Encoder Configuration for the SIMATIC S7 Technology Functions

SIMATIC S7-1500, SINAMICS S110/120/210, G120

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1 Encoder Connection on the Drive

For the following SINAMICS drive, there is the option to directly connect an encoder to the drive for the acquisition of speed or position and to evaluate the encoder value in the technology object.

- SINAMICS S110/S120/S210
- SINAMICS G120 CU250S/CU250D

Note As of TIA Portal V14, the drive or encoder parameters can be automatically transferred into the CPU for SINAMICS drives (FW ≥ V4.x) and PROFIdrive encoders (encoder profil ≥V4.2).

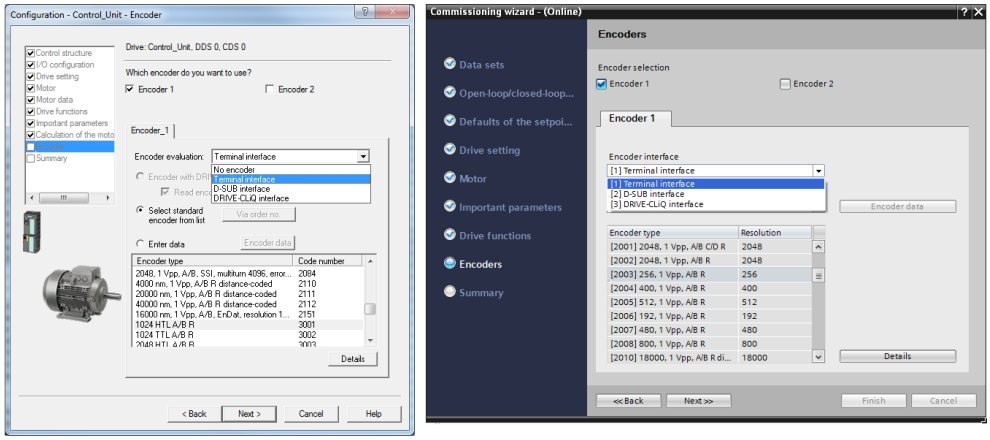
1.1 Configuring the drive

The SINAMICS drive can be configured with the use of the TIA Portal V13 SP1 with the following program:

- STARTER for SINAMICS G120 or SINAMICS S110/S120
- Startdrive for SINAMICS G120 or SINAMICS S120/S210

In both cases the configuration of the drive is carried out by running the commissioning wizard. In this wizard the technical data of the connected encoder is also entered.

Figure 1-1: Encoder configuration in STARTER and Startdrive



In the commissioning wizard there is the option to select between several standard encoders. When it is selected this way, the encoder parameters of the drive are automatically assigned.

Table 1-1: important encoder parameters of the SINAMICS drives

Encoder parameters in SINAMICS	Meaning
p400	Encoder type
p408	Encoder pulse number
p418	Fine resolution GN_XIST1
p419	Fine resolution GN_XIST2
p410	Encoder inversion

If the encoder used, is not included in the standard values, there is the option to enter the encoder data. You can enter other parameters via “Details”. For example the fine resolution that is used in the communication to the controller.

Figure 1-2: Entry of encoder data with STARTER

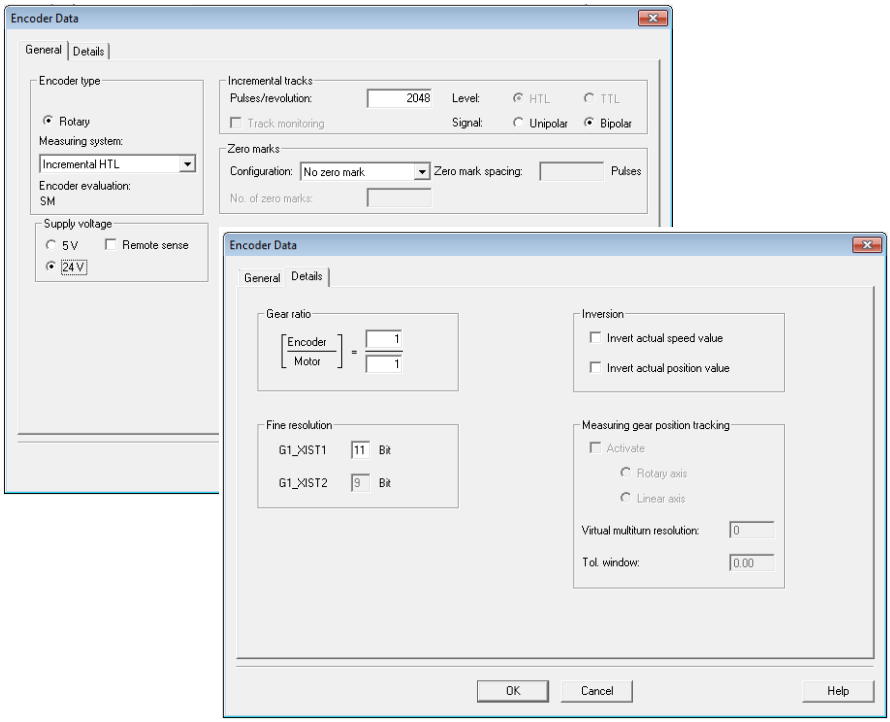
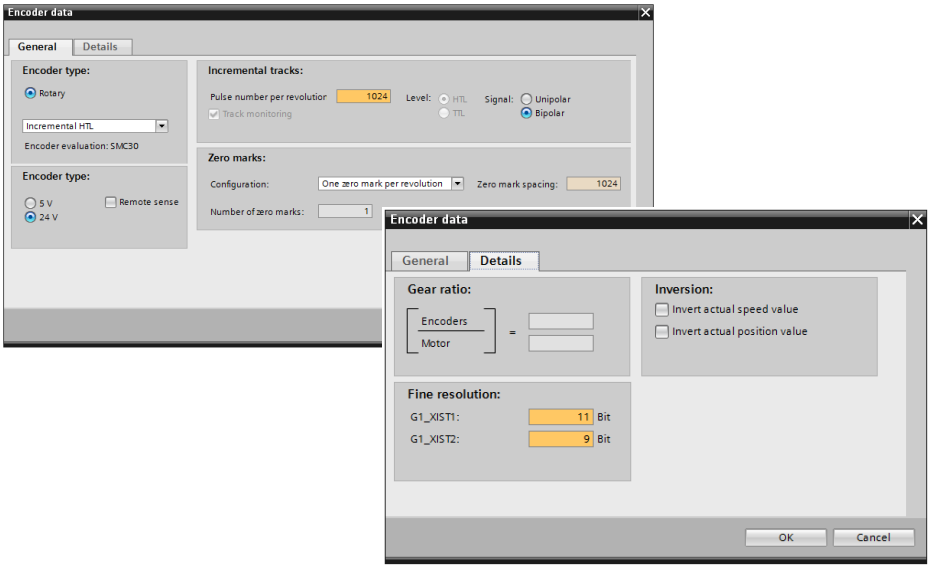


Figure 1-3: Entry of encoder data with Startdrive



For encoders with a with square-wave signal a fine resolution of 2 bit is sensible. Sinus/cosinus – encoders typically have 11 bit fine resolution.

Note

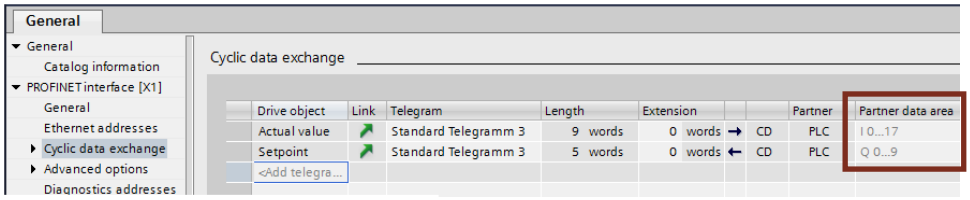
Information on permissible encoder types and the connection of the encoders can be found in the documentation of the SINAMICS drive (\3\).

1.2 Monitoring the encoder data

The encoder data can be displayed in a watch table. Of particular interest is the incremental actual value G1_XIST1 here. This value is used by a configured technology object to determine the position value of a drive.

In the present example the Standard telegram 3 was configured for the communication between controller and drive. For the display of the encoder values in a watch table, the address area of the standard telegram has to be determined. The address area can be viewed in the properties of the drive configuration.

Figure 1-4: Address area of the standard telegram



Watch the encoder value during a revolution of the encoder.

- After exactly one revolution, the revolution counter increments by one. This is how you can detect the position of revolution counter bits (multi-turn bits).
- The number of bits of the pulse counter (increments) result from the encoder pulse number/resolution of the encoder.
- The bits of the fine resolution follow.

In the present example an encoder was configured with the pulse number/resolution of 1024 and a fine resolution of 11 bit. After the first revolution of the encoder, the bit pattern, as shown in the following figure, results.

Figure 1-5: Encoder values in a watch table

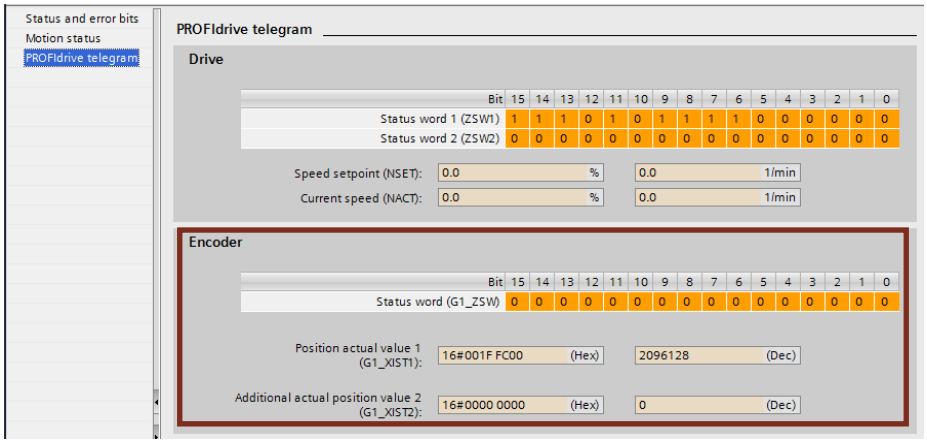
	Name	Address	Display format	Monitor value
1				
2	"ZSW1"	%IW0	Hex	16#EBC0
3	"NIST_B"	%ID2	Hex	16#0000_0000
4	"ZSW2"	%IW6	Hex	16#0000
5	"G1_ZSW"	%IW8	Hex	16#0000
6	"G1_XIST1"	%ID10	Bin	2#0000_0000_0001_1111_1111_1100_0000_0000
				Multi-turn bits / Increments / Fine resolution
7	"G1_XIST2"	%ID14	Hex	16#0000_0000
8				
9	"STW1"	%QW0	Hex	16#0400
10	"NSOLL_B"	%QD2	Hex	16#0000_0000
11	"STW2"	%QW6	Hex	16#0000
12	"G1_STW"	%QW8	Hex	16#0000

For a resolution of the encoder of 1024 and a fine resolution of 11 bit (2^{11} = 2048) there is a change of the incremental actual value of 2097152 for each revolution of the encoder.

$$2097152 = 1024 * 2048$$

The status word of the encoder as well as the incremental and the absolute actual value of the encoder can be displayed in the technology object with the “PROFIdrive telegram” diagnostic screen.

Figure 1-6: Diagnostic screen “PROFIdrive telegram”

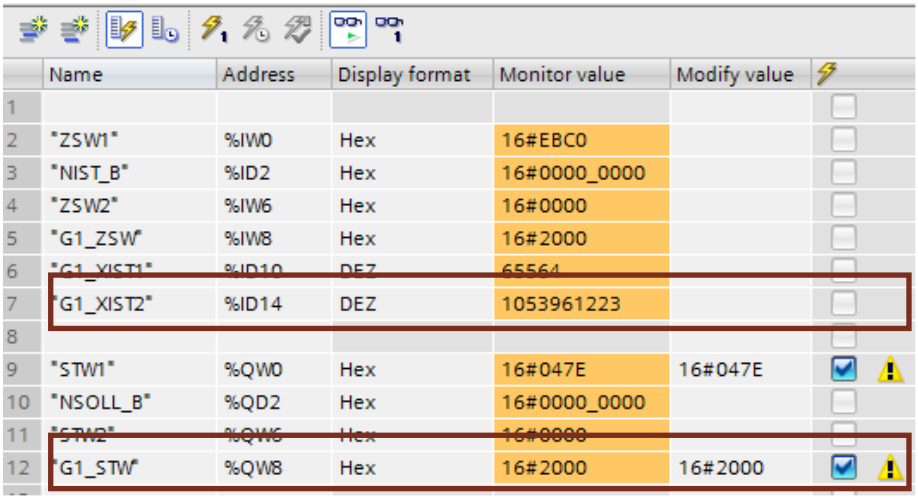


Monitoring the absolute actual value G1_XIST2

In G1_XIST2 the absolute positioning value is only transmitted when the bit 13 is set in the encoder control word. The technology object controls the encoder control word. The absolute encoder value is only read when starting up and this is why it cannot be as easily monitored as the incremental actual value.

In order to monitor G1_XIST2 in the TIA Portal you have to create a project without the respective technology object and load it into the S7-1500. Then you can, for example, write into the IO address of the G1_STW encoder control word with a 2000hex value table and thus request the cyclic transmission of the absolute encoder value.

Figure 1-7: Display of the absolute actual value



	Name	Address	Display format	Monitor value	Modify value
1					
2	"ZSW1"	%IW0	Hex	16#EBC0	
3	"NIST_B"	%ID2	Hex	16#0000_0000	
4	"ZSW2"	%IW6	Hex	16#0000	
5	"G1_ZSW"	%IW8	Hex	16#2000	
6	"G1_XIST1"	%ID10	DEZ	65564	
7	"G1_XIST2"	%ID14	DEZ	1053961223	
8					
9	"STW1"	%QW0	Hex	16#047E	16#047E
10	"NSOLL_B"	%QD2	Hex	16#0000_0000	
11	"STW2"	%QW6	Hex	16#0000	
12	"G1_STW"	%QW8	Hex	16#2000	16#2000

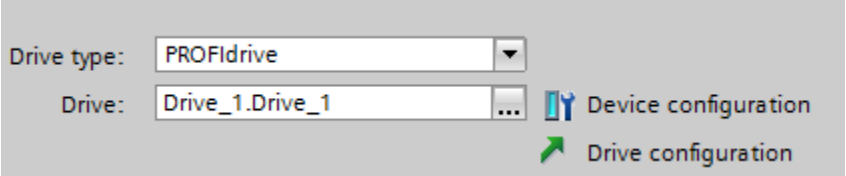
1.3 Configuration of the technology object

The configuration of the technology object is divided into several areas. The encoder is configured in the “Hardware interface” section.

Drive

This is where you select the drive to be used. It has to already have been created and configured in “Devices & networks”. You may have to enable “Show all modules” so that it is shown and can be selected.

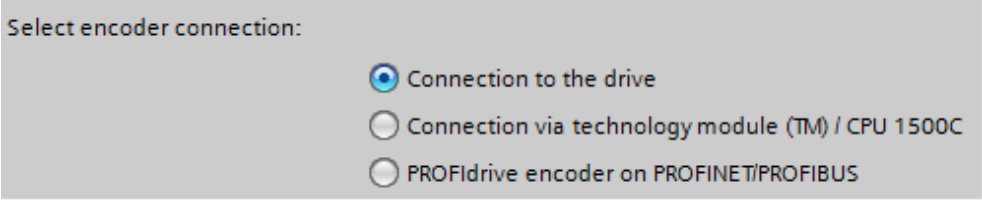
Figure 1-8: Setting the drive interface



Encoder

Select “Connection to the drive” here.

Figure 1-9: Setting the encoder interface



Data exchange drive

Here, you define the data exchange with the drive. In the process it is required to have the same settings of the parameters in the technology object and in the drive. In the table below, you can find the respective parameter numbers of a SINAMICS drive.

Table 1-2: Data exchange with the drive

Technology object	Parameters in SINAMICS	Meaning
Drive telegram	p922	PROFIdrive PZD telegram selection
Reference speed	p2000	Reference speed / reference frequency
Maximum speed	p1082	Maximum speed

Data exchange encoder

The encoder is connected to the drive. This is why the settings in the technology objects depend on the settings in the drive parameters.

Table 1-3: Data exchange with the encoder

Technology object	Entry
Encoder telegram	Select the same telegram as encoder telegram as for the drive (p922).
Encoder type	Rotatory incremental: An incremental encoder mounted on a rotating shaft (provides an incremental positioning value)
	Rotatory absolute: An absolute value encoder mounted on a rotating shaft (provides an incremental and an absolute positioning value)
	Rotatory cyclically absolute: An absolute value encoder with overflow mounted on a rotating shaft (provides an incremental and an absolute positioning value. The route is longer than the acquisition area of the encoder, so that an overflow of the position has to be taken into consideration when positioning.)
	Linear incremental: A linear incremental encoder provides an incremental positioning value
	Linear absolute: A linear absolute value encoder provides an incremental and an absolute positioning value
Steps per revolution /distance between two increments	Enter the nominal resolution of the encoder according to the type plate here (or for programmable encoders, according to the configuration). This entry has to correspond to the configuration in STARTER/Startdrive.
Number of revolutions	Configure the number of revolutions that the absolute value encoders can record in this field.
Fine resolution	Here, you enter the same values as for the details of the encoder configuration of the SINAMICS. With STARTER see Figure 1-10 With Startdrive see Figure 1-11

The settings in the data exchange with the encoder correspond to the following drive parameters of the SINAMICS drive:

Table 1-4: Encoder parameter of the drive

Technology object	Parameters in SINAMICS	Meaning
Encoder telegram	p922	PROFIdrive PZD telegram selection
Encoder type	p400	Encoder type
Steps per revolution	p408	Encoder pulse number
Gn_XIST1	p418	Fine resolution Gn_XIST1
Gn_XIST1	p419	Fine resolution Gn_XIST2
Inverting encoder direction	p410	Encoder inversion

Comparing the fine resolution

The following figures show the correlation between the configuration of the fine resolution of the encoder and the entry in the technology object.

Figure 1-10: Setting the fine resolution with STARTER

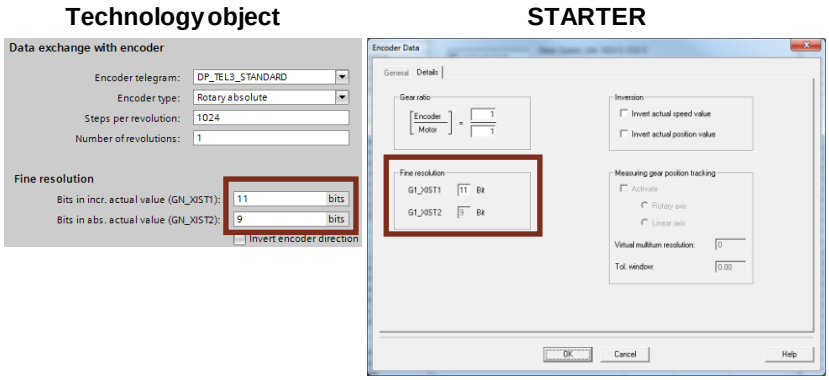
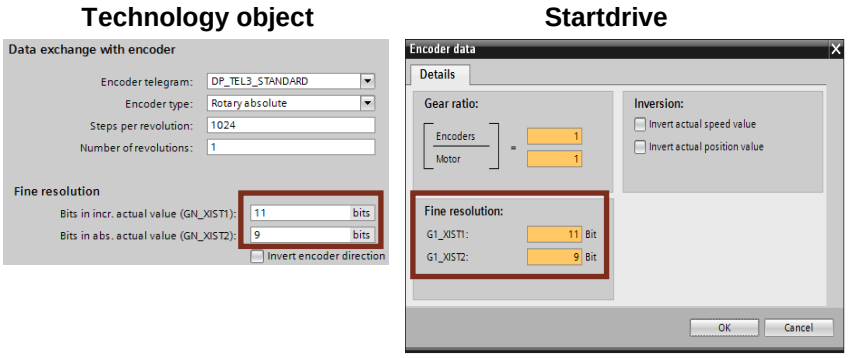


Figure 1-11: Setting the fine resolution with Startdrive



2 Encoder Connection to a Technology Module

You can operate the technology module centrally on a SIMATIC S7-1500 or in a distributed I/O. Use the TM Count 2x24V or TM PosInput 2 technology module for the connection of an incremental encoder. Only use the TM PosInput 2 technology module for the connection of an absolute value encoder.

Note

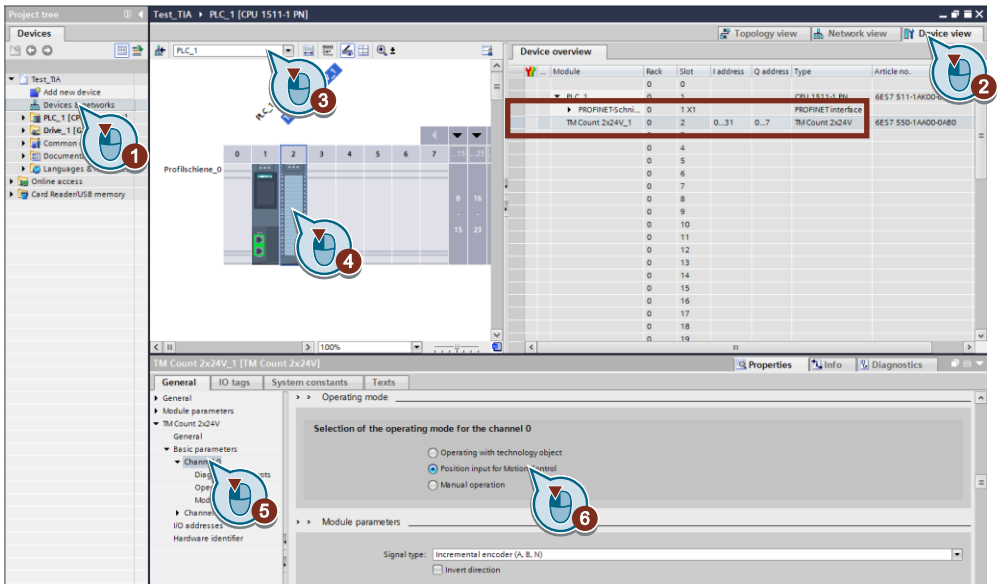
Information on the connection and configuration of the technology module can be found in the device manuals.

- Technology module TM Count 2x24V (\5\)
- Technology module TM PosInput 2 (\6\)

2.1 Configuring the technology module

In order to configure the technology module go to “Devices & networks” and there in “Device view”. Select the S7-CPU and add the desired technology module.

Figure 2-1: Configuring the technology module



For the operating mode the setting “Position input for Motion Control” has to be selected.

Address area of the technology module

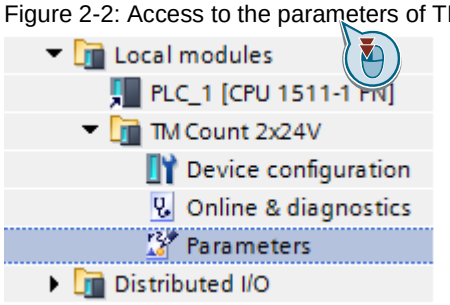
In terms of size, the extent of the input and output addresses of the technology module in the “Position input for Motion Control” operating mode corresponds to the Standard telegram 83.

2.2 Technology module TM Count

2.2.1 Parameters of TM Count

In the project navigation in “Local modules” the technology module is displayed with the following objects. You get to the desired editor via double click.

Figure 2-2: Access to the parameters of TM Count 2x24V



The parameters of the TM Count 2x24V technology module are the following:

Table 2-1: Parameters of TM Count 2x24V

Parameters of TM Count	Meaning	
Signal type	Selection of signal type to the counter inputs A, B and N	
Signal evaluation	Here, you specify whether a multiple evaluation of the pulses is to be used for an incremental encoder. Thus, the resolution of the encoder can be doubled or quadrupled.	
	simple	Only an edge of signal A is evaluated
	double	Both edges of signal A are evaluated.
	four fold	Both edges of signal A and B are evaluated.
Filter frequency	To suppress interferences, you can configure an input filter for the counting inputs A, B and N.	
Sensor type	Selection of sensor type on the counter inputs. When reading encoder signals, the “push-pull” setting is common because this enables wire break monitoring.	
Signal selection for ref. mark	Selection of the external reference signal that saves the reference mark for the encoder position.	
Increments per unit	Number of counting pulses per unit of the encoder used. The value of this parameter has to match the entry in “Steps per revolution ” of the technology object.	
Reference speed	Entry of speed, that is to correspond to an actual value of 100%. The value of this parameter has to match the entry in “Reference speed” of the technology object.	

Note

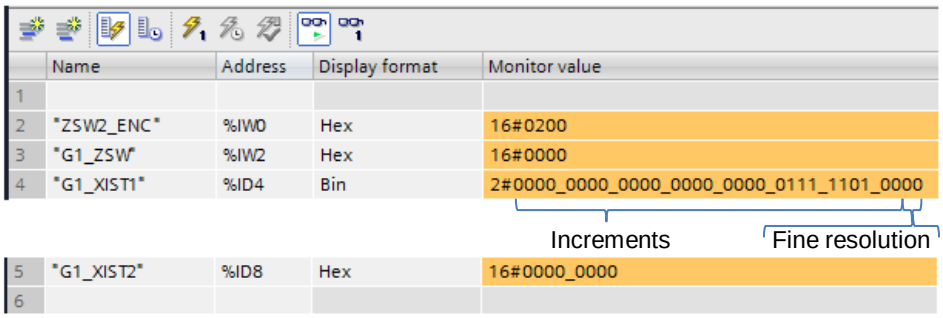
A detailed description of the parameters can be found in the TIA Portal online help or the function manual “Counting, measurement and position detection” (\7\) and in the manual "S7-1500/S7-1500T Motion Control Overview V6.0 as of STEP 7 V17" (see \12\ ) in chapter "Configuring technological modules and onboard I/O for Motion Control".

2.2.2 Monitoring the encoder data

The encoder data can be displayed in a watch table. Of particular interest is the incremental actual value G1_XIST1 here. This value is used by a configured technology object to determine the position value of a drive.

In the present example the Standard telegram 83 has been configured for the communication between controller and the TM Count technology module. For the display of the encoder values in a watch table, the address area of the standard telegram has to be determined. The address area is specified in the configuration of the technology module. (see Figure 2-1: Configuring the technology module)

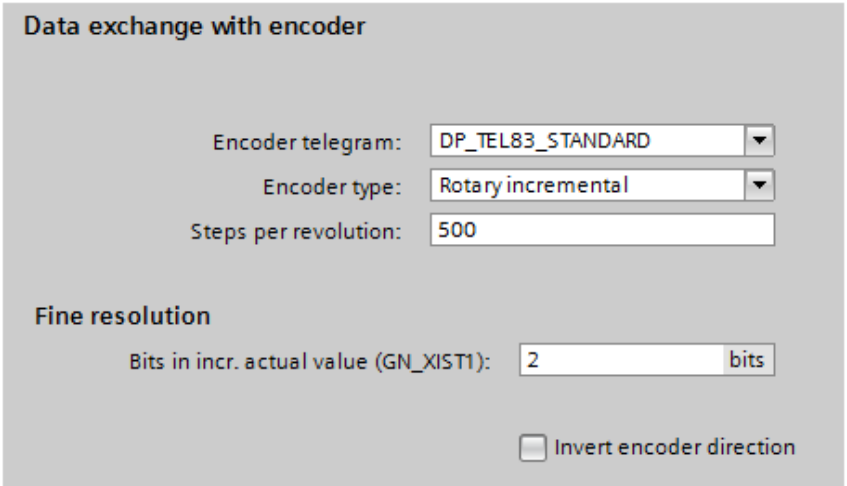
Figure 2-3: Encoder values in a watch table



An incremental encoder with a resolution/pulse number of 500 has been selected. In order to increase the precision of a positioning, a quadruple signal evaluation has been set in the configuration of the technology module. This results in the resolution of the G1_XIST1 incremental actual value to increase fourfold.

The change of the resolution from 500 to 2000 means a shift of the increments in value G1_XIST1 by 2 bits to the left. This is why a fine resolution of 2 is set in the encoder configuration in the technology object.

Figure 2-4: Configuring the encoder data in the technology object



For the “Steps per revolution” value the resolution of the encoder is entered.

The encoder value of the G1_XIST1 incremental actual value can be seen in the Diagnostic screen “PROFIdrive telegram” of the technology object.

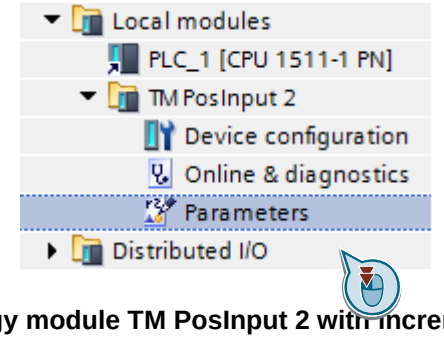
2.3 Technology module TM PosInput 2

2.3.1 Parameters of TM PosInput 2

Note This chapter is also valid for the SIMATIC ET 200SP, TM PosInput 1 module.

The technology module is displayed with the following objects in the project navigation in “Local modules”. You get to the desired editor via double click.

Figure 2-5: Access to the parameters of TM Count 2x24V



Technology module TM PosInput 2 with incremental encoder

The parameters of the TM PosInput 2 technology module are the following, when using a pulse/incremental encoder:

Table 2-2: Parameters of the TM PosInput 2 with pulse/incremental encoders

Parameters of TM PosInput	Meaning
Interfaces standard	With this parameter you specify whether the encoder supplies symmetrical (RS422) or asymmetrical signals (TTL) for the TM PosInput.
For the description of the parameters see Table 2-1.	

Technology module TM PosInput 2 with SSI absolute encoder

When using an incremental encoder or pulse encoder the position acquisition is based on the counting function of the technology module. For an SSI absolute value encoder the absolute value is read via a synchronous, serial interface and is provided to the S7-1500 Motion Control according to the configuration.

Table 2-3: Parameters of the TM PosInput 2 with SSI absolute value encoder

Parameters of TM PosInput	Meaning
Signal type	Select the “Absolute value encoder (SSI)” entry
Telegram length	With the configuration of the telegram length you specify the number of bits of a SSI telegram. The telegram length of your SSI absolute value encoder can be found in the data sheet of your encoder. An existing parity bit does not count towards the length of the telegram.
Code type	Gray: The position value supplied in the gray code by the SSI absolute encoder is converted into dual code.
	Dual: The value supplied by the SSI absolute value is not converted.
Transmission speed	With the configuration of the transmission speed you specify the speed of the data transmission from the SSI absolute value encoder to the technology module.
Monoflop time	With the configuration of the monoflop time you specify the break time between two SSI telegrams.

Parameters of TM PosInput	Meaning
Parity	With the configuration of the parity you specify whether the SSI absolute value encoder transfers a parity bit.
Bit number LSB	With this parameter you specify the bit number of the LSB (Least significant Bit) of the position value in the telegram of the SSI absolute value encoder.
Bit number MSB	With this parameter you specify the bit number of the MSB (Most significant Bit) of the position value in the telegram of the SSI absolute value encoder.
Increments per unit	With this parameter you specify the number of increments that the SSI absolute value encoder supplies per revolution.
Reference speed	Entry of speed, that is to correspond to an actual value of 100%. The value of this parameter has to match the entry in “Reference speed” of the technology object.

Note

A detailed description of the parameters can be found in the TIA Portal online help or the function manual “Counting, measurement and position detection” (\7\) and in the manual "S7-1500/S7-1500T Motion Control Overview V6.0 as of STEP 7 V17" (see \12\ ) in chapter "Configuring technological modules and onboard I/O for Motion Control".

Bit numbers LSB / MSB of the position value (SSI encoder)

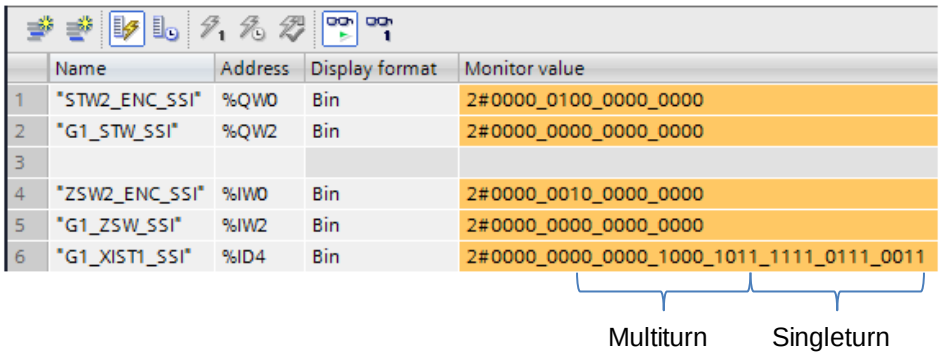
With the parameters of the LSB (Least significant Bit) and the MSB (Most significant Bit) you specify the length and the position of the position value in the telegram of the SSI absolute value encoder.

2.3.2 Monitoring the encoder data

The encoder data can be displayed in a watch table. Of particular interest is the incremental actual value G1_XIST1 here. This value is used by a configured technology object to determine the position value of a drive.

In the current example the Standard telegram 83 has been configured for the communication between controller and the TM PosInput technology module. For the display of the encoder values in a watch table, the address area of the standard telegram has to be determined. The address area is specified in the configuration of the technology module. (see Figure 2-1: Configuring the technology module)

Figure 2-6: Encoder values in a watch table



Example

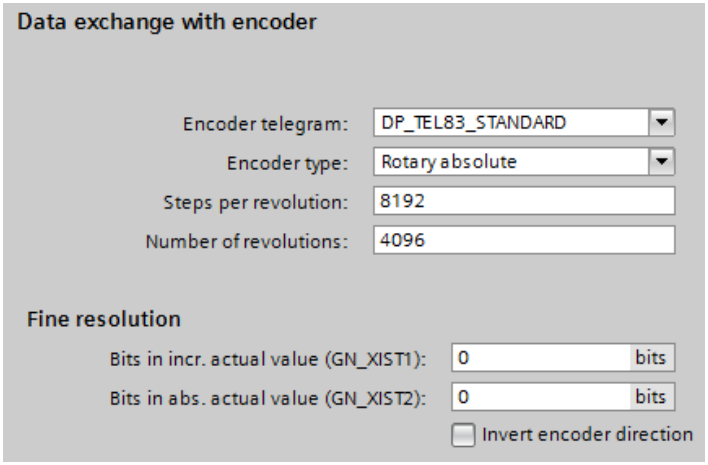
An SSI – absolute value encoder with a resolution of 25 bit is used. The number of the single-turn bits can be easily determined by monitoring the SSI telegram in watch table. In the area of the single-turn bit any possible value is reached once during a revolution of the encoder.

The number of bits in the multi-turn and single-turn area result in the number of steps for the encoder configuration in the technology object.

The SSI telegram with 25 bit is divided as follows:

- 12 bit multi-turn → from this results the setting for the “Number of revolutions”, the value 2^{12} = 4096.
- 13 bit single-turn → from this results the setting for the “Steps per revolution”, the value 2^{13} = 8192.

Figure 2-7: Configuring the encoder data in the technology object



When using an SSI absolute value encoder the fine resolution has to be entered as zero.

The encoder value of the G1_XIST1 incremental actual value and of the G1_XIST2 absolute actual value can be seen in the Diagnostic screen “PROFIdrive telegram” of the technology object.

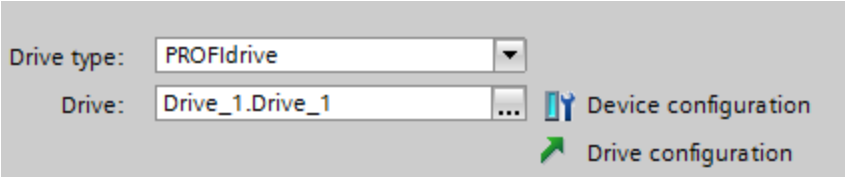
2.4 Configuration of the technology object

The configuration of the technology object is done in the settings “Configuration” >> “Hardware interface”.

Drive

This is where you select the drive to be used. It has to already have been created and configured in “Devices & networks”. You may have to enable “Show all modules” so that it is shown and can be selected.

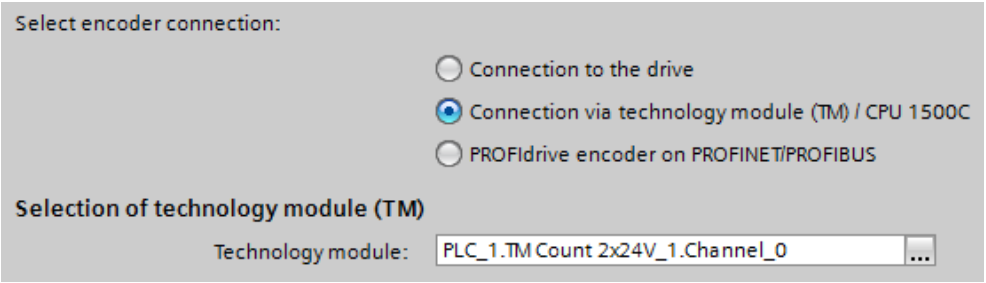
Figure 2-8: Setting the drive interface



Encoder

The technology module has to already have been created and configured in “Devices & networks”. Here, you select “Connection via technology module” now and the interface to be used for this axis on which the encoder is connected.

Figure 2-9: Setting of the encoder interface



Data exchange drive

Here, you define the data exchange with the drive. In the process it is required to have the same settings of the parameters in the technology object and in the drive. In the table below, you can find the respective parameter numbers of a SINAMICS drive.

Table 2-4: Data exchange with the drive

Technology object	Parameters in SINAMICS	Meaning
Drive telegram	p922	PROFIdrive PZD telegram selection
Reference speed	p2000	Reference speed / reference frequency
Maximum speed	p1082	Maximum speed

Data exchange encoder

Here, you define the data exchange with the encoder (meaning the technology module).

Table 2-5: Data exchange with the encoder

<table>
<tr><th>Technology object</th><th colspan="2">Entry</th></tr>
<tr><td>Encoder telegram</td><td colspan="2">Select Standard telegram 83.</td></tr>
<tr><td rowspan="5">Encoder type</td><td colspan="2">Rotatory incremental:
An incremental encoder mounted on a rotating shaft (provides an incremental positioning value)</td></tr>
<tr><td colspan="2">Rotatory absolute:
An absolute value encoder mounted on a rotating shaft (provides an incremental and an absolute positioning value)</td></tr>
<tr><td colspan="2">Rotatory cyclically absolute:
An absolute value encoder with overflow mounted on a rotating shaft (provides an incremental and an absolute positioning value. The route is longer than the acquisition area of the encoder, so that an overflow of the position has to be taken into consideration when positioning.)</td></tr>
<tr><td colspan="2">Linear incremental:
A linear incremental encoder provides an incremental positioning value</td></tr>
<tr><td colspan="2">Linear absolute:
A linear absolute value encoder provides an incremental and an absolute positioning value</td></tr>
<tr><td>Steps per revolution</td><td colspan="2">Enter the nominal resolution of the encoder according to the type plate here (or for programmable encoders, according to the configuration).</td></tr>
<tr><td>Number of revolutions</td><td colspan="2">Configure the number of revolutions that the absolute value encoders can record in this field.</td></tr>
<tr><td rowspan="5">Fine resolution</td><td colspan="2">With the use of an absolute value encoder (SSI encoder with TM PosInput 2), the values of the fine resolution in the incremental actual value (Gn_XIST1) and in the absolute actual value (Gn_XIST2) equal zero.</td></tr>
<tr><td colspan="2">When using an incremental encoder, the value for Gn_XIST1 has to correspond to the “signal evaluation” parameter of the channel used for the technology module.</td></tr>
<tr><td>Signal evaluation</td><td>Setting for Gn_XIST1</td></tr>
<tr><td>simple</td><td>0</td></tr>
<tr><td>double</td><td>1</td></tr>
<tr><td>four fold</td><td>2</td></tr>
</table>

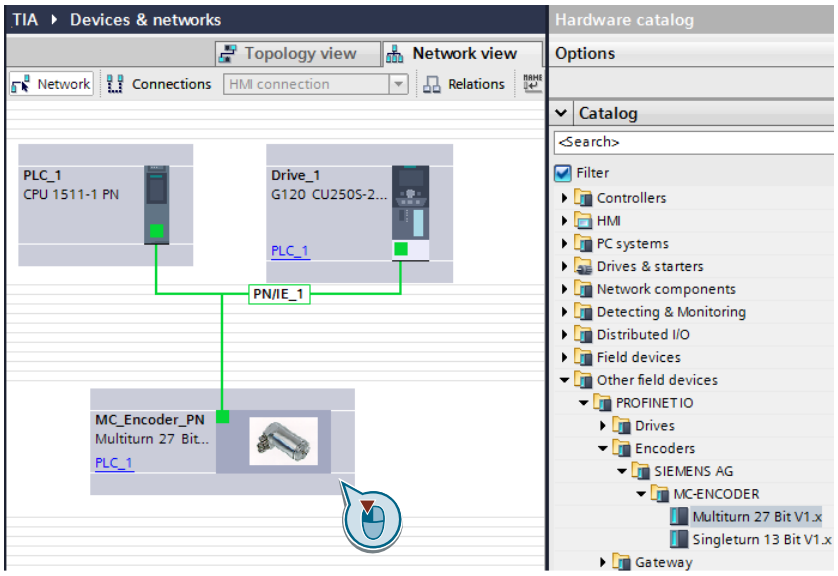
3 PROFINET/PROFIBUS Encoder

The PROFINET/PROFIBUS-capable encoders transfer the information gained directly in the telegram to the technology object.

3.1 Configuring the encoder

The encoder is configured as a usual PROFINET or PROFIBUS network component in the TIA Portal in “Network view”.

Figure 3-1: Inserting the encoder in the network view



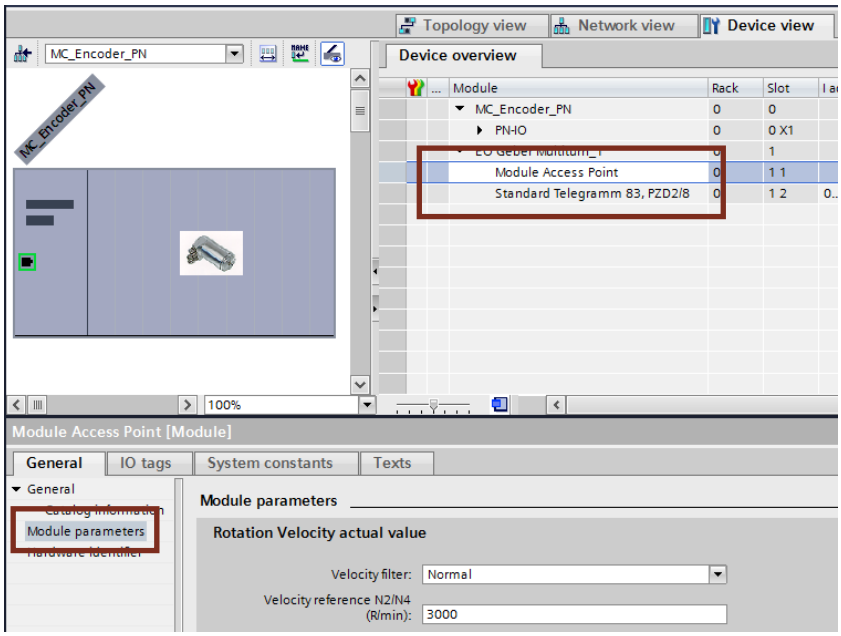
A standard telegram is entered in the "Device view". This telegram defines the data exchange between encoder and technology object and this is why it has to be the same in both objects.

Furthermore, the “Module parameters” of the encoder used also have to be set in the “Device view”. The number and type of these parameters depend on the encoder used and are described in its documentation.

Parameters of the MC_Encoder_PN:

- Measuring units per revolution
- Total measuring range
- Tolerated sign of life faults
- Velocity measuring units
- Code sequence
- Scaling function control

Figure 3-2: Configuring the encoder



Note

The operating manuals of the SIEMENS absolute value encoders with PROFINET and PROFIBUS connection are provided in the links and literature.

- for PROFINET \8\
- for PROFIBUS \9\

3.2 Configuration of the technology object

The configuration of the technology object is divided into several areas. The encoder is configured in the “Hardware interface” part.

Drive

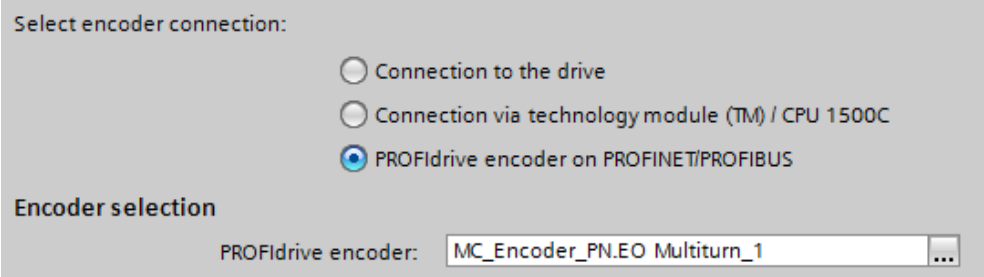
This is where you select the drive to be used. It has to already have been created and configured in “Devices & networks”. You may have to enable “Show all modules” so that it is shown and can be selected.

Figure 3-3: Settings the drive interface

Encoder

Select “PROFIdrive encoder in PROFINET/PROFIBUS”. It has to already have been created and configured in “Devices & networks”. You may have to enable “Show all modules” so that it is shown and can be selected.

Figure 3-4: Setting the encoder interface



Data exchange drive

Here, you define the data exchange with the drive. In the process it is required to have the same settings of the parameters in the technology object and in the drive. In the table below, you can find the respective parameter numbers of a SINAMICS drive.

Table 3-1: Data exchange with the drive

Technology object	Parameters in SINAMICS	Meaning
Drive telegram	p922	PROFIdrive PZD telegram selection
Reference speed	p2000	Reference speed / reference frequency
Maximum speed	p1082	Maximum speed

Data exchange encoder

Here, you define the data exchange with the encoder.

Table 3-2: Data exchange with the encoder

Technology object	Entry
Encoder telegram	Select the encoder telegram as the telegram that you used for the configuration of the encoder. (Figure 3-2)
Encoder type	Rotatory incremental: An incremental encoder mounted on a rotating shaft (provides an incremental positioning value)
	Rotatory absolute: An absolute value encoder mounted on a rotating shaft (provides an incremental and an absolute positioning value)
	Rotatory cyclically absolute: An absolute value encoder with overflow mounted on a rotating shaft (provides an incremental and an absolute positioning value. The route is longer than the acquisition area of the encoder, so that an overflow of the position has to be taken into consideration when positioning.)
	Linear incremental: A linear incremental encoder provides an incremental positioning value
	Linear absolute: A linear absolute value encoder provides an incremental and an absolute positioning value
Steps per revolution /distance between two increments	In this place, the same entry has to be made that has been made in the module parameters (Figure 3-2) of the encoder.
Number of revolutions	Configure the number of revolutions that the absolute value encoders can record in this field.

Technology object	Entry
Fine resolution	Whether the encoder uses bits for the fine resolution has to be found out in the encoder documentation.

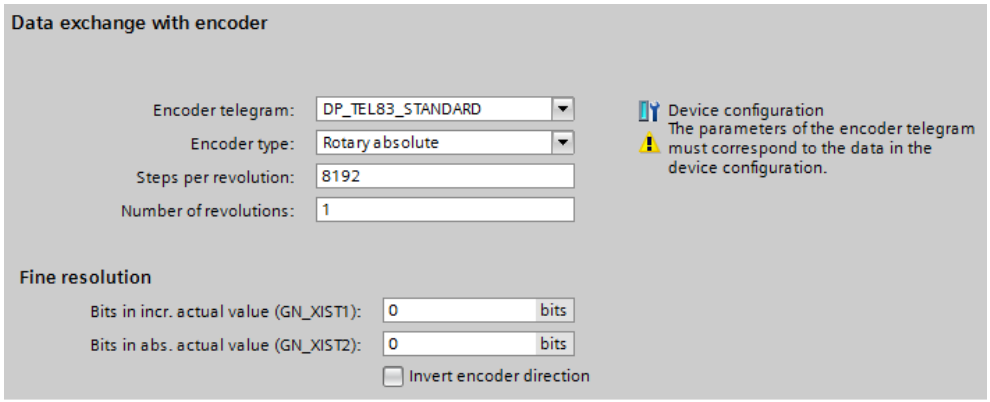
3.3 Configuration example MC encoder

The Siemens MC encoders for the connection to PROFIBUS or PROFINET have the following settings:

- Encoder type: rotatory absolute value encoder
- Encoder pulse number: 8192
- Fine resolution: Gn_XIST1 and Gn_XIST2 equals zero

In the following figure the respective configuration for the “Data exchange with encoder” of the technology object is displayed.

Figure 3-5: Settings on the technology object



The encoder value of the G1_XIST1 incremental actual value and of the G1_XIST2 absolute actual value can be seen in the Diagnostic screen “PROFIdrive telegram” of the technology object.

3.4 Typical values for the Motion Control Encoder PROFINET

It is generally recommended to use the automatic transfer of the encoder data.

If automatic data transfer is not possible (not supported, high communication load, ...), manual configuration is also possible.

Then use the values specified in the following subsections.

Function stand und GSDML files

The Motion Control Encoder PROFINET received a redesign in 10/2021 (see \10\). The redesigned encoders have a function stand ≥ FS10, while the encoders produced previously have a function stand ≤ FS06.

The function stand and the GSDML file used for integration into the project determine the available properties of the encoder:

- For encoders with a function stand ≥ FS10, you can use both the newer GSDML file and the improved properties and the previous GSDML file and the previous properties (e.g. as a spare part).
- For encoders with function status ≤ FS06, you must use the previous GSDML file.

Download GSDML file

You can download the newer GSDML file (GSDML-V2.35-SIEMENS-MC-ENCODER-20210324 or newer) in the product notification (see \10\).

You can download the previous GSDML file (GSDML-V2_2-SIEMENS-MC-ENCODER-20121002) from Industry Online Support (see\11\).

Note You can find the Motion Control Encoder PROFINET product data sheets with the technical data at: https://mall.industry.siemens.com/mall/en/WW/Catalog/Products/10052790

3.4.1 PROFINET IO absolute encoder (single-turn, 13 or 16 bits resolution)

with the article numbers:

- 6FX2001-5FN13
- 6FX2001-5QN13
- 6FX2001-5WN13

3.4.1.1 with function stand ≤ FS6 or with ≥ FS10 and previous GDSML file

Table 3-3 TIA Portal encoder settings

Setting	Value
Encoder telegram	81, 82, 83, 84, Siemens telegram 860
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	8.192 (13 bits)
Number of revolution	1
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

3.4.1.2 with function stand ≥ FS10 and newer GSDML file

Table 3-4 TIA Portal encoder settings

Setting	Value
Encoder telegram	81, 82, 83, 84, Siemens telegram 860
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	65.536 (16 bits)
Number of revolution	1
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

3.4.2 PROFINET IO absolute encoder (multi-turn, 27 or 30 bits resolution)

with the article numbers:

- 6FX2001-5FN25
- 6FX2001-5QN25
- 6FX2001-5WN25

3.4.2.1 with function stand ≤ FS6 or with ≥ FS10 and previous GDSML file

Table 3-5 TIA Portal encoder settings

Setting	Value
Encoder telegram	81, 82, 83, 84, Siemens telegram 860
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	8.192 (13 bit)
Number of revolution	16.384 (14 bits)
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

3.4.2.2 with function stand ≥ FS10 and newer GSDML file

Table 3-6 TIA Portal encoder settings

Setting	Value
Encoder telegram	81, 82, 83, 84, Siemens telegram 860
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	65.536 (16 bits)
Number of revolution	16.384 (14 bits)
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

3.5 Typical values for the Motion Control Encoder PROFIBUS

It is generally recommended to use the automatic transfer of the encoder data.

If automatic data transfer is not possible (not supported, high communication load, ...), manual configuration is also possible.

Then use the values specified in the following subsections.

Note You can find the Motion Control Encoder PROFIBUS product data sheets with the technical data at: https://mall.industry.siemens.com/mall/en/WW/Catalog/Products/10031421

3.5.1 PROFIBUS DP absolute encoder (single-turn, 13 bits resolution)

with the article numbers:

- 6FX2001-5FN12
- 6FX2001-5QN12
- 6FX2001-5WN12

Table 3-7 TIA Portal encoder settings

Setting	Value
Encoder telegram	81
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	8.192 (13 bits)
Number of revolution	1
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

3.5.2 PROFIBUS DP absolute encoder (multi-turn, 27 bits resolution)

with the article numbers:

- 6FX2001-5FN24
- 6FX2001-5QN24
- 6FX2001-5WN24

Table 3-8 TIA Portal encoder settings

Setting	Value
Encoder telegram	81
Encoder type	Cyclic absolute
Measuring system	Rotary
Increments per revolution	8.192 (13 bits)
Number of revolution	16.384 (14 bits)
Bits in Gx_XIST1	0
Bits in Gx_XIST2	0

4 Encoder connection via data block

As of TIA Portal V14, it is possible to parameterize a data block as encoder signal source.

Doing so, you have the option of reading in the encoder information in OB MC-PreServo, processing its value and storing it in a DB (in the form of an encoder telegram, e.g. Standard telegram 81).

The technology object then accesses this DB and takes the encoder information from it.

Further Information you can find…

- in the manual" S7-1500/S7-1500T Motion Control Overview V6.0 as of STEP 7 V17 "(see \12\ ) in the section "Connect drive/encoder via data block" and
- in the application example " Using the MC-PreServo and MC-PostServo organization blocks" (see \13\ ).

5 Technical Information

5.1 PROFIdrive telegrams

In this document, the following send and receive telegrams are used:

Table 5-1: Standard telegram 3

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9
STW1	NSOLL_B		STW2	G1_STW	-	-	-	-
ZSW1	NIST_B		ZSW2	G1_ZSW	G1_XIST1		G1_XIST2	

Table 5-2: Standard telegram 5

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9
STW1	NSOLL_B		STW2	G1_STW	XERR		KPC	
ZSW1	NIST_B		ZSW2	G1_ZSW	G1_XIST1		G1_XIST2	

Table 5-3: Standard telegram 81

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW2_ENC	G1_STW	-	-	-	-
ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2	

Table 5-4: Standard telegram 83

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8
STW2_ENC	G1_STW	-	-	-	-	-	-
ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2		NIST_B	

Table 5-5: Legend to telegram structure

Designation	Meaning	Format
STW1 and STW2	Control words (for the drive)	WORD
ZSW1 and ZSW2	Status words (of the drive)	WORD
NSOLL_B	Setpoint value (setpoint speed)	DWORD
NIST_B	Actual value (current speed)	DWORD
G1_STW	Control word for encoder 1	WORD
G1_ZSW	Status word of encoder 1	WORD
G1_XIST1	Incremental actual value of encoder 1	DWORD
G1_XIST2	Absolute actual value of encoder 1	DWORD
STW2_ENC	Control word 2 (for the encoder)	WORD
ZSW2_ENC	Status word 2 (of encoder)	WORD
XERR	Position deviation	DWORD
KPC	Position controller gain factor	DWORD

Note Further standard telegrams for the cyclic communication are listed in the documentation of the converter used.

5.2 Encoder values

5.2.1 Control and status words

Encoder control word G1_STW

Through the encoder control word, command signals can be transmitted to the encoder.

Table 5-6: Bit assignment of G1_STW

Bit number	Description
0 … 12	Entry dependent on the use encoder/drive
13	Request absolute value cyclically
14	Request parking encoder
15	Acknowledge encoder error

Encoder status word G1_ZSW

Messages of the encoder can be displayed by the encoder status word.

Table 5-7: Bit assignment of G1_ZSW

Bit number	Description
0 … 10	Entry dependent on the use encoder/drive
11	Acknowledgement of sensor error running
12	Set preset/shift reference point executed
13	Transfer absolute value cyclically
14	Enable parking encoder
15	Sensor error

Encoder control word STW2_ENC

In the STW2_ENC encoder control word a sign of live is transmitted in clock-synchronous mode from controller to encoder. Furthermore, the controller has to set bit 10 of the control word to 1 in order to tell the encoder that the data is valid.

Table 5-8: Bit assignment of STW2_ENC

Bit number	Description
0 … 9	Entry dependent on the use encoder/drive
10	Control by PLC
12 … 15	Configuring the controller

Encoder status word ZSW2_ENC

In the ZSW2_ENC encoder status word, a sign of life is transmitted from the encoder to the controller in clock-synchronous mode. Furthermore, the controller has to evaluate bit 9, in order to determine whether the cyclic data sent by the encoder is valid.

Table 5-9: Bit assignment of ZSW2_ENC

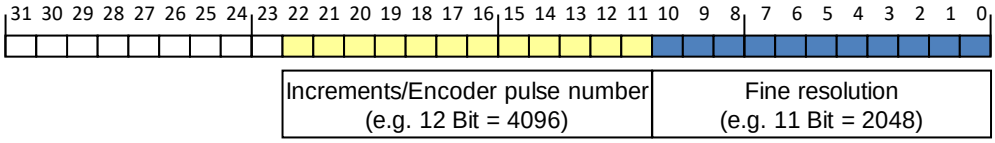
Bit number	Description
0 … 8	Entry dependent on the use encoder/drive
9	Control by PLC active
12 … 15	Encoder sign of life

5.2.2 Incremental actual value G1_XIST1

In G1_XIST1 the incremental actual value is transmitted with the set fine resolution. The actual value is continued according to the actual value change and when there is an overflow of the data width of G1_XIST1, it is reset. The incremental actual value in G1_XIST1 in incremental encoders and absolute value encoders is evaluated by the controller according to the respective settings for the encoder pulse number and fine resolution.

In order to be able to transfer the required information, the incremental actual value of the encoder has the following exemplary structure:

Figure 5-1: Example for G1_XIST1



Increments/Encoder pulse number

The increments (encoder pulse number) present the resolution if the encoder. This area contains the position value as it is transmitted from the encoder to an evaluation device (SINAMICS drive, technology module).

Fine resolution

The fine resolution is created by an evaluation device (SINAMICS drive, technology module) and added to the actual values G1_XIST1 or G1_XIST2. This fine resolution increases the encoder pulse number/resolution of the encoder signal.

Adding a fine resolution shifts the pure encoder value into the actual values. This is why the fine resolution is also called “shift factor”.

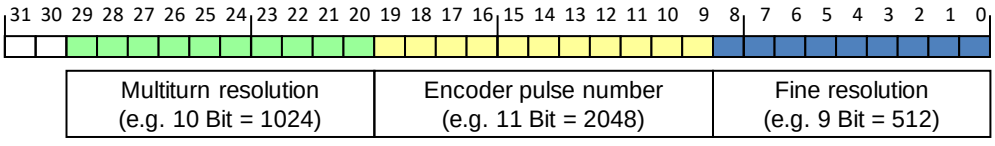
5.2.3 Absolute actual value G1_XIST2

However, in the G1_XIST2 absolute actual value, the positioning values but also the error telegram of the encoder are transmitted in the event of an error.

When using an absolute encoder, the technology object requests the absolute value of the position after start up, it evaluates it and from then on only uses the incremental actual value G1_XIST1.

The absolute actual value of the encoder has the following exemplary structure:

Figure 5-2: Example for G1_XIST2



Encoder pulse numbers and fine resolution

This values carry the same information as the G1_XIST1 incremental actual value.

Multi-turn resolution

The multi-turn resolution represents the counting stored in the encoder for the full revolutions of the encoder. The technology object then calculates the absolute position value of the axis from the encoder pulse number and the multi-turn resolution.

Note Information on the structure and orientation of the actual values can be found in the documentation of the encoder used.

5.2.4 Structure of a SSI telegram

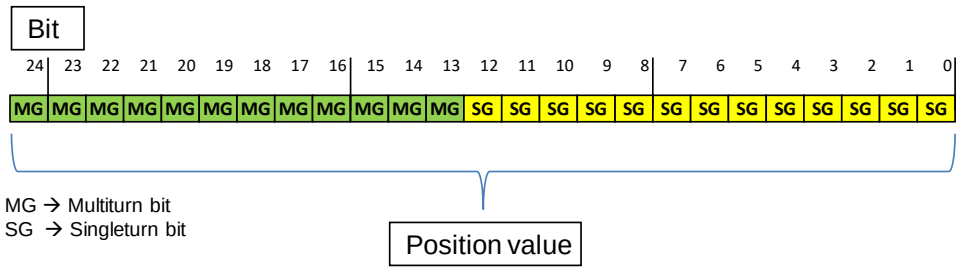
The SSI log is a serial data transmission between an encoder and an evaluation module (drive, technology module). The data transmission takes place in only one direction for the SSI log, i.e. data from the encoder is transmitted to the evaluation module. This is a position value of a rotatory or linear measuring system and, if required, further bits that describe the validity of the position value.

Example 1

The telegram of an SSI absolute encoder can have the following structure:

- The SSI telegram has a length of 25 bytes.
- The MSB of the positioning value is bit 24.
- The LSB of the positioning value is bit 0.
- The positioning value is gray-coded.
- A parity bit is not available.

Figure 5-3: Structure of a telegram of an SSI absolute value encoder

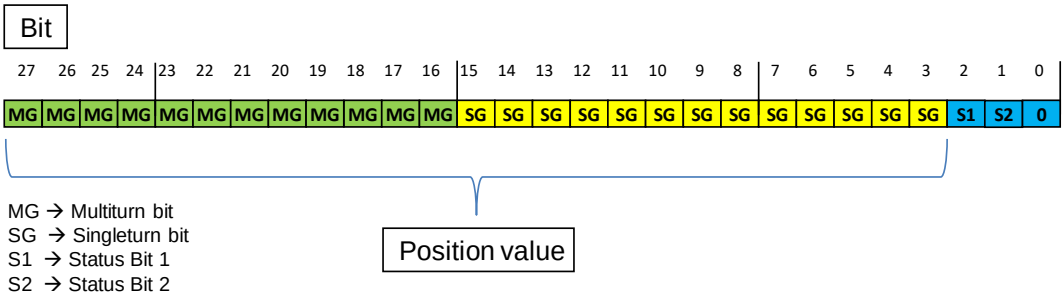


Example 2

If the SSI encoder transfers other information (for example status bits) apart from the positioning value, you have to specify where the positioning value is stored in the SSI telegram.

- The SSI telegram has a length of 28 bit.
- The MSB of the positioning value is bit 27.
- The LSB of the positioning value is bit 3.

Figure 5-4: Structure of a telegram of an SSI absolute value encoder



Note

Other examples for the structure of the telegram of a SSI absolute value encoder can be found in the “Using technology function” operating manual (\7\).

5.2.5 Parameters of the encoder values in SINAMICS

The following table summarizes the encoder parameters for control, status word and actual values.

Table 5-10: Parameters of encoder values

Meaning	Parameters in SINAMICS
Control word for encoder	p480
Status word of encoder	r481
Incremental actual value of encoder	r482
Absolute actual value of encoder	r483

6 Links & Literature

Table 6-1: Links & Literature

	Topic
\1\	Siemens Industry Online Support http://support.automation.siemens.com
\2\	Download page of the entry http://support.automation.siemens.com/WW/view/en/109486133
\3\	SINAMICS S120 List Manual https://support.industry.siemens.com/cs/ww/en/view/109781807 SINAMICS S120 Device Manual https://support.industry.siemens.com/cs/ww/en/view/109782370
	SINAMICS G120 CU250S-2 list manual https://support.industry.siemens.com/cs/ww/de/view/109782287 SINAMICS G120 CU250S-2 Operating Instruction https://support.industry.siemens.com/cs/ww/en/view/109782994
\4\	The information on SSI encoder telegrams is contained in \7\
\5\	Device Manual SIMATIC S7-1500 TM Count 2x24V https://support.industry.siemens.com/cs/ww/en/view/109783960
\6\	Device Manual SIMATIC S7-1500 TM PosInput 2 https://support.industry.siemens.com/cs/ww/en/view/109758598
\7\	Function Manual SIMATIC S7-1500, ET 200MP, ET 200SP Counting, measurement and position detection https://support.industry.siemens.com/cs/ww/en/view/59709820
\8\	User Manual Absolute Value Encoders with PROFINET IO Absolute Rotary Encoder with PROFINET IO https://support.industry.siemens.com/cs/ww/en/view/109804040
\9\	User Manual Absolute Value Encoders with PROFIBUS DP Absolute Value Encoder with PROFIBUS DP https://support.industry.siemens.com/cs/ww/en/view/103472305
\10\	Motion Control Encoder with PROFINET – Redesign https://support.industry.siemens.com/cs/ww/en/view/109803179
\11\	PROFINET GSDML file for Motion Control Encoder with PROFINET IO interface https://support.industry.siemens.com/cs/ww/en/view/53095298
\12\	S7-1500/S7-1500T Motion Control Overview V6.0 as of STEP 7 V17 https://support.industry.siemens.com/cs/ww/en/view/109781848
\13\	Using the MC-PreServo and MC-PostServo organization blocks https://support.industry.siemens.com/cs/ww/en/view/109741575