates an error and is left out in normal operation.

**Note**

If the MC-ENCODER identifies an error in the controller sign-of-life, then it stops sending the sign-of-life to the controller. This means that a missing sign-of-life (=0) from the MC-ENCODER to the controller can also be the consequence of an error in the controller sign-of-life to MC-ENCODER.

Table 3- 9 Bit assignment of ZSW2_ENC

| Bit | Value | Significance | Comments |
|---|---|---|---|
| 9 | 1 | Control requested | The automation system is requested to assume control, data is valid. |
| | 0 | No control by PLC | Data is not valid, except sign-of-life. |
| 12 .. 15 | | Encoder sign-of-life | Sending continuous counting value from 1 to 15. |

## 3.6 Sensor control word (G1_STW)

Signal G1_STW is used to control the state machine of the PROFIdrive encoder channel. As the MC-ENCODER is a gray-coded absolute encoder, the following functions are often significant:

- Preset of the absolute position
- Encoder parking
- Error acknowledgment

Table 3- 10 Bit assignment of G1_STW

| Bit | Value | Function | Comments |
|---|---|---|---|
| 0 ... 10 | | | Reserved, currently not used. |
| 11 | 0/1 | Home position mode | Specifies if the position value shall be set to a previously configured absolute value or shifted by this value.<br>0: set home position / preset (absolute)<br>1: shift home position / preset (relative = offset) |
| 12 | 1 | Set preset / request shift | Preset (resp. shift) is set when changing this Bit to "1" (rising edge). Default preset value (shift): 0<br>Note: It can also be parameterized that with a rising edge, the value XIST1 also makes a step. |

| Bit | Value | Function | Comments |
|---|---|---|---|
| 13 | 1 | Request absolute value cyclically | Request of additional cyclic transmission of the absolute actual position in G1_XIST2. If no other data needs to be transferred due to commands or errors the absolute position value will be transmitted automatically. |
| 14 | 1 | Activate parking sensor | If the "activate parking sensor" bit is set, the encoder is switched inactive and error will be reset. While the encoder is in the parking state, no errors will be generated. |
| 15 | 1 | Acknowledging a sensor error | Request to acknowledge / reset a sensor error. |

By appropriately parameterizing the absolute encoder, when accepting the preset value, you can set whether this is also directly accepted in G1_XIST1 or G1_XIST3. When the preset value is accepted, this value is also retentively saved automatically. This is to ensure that an absolute value set using preset is also kept after a reset/power up of the absolute encoder.

## 3.7 Sensor status word (G1_ZSW)

Signal G1_ZSW is used to control the state machine of the PROFIdrive encoder channel and is the counterpart to control word G1_STW.

Table 3- 11 Bit assignment of G1_ZSW

| Bit | Value | Meaning | Comment |
|---|---|---|---|
| 0 … 10 | | | Reserved, currently not used. |
| 11 | | Acknowledgement sensor error in process | Is set while requested error acknowledge is processed. Handshake signal related to G1_STW bit 15. |
| 12 | 1 | Set preset / shift reference point executed | Acknowledgement for "set preset / request shift". |
| 13 | 1 | Transmit absolute value cyclically | Acknowledgement for "request absolute value cyclically". |
| 14 | 1 | Parking sensor activated | Acknowledgement for "activate parking sensor". The encoder transmits no valid position value, sensor errors are reset. |
| 15 | 1 | Sensor error | Indicates a sensor error. A device specific error code is transmitted in G1_XIST2. |

## 3.8 Telegrams

Configuration of the cyclic data interface of the MC-ENCODER is done by selecting one of the following standard telegrams. The selection of the required standard telegram is done by inserting the related telegram submodule when setting up the PROFINET configuration of the encoder in STEP7 "HW Config", see also Auto-Hotspot

Standard telegrams 81 to 84 are typically used if the encoder is used together with a motion control system with PROFIdrive interface such as e.g. SIMOTION or SINUMERIK. Telegrams 81 to 84 offer a standard PROFIdrive sensor interface, which is equal to the sensor interface offered by a standard drive. Nevertheless, telegrams 81 to 84 may also be used with a PLC controller if sign-of-life supervision or error codes via cyclic interface is required.

For more simple applications, convenient transmission of position and velocity actual values to PLC based controllers is possible using telegram 860.

### See also

Configuration (Page 29)

### 3.8.1 Standard telegram 81

Telegram 81 provides the following:

- Standard PROFIdrive encoder channel

Table 3- 12 Telegramm 81, structure

| Output data (PZD/Word) | 1 | 2 |
|---|---|---|
| Setpoint value | STW2_ENC | G1_STW |

| Input data (PZD/Word) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Actual value | ZSW2_ENC | G1_ZSW | G1_XIST1 | | G1_XIST2 | |

### See also

G1_XIST1 (Page 18)

Encoder control word (STW2_ENC) (Page 21)

Sensor control word (G1_STW) (Page 23)

Sensor status word (G1_ZSW) (Page 24)

## 3.8.2 Standard telegram 82

Telegram 82 provides the following:

- Standard PROFIdrive encoder channel
- 16 bit velocity actual value

Table 3- 13 Telegram 82, structure

| Output data (PZD/Word) | 1 | 2 |
|---|---|---|
| Setpoint value | STW2_ENC | G1_STW |

| Input data (PZD/Word) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Actual value | ZSW2_ENC | G1_ZSW | G1_XIST1 | | G1_XIST2 | | NIST_A |

## 3.8.3 Standard telegram 83

Telegram 83 provides the following:

- Standard PROFIdrive encoder channel
- 32 bit velocity actual value

Table 3- 14 Telegram 83, structure

| Output data (PZD/Word) | 1 | 2 |
|---|---|---|
| Setpoint value | STW2_ENC | G1_STW |

| Input data (PZD/Word) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Actual value | ZSW2_ENC | G1_ZSW | G1_XIST1 | | G1_XIST2 | | NIST_B | |

## 3.8.4 Standard telegram 84

Telegram 84 provides the following:

- PROFIdrive encoder channel with a 64 bit XIST
- 32 bit velocity actual value

Table 3- 15 Telegram 84, structure

| Output data (PZD/Word) | 1 | 2 |
|---|---|---|
| Setpoint value | STW2_ENC | G1_STW |

| Input data (PZD/Word) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual value | ZSW2_ENC | G1_ZSW | G1_XIST3 | | | | G1_XIST2 | | NIST_B | |

## 3.8.5 Telegram 860

Telegram 860 provides the following:

- 32 bit position actual value XIST1
- 32 bit velocity actual value
- Using cyclic data, in the G1_XIST_PRESET_A signal a preset value can be entered for the position and activated.

**Note**

The telegram does not have a sign-of-life monitoring.

Encoded diagnostics is only possible using the standard PROFINET diagnostics.

Table 3- 16 Telegram 860, structure

| Output data (PZD/Word) | 1 | 2 |
|---|---|---|
| Setpoint value | G1_XIST_PRESET_A | |

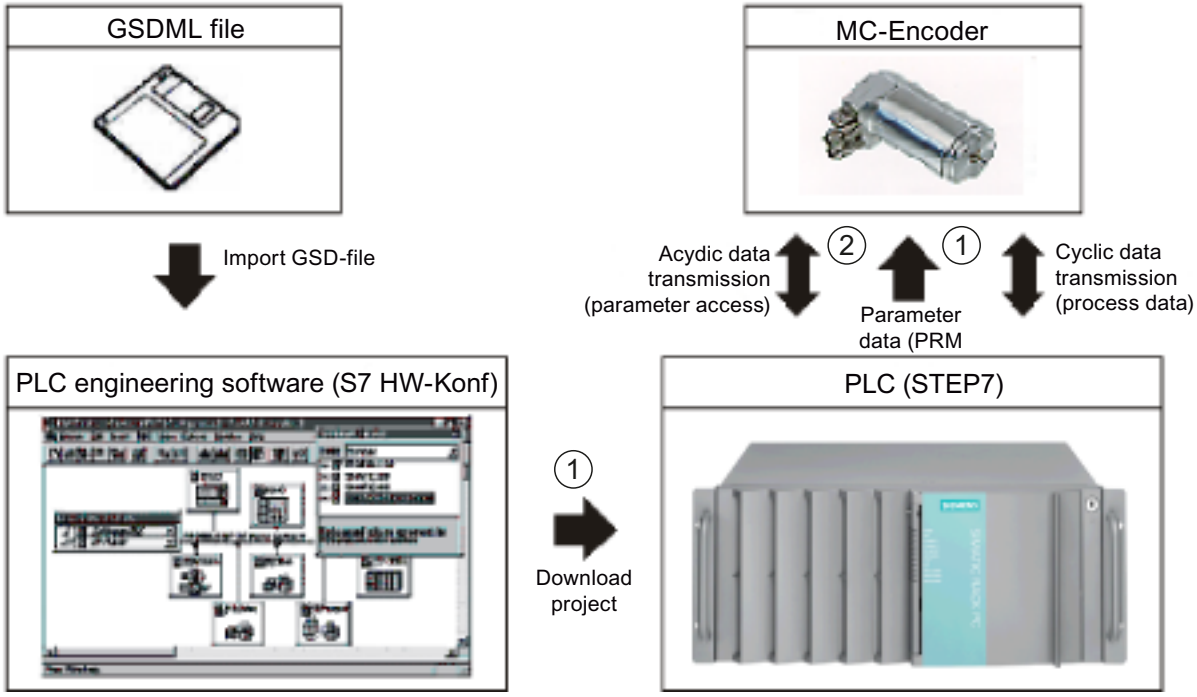
| Input data (PZD/Word) | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Actual value | G1_XIST1 | | NIST_B | |

# Configuration

# 4

The MC-ENCODER with PROFINET IO interface has to be configured by parameterization corresponding to the purpose of the application. The GSDML file pertaining to the encoder has to be installed in the PLC engineering software tool that is being used to enable this configuration.

## 4.1 Encoder configuration overview




① Offline configuration path via the hardware configuration

② Online access to encoder parameters via the non-cyclic parameter channel

Figure 4-1 Rotary encoder functions

The MC-ENCODER is essentially configured and parameterized offline using STEP7 HW-Config (Figure: ①).

In online operation of the MC-ENCODER, a non-cyclic parameter channel according to the encoder profile/x/ or PROFIdrive profile/y/is also available (Figure: ②). Using this PROFIdrive parameter channel, parameters can be read and write accessed in online operation.

### Literature

You can find additional information on this topic in this documentation:

Additional literature (Page 76) [3b]

Encoder-Profil

Additional literature (Page 76) [1]

PROFIdrive-Norm

Additional literature (Page 76) [2]

## 4.2 Encoder offline configuration

The MC-ENCODER is configured and parameterized offline using STEP7 HW Config. HW Config is made aware of the MC-ENCODER by importing the GSDML of the encoder device.

### Procedure

After importing the GSDML, the MC-ENCODER is inserted into the project and configured and/or parameterized.

After compiling the project, when the project is downloaded to the controller (SIMATIC or SIMOTION CPU), then the encoder parameterization is also transferred. When the CPU goes online and when the PROFINET connection is established to the MC-ENCODER, then also the parameterization is automatically transferred to the encoder (PRM data record) and becomes active.

When configuring the MC-ENCODERS in the HW Config, then principally, a distinction is made between the following three configuration areas:

### Interface configuration, PROFINET

Configuration of the general communication properties of the encoder PROFINET interface e.g.:

- RT/IRT communication
- Cycle time
- Times Ti and To (for IRT operation)

You configure the properties at the interface submodule X1 at slot 0.

### Configuration, telegrams

By selecting the telegram, you select the type of cyclic interface of the MC-ENCODER. The configuration is realized by selecting and inserting the appropriate telegram submodule (81, 82, 83, 84, 860).

## Function configuration, MC-ENCODER

Using the encoder parameters in the MAP submodule, then for example, the following individual MC-ENCODER functions are configured:

- Parameterization of the direction of rotation
- Optional scaling function
- Velocity signal
- Sign-of-life monitoring

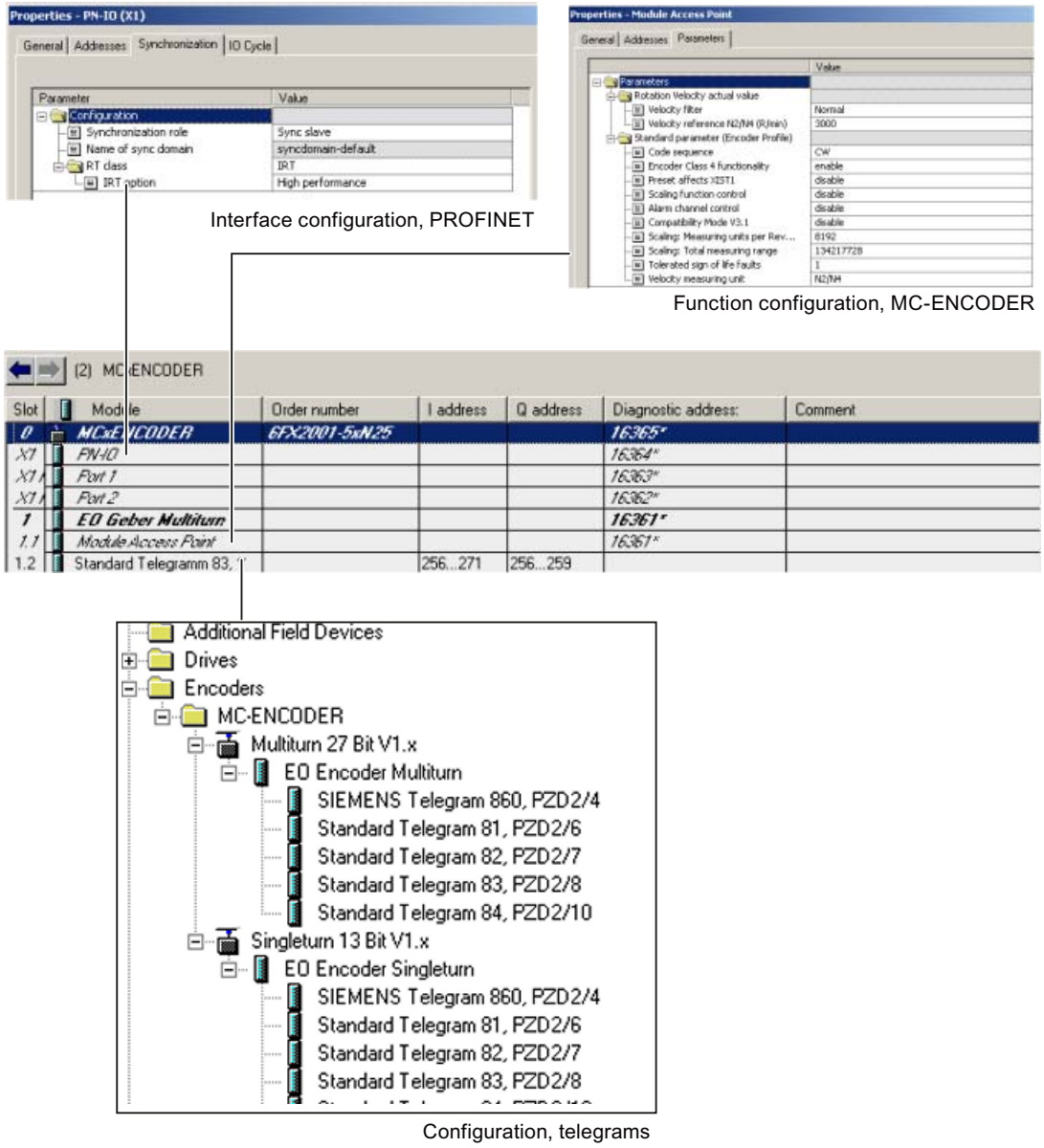



Figure 4-2 Encoder access points for configuration and parameterization

# 4.3 Encoder parameter description

## 4.3.1 Encoder parameter

### Parameter setting options

The MC-ENCODER parameters can be set offline using HW Config.

For specific parameters there is also the option of being able to access these online via the non-cyclic parameter channel – as well as retentively saving these in the encoder.

Also refer to:

Encoder configuration overview (Page 29)

## 4.3.2 Parameterizing the position actual value

The following table provides you with an overview of the configuration parameters of the position actual value in XIST1 and XIST2 (telegrams 81, 82, 83, 84 and 860).

These parameters are only available via HW Config.

### Overview

Table 4- 1 Position actual value in XIST1 and XIST2

| Parameter | Significance | Value | |
|---|---|---|---|
| Direction of rotation | This parameter influences the positive count direction of the MC-ENCODERS (when viewing from the shaft side).<br>Note:<br>"Encoder Class 4 functionality" must be activated. | 0 | Clockwise direction of rotation, positive (default). |
| | | 1 | Counter-clockwise direction of rotation, positive. |
| Preset influences XIST1 | This parameter is used to control whether, XIST1 should also make a step when presetting.<br>Note:<br>"Encoder Class 4 functionality" must be activated. | 0 | XIST1 is influenced by a preset command. |
| | | 1 | XIST1 is not influenced by a preset command (default). |
| Encoder class 4 functionality | This function is used to enable or inhibit the following supplementary functions:<br>• Scaling<br>• Preset<br>• Direction of rotation | 0 | No Class 4 functionality. |
| | | 1 | Class 4 functionality enabled (default). |

### Enabled/disabled functions

The following table provides you with an overview of the enabled/disabled MC-ENCODER functions depending on the setting of "Encoder Class 4 functionality".

Table 4- 2 Overview of the functions

| Function | Class 4 functionality disabled | Class 4 functionality enabled |
|---|---|---|
| Code sequence | - | ✓ |
| G1_XIST1 preset control | - | ✓ |
| Scaling function control | - | ✓ |
| Alarm channel control | ✓ | ✓ |
| 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 controller sign-of-life failures | - | ✓ |
| Velocity measuring unit | ✓ | ✓ |
| Operating time | - | - |
| Offset line | - | ✓ |
| Offset value | - | ✓ |
| Offset value 64 bit | - | ✓ |
| Rotary axis (endless shaft) | Always active | Always active |
| Velocity filter | ✓ | ✓ |

## 4.3.3 Parameterizing the scaling function

The following table provides you with an overview of the configuration parameters of the scaling function for the position actual value XIST1 and XIST2 (telegrams 81, 82, 83, 84 and 860).

These parameters are only available via HW Config.

### Overview

Table 4- 3 Scaling function in XIST1 and XIST2

| Parameter | Significance | Value | |
|---|---|---|---|
| Scaling function | Using this parameter, the scaling function in the MC-ENCODER is enabled or disabled.<br>Note:<br>"Encoder Class 4 functionality" must be activated, otherwise the scaling function is always off. | 0 | Scaling off (default) |
| | | 1 | Scaling enabled |

| Parameter | Significance | Value | |
|---|---|---|---|
| Scaling: resolution per revolution | Singleturn resolution in increments per revolution when the scaling function is active. | 11 | Unsigned 32 |
| Scaling: Total resolution | Absolute measuring range in increments per revolution when the scaling function is active. | 11 | Unsigned 32 |

## 4.3.4 Parameterizing the velocity signal

An overview of the configuration parameters of the velocity signal in NIST_A or NIST_B (telegrams 82, 83, 84 and 860) is provided in the following table.

Parameters "Speed filtering" and "Speed scaling" are only available via HW Config.

Parameter "Reference speed N2/N4" can be set via HW Config, and can be read via the parameter channel of parameter p2000.

### Overview

Table 4- 4 Velocity signal in NIST_A and NIST_B

| Parameter | Significance | Value | |
|---|---|---|---|
| Speed filtering | Active velocity filter for the speed actual value in NIST_x. | 1 | Fine (no filtering) |
| | | 2 | Medium (default) |
| | | 3 | Coarse |
| Speed scaling | Unit or scaling of the velocity actual value in NIST_x. | 0 | Increments / s |
| | | 1 | Increments / 100 ms |
| | | 2 | Increments / 10 ms |
| | | 3 | rpm |
| | | 4 | N2/N4 scaling |
| Reference speed N2/N4 (rpm) | Speed reference value for 100 % for selected N2/N4 scaling in rpm. | UINT 32 | |

## 4.3.5 Parameterizing the communication interface

The following table provides you with an overview of the configuration parameters to configure help functions in the cyclic communication channel (telegrams 81, 82, 83, 84 and 860).

Parameters "Compatibility module V3.1" and "Diagnostics via alarm channel" are only available via HW Config.

Parameter "Tolerable sign-of-life error" can be set via HW Config and can also be additionally read and written to via the parameter channel as parameter 925.

## Overview

Table 4- 5 Help functions in the cyclic communication channel

| Parameter | Significance | Value | |
|---|---|---|---|
| Tolerated sign-of-life error | This parameter is used to set the maximum number of tolerated sign-of-life errors.<br>Note:<br>The "Compatibility mode V3.1" must be activated.<br>The setting has no effect for telegram 860. | 0 | No error tolerated (e.g. for communication test) |
| | | 1... 254 | Number of tolerated sign-of-life errors (1 = default) |
| | | 255 | Monitoring off (e.g. for commissioning) |
| Compatibility mode V3.1 | Using this parameter, an encoder interface behavior compatible with encoder profile V3.1 is set (only for compatibility in previous projects).<br>Note:<br>The setting has no effect for telegram 860. | 0 | V3.1 compatibility |
| | | 1 | V4.x interface (default) |
| Diagnostics via alarm channel | Using this parameter, diagnostic alarms are either enabled or disabled via the PROFINET alarm channel.<br>Note:<br>"Compatibility mode V3.1" must be activated, as otherwise, the diagnostic alarms are always enabled. | 0 | Alarm channel disabled (default) |
| | | 1 | Alarm channel enabled |

## Overview

In the online operation of the MC-ENCODER, a non-cyclic parameter channel according to the encoder profile/x/or PROFIdrive profile/y/is available. Parameters can be read and write accessed in online operation using this PROFIdrive parameter channel.

For MC-ENCODER, the access point to this parameter channel is at the MAP submodule (module 1, submodule 1.1) via the data record with index 0xB02E.

Access to the parameter channel is realized via the non-cyclic communication channel and is therefore possible by the controller as well as also a supervisor.

## Literature

You can find a detailed description of the access protocol in the following documentation: Additional literature:

Additional literature (Page 76) [3b]

## Parameters supported via parameter channel

Below is a list of the online parameters available via the parameter channel on the MC-ENCODER with their properties.

Table 4- 6 MC-ENCODER PROFIdrive parameters

| Number | Parameter | Significance | Data type | Access |
|---|---|---|---|---|
| 922 | Telegram selection | Information about the currently set telegram (PROFIdrive parameters). | Unsigned16 | Read only |
| 925 | Number of controller sign-of-life failures which may be tolerated | Maximum number of tolerated sign-of-life errors (PROFIdrive parameters). | Unsigned16 | Read/write |
| 964 | Drive unit identification | Information about the manufacturer, type, version of the encoder (PROFIdrive parameters). | Array[6] Unsigned16 | Read only |
| 965 | Profile identification number | Information about the supported encoder profile version (PROFIdrive parameters). | Octet string[2] | Read only |
| 971 | Transfer into non volatile memory | The parameter set is saved in the NV-RAM (PROFIdrive parameters). | Unsigned16 | Read/write |
| 975 | EO identification | Profile-specific information on the encoder object/module 1 (PROFIdrive parameters). | Array[n] Unsigned32 | Read only |
| 979 | Sensor format | Information on the position sensor (PROFIdrive parameters). | Array[n] Unsigned32 | Read only |
| 980 | Number list of defined parameter | List of all of the parameters available online via the parameter channel (PROFIdrive parameters). [2] | Array[n] Unsigned16 | Read only |
| 2000 | Velocity reference value | Speed reference value for 100% in the speed actual value signal NIST_A or NIST_B. | Float32 | Read only |
| 65000 | Preset value | Position preset value, which for telegrams 81, 82, 83 and 84, which become active when using the set/shift home position function via G1_STW, bit 12 (encoder profile parameter). | Integer32 | Read/write |
| 65001 | Operating status | Information about the actual configuration and error status of the encoder (encoder profile parameter).[1] | Array[n] Integer 32 | Read only |

## Literature

Additional literature (Page 76) [1]

Additional literature (Page 76) [2]

# Operating with STEP7

# 5

In the following chapter the configuration of the encoder with the configuration tool STEP7 "HW Config" is shown as example.

## 5.1 Installing the GSDML file

If the MC-ENCODER is used for the first time it is necessary to install the GSDML file to import the encoder description into the hardware catalog of the HW Config-tool:

Choose "Install GSD File..." in the HW Config-window of the project (menu item "Options") and select the GSDML-file.

The GSDML file is supplied by SIEMENS. In order to represent the encoder with a bitmap in STEP7; the bitmap file will be installed automatically with the GSDML file – therefore both files must be in the same directory.

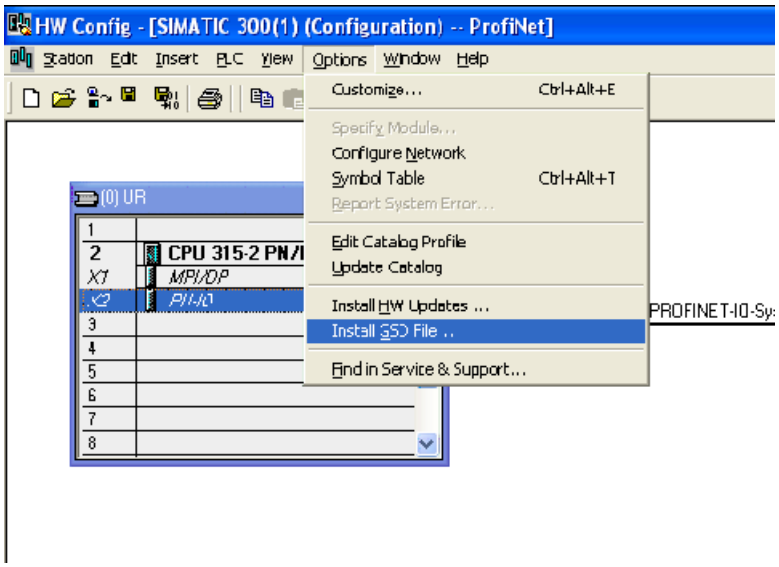



Figure 5-1 Installing GSD file in STEP7 HW Config

After the GSDML file has been successfully installed, the encoder can be found in the hardware catalog under "PROFINET-IO" – "Encoders".

## 5.2 Engineering the MC-ENCODER in a STEP7 project

To engineer the encoder in a project, drag the device MC-ENCODER on to an existing PROFINET Ethernet network.

or

Choose the network and double-click the "MCxENCODER" icon.

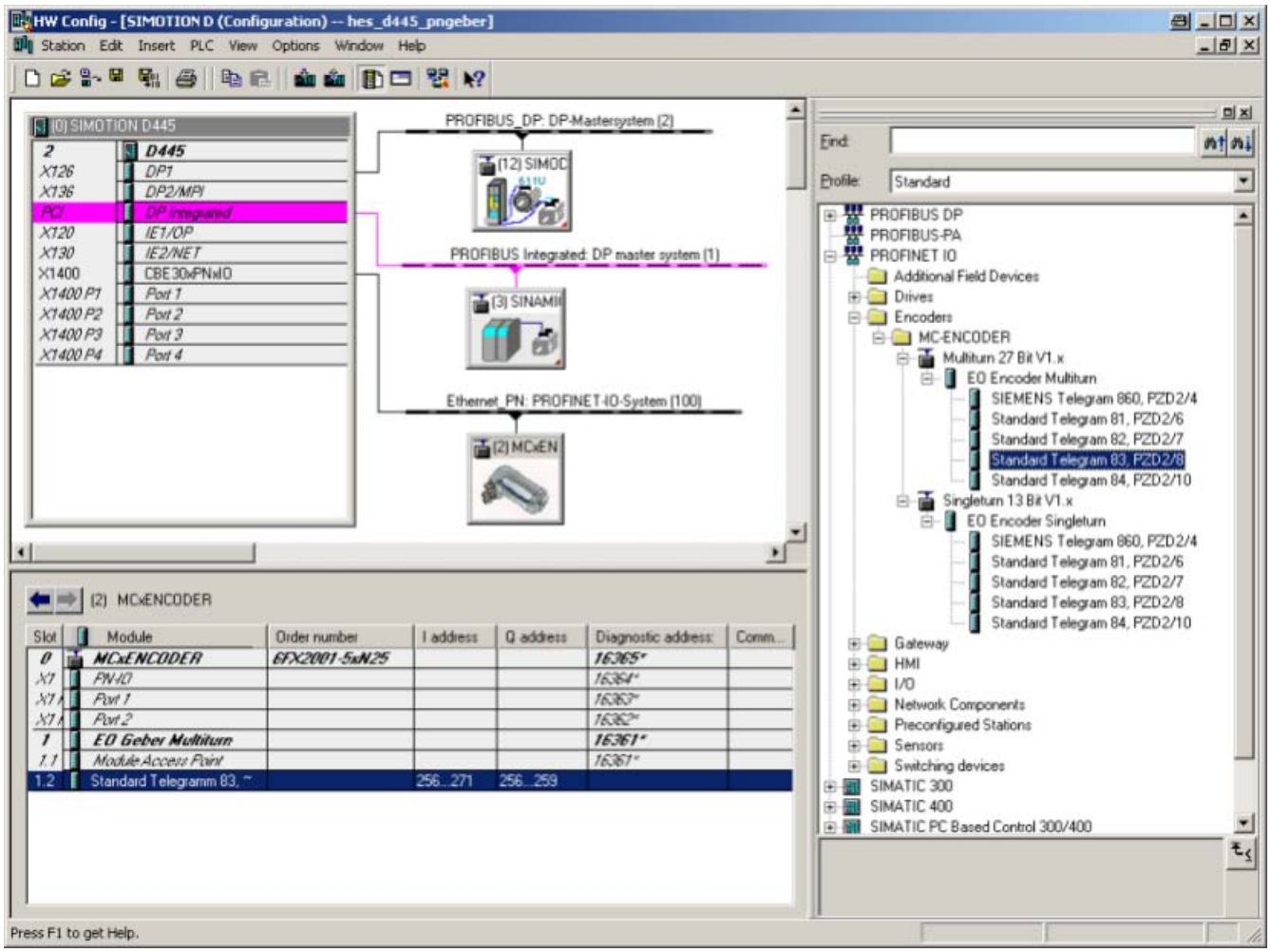



Figure 5-2 Engineering an encoder in a STEP7 project

Double-click the encoder icon to set the communication parameters that the PLC will use.

Set a device name and by clicking on "Ethernet" set the IP address of the encoder.

Also, under the "IO cycle" tab, set the desired update time.

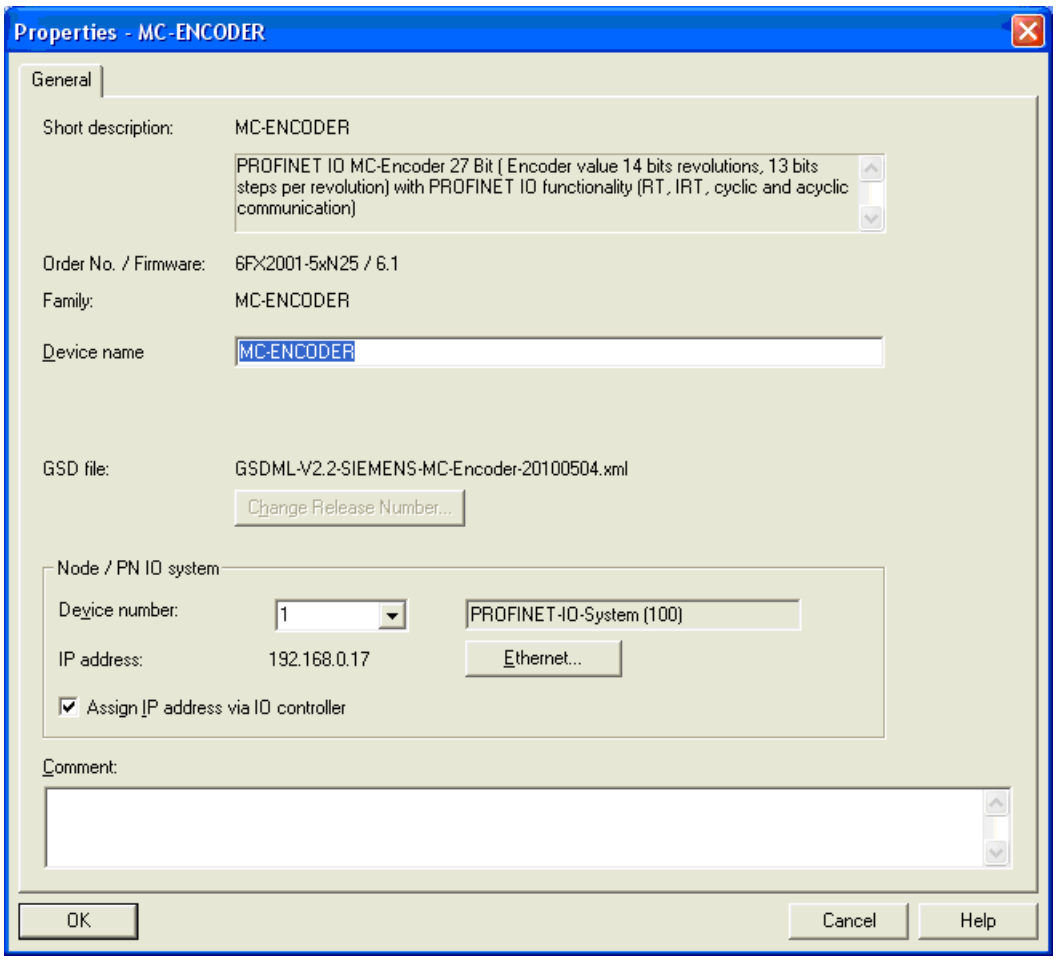



Figure 5-3 Setting device properties

The device name and IP address now have to be set physically in the encoder.

Connect the PLC and encoder to the Ethernet and switch them on.

Click "PLC" → "Ethernet" → "Edit Ethernet Node" and click "Browse" for accessible Ethernet nodes in the new window.

STEP7 will scan for devices on the Ethernet and will displays them in a window.

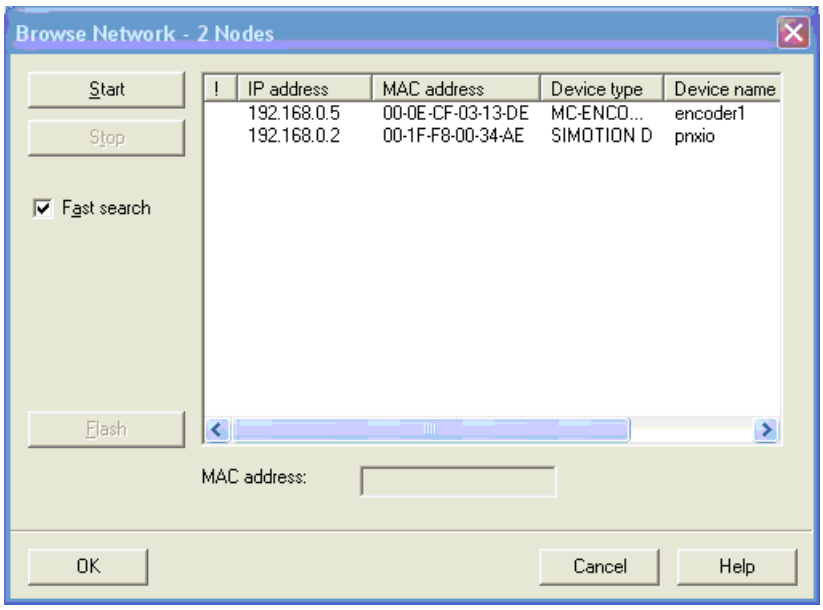


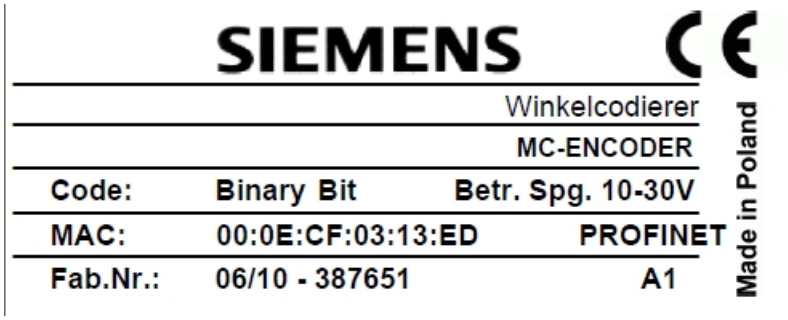

Figure 5-4 Network browser

The encoder should be displayed under the device type MC-ENCODER.

Select this entry and click "Flash" to have the identification LED flash with 2 Hz.

Click "OK" to take the MAC address of the chosen device to the previous window and select "Use IP parameters".

The MAC address of the MC-ENCODER is available on the type plate (see the diagram below).




Enter the IP address (and subnet mask) for the encoder that you previously assigned and click "Assign IP configuration".

Also, enter the device name previously chosen in the text field "Device name" and click "Assign Name".

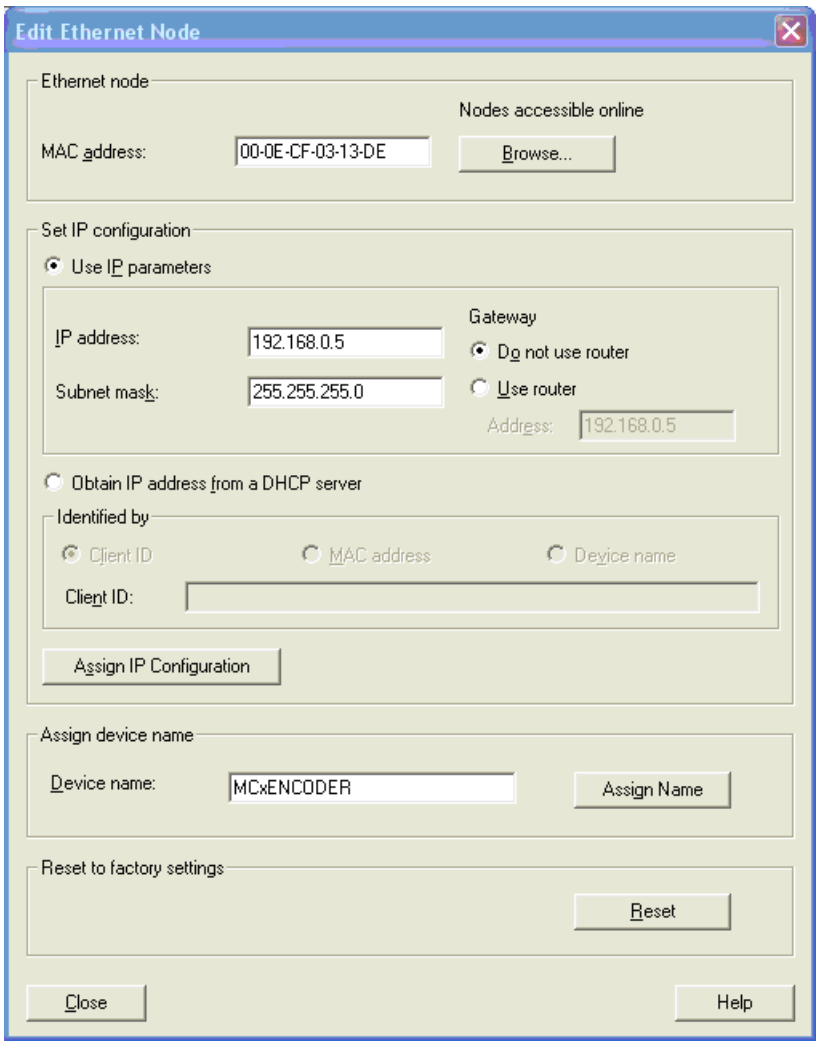



Figure 5-5 Editing an Ethernet node

**Note**

If more than one encoder is used in the same PROFINET domain, each encoder must have a different name and each encoder must be assigned its name before another is connected to the network.

## 5.3 LLDP (Link Layer Discovery Protocol)

The Link Layer Discovery Protocol allows a device in the PROFINET network to be replaced. The partner port in front of and behind the replaced device saves relevant information so that no additional configuration is necessary.

But the flag for activate "Device replacement without replacement medium" must be activated under the General tab.


Figure 5-6 Properties PNxIO

Using the Topology Editor in the STEP7 Hardware manager, it is possible to get an overview about the connections, the cable length and signal delay.

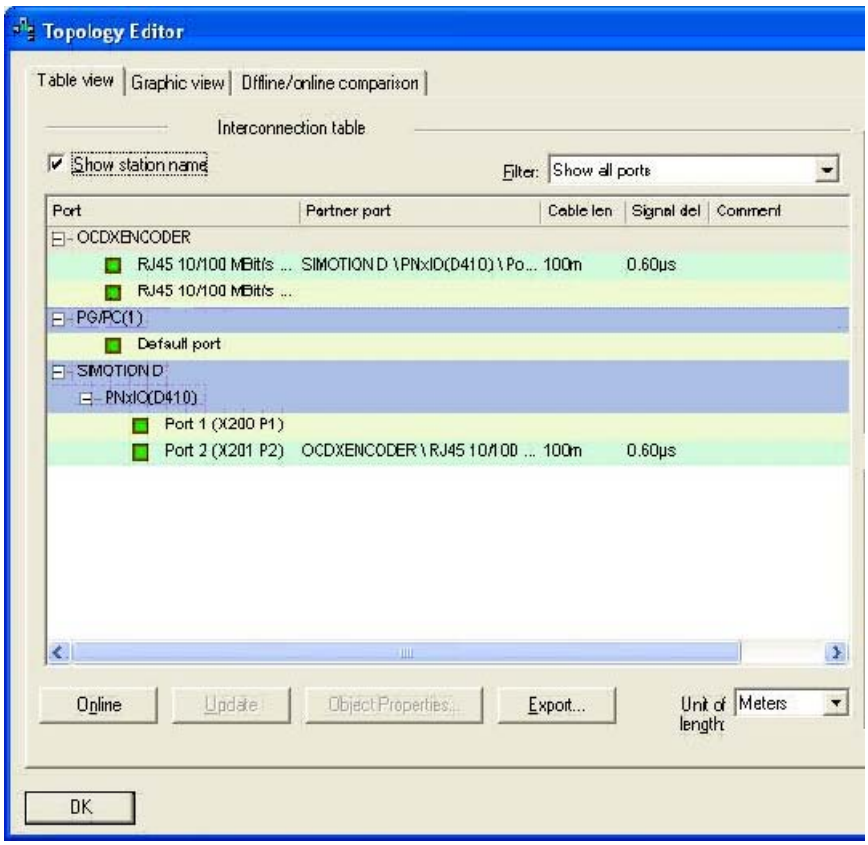



Figure 5-7 Topology Editor, table view

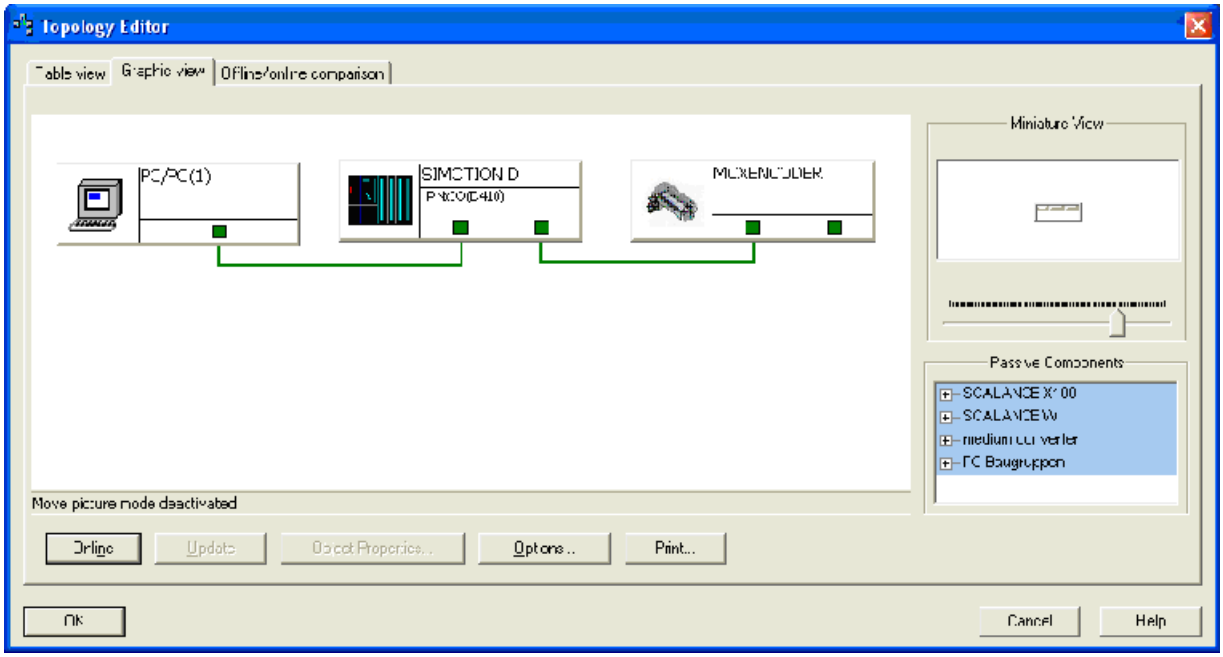



Figure 5-8 Topology Editor, graphic view

It is possible to compare the configuration with the physical network.

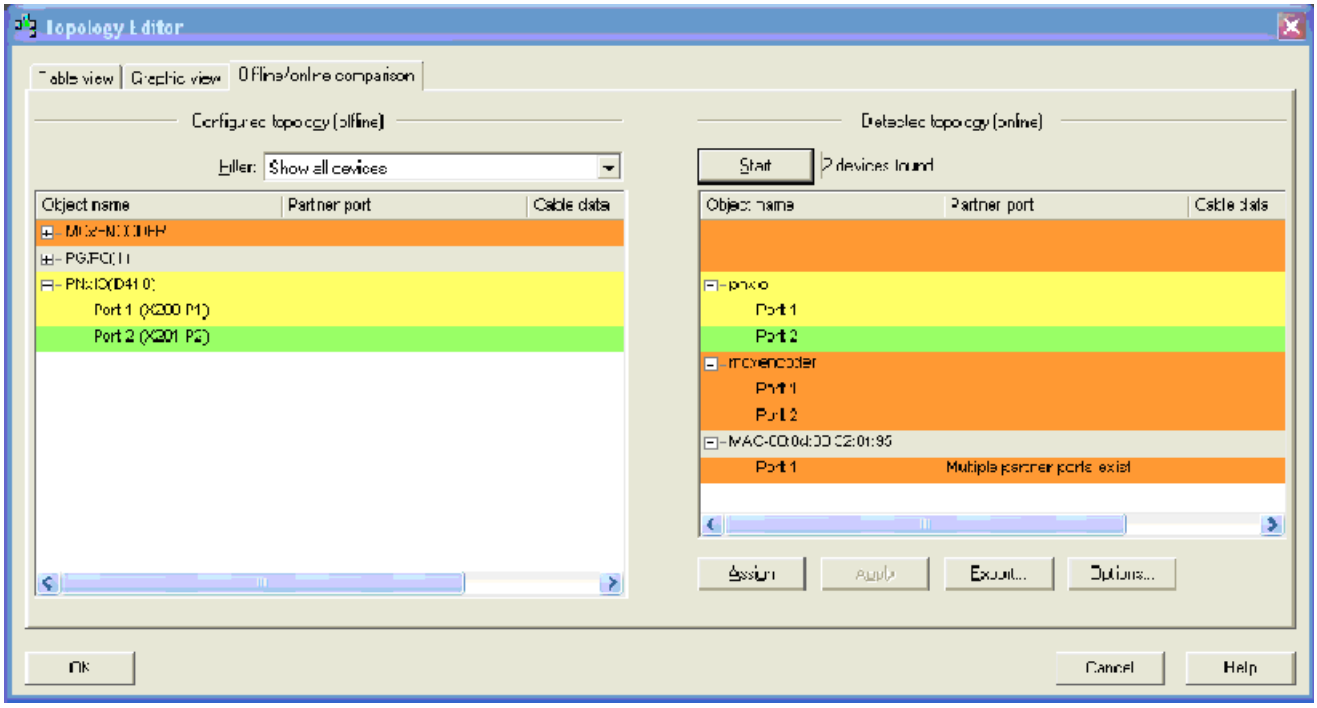



Figure 5-9 Topology Editor, offline/online comparison

## 5.4 Selecting the MC-ENCODER telegram

The functionality and interface is dependant on the selected telegram. The telegram is selected by inserting the appropriate telegram submodule (81, 82, 83, 84, 860).

Insert the corresponding telegram submodule by dragging it from the hardware catalog and dropping it into subslot 1.2 of the MC-ENCODERS.

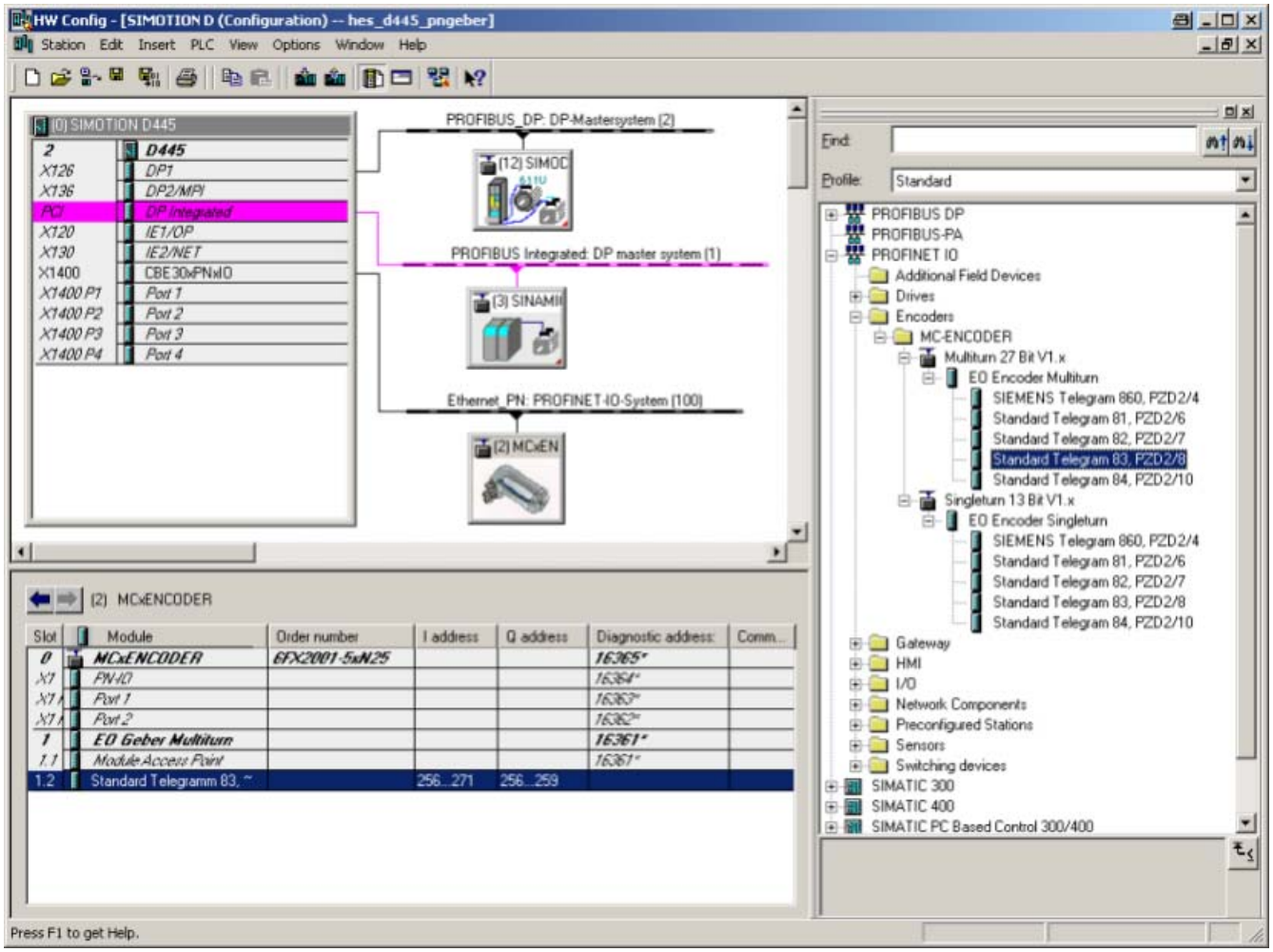



Figure 5-10 Selecting of telegram

## 5.5 Setting encoder parameters

Select the encoder in the hardware configuration and double click the MAP submodule 1.1. The properties dialog will appear. The input addresses can be changed under the tab "Addresses" (if desired). To set the encoder parameters, the "Parameters" tab has to be selected.

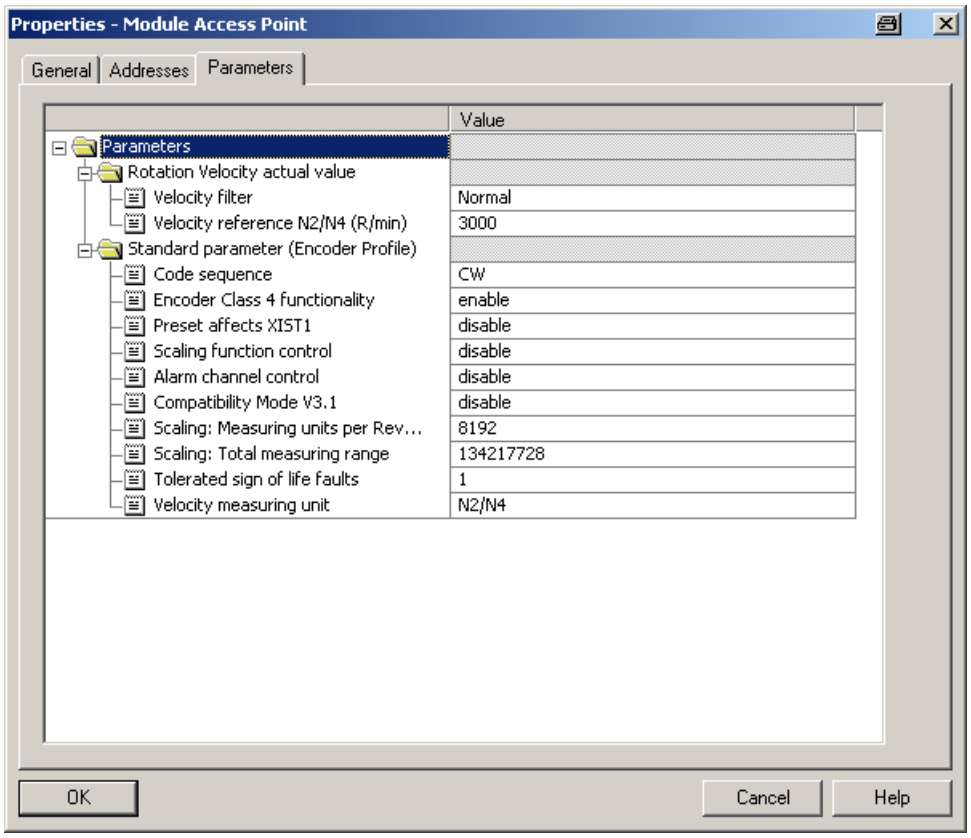



Figure 5-11 Setting encoder parameters

## 5.6 Setting device properties

PROFINET IO Domain Management (i.e. right click on slot 0) allows the synchronization role and the RT class to be selected.

If the synchronization role is selected as "unsynchronized", then the encoder operates in the RT class. If sync controller is selected, then it is possible to switch between "high flexibility" (FLEX) and "high performance" (TOP).

Domain Management provides an overview of all of the available devices. All devices should use the same Synchronization Role and RT class.

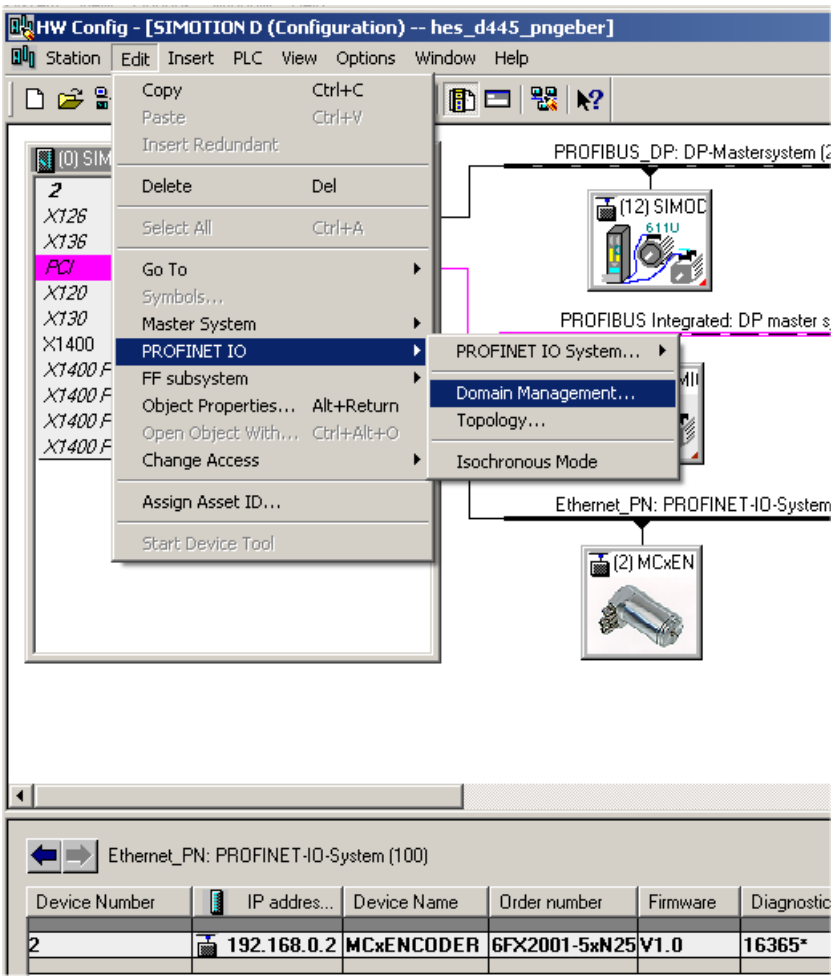



Figure 5-12 Domain management

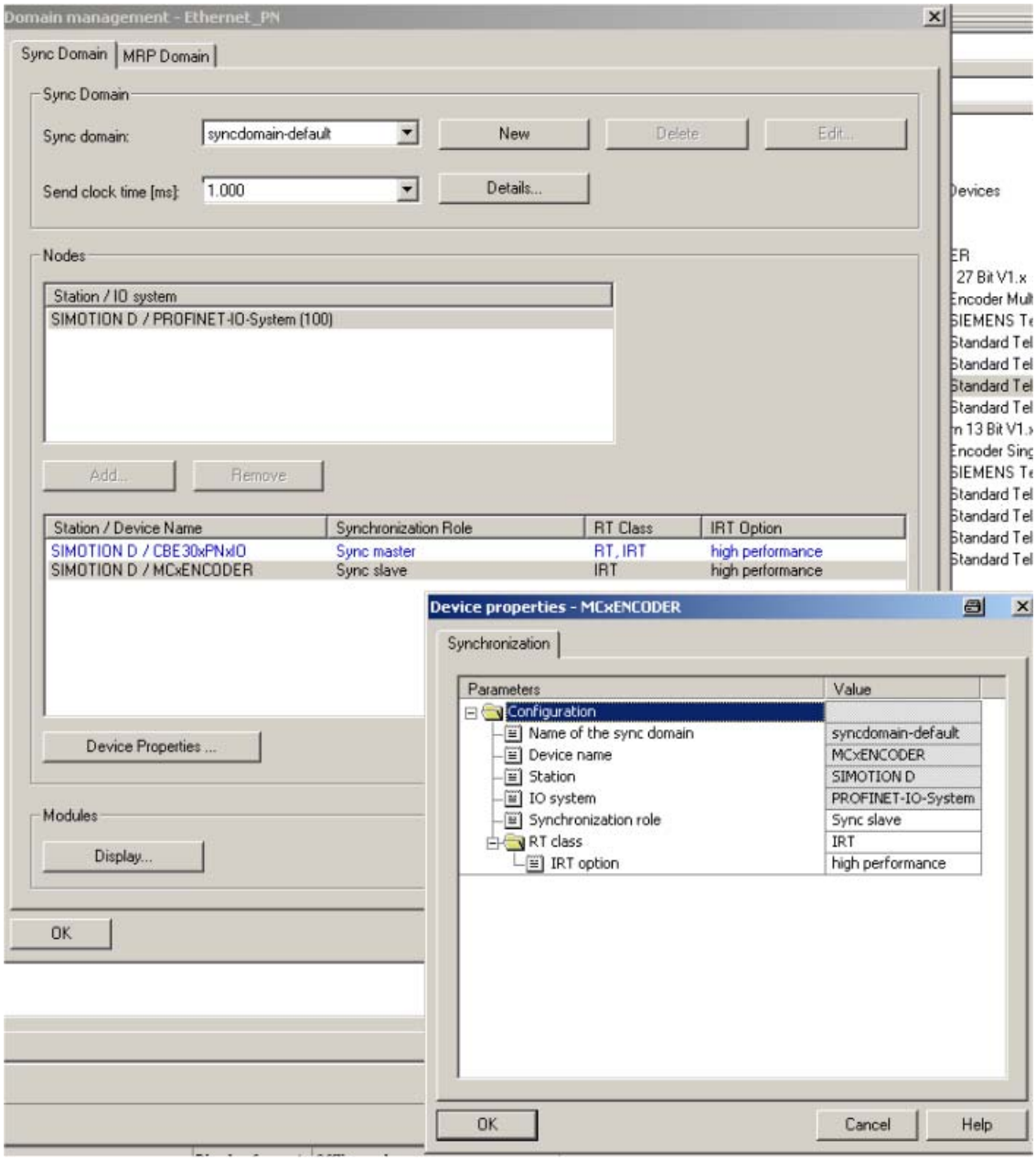



Figure 5-13 Synchronization

## 5.7 IRT settings

The upper limit for IRT transmission can be set.

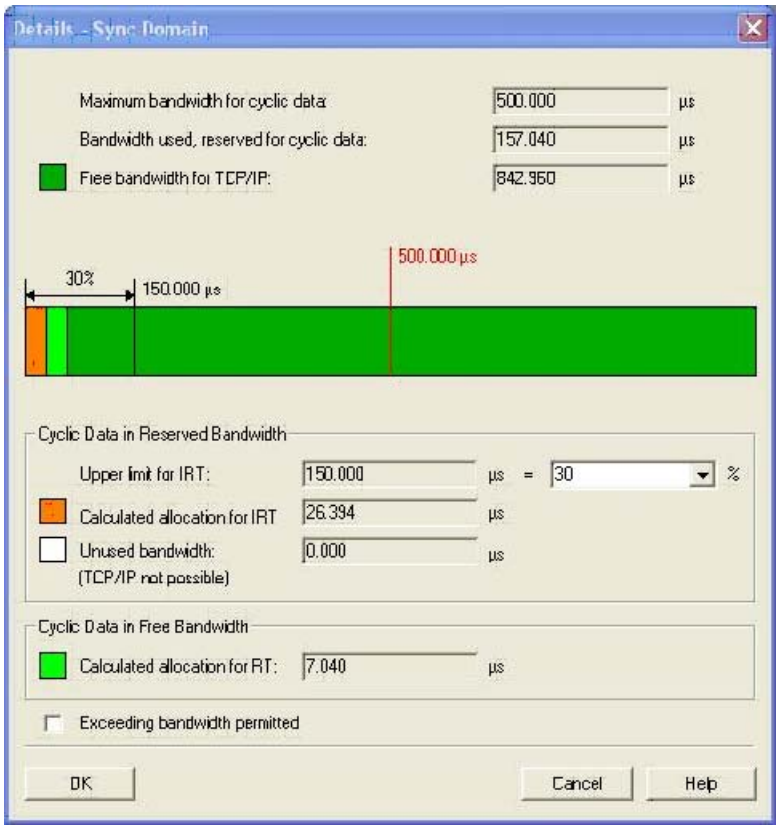



Figure 5-14 IRT transmission

## 5.8 Changing and reading encoder parameters during the run-time

Encoder parameters will be set when configuring the encoder. You can find information on the parameters under: Encoder parameter description (Page 32)

To change or read encoder parameters in a STEP7 automation program, refer to system function blocks SFB53 and SFB52 (write/read record) or with the variable table for testing.

### Literature

For additional information see

Additional literature (Page 76) [3b]

# 5.9 Accessing cyclic data

## Settings

To access the cyclic data in the telegram, create a variable for each signal used in the telegram input and output data.

As a logical address, use the basis address of submodule 1.2 from HW Config and the relevant byte offset of the signal in the telegram.

# Operating with SIMOTION

# 6

In the following chapter the configuration and operation of the encoder with the SIMOTION controllers is shown. In this example SIMOTION SCOUT Version 4.2 is used.

## 6.1 Applications

### Applications

In general, there are two use case for operation of the encoder with SIMOTION:

- MC-ENCODER together with TO "External encoder":
  The MC-ENCODER is used as sensor device for the TO "External encoder". In this case, the encoder is typically operated isosynchronously (IRT device).
  The encoder is completely controlled by the TO.
  Sign-of-life monitoring is automatically used.
  Telegrams 81 or 83 are used.
- MC-ENCODER operated directly from AWP:
  The encoder telegram is directly accessed from the user program. The MC-ENCODER is completely controlled and managed by the user program. Telegram 860 is typically used.

In addition, SIMOTION provides system functions for accessing parameters online via the non-cyclic standard parameter channel for the MC-ENCODER. You can use these system functions for both of the applications described above.

## 6.2 MC-ENCODER used together with TO External encoder

The following steps are necessary in order to configure the MC-ENCODER at SIMOTION as sensor at the TO " External encoder.

For the general procedure to create and configure MC-ENCODER in the HW Config, refer to the chapter Configuration (Page 29) and chapter Operating with STEP7 (Page 37)

You can find the online parameter access via the parameter channel in the chapter Online parameter access (Page 62)

### Configuring MC-ENCODER in HW Config

For this particular application, select the following settings:

- IRT communication (IRT with high performance)
- Cycle time and Ti identical to the drive axes
- Select the telegram
  - Telegram 81
    or
  - Telegram 83 (for 32 bit speed actual value NIST_B)
- Set the encoder parameters:
  Accept the default setting.
  If you use the speed actual value NIST from MC-ENCODER in the TO, then set the speed reference value in parameter "Reference speed N2/N4 (rpm)" to a value that is suitable for your application.

## Example

The following example shows the configuration settings for the MC-ENCODER in HW Config for telegram 83 and a reference speed (100%) of 3000 rpm.

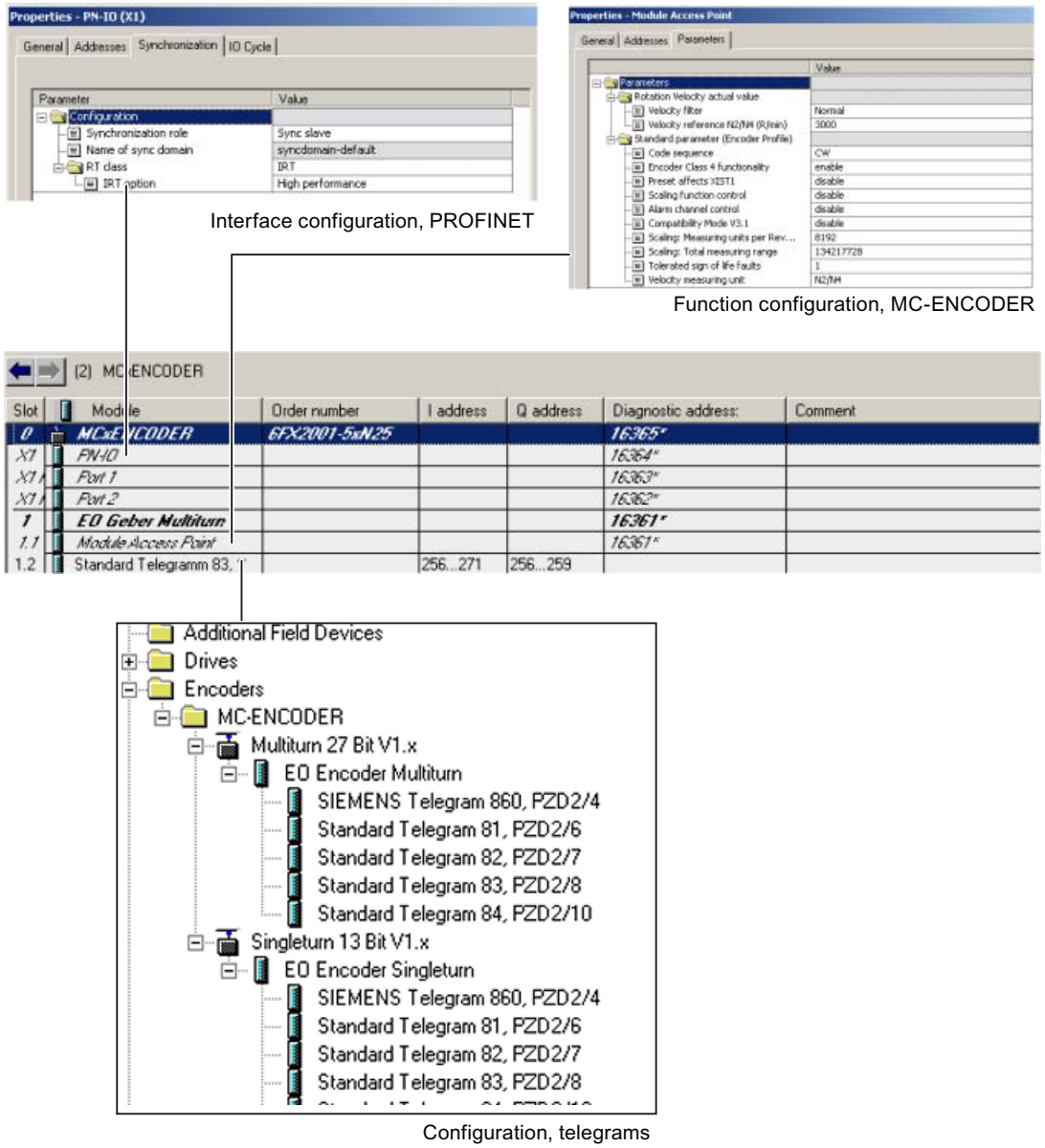



Figure 6-1 Example: Setting required in HW Config

## Creating and configuring TO "External encoder"

Insert a TO "External encoder" in the project and run the wizards for the external encoder configuration.

Select the following settings:

- Encoder type: rotary
- Encoder type: absolute encoder or absolute encoder, cyclic, absolute
- Encoder mode: SSI
- Encoder pulse number: 8.192
- Fine resolution: 0
- Fine resolution, absolute value in Gn_XIST2: 0
- Data width, absolute value without fine resolution:
  - 27 (for multiturn encoder)
    or
  - 13 (for singleturn encoder)
- Encoder monitoring: activate

## Procedure

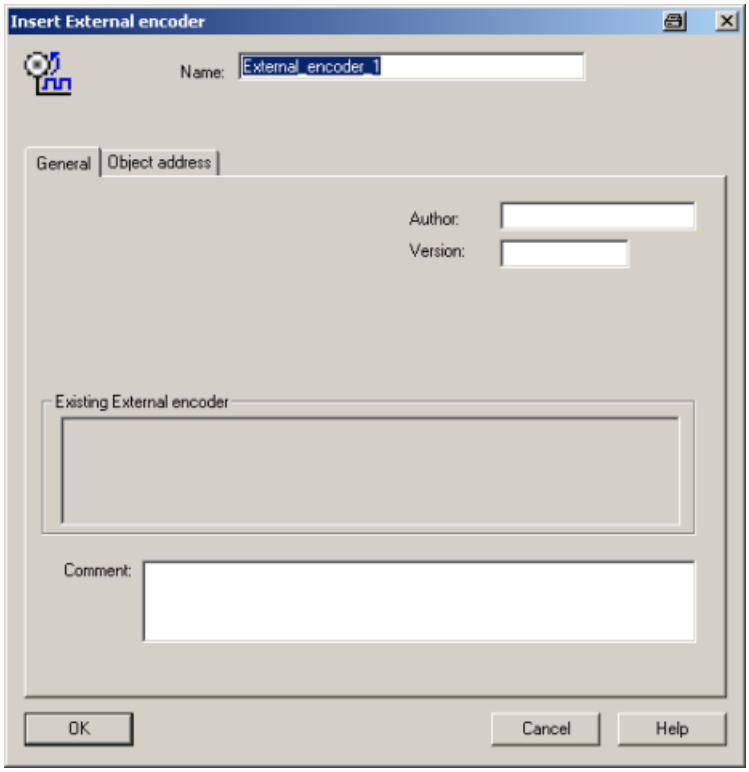



Figure 6-2 Inserting an encoder

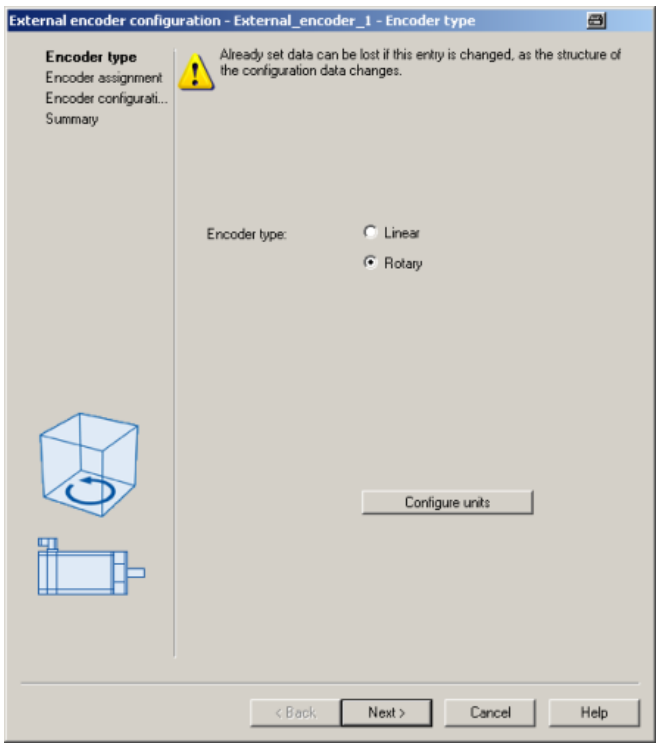



Figure 6-3 Configuring the encoder type

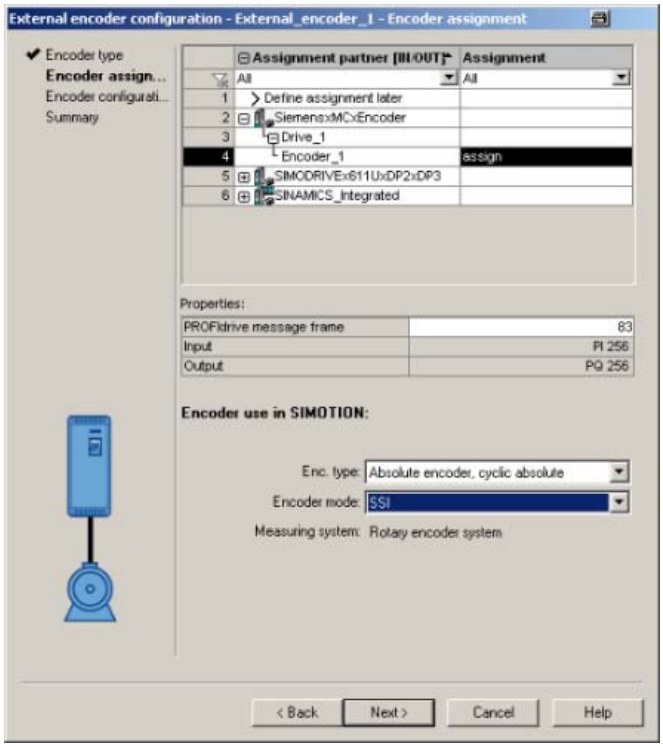



Figure 6-4 Assigning an encoder, configuring the type and mode

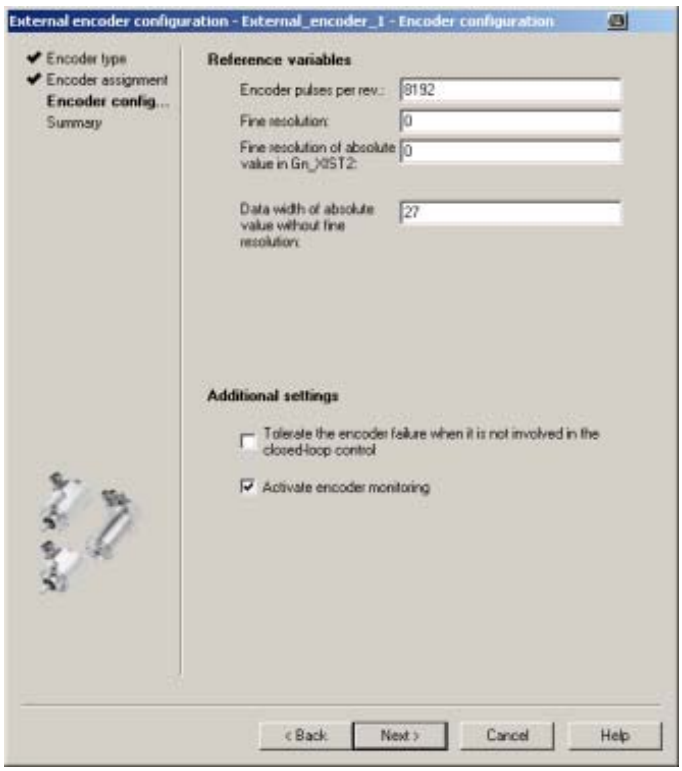



Figure 6-5 Configuring an encoder

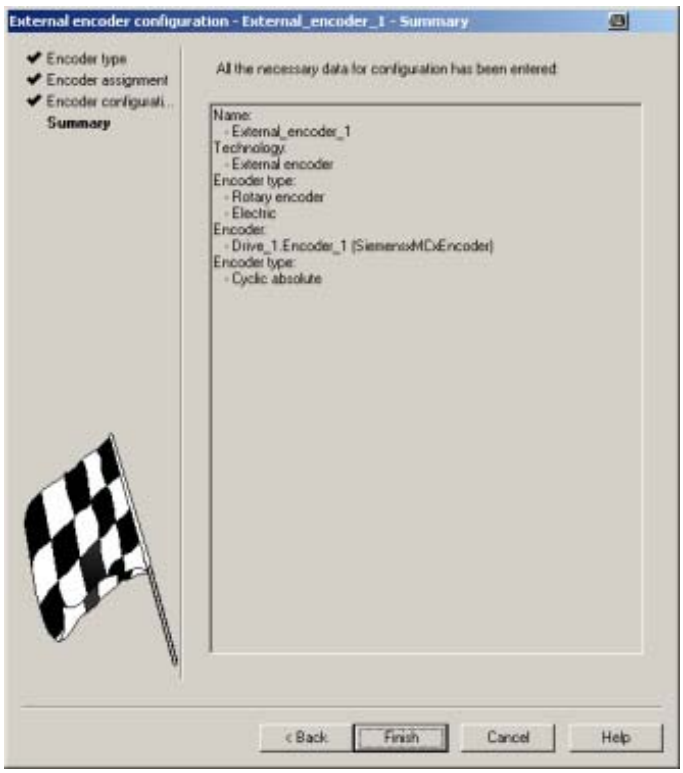



Figure 6-6 TO configuration, summary

## Example

After the MC-ENCODER has been successfully configured at the TO, the following configuration settings are shown at the TO "External encoder".

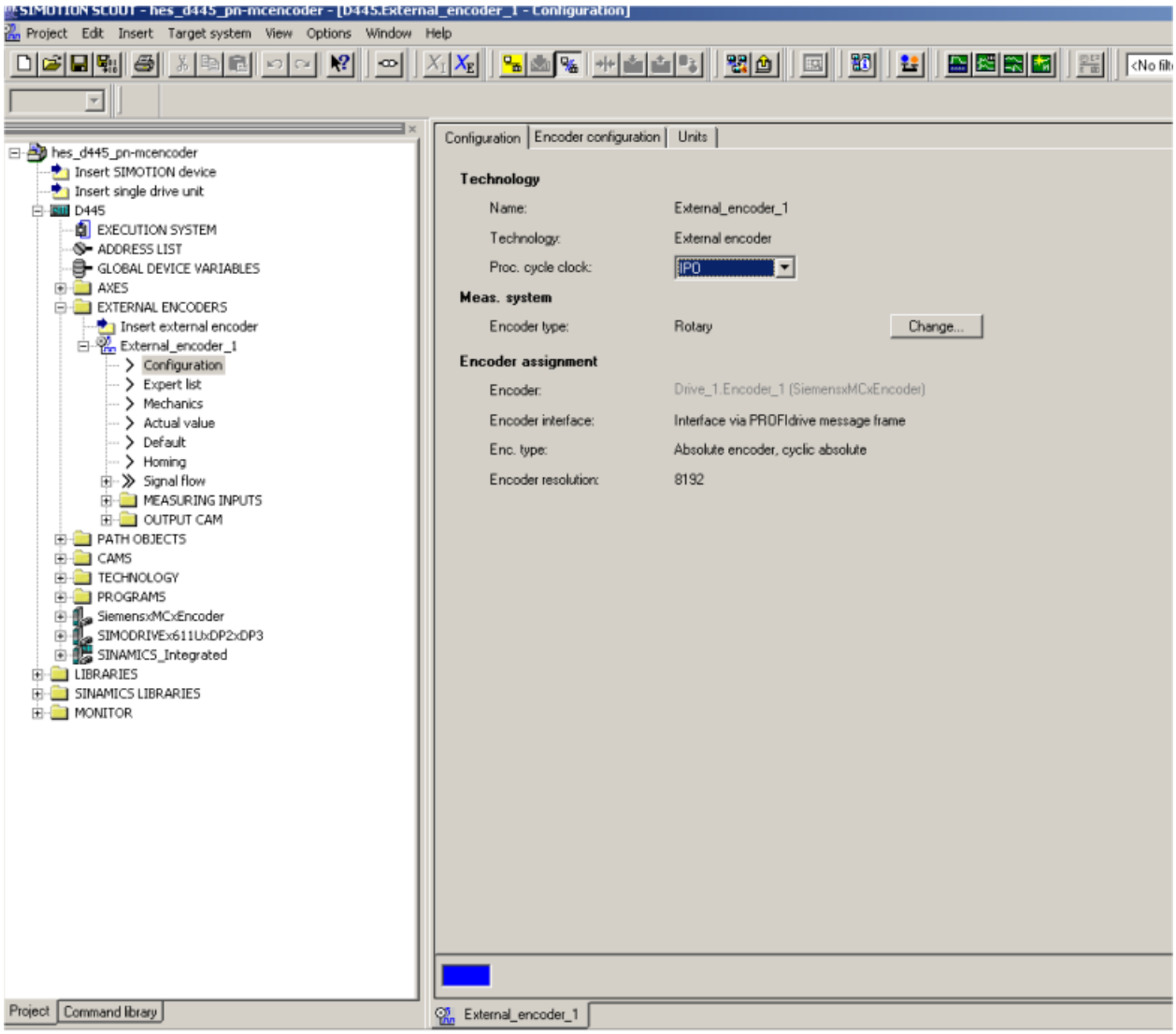



Figure 6-7 Example: TO configuration, "Configuration" tab

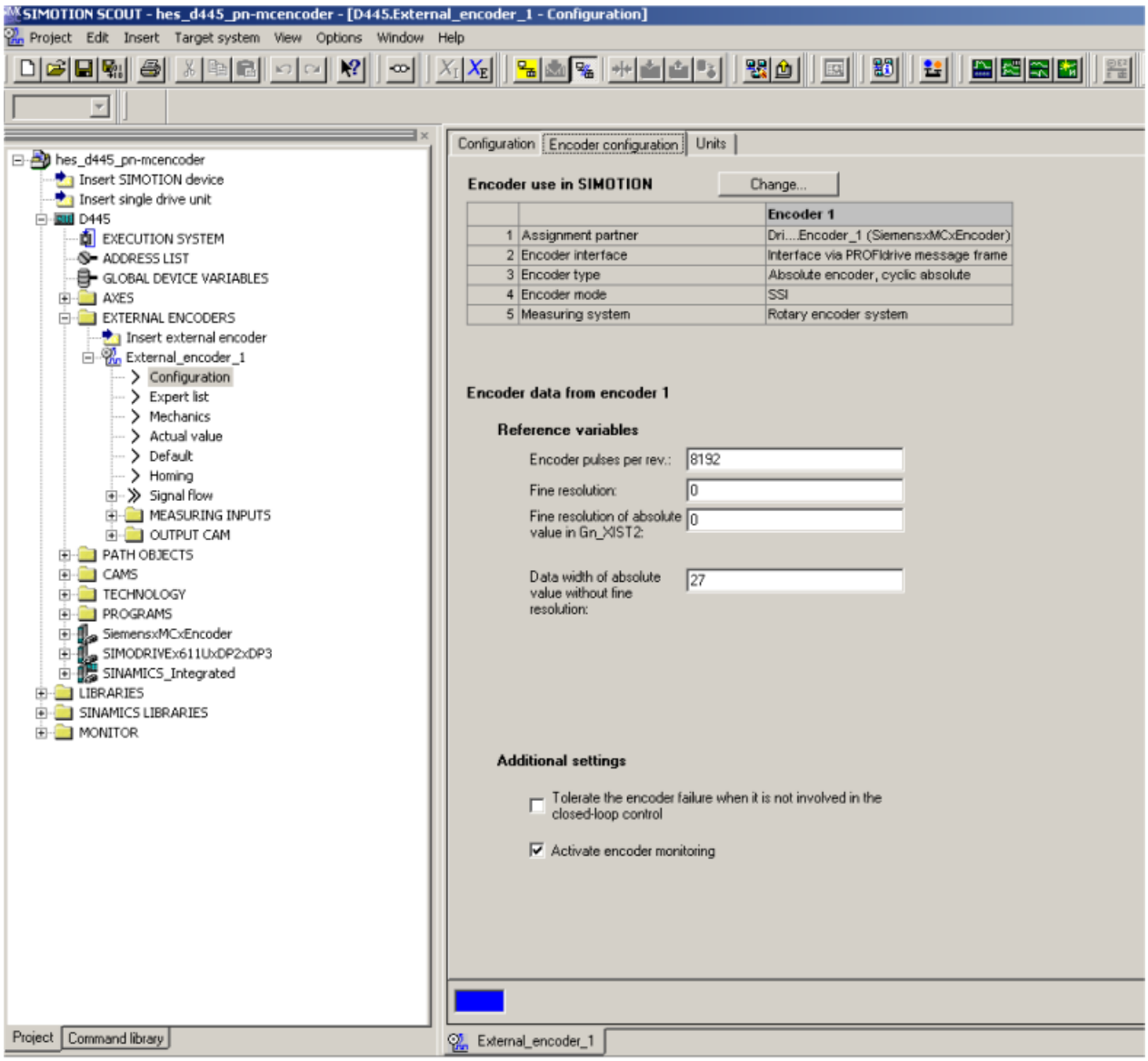



Figure 6-8 Example: TO configuration, "Encoder configuration" tab

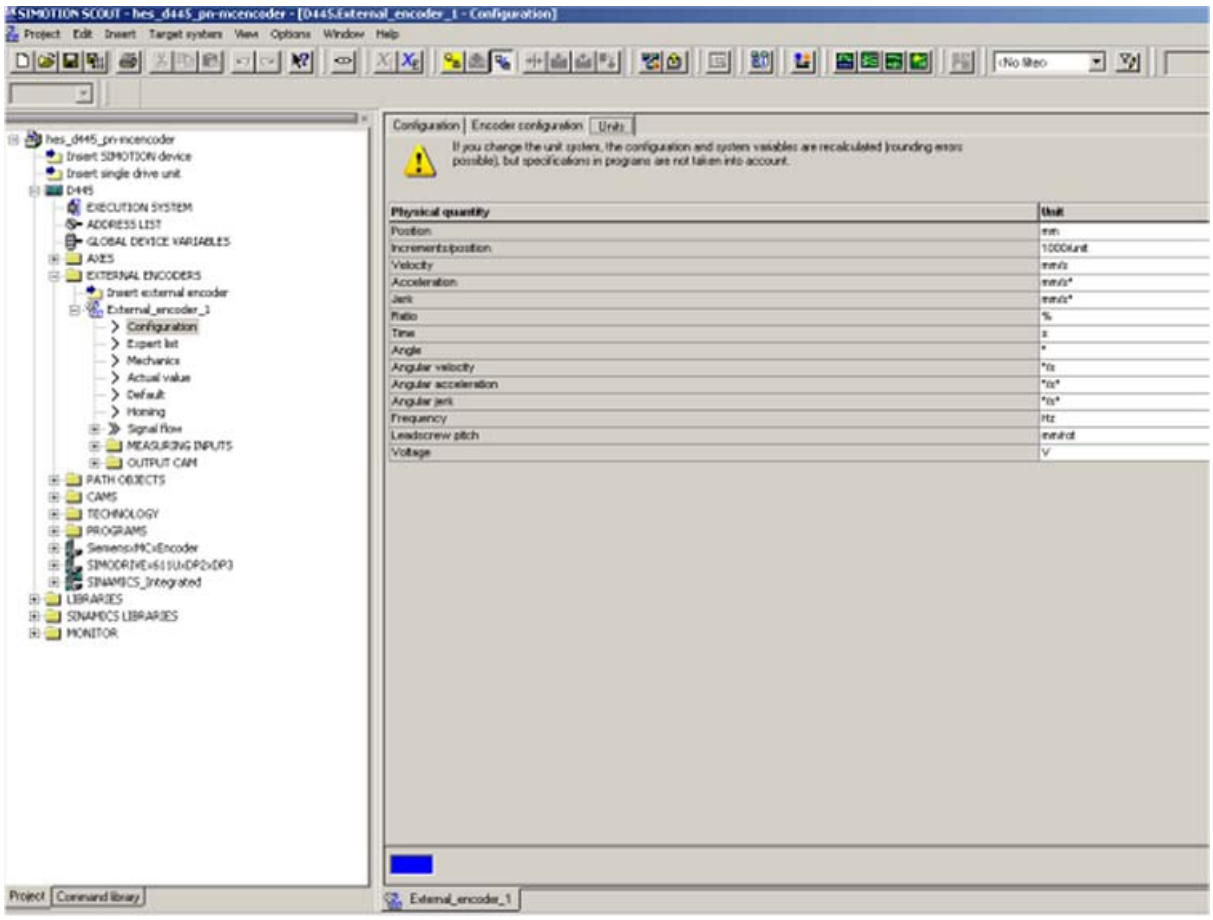



Figure 6-9 Example: TO configuration, "Units" tab

## Using the velocity actual value NIST from MC-ENCODER

The TO "External encoder" can calculate its internal velocity actual values as follows:

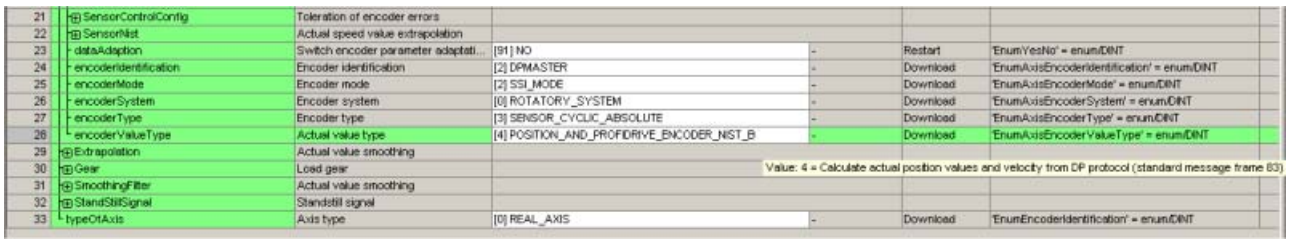
- From the internal position actual values
- From the external velocity value NIST_B of the MC-ENCODER

Using the expert list of the TO, you parameterize which velocity actual value is used in TO.

## Example

The following screenshot shows the setting options using the TO parameter "encoderValueType". In this particular example, the following values are relevant:

| | | |
|---|---|---|
| [0]: | ROTARY_SYSTEM | The velocity is calculated in the TO from the position. |
| [4]: | POSITION_AND_PROFIDRIVE_ENCODER_NISTB | The velocity is taken from the encoder signal NIST_B. |



| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | SensorControlConfig | Toleration of encoder errors | | | | |
| 22 | SensorNist | Actual speed value extrapolation | | | | |
| 23 | dataAdaption | Switch encoder parameter adaptati... | [91] NO | - | Restart | 'EnumYesNo' = enum/DINT |
| 24 | encoderIdentification | Encoder identification | [2] DPMASTER | - | Download | 'EnumAxisEncoderIdentification' = enum/DINT |
| 25 | encoderMode | Encoder mode | [2] SSI_MODE | - | Download | 'EnumAxisEncoderMode' = enum/DINT |
| 26 | encoderSystem | Encoder system | [0] ROTATORY_SYSTEM | - | Download | 'EnumAxisEncoderSystem' = enum/DINT |
| 27 | encoderType | Encoder type | [3] SENSOR_CYCLIC_ABSOLUTE | - | Download | 'EnumAxisEncoderType' = enum/DINT |
| 28 | encoderValueType | Actual value type | [4] POSITION_AND_PROFIDRIVE_ENCODER_NIST_B | - | Download | 'EnumAxisEncoderValueType' = enum/DINT |
| 29 | Extrapolation | Actual value smoothing | | | | |
| 30 | Gear | Load gear | Value: 4 = Calculate actual position values and velocity from DP protocol (standard message frame 83) | | | |
| 31 | SmoothingFilter | Actual value smoothing | | | | |
| 32 | StandStillSignal | Standstill signal | | | | |
| 33 | typeOfAxis | Axis type | [0] REAL_AXIS | - | Download | 'EnumEncoderIdentification' = enum/DINT |

Figure 6-10 Configuring the velocity source at the TO "External encoder"

## 6.3 MC-ENCODER used directly from AWP

The following steps are necessary in order to use the MC-ENCODER directly from a SIMOTION user program as sensor:

The general procedure for creating and configuring MC-ENCODER in HW Config is provided in the chapter Configuration (Page 29) and chapter Operating with STEP7 (Page 37)

### Configuring MC-ENCODER in HW Config

#### Access via telegram 860

You can freely select the settings corresponding to the requirements of your particular application.

The simplest option of accessing the position supplied from the MC-ENCODER from the user program is by using telegram 860. If you use telegram 860, the user program does not have to use any control or status word when transferring the pure position. Further, the user program does not have to generate or monitor a sign-of-life, as telegram 860 has no sign-of-life monitoring. To simplify the position calculation in the user program, parameterizable help functions for scaling as well as to set a preset position value are available in the MC-ENCODER.

#### Access using telegrams 81, 82, 83, 84

If you control the MC-ENCODER using telegrams 81, 82, 83 or 84, then in the user program, you must program the control and status words, where relevant, also sign-of-life counting and monitoring according to the standard MC-ENCODER profile or PROFIdrive profile.

### Accessing cyclic data

In order to access the cyclic data in the telegram, create one IO variable each in the address list on the SIMOTION device for each signal used in the input and output data of the telegram.

As logical address, use the basis address of submodule 1.2 from HW Config and the relevant byte offset of the signal in the telegram.

## Example

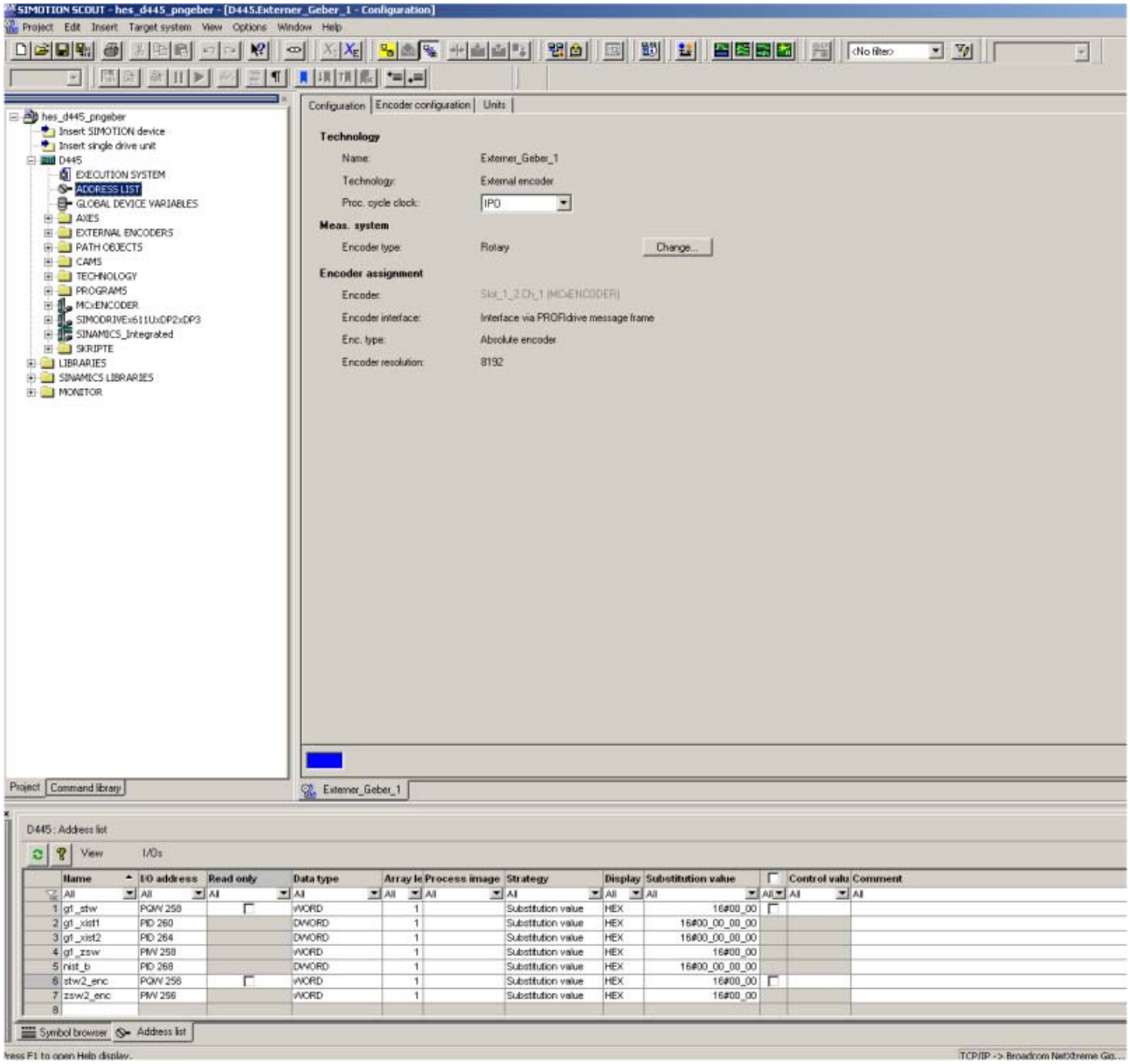



Figure 6-11 Variable list for MC-ENCODER cyclic data in SIMOTION Scout

# 6.4 Online parameter access

## Online parameter access via the parameter channel

To access the parameters of the MC-ENCODER online, the encoder has the standard parameter channel. For the encoder, the access point to this parameter channel is at the MAP submodule (module 1, submodule 1.1) via the data record with index 0xB02E.

Access to the parameter channel is realized via the non-cyclic communication channel, and is therefore possible from the controller as well as from a supervisor. The access protocol for the parameter channel is standardized in the PROFIdrive profile.

## Literature

Refer to the following documentation for details:

Additional literature (Page 76) [2]

You can find a detailed description of the access protocol in the following documentation:

Additional literature (Page 76) [3b]

## Online parameter access using SIMOTION system functions

To simplify online parameter access, SIMOTION provides the appropriate system functions. These system functions can be generally used for the encoder, independent of whether the MC-ENCODER is interconnected with a TO – or is directly controlled by the user program.

The following SIMOTION system functions are available for simple online access to the parameters of the MC-ENCODER:

- _readDriveParameter: reading the value of an individual parameter
- _readDriveMultiParameter: reading the values of several parameters at the same time
- _writeDriveParameter: writing the value of an individual parameter

## Literature

You can find a detailed description of the system functions in the following documentation:

Additional literature (Page 76) [3c / 3d]

As logical address for the parameter channel, enter the address of the MAP submodule of the encoder (submodule 1.1).

The parameters available on the MC-ENCODER for the online access can be taken from the chapter Parameterizing the communication interface (Page 34)

## Example

ST Program to read the reference parameters for the speed actual value in signal NIST_A or NIST_B:

```
INTERFACE
     PROGRAM readParaRefSpeed; // Motion Task.

END_INTERFACE
IMPLEMENTATION
     VAR_GLOBAL

           refSpeed : REAL := 0.0;

           readP2000 : structretreaddriveparameter;

     END_VAR

     PROGRAM readParaRefSpeed

         readP2000:=_readdriveparameter(

            logaddress := 256,

            parameternumber := 2000,

            nextcommand := WHEN_COMMAND_DONE,

            Commandid := _getCommandId( )

         );

         IF ((readP2000.functionResult = 0) AND (readP2000.parameterResult = 0)) THEN
         // Conversion to real.
         refSpeed := BIGBYTEARRAY_TO_ANYTYPE (byteArray := readP2000.data);

         END_if;

     END_PROGRAM

END_IMPLEMENTATION
```

# Troubleshooting/FAQs

# 7

## 7.1 FAQ

### Why don't I obtain position values?

According to the encoder profile it is necessary to set bit 10 to "1" in stw2 and bit 13 in g1_stw1.

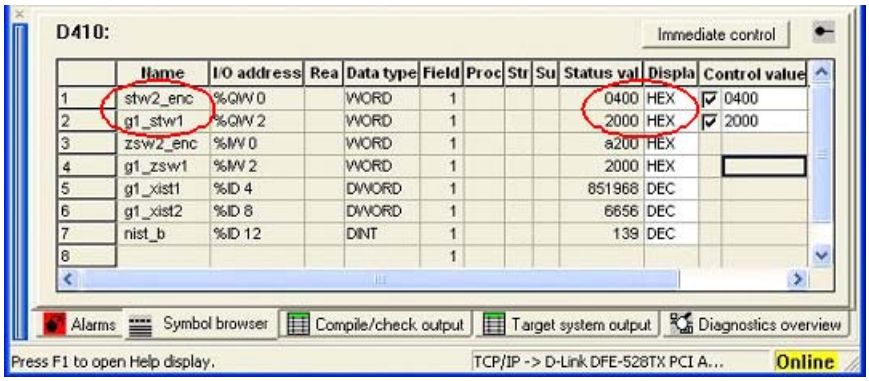



Figure 7-1 Restore the encoder profile

### Why doesn't the neighboring detection work?

The encoder supports the LLDP protocol, but it is necessary to use the latest version of STEP7 or SIMOTION Scout. The flag "Device replacement without replacement medium" must be active in the Properties window under General.

### What has to be done if an encoder has to be replaced by a new one?

See answer: Why doesn't the neighboring detection work?

### What is the easiest way to set the preset value?

Set the preset value in the Hardware Manager from STEP7 or SIMOTION Scout. That preset value will then be transmitted to the encoder during the starting phase. To activate it, it is necessary to set bit 12 to "1". In the screenshot above it should send 3000 instead of 2000.

### Why can I not set the preset value or the other parameters?

It is only possible to set the parameters in class 3 with activated class 4 functionality. If necessary, it is important to use class 4 or to activate the class 4 functionality in the Hardware Manager.

## When using the D410, the error "Synchronization error between PROFIBUS and PROFINET" popped up. What must I to do?

Both systems have to use the same cycle time. If the PROFINET cycle time is 1 ms then the PROFIBUS must use the same time. See the next screenshot with the settings for 1 ms.

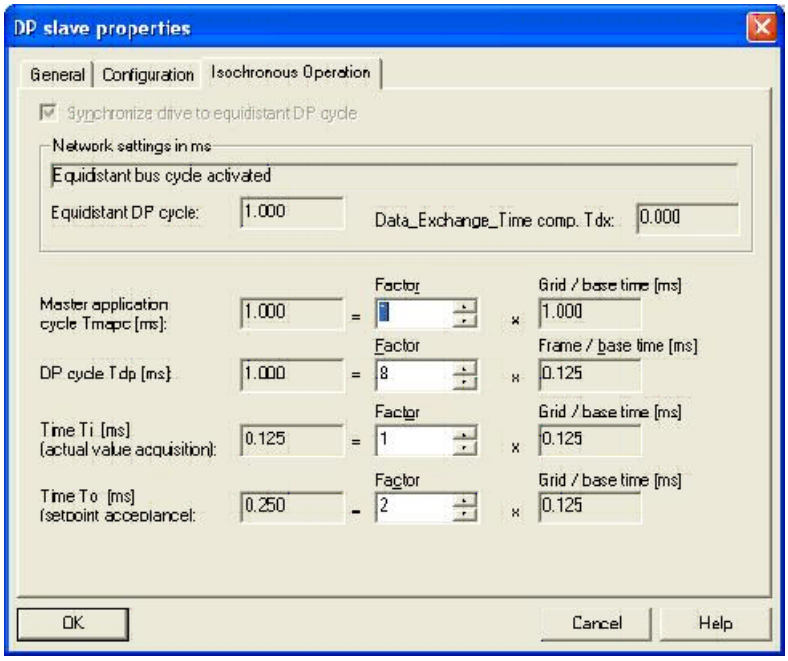



Figure 7-2 Synchronization between PROFIBUS and PROFINET

# Technical Data

# 8

## 8.1 Electrical data

| | |
|---|---|
| Supply voltage | 10 - 30 V DC (absolute limits) |
| Power consumption | Max. 4 Watt |
| EMC | Emitted interference: EN 61000-6-4 |
| | Noise immunity: EN 61326-1 |
| Bus connection | Ethernet |
| Transmission rate | 10/100 MBit |
| Accuracy of division | ± 1 LSB (± 0,0439 ° ) |
| Speed | Max. 5000 rpm (valid code) |
| Cycle time | 1... 100 ms |
| Electrical lifetime | > $10^5$ h |
| Cycle of parameter saving | 50 million |
| Conformance class | C (IRT communication, …), B, A (RT communication) |
| Device addressing | Programmable IP address and network parameters |

## 8.2 Mechanical data

| | |
|---|---|
| Housing | Aluminum |
| Lifetime | Dependent on shaft version and shaft loading – refer to table |
| Max. shaft loading | Axial 40 N, radial 110 N |
| Inertia of rotor | ≤ 30 gcm$^2$ |
| Friction torque | ≤ 3 Ncm |
| RPM (continuous operation) | Max. 12000 rpm |
| Shock (EN 60068-2-27) | ≤ 30 g (half sine, 11 ms) |
| Vibration (EN 60068-2-6) | ≤ 10 g (10 Hz ... 1000 Hz) |
| Weight (standard version) | Singleturn:≈ 500 g |
| | Multiturn:≈ 700 g |

| Flange | Synchro (F) | Clamp (Q) | Hollow shaft (W) |
|---|---|---|---|
| Shaft diameter | 6 mm | 10 mm | 8, 10, 12, 15 mm |
| Shaft length | 10 mm | 20 mm | - |
| Hollow shaft depth min. / max. | - | - | 15 mm / 30 mm |

**Minimum (mechanical) lifetime**

| Flange | Lifetime in $10^8$ revolutions with $F_a$ / $F_r$ | | |
|---|---|---|---|
| | 40 N / 60 N | 40 N / 80 N | 40 N / 110 N |
| Clamp flange 10 x 20 | 247 | 104 | 40 |
| Synchro flange 6 x 10 | 822 | 347 | 133 |

## 8.3 Environmental conditions

| | |
|---|---|
| Operating temperature | - 40 .. + 70°C |
| Storage temperature | - 40 .. + 70°C |
| Humidity | Up to 98 % (without moisture condensation) |
| Degree of protection DIN 40050 | Housing side: IP 67 |
| | Shaft side: IP 64 |

# Mechanical Drawings

# 9

## 9.1 Synchro flange

### Overview

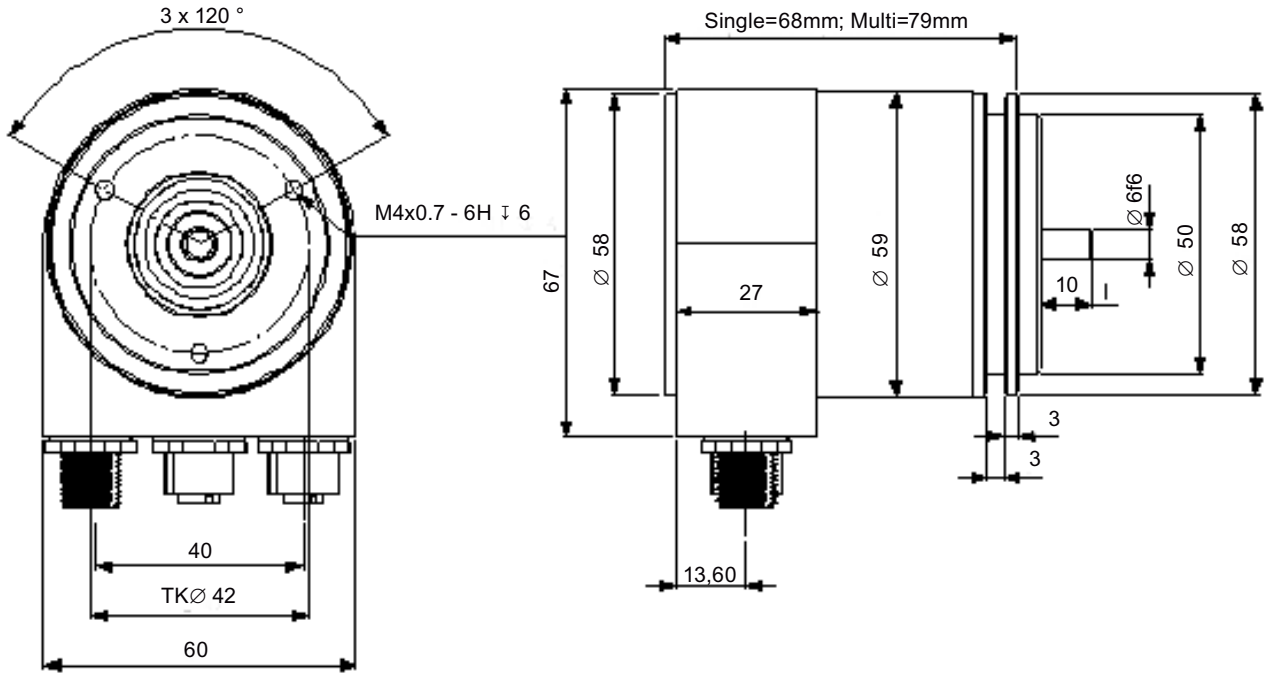



Figure 9-1 Syncro flange

# 9.2 Clamp flange

## Overview

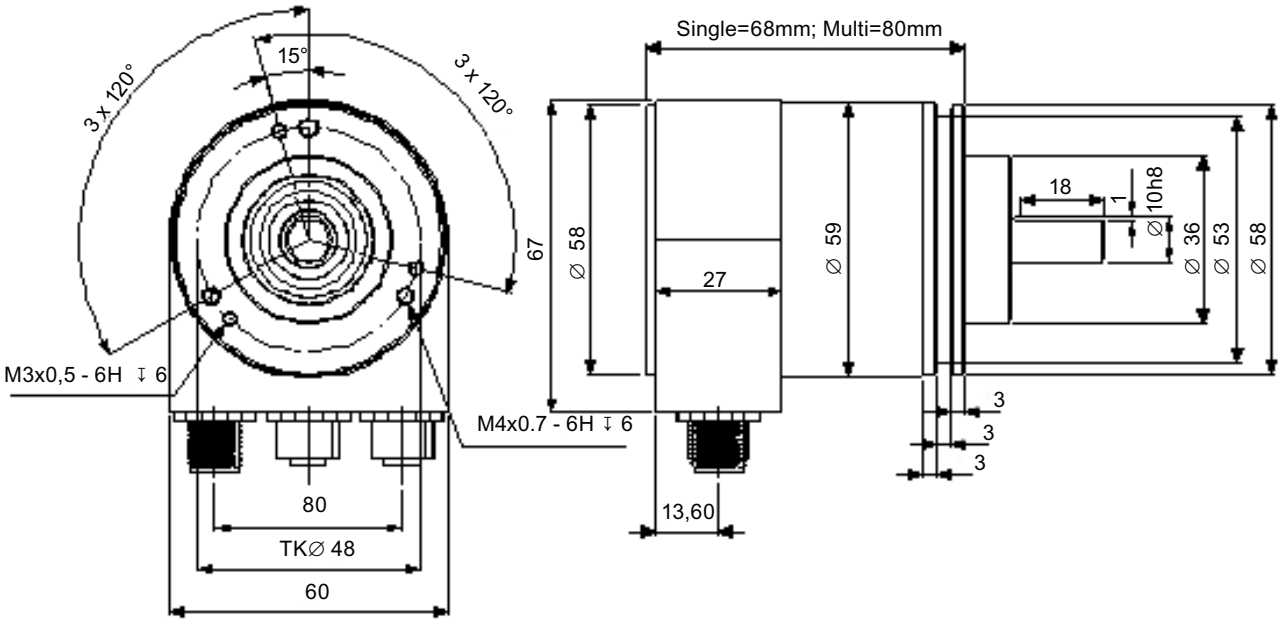



Figure 9-2 Clamp flange

# 9.3 Hollow shaft

## Overview

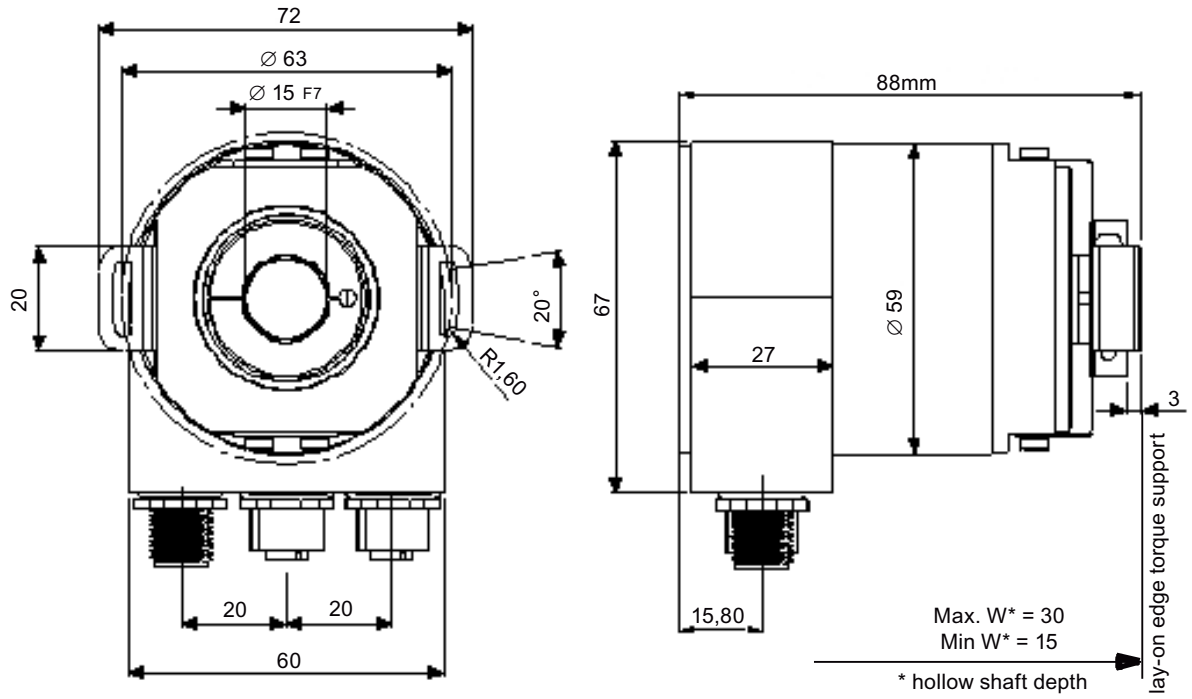



Figure 9-3 Hallow shaft

**Note**

**Mounting instructions**

The clamp ring should only be tightened after the shaft of the drive element has been inserted into the hollow shaft.

The diameter of the hollow shaft can be reduced to 12 mm, 10 mm or 8 mm using a reducing adapter (these are included in the scope of supply). These reducing adapters are simply inserted into the hollow shaft.

Maximum radial and axial misalignment of the drive shaft:

| | Axial | Radial |
|---|---|---|
| static | ± 0.3 mm | ± 0.5 mm |
| dynamic | ± 0.1 mm | ± 0.2 mm |

# Accessories

# 10

## 10.1 Accessories and Documentation

| Description | | Type |
|---|---|---|
| Spring disk coupling | 6 mm/ 6 mm | 6FX2001-7KF10 |
| | 6 mm/ 5 mm | 6FX2001-7KF06 |
| Connecting cable, Ethernet | PAM4/RJ45 Straight 5 m | 6XV1871-5TH50 |
| Connecting cable, power | PAM5 2 m Shielded | 6XV1801-5DH50 |
| Coupling ** | Drilling: Ø 10 mm | 6FX2001-7KS10 |
| Clamp disk ** | Set = 1 pcs | 6FX2001-7KP01 |
| Operating Instructions * | Installation / configuration manual, English | 6SN1197-0AB11-0BP0 |
| GSDML file * | | |

Additional information about the accessories is provided in the Catalog:

"SIMOTION & SINAMICS PM 21", Part 7: Measuring systems

* This can be downloaded free of charge from MDM, see: Preface (Page 3)

** Can only be used for full shaft

We do not assume responsibility for technical inaccuracies or omissions. Specifications are subject to change without notice.

## 10.2 Ordering description

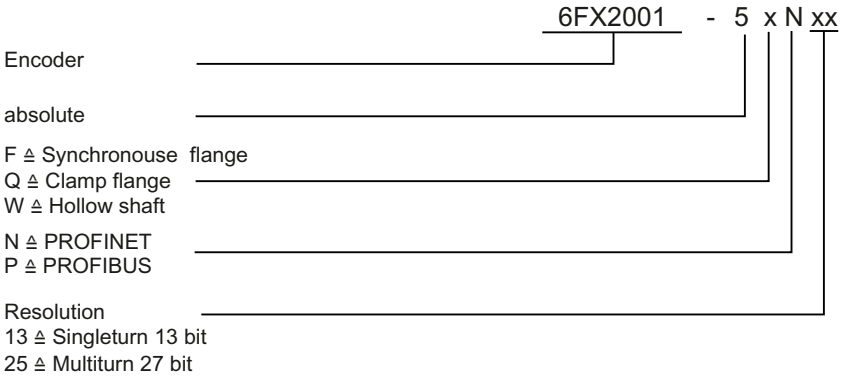
The order designation consists of a combination of alphanumeric characters, the machine-readable product designation MLFB. When placing an order, it is sufficient just to specify the unique MLFB.

The MLFB consists of three blocks that are separated by hyphens. The first block has seven characters and designates the product family and size of the primary or secondary section. In the second block, further design features are encoded, such as length and speed. The third block is provided for additional data.

Note that not every theoretical combination is possible in practice.

# 10.3 Models / ordering description

## Overview



# Appendix

# A

## A.1 Glossary

| Term | Explanations |
|---|---|
| 10Base-T | Transmission line with 10 Mbit data transmission rate. |
| 100Base-T | Transmission line with 100 Mbit data transmission rate. |
| Auto crossing | Allow to use straight or crossover wiring. |
| Auto negotiation | Is an Ethernet procedure by which two connected devices choose common transmission parameters, such as speed and duplex mode. |
| AWP | User program running on the PLC or SIMOTION. |
| Baud rate | Transmission rate; it display the transmission bits per second. |
| Binary | Numeric system with value 0 or 1. |
| BMP | PROFIdrive "Bau Mode Parameter Access" channel defined in PROFIdrive Profile, standard for online Parameter access (Access Point Data Record 0xB02E). |
| CAT5 | Terminations for transmission rates up to 100 Mbit. |
| DCP.Hello | On Fast Start up the encoder will register to the IO-Controller with the "DCP.Hello"-Service. |
| EMC | Electromagnetic compatibility, there are rules to verifying devices. |
| Ethernet | Ethernet is a computer network technology based on frames. |
| Endless shaft | (Rotary axis) solves the problem with non binary values for revolutions. |
| Fast Ethernet | Transmission technology with 100 Mbit transmission rate. |
| Fast starting | Optimized start time for PROFINET (< 1s). |
| Flash | Internal memory, saved data will be available after power down. |
| GSDML | Generic Station Description Markup Language: XML based description language. Contains all available parameters, classes, … Generic Station Description Markup Language: XML based description language. Contains all available parameters, classes. |
| Implicit Messaging | IO Connection: communication between IO-controller and IO-device. |
| IP address | Allows a computer to be logically addressed in a network. |
| IRT | Isochronous Real Time (Ethernet). |
| LLDP | Link Layer Discovery Protocol. |
| MAC address | Worldwide explicit address of a device. The encoder uses three MAC Addresses: one for internal interface and two for the ports. The basic MAC Address is stamped on the type plate. |
| Mbit | Transmission rate or baud rate, million bits per second. |
| MAP | Module Access Point. This MAP submodule contains at least the mandatory Parameter Access Point (PAP) which is mapped to a dedicated Record Data Object. |
| OSI-Model | The Open System Interconnection reference model is a open layer model for the organization of a communication. |
| PDEV | Physical device. Not all PLCs support several sub slots. Then select in the product tree Customized - otherwise ProfileV4.x. |
| PZD | Process Data: Process data part of a PPO. |
| Rotary axis | See -> Endless shaft. |

| Term | Explanations |
|---|---|
| Switch | A switch is an electronic device to connect computers e.g. network segments in a local network. Unlike a hub, a switch uses stacks to avoid network collisions. |
| TCP | The Transmission Control Protocol is a connection orientated transmission protocol, in a network. |
| UDP | User Datagram Protocol is used to send data that does not need to be transferred in a reliable way. |

## A.2 Additional literature

[1] Encoder Profile
Profile Encoder
Version 4.1, December 2008
PROFIBUS User Organization e.V.
Haid- und Neu-Straße 7, D-76131 Karlsruhe
http://www.profibus.com
Order Number 3.162

[2] PROFIdrive Profile
PROFIBUS Profile PROFIdrive – Profile Drive Technology
Version V4.1, May 2006,
PROFIBUS User Organization e.V.
Haid-und-Neu-Straße 7, D-76131 Karlsruhe
http://www.profibus.com
Order Number 3.172

[3] System Manual SIMOTION SCOUT Communication

[3a] Chapter: PROFIdrive; PROFIdrive overview

[3b] Chapter: PROFIdrive; acyclic communication (Base Mode Parameter Access)

[3c] Chapter: PROFIdrive; acyclic communication (Base Mode Parameter Access); system commands in SIMOTION

[3d] Chapter: PROFIdrive; acyclic communication (Base Mode Parameter Access); rules for using _readRecord and _writeRecord