POSITAL
FRABA

PROFINET INDUSTRIAL ETHERNET

ABSOLUTE ROTARY ENCODER WITH PROFINET INTERFACE USER MANUAL

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1. Introduction

This manual describes the implementation and configuration of an absolute rotary encoder with PROFINET interface. The device fulfills the requirements of a PROFINET IO device with RT (real time) or IRT (isochronous real time) classification.

1.1 Absolute rotary encoder

The basic principle of an absolute rotary encoder is the optical sampling of a transparent code disc which is fixed with the driving shaft.
The absolute rotary encoder has a maximum resolution of 65,536 steps per revolution (16 bits).
The mutli-turn version can detect up to 16,384 revolutions (14 bits). Therefore the largest resulting resolution is 30 bits = 2^{30} = 1,073,741,824 steps. The standard single-turn version has 13 bits, the standard multi-turn version 25 bits.

For further information about the function principle or the setup of a PROFINET network please, refer to http://www.profibus.com/pn.

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 device profiles (GSDML files).
Two ways of using PROFINET are available: PROFINET IO, similar to PROFIBUS DP as a distributed I/O system and PROFINET CBA as a modular component-based system for larger systems.
PROFINET offers scalable communication for different applications in industrial automation:

- PROFINET NRT (non real time) is suited 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 of use for motion control applications.

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

The engineering of PROFINET IO is done similar to PROFIBUS. The field buses (i.e. Ethernet topologies) are assigned to control systems during configuration. The IO device is configured in the actual system based on the contents of its GSDML file.
After completion of the engineering the installer loads the data for the expansion into the IO controller (PLC) and the IO controller assumes data exchange with the IO device.

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

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

1.3 Features of the Encoder

- Integrated Boot loader for customer firmware upgrades
- Round axis (Endless shaft)
- Neighboring detection
- Engineering identification call
- Different filters for velocity
- Used Profinet Encoder Profile V4

2. Installation

2.1 Electrical Connection

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

The Encoder uses a second D-coded connector and provides integrated switch functionality. On or in the packaging of the connector is the mounting description.

Connector Ethernet

4 pin female, D-coded

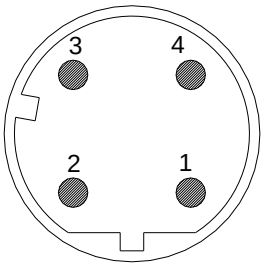
Pin Number	Signal
1	Tx +
2	Rx +
3	Tx -
4	Rx -

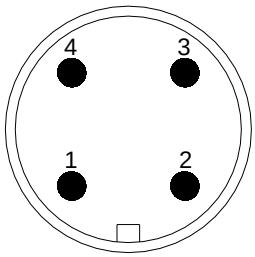
Connector power supply

4 pin male, A-coded

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

Sketch on encoder view





2.2 Ethernet cables

2.2.1 RJ45 – M12 crossed

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

2.2.2 RJ45 – M12 straight

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

2.2.3 M12 – M12 crossed

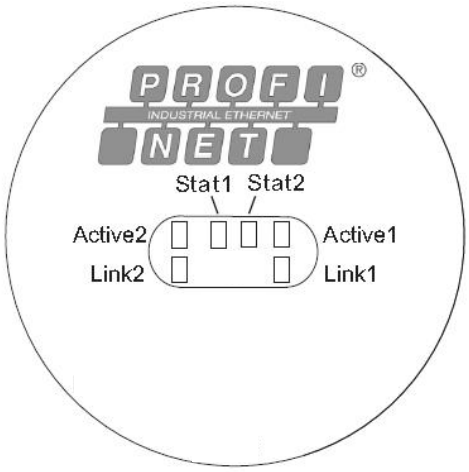
Signal	M12 Pin	M12 Pin
Tx+	1	1
Tx-	2	2
Rx+	3	3
Rx-	4	4

2.3 Diagnostic LEDs

LED	Color	Description for LED = on
Active1	Yellow	Incoming and outgoing traffic for port 1
Link1*	Green	Link to another Ethernet component for port 1
Active2	Yellow	Incoming and outgoing traffic for port 2
Link2*	Green	Link to another Ethernet component for port 2
Stat1	Green	Status 1, details in the next table
Stat2	Red	Status 2, details in the next table

* Flashes with 2Hz if engineering identification call is activated and link connection is available

2.4 Status LED indication



Status 1 Green	Status 2 Red (Bus failure)	Meaning	Cause
Off	Off	No power	
On	On	No connection to another device Criteria: no data exchange	- bus disconnected - Master not available / switched off
On	Blinking 1)	Parameterization fault, no data exchange Criteria: data exchange correct. However, the slave did not switch to the data exchange mode.	- Slave not configured yet or wrong configuration - Wrong station address assigned (but not outside the permitted range) - Actual configuration of the slave differs from the nominal configuration
On	Off	Data exchange. Slave and operation ok.	

1) The blinking frequency is 0.5 Hz. Minimal indication time is 3 sec.

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

The following points should be observed:

- 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 (this does not mean that you cannot remove the connection cap). If the device is opened and closed again, it can be damaged and dirt may enter the unit.

- The angular encoder shaft must be connected to the shaft to be measured through a suitable coupling (full shaft version). This coupling is used to dampen vibrations and imbalance on the encoder shaft and to avoid inadmissible high forces. Suitable couplings are available from Posital.

- Although Posital absolute encoders are rugged, when used in tough 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 may 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 erroneous functions and uncontrolled statuses which can even include severe personnel injury and material damage.

- The encoder should have got a large-area connection to PE. If the flange don't have a good electrical connection to the machine – i.e. if there was used a plastic mounting device – then use i.e. a 30cm long and 2cm wide copper tape to get the PE connection.

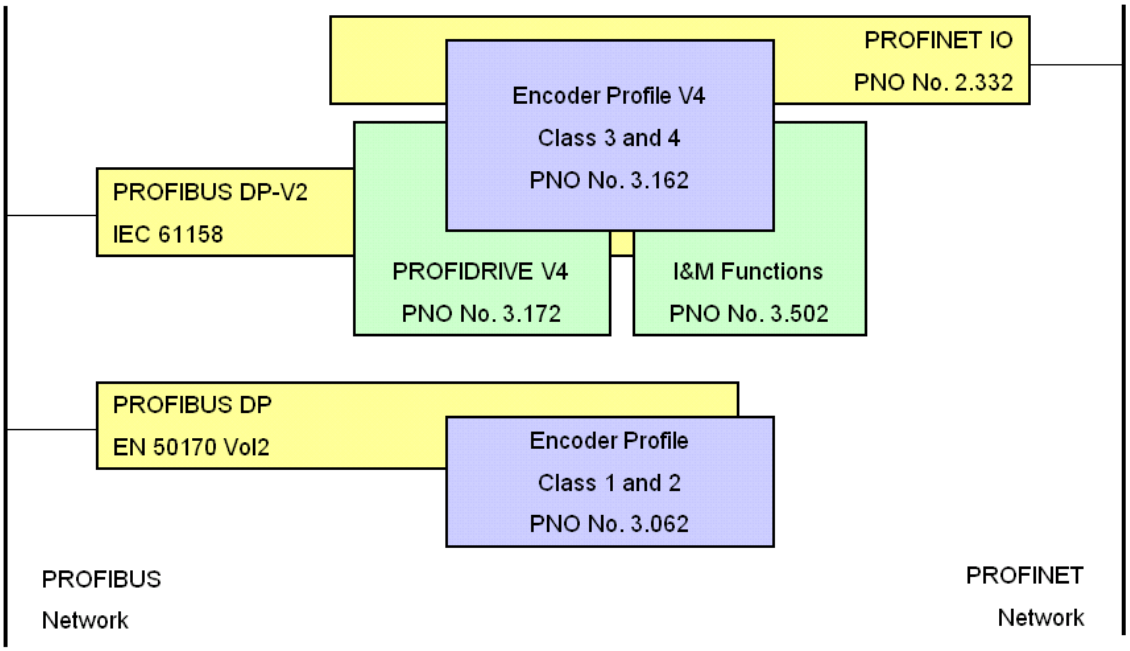
Before powering-up the system, check all of the electrical connections. Connections, which are not correct, can cause the system to function incorrectly. Fault connections can result in severe personnel injury and material damage.

3. Device configuration

3.1 Standardization

This actual generation of PROFINET devices is based on the Encoder Profile V4 (PNO No. 3.162). With this standardization it is possible to substitute all products that fulfill the specification.

See the next figure with the coherences.



3.2 Encoder Classes

Application Class	Description
3	Isochronous mode **is not** supported (RT)
4	Isochronous mode **is** supported (IRT)

3.3 Encoder functions

Function	Implementation	
	Class 3	Class 4
Code sequence	-/✓*	✓
Class 4 functionality	✓	✓
G1_XIST1 Preset control	-/✓*	✓
Scaling function control	-/✓*	✓
Alarm channel control	✓	✓
Preset value	-/✓*	✓
Preset value 64bit	-	-
Measuring units per revolution / Measuring step	-/✓*	✓
Total measuring range	-/✓*	✓
Measuring units per revolution 64bit	-/✓*	✓
Total measuring range 64bit	-/✓*	✓
Maximum Master Sign-Of-Life failures	-/✓*	✓
Velocity measuring unit	-/✓*	✓
Encoder Profile version	✓	✓
Operating time	-	-
Offset value	-/✓*	✓
Offset value 64 bit	-/✓*	✓
Round axis (Endless shaft)	✓	✓
Velocity filter	✓	✓

* If Class 4 functionality is activated

3.4 Signal list for Cyclic Data Transmission

Signal No.	Significance	Abbreviation	Lenght (bit)	Sign
3	Master's sign-of-life	STW2_ENC	16	-
4	Slave's sign of life	ZSW2_ENC	16	-
6	Velocity value A	NIST_A	16	✓
8	Velocity value B	NIST_B	32	✓
9	Control word	G1_STW	16	-
10	Status word	G1_ZSW	16	-
11	Position value 1	G1_XIST1	32	-
12	Position value 2	G1_XIST2	32	-
39	Position value 3	G1_XIST3	64	-

3.4.1 Format of actual position values

G1_XIST1 and G1_XIST2 are the actual position values in binary. For absolute encoders one format example is given below. **NOTE:** the alignment in the data-frame (left or right-aligned) is considered for each individual resolution.

Example: 25 bit Multiturn absolute encoder (8192 steps per revolution, 4096 distinguishable revolutions).

- All values are presented in binary format
- The shifting factors in P979 "sensor format" display the actual format. The default setting is G1_XIST1 left aligned and G1_XIST2 right aligned.
- The settings in the Encoder parameter data affect the position value in both G1_XIST1 and G1_XIST2.
- G1_XIST2 displays the error telegram instead of the position value if error occurs.

P979, Subindex 3 (Shift factor for G1_XIST1)
= 7
P979, Subindex 4 (Shift factor for G1_XIST2)
= 0
M = Distinguishable Revolutions (Multiturn value)
S = Pulses (Singleturn steps per revolution)

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

Absolute value in G1_XIST1

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

Absolute value in G1_XIST2

G1_XIST3
For 64bit position values is the G1_XIST3 available. The binary value will transmit right aligned and without shifting factor.

IO Data	1	2	3	4
Format	64 bit position value			

3.4.2 Encoder control word (STW2_ENC)

4-Bit-counter, left justified. The master application starts the sign of life with any value between 1 and 15. The master increases the counter in every cycle of the master application. Valid values for the master's sign of life are 1 to 15, "0" indicates an error and is left out in normal operation.

Bit	Function	Implementation	
		Class 3	Class 4
0…9	Reserved, currently not used		
10	Control by PLC	✓	✓
11	Reserved, currently not used		
12…15	Controller Sign-Of-Life	-	✓

Bit	Value	Significance	Comments
10	1	Control by PLC	Control via interface, EO IO Data is valid
	0	No control by PLC	EO IO Data is not valid. Except Sign-Of-Life
12…15		Controller Sign-Of-Life	Send continuous counting value from 0 to 15

3.4.3 Encoder status word (ZSW2_ENC)

4-Bit-counter, left justified. The slave application starts the sign of life with any value between 1 and 15 after successful synchronization to the clock pulse. The counter is increased by the slave application in every DP-cycle. Valid values for the slave's sign of life are 1 to 15, "0" indicates an error and is left out in normal operation.

Bit	Function	Implementation	
		Class 3	Class 4
0…8	Reserved, currently not used		
9	Control requested	Mandatory	Mandatory
10…11	Reserved, currently not used		
12…15	Encoder Sign-Of-Life	-	Mandatory

Bit	Value	Significance	Comments
9	1	Control requested	The automation system is requested to assume control
	0	No control by PLC	EO IO Data is not valid. Except Sign-Of-Life
12…15		Encoder Sign-Of-Life	Send back continuous Controller Sign-Of-Life (counting value from 0 to 15)

3.4.4 Encoder control word (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 programmed absolute value or shifted by this value. 0: set home position / preset (absolute) 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 **Warning:** After setting the preset the offset will be save in the non volatile memory. In this 5-10ms the encoder will not send position values.
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 transmits no error messages.
15	1	Acknowledging a sensor error	Request to acknowledge / reset a sensor error

3.4.5 Encoder status word (G1_ZSW)

Bit	Value	Meaning	Comment
0 .. 10			Reserved, currently not used
11		Acknowledgement sensor error in process	Is set if the reset of a sensor error (after acknowledging) takes longer than one bus cycle.
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 error messages.
15	1	Sensor error	Indicates a sensor error. A device specific error code is transmitted in G1_XIST2.

3.5 Standard telegrams

Standard Telegram 81

IO Data (DWord)	1	2
Setpoint	STW2_ENC*	G1_STW1*

* Details about the variables are available in chapter 3.4

IO Data (DWord)	1	2	3	4	5	6
Actual value	ZSW2_ENC*	G1_ZSW1*	G1_XIST1*		G1_XIST2*	

Standard Telegram 82

IO Data (DWord)	1	2
Setpoint	STW2_ENC*	G1_STW1*

IO Data (DWord)	1	2	3	4	5	6	7
Actual value	ZSW2_ENC*	G1_ZSW1*	G1_XIST1*		G1_XIST2*		NIST_A*

Standard Telegram 83

IO Data (DWord)	1	2
Setpoint	STW2_ENC*	G1_STW1*

IO Data (DWord)	1	2	3	4	5	6	7	8
Actual value	ZSW2_ENC*	G1_ZSW1*	G1_XIST1*		G1_XIST2*		NIST_B*	

Standard Telegram 84

IO Data (DWord)	1	2
Setpoint	STW2_ENC*	G1_STW1*

IO Data (DWord)	1	2	3	4	5	6	7	8	9	10
Actual value	ZSW2_ENC*	G1_ZSW1*	G1_XIST3*				G1_XIST2*		NIST_B*	

3.6 Configuration principle

The rotary encoder with PROFINET interface can be programmed according to the needs of the user. The GSDML file pertaining to the rotary encoder has to be installed in the used PLC engineering software tool.

3.7 Rotary encoder functionality overview

Function	Communication channel
Position value	Cyclic input (IO device -> IO controller)
Preset	Cyclic output (IO controller -> IO device)
Coding sequence	Acyclic input/output
Scaling function	Acyclic input/output

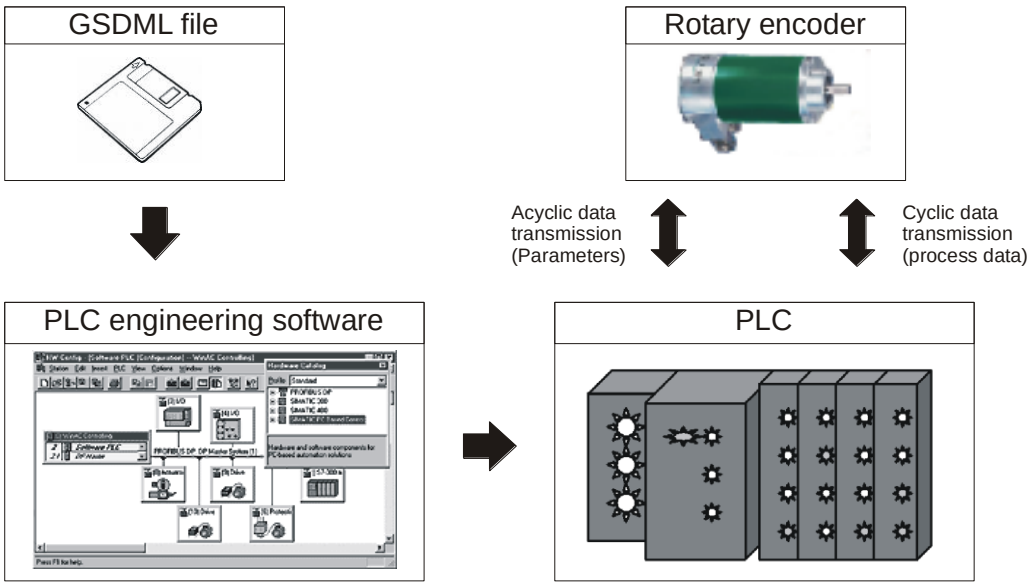
3.8 Rotary encoder functions – data format

PROFINET IO devices are set up in modules. Each module can be plugged in physical and/or logical slots. These are subdivided into sub slots individually to accommodate further data hierarchy. One sub slot can contain several cyclic input/output channels as well as acyclic record channels (used for parameters).

There are two versions of PLC available. Some of them support only one sub slot. Other ones i.e. S7 400 support several sub slots. To work with both PLCs there are in the GSDML-file two directories: Standard and Encoder Profile 4.

POSITAL rotary encoders offer for the standard profile one slot (address #0) with one sub slot (address #0) for all device data for old PLC's that doesn't support several sub slots.

Device parameters are grouped together as records in the PROFINET interface. The following table gives an overview over addresses of POSITAL rotary encoder's data channels.



Parameter for Acyclic Data Transmission

3.8.1 Base Mode Parameter

Function	Slot	Sub slot	Index	Offset	Length	IO
Code sequence	1	1	0xBF00	0.0	1 Bit	-
Class 4 functionality	1	1	0xBF00	0.1	1 Bit	-
G1_XIST1 Preset control	1	1	0xBF00	0.2	1 Bit	-
Scaling function control	1	1	0xBF00	0.3	1 Bit	-
Alarm channel control	1	1	0xBF00	0.4	1 Bit	-
Measuring units per revolution	1	1	0xBF00	1	8 Byte	-
Total measuring range	1	1	0xBF00	9	8 Byte	-
Maximum Master Sign-Of-Life failures	1	1	0xBF00	17	1 Byte	-
Velocity measuring unit	1	1	0xBF00	18	1 Byte	-
Preset value	1	1	0xB02E	Via Parameter Number 65000		-

3.8.2 Device Parameter

Function	Slot	Sub slot	Index	Offset	Length	IO
Preset value	1	1	0xB02E	Via Parameter Number 65000		-

3.8.3 Vendor Parameter

Function	Slot	Sub slot	Index	Offset	Length	IO
Velocity filter	1	1	0x1000	0	1 Byte	-
Endless shaft (Round axis)	1	1	0x1000	1	1 Byte	-

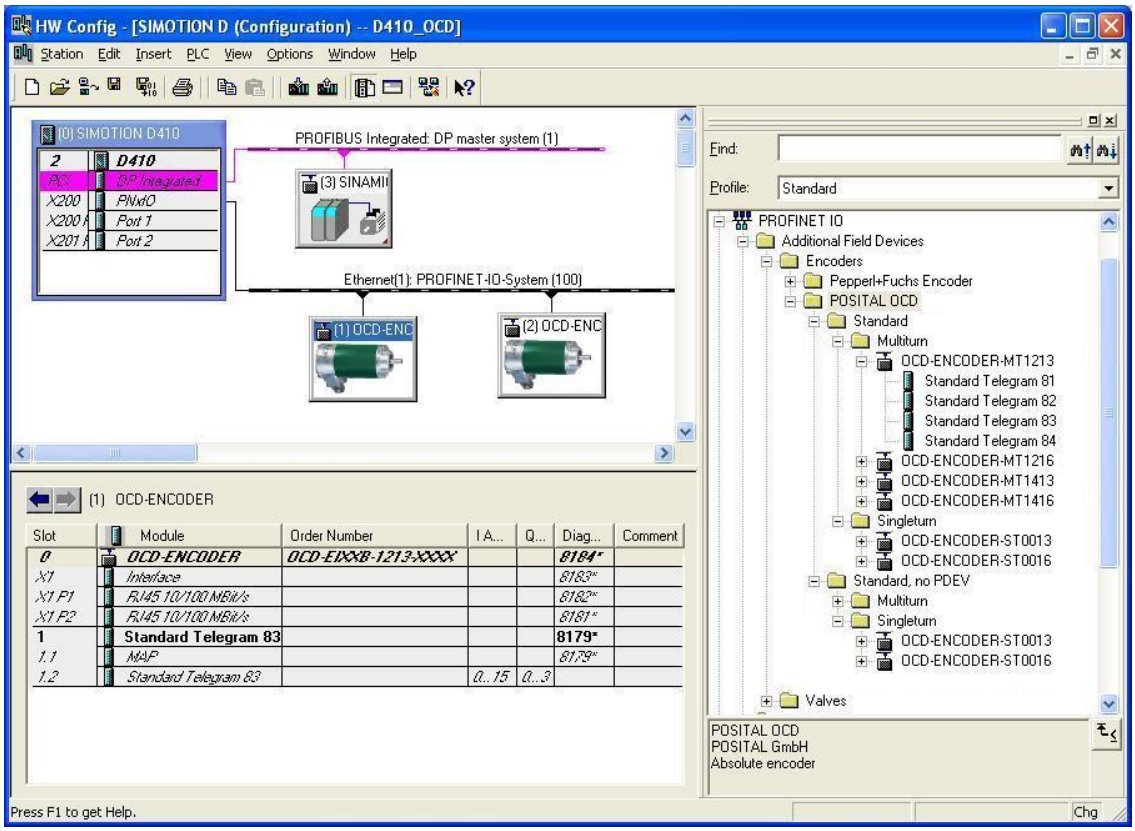
For PLC's that support several sub modules (Standard section in Device list, not no PDEV) the following table will be in use for the Encoder Profile 4.

Slot 0	Slot 1 Standard Telegrams		
Sub 0	Sub 0	Sub 1	Sub 2
		MAP (Parameter)	Standard Telegram 81,82 or 83
		Acyclic Data Channel	Cyclic Data Channel

3.9 Patronized Parameter

Parameter	Read only	Write only	Read/Write
PNU_922_TELEGRAM_SELECTION	✓		
PNU_964_DEVICE_IDENT	✓		
PNU_965_ENCODER_PROFILE_NUMBER	✓		
PNU_971_STORE_LOCAL_PARAMS		✓	
PNU_975_ENCODER_OBJECT_IDENT	✓		
PNU_979_SENSOR_FORMAT	✓		
PNU_980_NUMBER_LIST_OF_DEFINED_PARAM	✓		
PNU_65000_PRESET_VALUE			✓
PNU_65001_OPERATING_STATUS	✓		

Sample of configuration according Encoder Profile V4



3.9 Rotary encoder function description

Function	Implementation	
	Class 3	Class 4
Code sequence	-/✓*	✓
Class 4 functionality	✓	✓
G1_XIST1 Preset control	-/✓*	✓
Scaling function control	-/✓*	✓
Alarm channel control	✓	✓
Preset value	-/✓*	✓
Preset value 64bit	-	-
Measuring units per revolution / Measuring step	-/✓*	✓
Total measuring range	-/✓*	✓
Measuring units per revolution 64bit	-/✓*	✓
Total measuring range 64bit	-/✓*	✓
Maximum Master Sign-Of-Life failures	-/✓*	✓
Velocity measuring unit	-/✓*	✓
Encoder Profile version	✓	✓
Operating time	-	-
Offset value	-/✓*	✓
Offset value 64 bit	-/✓*	✓
Round axis (Endless shaft)	✓	✓
Velocity filter	✓	✓

* If Class 4 functionality is activated

3.9.1 Code sequence

The parameter “code sequence“ defines the counting direction of the position value. The code increases when the shaft is rotating clockwise (CW) or counter-clockwise (CCW) (view onto the shaft).

Code sequence	**Direction of rotation when viewing the shaft**	**Code sequence**
0 (default)	Clockwise (CW)	Increasing
1	Counter-clockwise (CCW)	Decreasing

3.9.2 Class 4 functionality

The parameter “Class 4 functionality“ defines that the scaling, preset and code sequence affects the position value in G1_XIST1, 2 and 3.

Class 4 control	Class 4 function
0 (default)	Deactivated
1	Activated

3.9.3 Preset control for G1_XIST1

The parameter “preset control“ defines the preset functionality. If parameter Class 4 is activated and Preset control is disabled then the Preset will not be affected for G1_XIST1.

Preset control	Preset function
1	Preset does not affect G1_XIST1
0 (default)	G1_XIST1 is affected by a Preset command

3.9.4 Scaling function control

The parameter “scaling function control“ enable / disenable the scaling function. If not, the physical position value is returned by the rotary encoder. This is only available if class 4 control is activated.

Scaling function control	Scaling function
0	Deactivated
1 (default)	Activated

3.9.5 Alarm channel control

The parameter “Alarm channel control“ defines the length of diagnostic telegram. If the Alarm channel is deactivated then will only transmit the first 6 bytes of diagnostic telegram.

Alarm channel control	Alarm channel function
0 (default)	Deactivated
1	Activated

3.9.6 Preset value

With the Preset value it is possible to adapt the encoder zero point to the zero point of the application. When using this function the current encoder position value is set to the desired preset value. The integrated microcontroller calculates the internal zero point shift. It is stored in a permanent memory (~ 10 ms).

NOTE:

- Set Preset only in standstill!
- There is no preset activated when the Preset value is written to the encoder. The preset function is controlled by the bits in sensor control and status words (G1_STW and G1_ZSW). The Preset value is used when a preset is requested by bit 12 in the Sensor control word (G1_STW).

Parameter	Meaning	Data type
Preset value	Preset value will defined during startup or with asynchronous data exchange	Integer 32

Function call for setting Preset = 100 Decimal (= 0x000000C8 hex) following with Request Header, Parameter-Address and -Value:

CALL " WR_REC"	
REC	
ID	
INDEX	0xB02E
LEN	16
DONE	
BUSY	
ERROR	
STATUS	
RECORD	

Request Header :

0x02,0x00,0x01,0x00,

Byte 0) Req ID (Change parameter)

Byte 1) Req Reference

Byte 2) No. Of Parameters 1

Byte 3) DO-ID

Parameter Address:

0x00,0x10,0xFD,0xE8,0x00,0x00,

Byte 0) No. Of Elements (0)

Byte 1) Attribute (Value)

Byte 2-3) Parameter number: 65000 (Preset)

Byte 4-5) Subindex

Parameter Value:

0x01,0x43, 0x00,0x00,0x00,0xC8

Byte 0) No. of Values (1)

Byte 1) Format (0x43) (Integer32)

Byte 2-5) Value (Preset = 100)

3.9.7 Offset value

The offset value is calculated in the preset function and shifts the position value with the calculated value.

Parameter	Meaning	Data type
Measuring units per revolution / Measuring step	Single turn resolution in steps	Unsigned 32
Total measuring range in measuring units	Total measuring range measuring steps	Unsigned 32

3.9.8 Scaling parameters

The Scaling parameters will be used to change the resolution. This parameter will only affect to the output values if the Scaling function is activated.

Parameter	Meaning	Data type
Measuring units per revolution / Measuring step	Single turn resolution in steps	Unsigned 32
Total measuring range in measuring units	Total measuring range measuring steps	Unsigned 32

3.9.9 Max. Master Sign-Of-Life failures

With this parameter the number of allowed failures of the master's sign of life is defined.

Parameter	Meaning	Value
Maximum Master Sign-Of-Life failures	Number of permissible failures of the master's life sign	1 … 255

3.9.10 Velocity measuring units

This parameter defines the coding of velocity measuring units used to configure the values NIST_A and NIST_B. Only Telegrams 82-84 uses the velocity outputs.

With each cycle will calculate the velocity from the position value. To get a high velocity precision it is necessary to use a short cycle time.

Velocity measuring unit	Value
Steps/s	0
Steps/100ms	1
Steps/10ms	2
RPM	3

3.9.11 Velocity filter

The velocity value can used with three different moving averaging filter types. Default: Fine

Parameter	Meaning	Data type
Velocity filter	Select for the parameter Fine, Normal, Coarse	Integer 32

3.9.12 Endless Shaft (RoundAxis)

Normally the period, i.e. “Total resolution” / “measuring units” per revolution must be an integer and it must fit an integer number of times (integer multiple) into 4096 for an encoder with 12 Bit for the revolutions. This means that i.e. 100 or 325 revolutions could make trouble. So the following equation must apply:

(4096 x measuring units per revolution) / Total resolution = integer

But with this Profinet encoder it is possible to solve this problem. If the Endless Shaft (Round axis) is activated then this problem will be solved by the encoder. The default value is “Off”. With value = “Auto” the encoder checks if the parameters need the endless shaft. “On” activate this functionality during the complete working time.

Note: The internal software routine only works if the encoder is in operation. If it is necessary to turn the encoder shaft more than 1024 revolutions without power supply this can lead to problems (the internal routine will not work without power supply). With this function there will be save additional values in the internal eeprom.

If the cycle time is ≤ 10ms then there will come four times over the total resolution a pause of sending position values of 5-10ms because the offset value has to save in the non volatile memory.

Parameter	Meaning	Data type
Endless Shaft (Round axis)	Select for the parameter On, Off, Auto	Integer 32

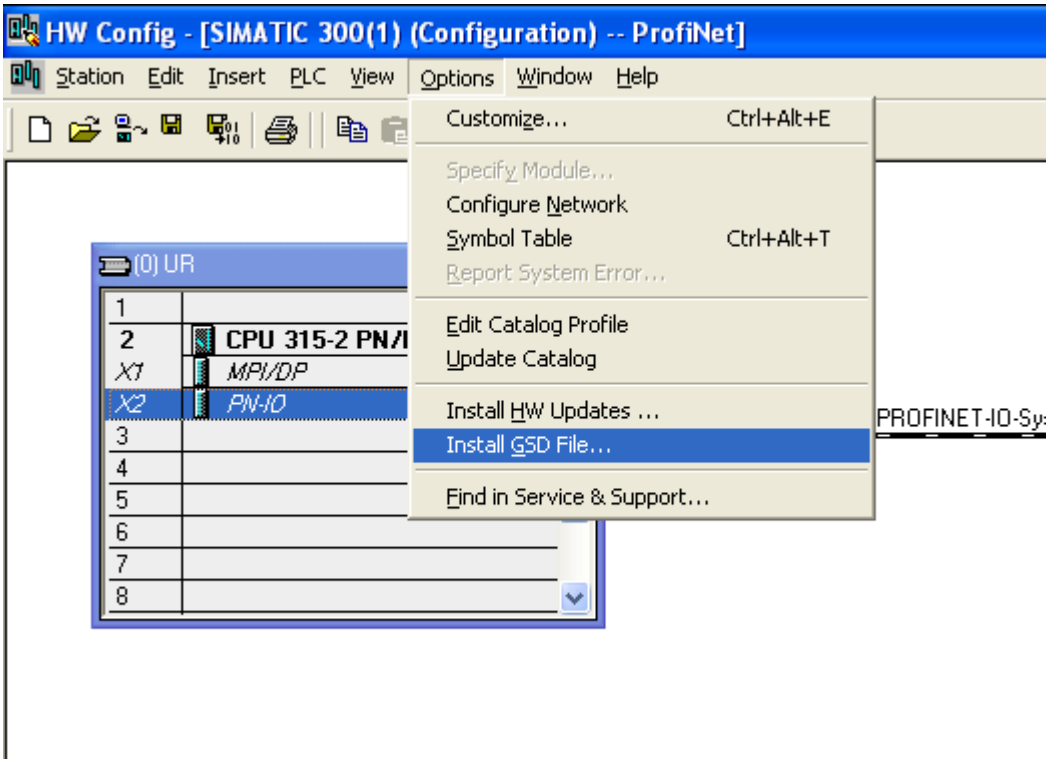
4. Configuring with STEP7

In the following chapter the configuration of the POSITAL encoder with the configuration tool Hardwaremanager STEP 7 is shown exemplarily. In this example STEP 7 Version 5.4 SP1 and the CPU 315-2PN/DP or Simotion Scout with single axis controller D410 (PROFINET controller integrated) are used. If there are questions about other software tools please contact the manufacturer.

4.1 Installing the GSDML file

If POSITAL encoders are used for the first time it is necessary to install the GSDML file to import encoder parameterization into the hardware catalogue of the tool:
Choose “Install GSD File...” in the “HW Config”-window of the project (menu item “Options”) and select the GSDML-file.

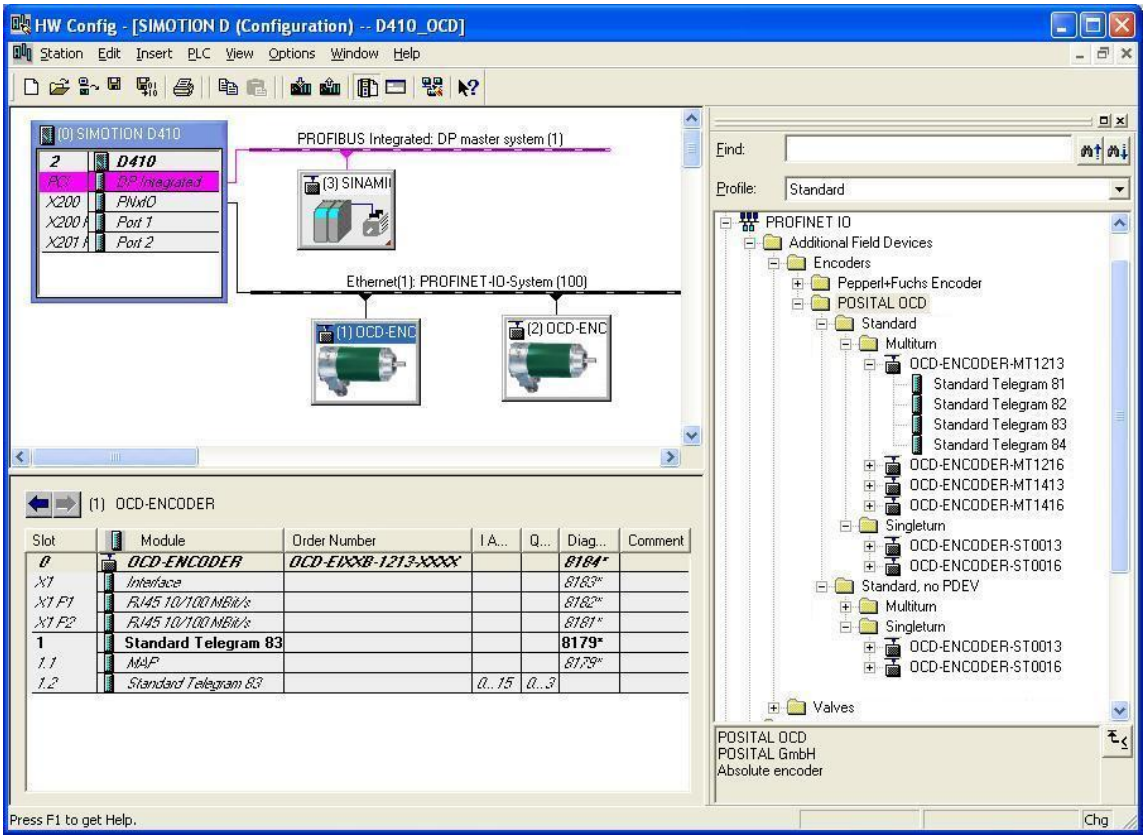
The GSDML file is supplied by POSITAL (free of charge from www.posital.eu). In order to represent the encoder with a bitmap in STEP7 the bitmap file will be installed automatically with the GSDML file – both files must be in the same directory. The main number of the “Software Release” in the GSDML file and the Firmware must be the same, i.e. 4.xx.



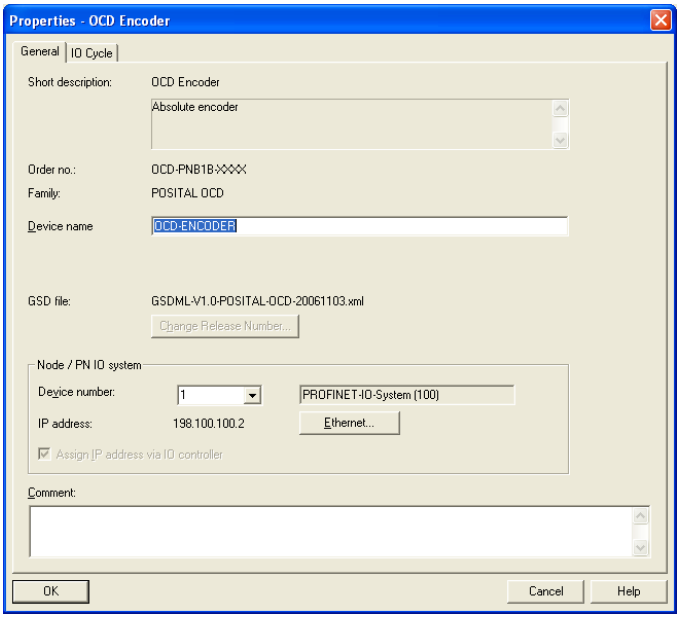
After the successful installation of the GSDML file the POSITAL encoder can be found in the hardware catalog under „PROFINET-IO“ – „Additional Field Devices“ – „Encoders“ – „POSITAL OCD“. (Possibly, you need to update the hardware catalog by choosing “Options” -> “Update catalog”).

4.2 Engineering a POSITAL encoder into a STEP7 project

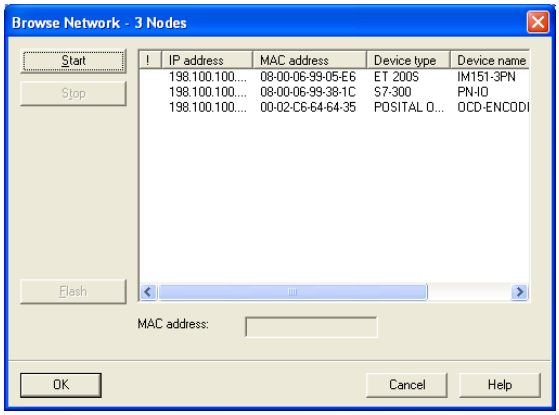
To engineer the rotary encoder into a project, drag the device “OCD encoder” on to an existing PROFINET ethernet network (or choose the network and double-click the “OCD encoder” icon).



Double-click the rotary encoder icon to set communication parameters that the PLC will use. Set a device name and by clicking “Ethernet” the IP address of the POSITAL encoder. Also, under the “IO cycle” tab, set the desired update time.

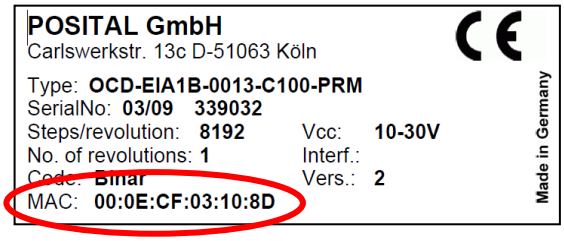


The device name and IP address now have to be set physically within the rotary encoder. Connect the PLC and rotary encoder to ethernet and switch them on. Click “PLC” -> “Ethernet” -> “Edit Ethernet Node” and click “Browse” for accessible ethernet nodes in the new window. STEP7 will scan for devices on Ethernet and will displays them in a window. The rotary encoder should be displayed under the device type “POSITAL OCD”. 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 is available on the type label on the bottom left (see picture below with red marking). 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”.

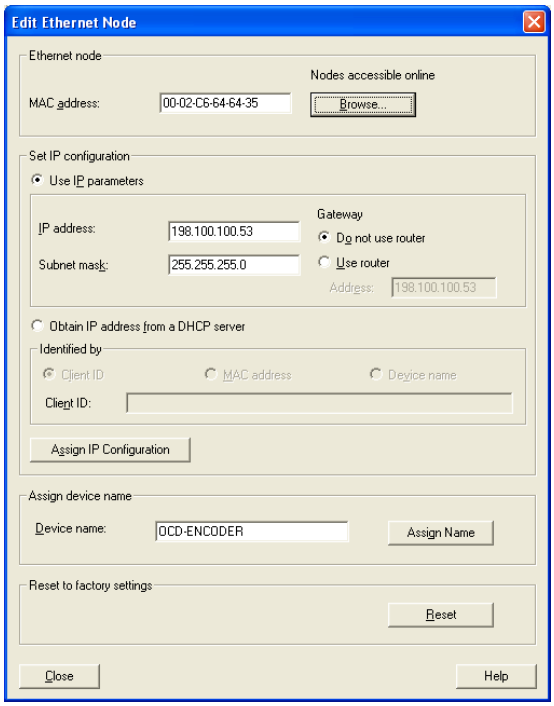


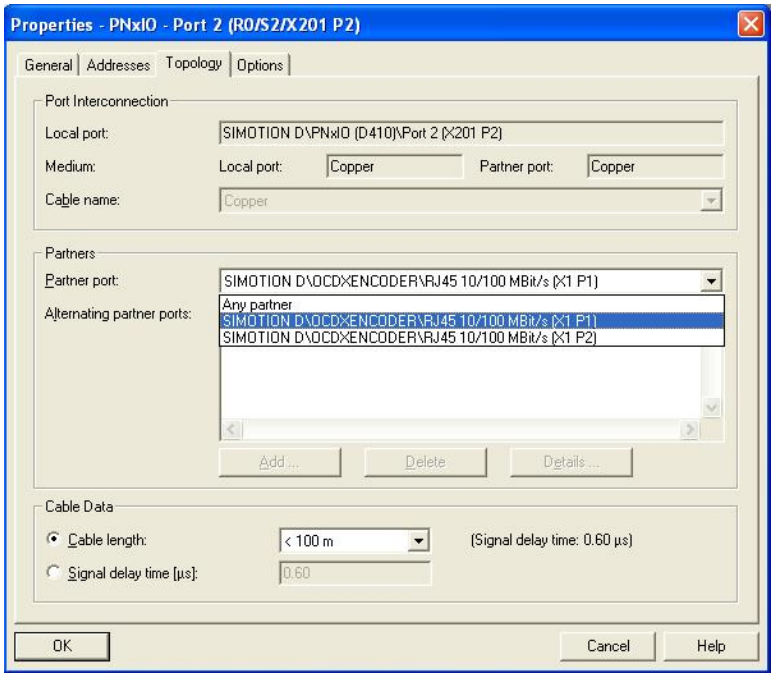
Please note:

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



4.3 LLDP (Link Layer Discovery Protocol)

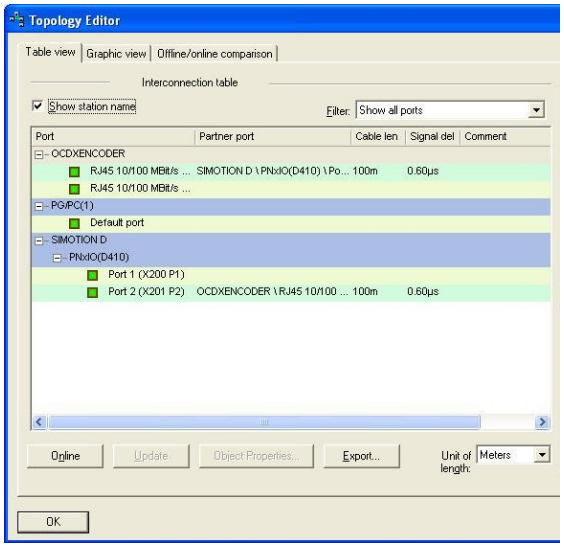


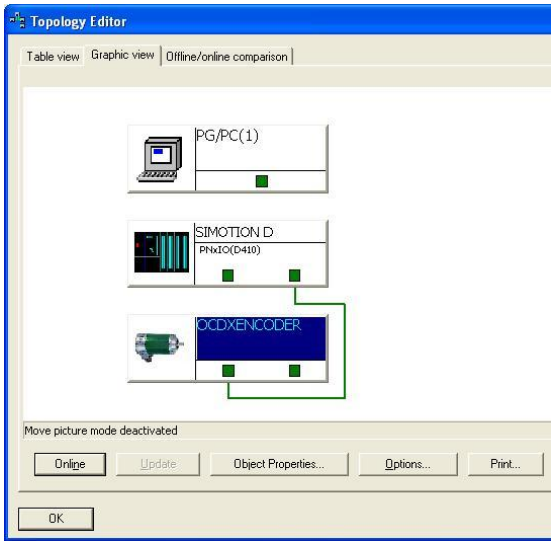


The Link Layer Discovery Protocol allows replacing a device of the Profinet-network. The partner port before and behind of the replaced device save relevant information's so that no additional configuration is necessary.

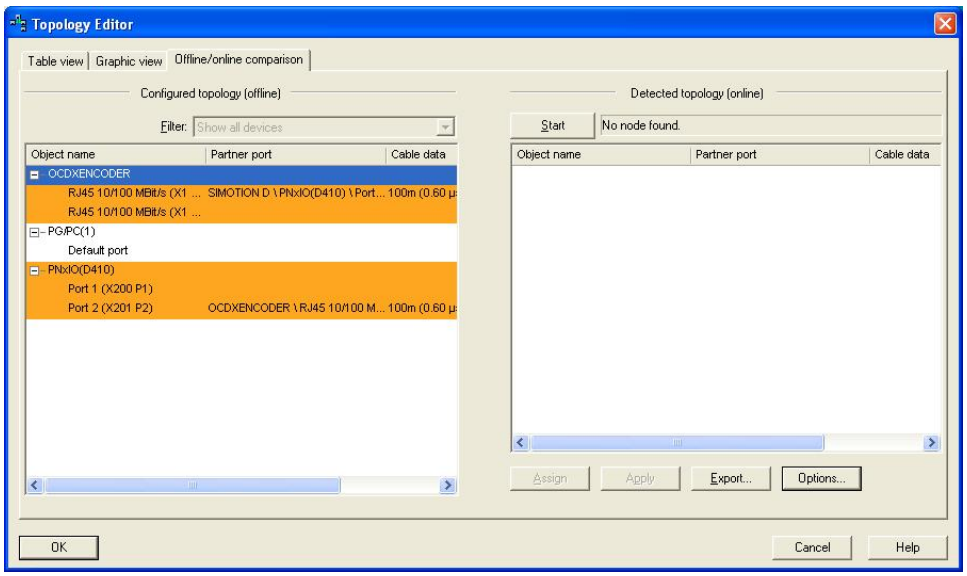
But the flag for activate "**Device replacement without replacement medium"** must be activated under tab General.

With the Topology Editor in the Step 7 Hardware manager it is possible to get an overview the connections, the cable length and signal delay.



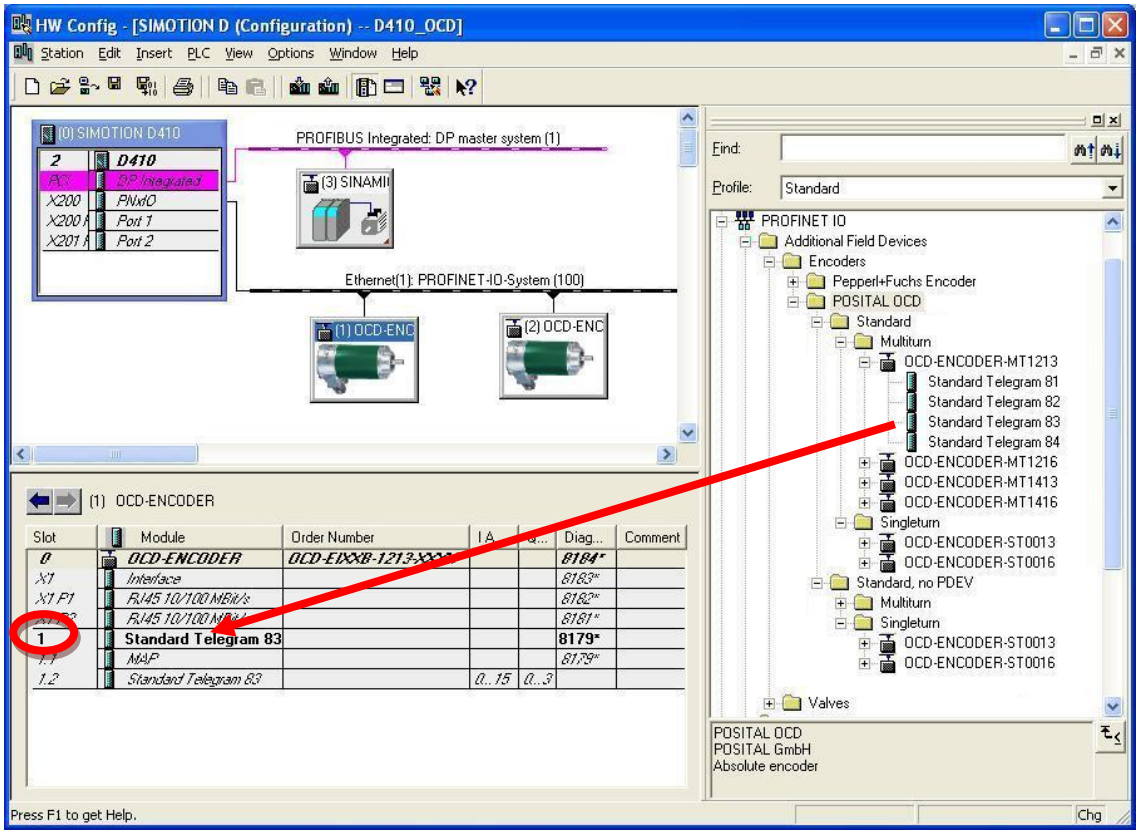


It is possible to compare the configuration with the physical network.



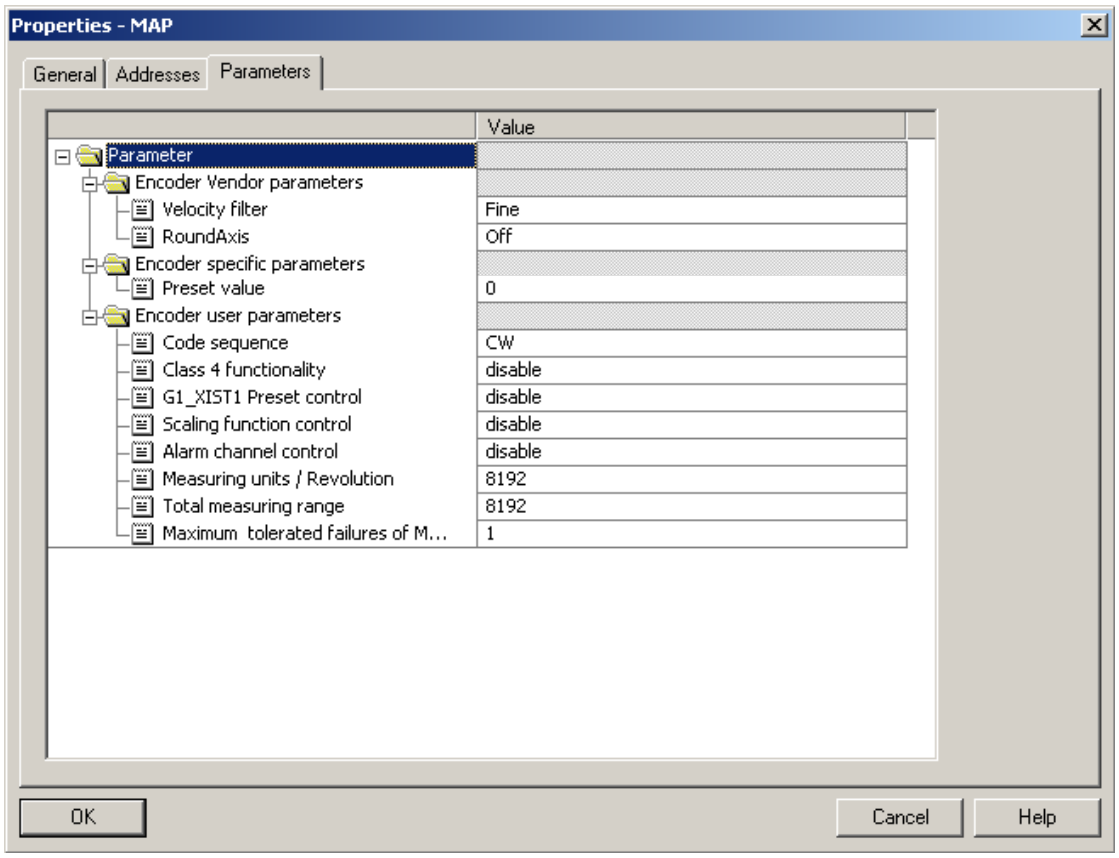
4.4 Selecting an encoder version

Some functionality and default parameters depend on the encoder version. These different versions are realized as several modules within the GSDML file that can be plugged into the free encoder slot (number 1). For this, one of the modules listed under FRABA encoder has to be dragged to Slot 1 in the displayed configuration table of the encoder.



4.4 Setting encoder parameters

Select the encoder in the hardware configuration and double click slot one – or MAP in slot one is available – in the configuration table of the encoder. The properties dialog will appear. The input addresses can be changed under the tab “Addresses” (if desired). To set the encoder parameters the tab “Parameters” has to be selected.



4.5 Changing and reading encoder parameters at run-time

Encoder parameters will be set during engineering of the encoder (upload to PLC during hardware configuration).

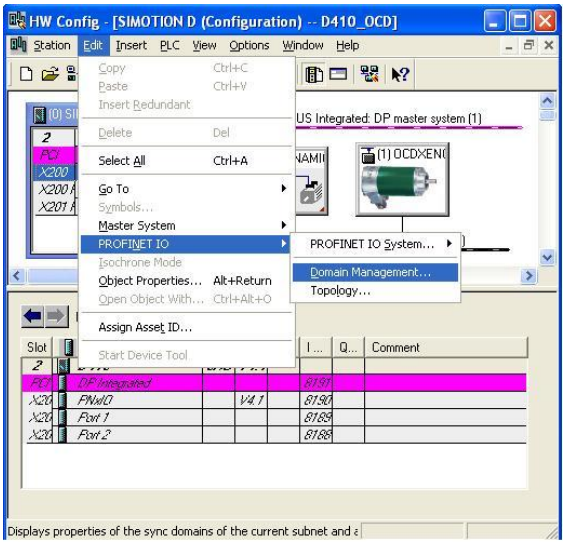
To change or read encoder parameters in a STEP7 automation program, refer to system function blocks SFB53 and SFB52 (write/read record) or with the variable table for testing.

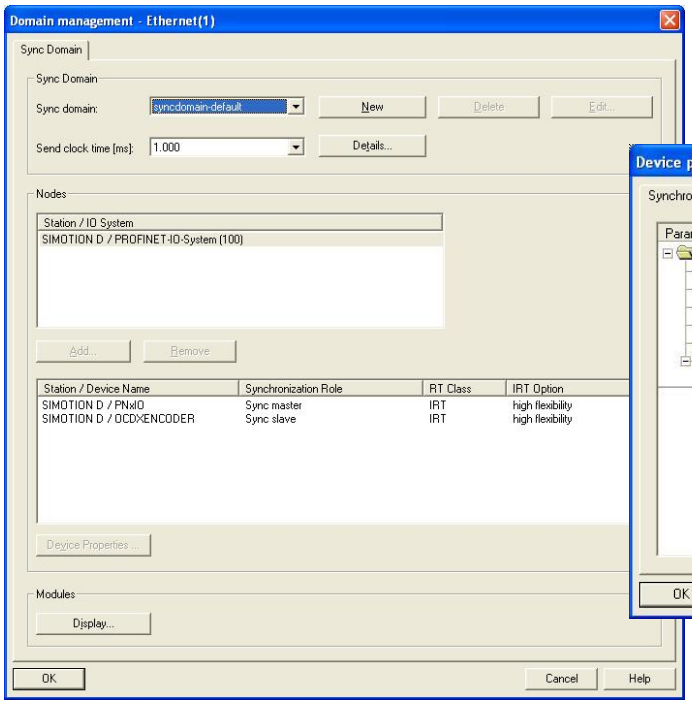
4.6 Setting of device properties

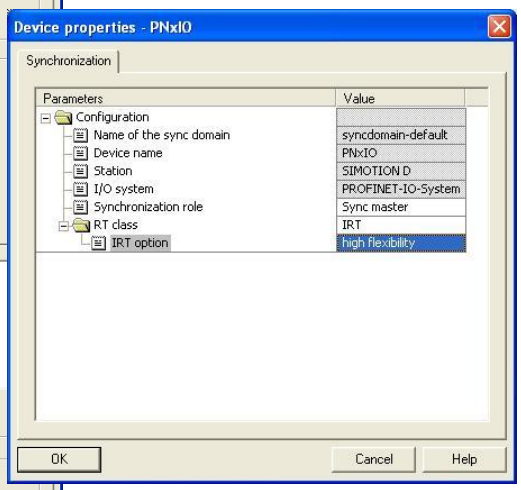
Under Profinet IO Domain Management (i.e. right click on Slot 0) allows to select the Synchronization type and the RT Class.

If the Synchronization role is selected as “unsynchronized” then the encoder works in RT-Mode. If Sync master is selected then is it possible to switch between “high flexibility” (FLEX) and “high performance” (TOP).

In the Domain Management is an overview with all devices available. There should use all devices the same Synchronization Role and RT Class.

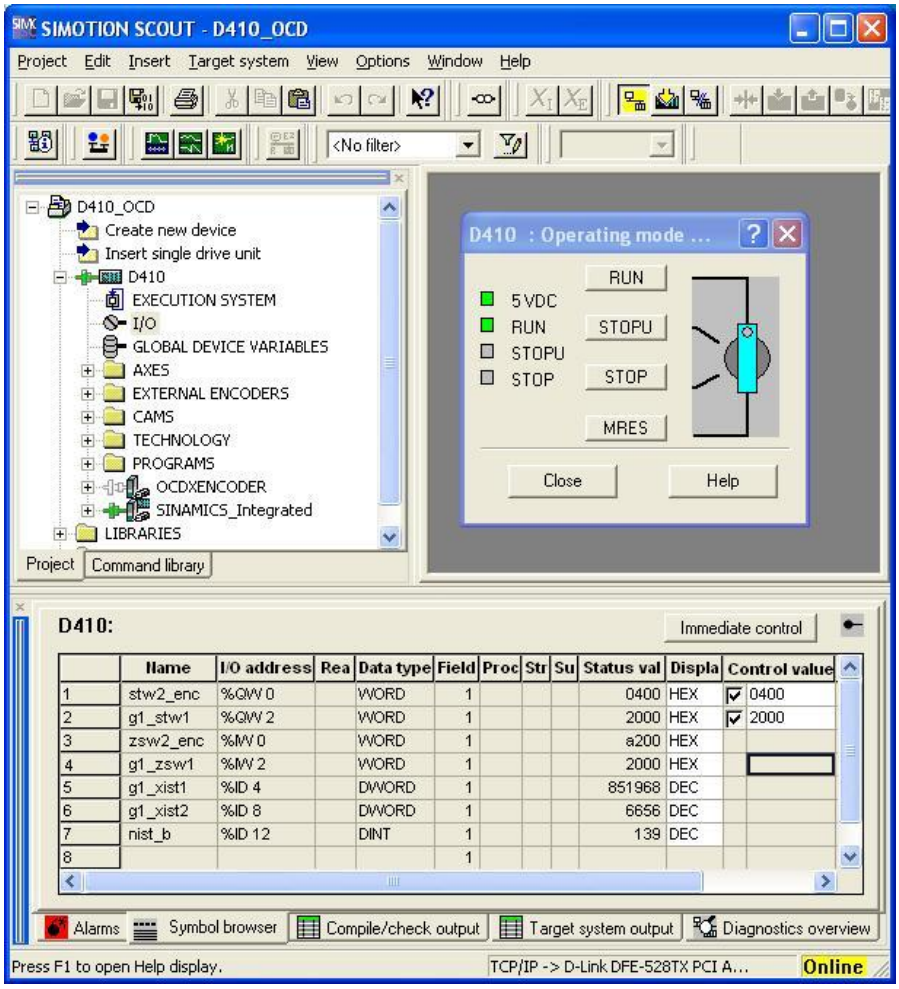






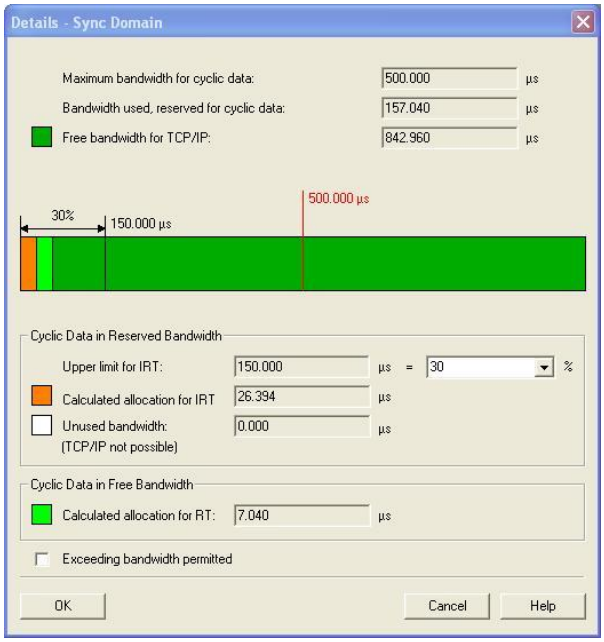
4.7 Sample of Variable table

In the next hardcopy is a variable table with all necessary control and data words.



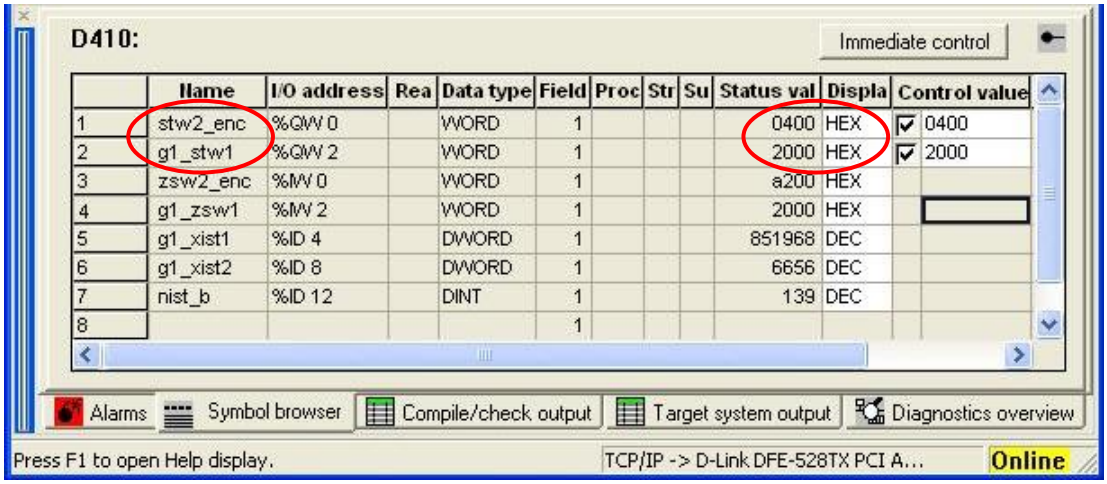
4.8 IRT settings

It is possible to set the upper limit for IRT transmission.



5 FAQ

1. **Question:** Why don't I get back position values?
   Answer: According the encoder profile it is necessary to set Bit 11 to "1" in stw2 and bit 14 in g1_stw1. See the next hardcopy



2. **Question:** Why doesn't the neighboring detection work?
   Answer: The encoder supports the LLDP protocol. But it is necessary to use the newest version of Step 7 or Simotion Scout. The flag "Device replacement without replacement medium" must be active in the Properties window under General.

3. **Question:** What to do if one encoder has to be replaced by a new one?
   Answer: See answer 2 or chapter 4.3.

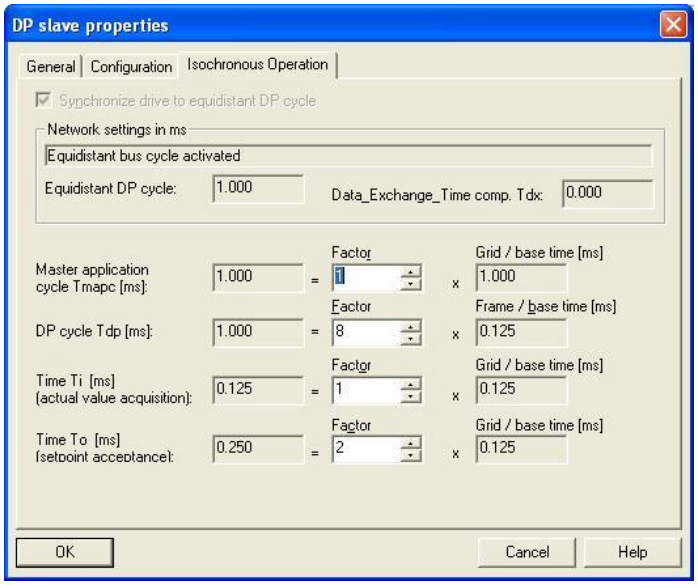
4. **Question:** Why doesn't the communication between encoder and PLC work correctly?
   Answer: The Firmware of the PLC and the STEP 7 (with minimum Hot fix 6) or Simotion Scout has to use the newest firmware that support IRT 2.2 or Stack version 3.1 for Ertec devices.

5. **Question:** Why doesn't the encoder send position values back to the bus after sending acyclic data that has to save in non volatile memory during real-time communication?
   Answer: If the cycle time is ≤ 10ms the encoder needs 5-10ms for saving the information in the non volatile memory. Change i.e. the preset value with the acyclic data during the RUN-Phase of the PLC or deactivate the Round Axis functionality.

6. **Question:** What is the easiest way to set the preset value?
   Answer: Set the preset value in the Hardware Manager from Step 7 or Simotion Scout. So will transmitting the preset value during the start up phase to the encoder. To activate it is necessary to

set Bit 12 to “1”. In the hardcopy above should send 3000 instead 2000. For details see chapter 3.4.4.

7. **Question:** Why can I not set the preset value or the other parameters?
   Answer: Only in class 3 with activated Class 4 functionality or class 4 is it possible to set the parameters. If necessary it is important to use class 4 or to activate the class 4 functionality in the Hardware Manager.
8. **Question:** On using the D410 the error “Synchronization error between Profibus and Profinet” popped up. What is to do?
   Answer: Both systems have to use the same cycle time. If the Profinet cycle time amounts 1ms then must use the Profibus the same time. See the next Hardcopy with the settings for 1ms.



6 Glossary

Term	Explantations
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
Baud rate	Transmission rate; it display the transmission bits per second
Binary	Numeric system with value 0 or 1.
CAT5	Terminations for transmission rates up to 100 Mbit.
EMC	**E**lectro**m**agnetic **c**ompatibility, there are rules to verifying devices.
Ethernet	Ethernet is a computer network technology based on frames.
Endless shaft	(Round axis) Solve the problem with not binary values for revolutions
Fast Ethernet	Transmission technology with 100 Mbit transmission rate.
Flash	Internal memory, saved data will be available after power down.
Implicit Messaging	IO Connection: communication between controller and device
IP-Address	Allow a logic addressing from computer in a network.
IRT flex	Former name for the IRT synchronization “High Flexibility”
IRT top	Former name for the IRT synchronization “High Performance”
LLDP	**L**ink **L**ayer **D**iscovery **P**rotocol
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 available on the type label.
Mbit	Transmission rate or baud rate, million bits per second
MAP	**M**odule **A**ccess **P**oint. This MAP Sub module contains at least the mandatory Parameter Access Point (PAP) which is mapped to a dedicated Record Data Object
OCD	Acronym: **O**PTO**C**O**D**E, name of an encoder series manufactured by FRABA POSITAL.
OSI-Model	The **O**pen **S**ystem **I**nterconnection reference model is a open layer model for the organization of a communication.
PDEV	**P**hysical **dev**ice. Not all PLC’s support several sub slots. Then select in the product tree Customized otherwise ProfileV4.x
Round Axis	See -> Endless shaft
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 **T**ransmission **C**ontrol **P**rotocol is a connection orientated transmission protocol, in a network.

UDP	**U**ser **D**atagram **P**rotocol is utilized to send data that does not need to be transferred in a reliable way.

11 Revision index

Revision	Date	Revision
First release	5.6.2008	2.00
Add mechanical drawings, change some details	6.3.2009	2.01
Several small corrections	8.3.2009	2.02
G1_XIST3 -> G1_XIST1 for Telegram 81-83	27.3.2009	2.03
Add FAQ and detailed info about IRT configuration	29.4.2009	2.04
Update the information about “Device replacement without replacement medium”	15.5.2009	2.05
Update information about Preset setting, update Encoder functions, CD, PDEV	27.5.2009	2.06
Update Preset details	1.7.2009	2.07