OPERATING INSTRUCTIONS

AFS/AFM60 PROFINET

Absolute Encoder

SICK
Sensor Intelligence.

Described product

AFS60/AFM60 PROFINET

Manufacturer

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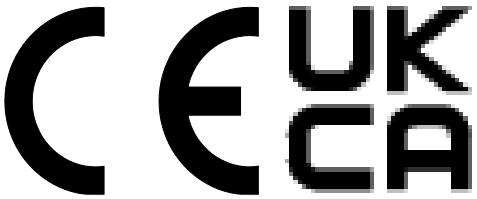
Legal information

Original document

This document is an original document of SICK AG.



Contents

1 About this document

Please read this chapter carefully before working with this documentation and the AFS60/AFM60 PROFINET Absolute Encoder.

1.1 Function of this document

This technical information is designed to address *the technical personnel of the machine manufacturer* or *the machine operator* in regards to correct configuration, electrical installation, commissioning, operation and maintenance of the AFS60/AFM60 PROFINET Absolute Encoder.

1.2 Scope

NOTE

This technical information applies to the AFS60/AFM60 PROFINET Absolute Encoder with the following type codes:

- Singleturn Encoder Advanced = AFS60A-xxNx262144
- Multiturn Encoder Advanced = AFM60A-xxNx018x12

1.3 Target group

This technical information is addressed at the *planners*, *developers* and *operators* of systems in which one or more AFS60/AFM60 PROFINET Absolute Encoders are to be integrated. It also addresses people who initialize the use of the AFS60/AFM60 PROFINET or who are in charge of servicing and maintaining the device.

These instructions are written for trained persons who are responsible for the installation, mounting and operation of the AFS60/AFM60 PROFINET in an industrial environment.

1.4 Information depth

This technical information contains information on the AFS60/AFM60 PROFINET Absolute Encoder on the following subjects:

- Product features
- Electrical installation
- Putting into operation and configuration
- Troubleshooting
- Conformity

This technical information does not contain any information on the mounting of the AFS60/AFM60 PROFINET. You will find this information in the mounting instructions included with the device.

It also does not contain any information on technical specifications, dimensional drawings, ordering information or accessories. You will find this information in the data sheet for the AFS60/AFM60 PROFINET.

Planning and using measurement systems such as the AFS60/AFM60 PROFINET also requires specific technical skills beyond the information in the operating instructions and mounting instructions. The information required to acquire these specific skills is not contained in this document.

When operating the AFS60/AFM60 PROFINET, the national, local and statutory rules and regulations must be observed.

Further information

PROFINET/PROFIBUS Nutzerorganisation e.V. (PNO), Haid-und-Neu-Str. 7, D-76131 Karlsruhe
Web: www.profinet.com
www.profinet.de

1.5 Symbols used

NOTE

Refer to notes for special features of the device.

●, ☼, ○ LED symbols describe the state of a diagnostics LED. Examples:

- ● The LED is illuminated constantly.
- ☼ The LED is flashing.
- ○ The LED is off.

➢ Take action ... Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

WARNING
Warning!

A warning notice indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents.

Read carefully and follow the warning notices.

1.6 Abbreviations used

CNR_D Customized Number of Revolutions, Divisor = divisor of the customized number of revolutions

CNR_N

	Customized Number of Revolutions, Nominator = nominator of the customized number of revolutions
CPR	Counts Per Revolution
EEPROM	Electrically Erasable Programmable Read-only Memory
FPGA	Field Programmable Gate Array = electronic component that can be programmed to provide an application-specific circuit
GSDML	Generic Station Description Markup Language = electronic device data sheet based on XML
I/O	Input and Output Data = input and output data
LLDP	Link Layer Discovery Protocol
LSDW	Least Significant Double Word
LSW	Least Significant Word
MAC	Media Access Control
MAP	Module Access Point
MR	Counts per Measuring Range
MSDW	Most Significant Double Word
MSW	Most Significant Word
PLC	Programmable Logic Controller
PMR	Physical Measuring Range
PROFINET	Process Field Network
SPS	Programmable Logic Controller
TCP/IP	Transmission Control Protocol/Internet Protocol
UDP/IP	User Datagram Protocol (connectionless network protocol)/Internet Protocol

2 On safety

This chapter deals with your own safety and the safety of the equipment operators.

- Please read this chapter carefully before working with the AFS60/AFM60 PROFINET or with the machine or system in which the AFS60/AFM60 PROFINET is used.

2.1 Authorized personnel

The AFS60/AFM60 PROFINET Absolute Encoder must only be installed, commissioned and serviced by authorized personnel.

NOTE

Repairs to the AFS60/AFM60 PROFINET are only allowed to be undertaken by trained and authorized service personnel from SICK AG.

The following qualifications are necessary for the various tasks:

Activity	Qualification
Mounting	• Basic technical training • Knowledge of the current safety regulations in the workplace
Electrical installation and replacement	• Practical electrical training • Knowledge of current electrical safety regulations • Knowledge on the use and operation of devices in the related application (e.g. industrial robots, storage and conveyor technology)
Commissioning, operation and configuration	• Knowledge on the current safety regulations and the use and operation of devices in the related application • Knowledge of automation systems like programmable logic controllers • Knowledge of PROFINET • Knowledge of a projecting tool (e.g. the SIEMENS TIA Portal V13)

Table 1: Authorized personnel

2.2 Correct use

The AFS60/AFM60 PROFINET Absolute Encoder is a measuring device that is manufactured in accordance with recognized industrial regulations and meets the quality requirements as per ISO 9001:2008 as well as those of an environment management system as per ISO 14001:2009.

An encoder is a device for mounting that cannot be used independent of its foreseen function. For this reason an encoder is not equipped with immediate safe devices.

Measures for the safety of persons and systems must be provided by the constructor of the system as per statutory regulations.

The AFS60/AFM60 PROFINET is only allowed to be operated in a PROFINET network as per its purpose defined by its design. It is necessary to comply with the PROFINET specifications and guidelines for setting up a PROFINET network.

In case of any other usage or modifications to the AFS60/AFM60 PROFINET, e.g. opening the housing during mounting and electrical installation, or in case of modifications to the SICK software, any claims against SICK AG under warranty will be rendered void.

2.3 General safety notes and protective measures

WARNING

Please observe the following procedures in order to ensure the correct and safe use of the AFS60/AFM60 PROFINET!

The encoder is to be installed and maintained by trained and qualified personnel with knowledge of electronics, precision mechanics and control system programming. It is necessary to comply with the related standards covering the technical safety stipulations.

The safety regulations are to be met by all persons who are tasked with the installation, the operation or the maintenance of the device:

- The technical information must always be available and must always be followed.
- Unqualified personnel are not allowed to be present in the vicinity of the system during installation.
- The system is to be installed in accordance with the applicable safety stipulations and the mounting instructions.
- All work safety regulations of the applicable countries are to be followed during installation.
- Failure to follow all applicable health and safety regulations may result in injury or damage to the system.
- The current and voltage sources in the encoder are designed in accordance with all applicable technical regulations.

2.4 Environmental protection

Please note the following information on disposal.

Assembly	Material	Disposal
Packaging	Cardboard	Waste paper
Shaft	Stainless steel	Scrap metal
Flange	Aluminium	Scrap metal
Housing	Aluminium die cast	Scrap metal
Electronic assemblies	Various	Electronic waste

Table 2: Disposal of the assemblies

3 Product description

This chapter provides information on the special features and properties of the Absolute Encoder AFS60/AFM60 PROFINET. It describes the construction and the operating principle of the device.

- Please read this chapter before mounting, installing and commissioning the device.

3.1 Special features

Properties	Singleturn Encoder Advanced	Multiturn Encoder Advanced
Absolute Encoder in 60 mm design	■	■
Robust nickel coded disk for harsh environments	■	■
High precision and reliability	■	■
Large ball bearing spacing of 30 mm	■	■
High level of resistance to vibration	■	■
Optimal rotational accuracy	■	■
Compact design	■	■
Face mount flange, servo flange and blind hollow shaft	■	■
18 bit singleturn resolution (1 to 262,144 steps)	■	■
30 bit total resolution	–	■
12 bit multiturn resolution (1 to 4,096 revolutions)	–	■
Round axis functionality	–	■
PROFINET interface (as per IEC 61784-2)	■	■
Supports the encoder profile V4.1 class 3 and 4	■	■
Ethernet with Full Duplex, Switched Ethernet, 100 Mbit/s	■	■
Supports the Link Layer Discovery Protocol	■	■
Supports the diagnostic functions “General diagnosis history” and “Error counter history”	■	■
Supports the function “External Default Setting”	■	■

Table 3: Special features of the encoder variants

3.2 Operating principle of the encoder

The sensing system in the AFS60/AFM60 PROFINET Absolute Encoder is based on absolute acquisition of revolutions without an external power supply or battery.

The AFS60/AFM60 PROFINET acquires the position of rotating axes and outputs the position in the form of a unique digital numeric value. The number of steps in a turn is acquired optically via an internal code disk. The number of turns is acquired using a magnetic gearbox.

The AFS60 PROFINET is a singleturn encoder

Singleturn encoders are used if absolute acquisition of the rotation of a shaft is required.

The AFM60 PROFINET is a multiturn encoder

Multiturn encoders are used if more than one shaft revolution must be acquired absolutely.

3.2.1 Scaleable resolution

The steps per revolution and the total resolution can be scaled and adapted to the related application.

The steps per revolution can be scaled from 1 ... 262,144 as an integer. The total resolution of the AFS60/AFM60 PROFINET must be 2^n times the resolution per revolution. This restriction is not relevant if the round axis functionality is activated.

3.2.2 Round axis functionality

The encoder supports the function for round axes. During this process, the steps per revolution are set as a fraction (see section 3.6.12 on page 40). As a result, the total resolution does not have to be configured to 2^n times the resolution per revolution and can also be a decimal number (e.g. 12.5).

NOTE

The output position value is adjusted with the zero point correction, the counting direction set and the gearbox parameters entered.

Example with transmission ratio

A rotary table for a filling system is to be controlled. The resolution per revolution is pre-defined by the number of filling stations. There are nine filling stations. For the precise measurement of the distance between two filling stations, 1,000 steps are required.

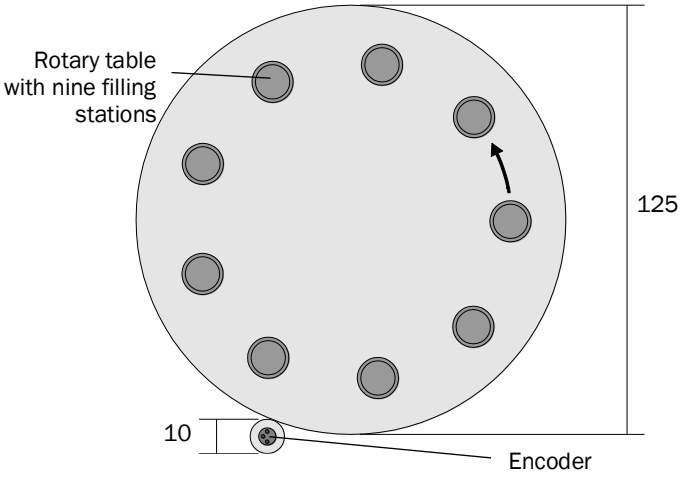


Figure 1: Example position measurement on a rotary table with transmission ratio

The number of revolutions is pre-defined by the transmission ratio = 12.5 of the rotary table gearing.

The total resolution is then 9 × 1,000 = 9,000 steps, to be realized in 12.5 revolutions of the encoder. This ratio cannot be realized via the steps per revolution and the total resolution, as the total resolution is not 2^n times the steps per revolution.

The application problem can be solved using the round axis functionality. Here the resolution per revolution is ignored. The total resolution as well as the nominator and divisor for the number of revolutions are configured.

9,000 steps are configured as the total resolution.

For the nominator for the number of revolutions 125 is configured, 10 as the divisor ($^{125}/_{10}$ = 12.5).

After 12.5 revolutions (that is after one complete revolution of the rotary table) the encoder reaches the total resolution of 9,000.

Example without transmission ratio

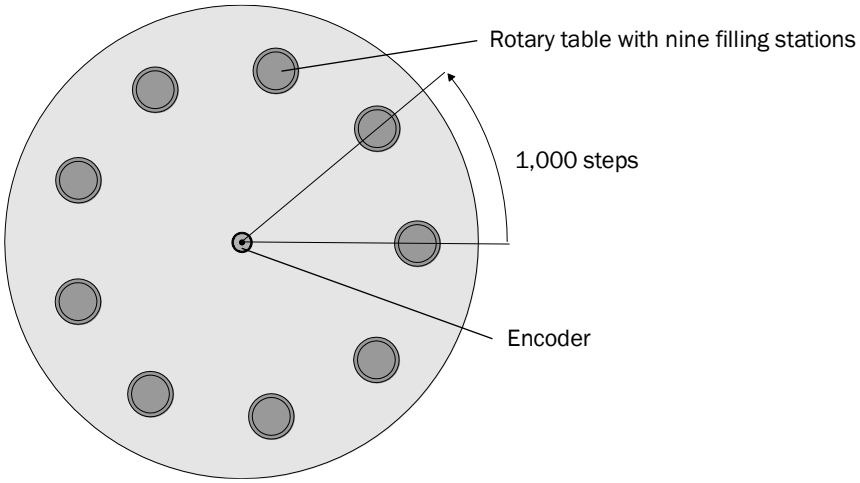


Figure 2: Example position measurement on a rotary table without transmission ratio

The encoder is mounted directly on the rotary table. The transmission ratio is 1:1.

The rotary table has 9 filling stations. The encoder must be configured such that it starts to count with 0 at one filling station and counts to 999 on moving to the next filling station position.

1,000 steps are configured as the total resolution.

For the nominator for the number of revolutions 1 is configured, 9 as the divisor ($^1/_9$ revolutions = 1,000).

After $^1/_9$ revolutions of the encoder shaft there are 1,000 steps, then the encoder starts to count at 0 again.

3.3 Integration in PROFINET

PROFINET is a communication protocol that is based on the open Ethernet standard as per IEEE 802.3.

PROFINET defines the real-time communication for the fast transmission of process data.

The AFS60/AFM60 PROFINET is a PROFINET peripheral device and is integrated in a PROFINET network as a slave.

The encoder is an input/output device. This means that the encoder uses data from the master on the PROFINET (output data) and also produces data for the PROFINET itself (input data).

The AFS60/AFM60 PROFINET complies with the guidelines of the encoder profile version 4.1 class 3 with the encoder profile number 3D00h.

3.3.1 Communication channels

Data can be communicated in PROFINET over various channels. The following channels are available:

- Real-time channel for the cyclic I/O data between master and slave
- Real-time channel for alarm data from the slave to the master
- Standard channel for configuring the slave or for requesting the status information

UDP/IP is used, e.g., to output the I/O data and to output alarms. TCP/IP is used, e.g., during configuration and diagnostics.

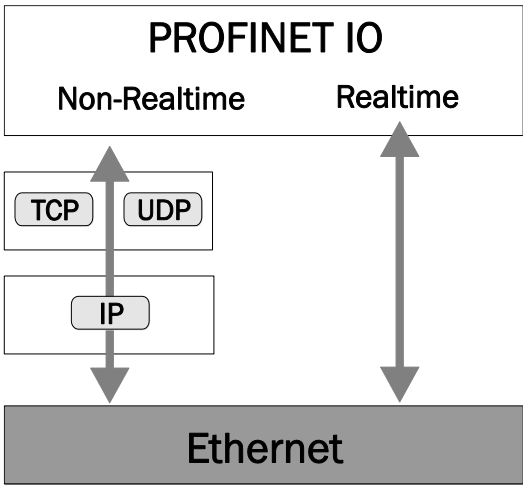


Figure 3: PROFINET communication channels

3.3.2 Device identification in the PROFINET

The following IDs are registered with the PROFIBUS-/PROFINET-Nutzerorganisation (PNO – PROFIBUS/PROFINET user organization).

- Manufacturer ID = 0101h
- Device ID = 7701h

3.3.3 GSDML file

Common configuration tools (e.g. Siemens TIA Portal V13) require a GSDML file to integrate the device into the network.

The GSDML file GSDML-V2.25-SICK-AFx60-xxxxxxxx.xml for the AFS60/AFM60 PROFINET is available at www.sick.com for download.

3.3.4 Encoder model

The encoder object model defined in the encoder profile version 4.1 is implemented in the AFS60/AFM60 PROFINET; this profile describes the software architecture of the encoder.

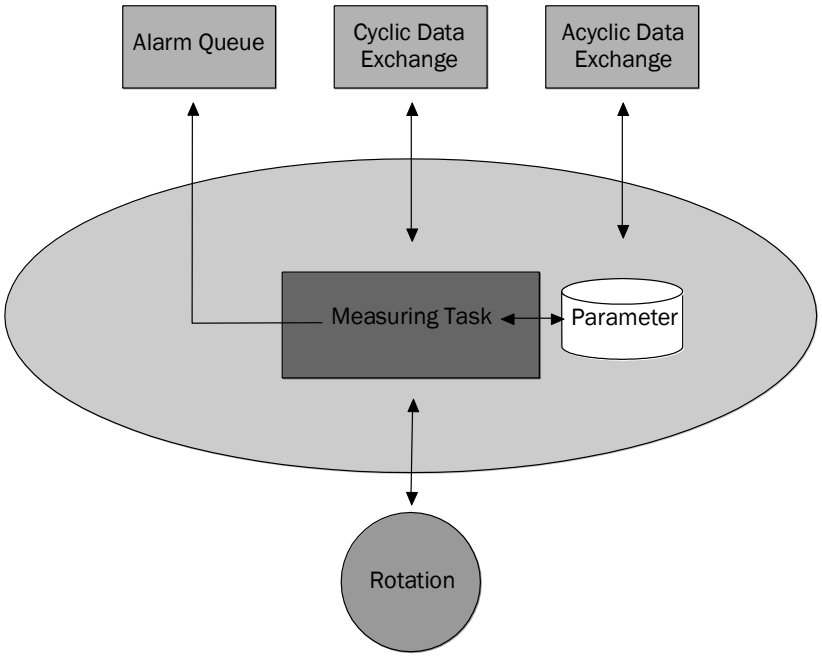


Figure 4: Encoder object model

The following encoder object functions are supported by the AFS60/AFM60 PROFINET:

- Alarm Queue (e.g. for the output of alarms)
- Cyclic Data Exchange (e.g. for the output of the measured data)
- Acyclic Data Exchange (e.g. for configuration)
- Measuring Task (e.g. for the measurement of position and speed)

3.3.5 Submodules

The submodules 81 to 84 are used for the transmission of the cyclic data. The submodule 65,535 is used for the transmission of the acyclic data.

Number	Description	Number of output data words	Number of input data words
81	Telegram 81	2	6
82	Telegram 82	2	7
83	Telegram 83	2	8
84	Telegram 84	2	10
65,535	EO module representative (MAP)	0	0

Table 4: Submodules

3.4 Communication telegrams for cyclic process data

3.4.1 I/O signals

Different signals are processed in the different telegrams. Table 5 shows all the signals implemented in the AFS60/AFM60 PROFINET.

Signal numbers	Meaning	Abbreviation	Length (bit)	Sign
6	Speed A	NIST_A	16	Yes
8	Speed B	NIST_B	32	Yes
9	Sensor 1 control word	G1_STW	16	No
10	Sensor 1 state word	G1_ZSW	16	No
11	Position 1	G1_XIST1	32	No
12	Position 2	G1_XIST2	32	No
39	Position 3	G1_XIST3	64	No
80	Encoder control word 2	STW2_ENC	16	No
81	Encoder state word 2	ZSW2_ENC	16	No

Table 5: Signal numbers of the I/O data

3.4.2 Structure of telegram 81 to 84 (as per encoder profile V4.1)

Structure of telegram 81

- Output (PLC to slave)
- Input (slave to PLC): Position 1 and position 2

Data word	1	2
Value	STW2_ENC	G1_STW
Signal[1)]	80	9
Length	16 Bit	16 Bit
Meaning	Encoder control word 2	Sensor 1 control word

Table 6: Output data in the telegram 81

Data word	1	2	3	4	5	6
Value	ZSW2_ENC	G1_ZSW	G1_XIST1 MSW	G1_XIST1 LSW	G1_XIST2 MSW	G1_XIST2 LSW
Signal[1)]	81	10	11		12	
Length	16 Bit	16 Bit	32 Bit		32 Bit	
Meaning	Encoder state word 2	Sensor 1 state word	Position 1		Position 2	

Table 7: Input data in telegram 81

1) Signal numbers as per encoder profile V4.1.

Structure of telegram 82

- Output (PLC to slave)
- Input (slave to PLC): Position 1 and position 2 as well as speed A

Data word	1	2
Value	STW2_ENC	G1_STW
Signal[2)]	80	9
Length	16 Bit	16 Bit
Meaning	Encoder control word 2	Sensor 1 control word

Table 8: Output data in the telegram 82

Data word	1	2	3	4	5	6	7
Value	ZSW2_ENC	G1_ZSW	G1_XIST1 MSW	G1_XIST1 LSW	G1_XIST2 MSW	G1_XIST2 LSW	NIST_A
Signal[2)]	81	10	11		12		6
Length	16 Bit	16 Bit	32 Bit		32 Bit		16 Bit
Meaning	Encoder state word 2	Sensor 1 state word	Position 1		Position 2		Speed A

Table 9: Input data in telegram 82

2) Signal numbers as per encoder profile V4.1.

Structure of telegram 83

- Output (PLC to slave)
- Input (slave to PLC): Position 1 and position 2 as well as speed B

Data word	1	2
Value	STW2_ENC	G1_STW
Signal[2)]	80	9
Length	16 Bit	16 Bit
Meaning	Encoder control word 2	Sensor 1 control word

Table 10: Output data in the telegram 83

Data word	1	2	3	4
Value	ZSW2_ENC	G1_ZSW	G1_XIST1 MSW	G1_XIST1 LSW
Signal[2)]	81	10	11	
Length	16 Bit	16 Bit	32 Bit	
Meaning	Encoder state word 2	Sensor 1 state word	Position 1	

Data word	5	6	7	8
Value	G1_XIST2 MSW	G1_XIST2 LSW	NIST_B MSW	NIST_B LSW
Signal[2)]	12		8	
Length	32 Bit		32 Bit	
Meaning	Position 2		Speed B	

Table 11: Input data in telegram 83

Structure of telegram 84

- Output (PLC to slave)
- Input (slave to PLC): Position 2 and position 3 as well as speed B

Data word	1	2
Value	STW2_ENC	G1_STW
Signal[3)]	80	9
Length	16 Bit	16 Bit
Meaning	Encoder control word 2	Sensor 1 control word

Table 12: Output data in the telegram 84

Data word	1	2
Value	ZSW2_ENC	G1_ZSW
Signal[3)]	81	10
Length	16 Bit	16 Bit
Meaning	Encoder state word 2	Sensor 1 state word

Data word	3	4	5	6
Value	G1_XIST3 MSW	G1_XIST3	G1_XIST3	G1_XIST3 LSW
Signal[3)]	39			
Length	64 Bit			
Meaning	Position 3			

Data word	7	8	9	10
Value	G1_XIST2 MSW	G1_XIST2 LSW	NIST_B MSW	NIST_B LSW
Signal[3)]	12		8	
Length	32 Bit		32 Bit	
Meaning	Position 2		Speed B	

Table 13: Input data in telegram 84

3) Signal numbers as per encoder profile V4.1.

3.4.3 Contents of the signals

Signal 6: Speed value NIST_A

The current speed value is transmitted in 16 bits **right-justified**.

The value is output based on the units configured for the speed measurement (see section 3.6.9 on page 39).

NOTE

Ensure that you use a unit for the speed measurement suitable for the rotational speed of the encoder. Otherwise the value that can be represented within the 16 bits may be exceeded.

Signal 8: Speed value NIST_B

The current speed value is transmitted in 32 bits **right-justified**.

The value is output based on the units configured for the speed measurement (see section 3.6.9 on page 39).

Signal 9: Sensor 1 control word (G1_STW)

Bit	Designation	Description
15	Acknowledging a sensor error	**0** = Encoder error message **not** acknowledged by PLC **1** = Encoder error message acknowledged by the PLC
14	Activate park mode	**0** = Normal operation **1** = Activate park mode
13	Request for the absolute position value	**0** = No request **1** = Request by the master Results in the cyclic output of the position values in **G1_XIST2**
12	Activate preset value (see note below)	Defines that a configured preset value is used (see section 3.5 on page 24) **0** = Preset value is **not** activated **1** = Preset value is activated
11	Preset mode	Defines how a configured preset value is used **0** = Preset value is used as a new absolute value **1** = Preset value is added to the previous value
10 ... 0	Reserved	–

Table 14: Sensor 1 control word (G1_STW)

NOTE

To activate the preset value, bit 10 in control word STW2_ENC has to be set:
STW2_ENC = 0400h
(Not relevant when using encoder profile version 3)

Signal 10: Sensor 1 state word (G1_ZSW)

Bit	Designation	Description
15	Encoder error	**0** = No error **1** = Error The error code is output in **G1_XIST2**.
14	Park mode activated	**0** = Normal operation **1** = Park mode activated Feedback based on G1_STW bit 14: No output of position data **G1_XIST1** and **G1_XIST2**
13	Transmission of absolute position value	**0** = No transmission **1** = Position value is output in G1_XIST2
12	Status of the Preset function (set/shift of home position executed)	**0** = No Preset function active **1** = Preset function is run Feedback based on G1_STW bit 12: • New position value is output in **G1_XIST1** and **G1_XIST2**. • On conclusion of the preset function the bit is set to 0.
11	Requirement of error acknowledgement detected	**0** = No return acknowledgement of encoder error **1** = Requirement of error acknowledgement detected Reaction to bit 15 in the sensor control word 1 G1_STW is acknowledged (see Table 14)
10	Reserved	–
9 ... 0	Not supported	–

Table 15: Sensor 1 state word (G1_ZSW)

Signal 11: Position values in the telegram part G1_XIST1

The current position value is transmitted in 32 bits **shifted to left** by the shift factor in the two data words. The shift factor **always** has the following values:

- AFS60 = 14
- AFM60 = 2

The configuration of the parameter **Total measuring range** (see section 3.6.8 on page 39) has an influence on this position value.

The following example shows the largest possible position value of 1,073,741,824 steps in 30 bits.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 16: Example for position values in G1_XIST1 MSW

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0

Table 17: Example for position values in G1_XIST1 LSW

NOTE

A preset value transmitted via acyclic process data only has an effect on G1_XIST1 if the parameter **G1_XIST1 Preset Control** is active (see section 3.6.3 on page 38).

Signal 12: Position values in the telegram part G1_XIST2

The current position value is transmitted in 32 bits **right-justified** in the two data words. The configuration of the parameter **Total measuring range** (see section 3.6.8 on page 39) and a configured preset value have always an influence on the position value.

The following example shows the largest possible position value of 1,073,741,824 steps in 30 bits.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Value	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 18: Example for position values in G1_XIST2 MSW

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 19: Example for position values in G1_XIST2 LSW

NOTE

- If errors occur, an error code instead of the position value is output via G1_XIST2.
- To transmit the position value in the telegram part G1_XIST2, corresponding bits must be set in the control words:
  - G1_STW = 2000h
  - STW2_ENC = 0400h

Signal 39: Position values in the telegram part G1_XIST3

The current position value is transmitted in 64 bits **right-justified**. The configuration of the parameter **Total measuring range** (see section 3.6.8 on page 39) and a configured preset value have always an influence on the position value.

The following example shows the largest possible position value of 1,073,741,824 steps in 30 bits.

Bit	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Value	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 20: Example for position values in G1_XIST3

Signal 80: Encoder control word 2 (STW2_ENC)

Bit	Designation	Description
15 ... 12	Master's Sign-of-Life (not relevant)	–
10	Control by PLC	**0** = No control by the PLC **1** = Control by the PLC Enables the PLC by using control words to activate / deactivate encoder functions
7	Fault acknowledge	Error-buffer handling not supported
11, 9, 8, 6 ... 0	Reserved	–

Table 21: Encoder control word 2 (STW2_ENC)

Signal 81: Encoder state word 2 (ZSW2_ENC)

Bit	Designation	Description
15 ... 12	Encoder's Sign-of-Life (not relevant)	–
11, 10	Reserved	–
9	Control requested	**0** = No control by the PLC requested **1** = Control by the PLC requested
8 ... 0	Reserved	–

Table 22: Encoder state word 2 (ZSW2_ENC)

3.5 Acyclic process data

The acyclic process data are processed in parallel and in addition to the cyclic process data transmission. The acyclic process data are normally not used continuously, but only as required. They are used to configure the encoder or for requesting its status information.

The acyclic process data essentially comprise the services **Read** and **Write** with which the master can obtain read or write access to data blocks in the PROFINET slave.

The access to the acyclic process data in the AFS60/AFM60 PROFINET has been implemented in accordance with the PROFIdrive profile. For the access to these data the profile uses the client-server model. Communication is undertaken using the **Request** parameter and the **Response** parameter.

A write or read task for one or more parameters is transmitted in the **Request** parameter. The **Response** parameter then contains the response to a request.

The profile provides various indices for the data access:

Record Data Object	MAP index
Start-up configuration	BF00h
Start-up configuration vendor specific	1000h
Base mode parameter access	B02Eh
I&M0 parameters	AFF0h

Table 23: Indices for the data access

The parameters described in this section are communicated via the **index B02Eh**, which is stipulated for the base mode parameters as per PROFIdrive.

A **Request** is transmitted from the master to the slave. Transmission is via write access to the index B02Eh. The encoder interprets the **Request** parameter and makes available the data. These data (**Response** parameter) must also be read via the same index.

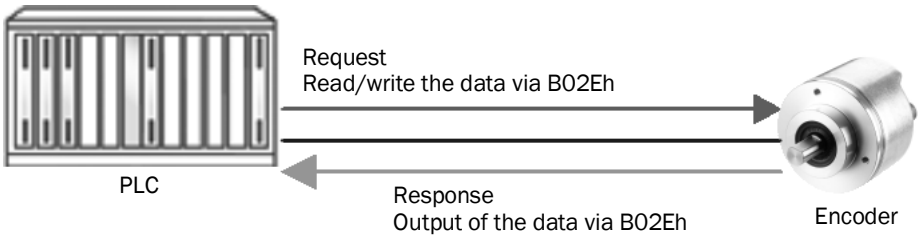


Figure 5: Request and Response

System function blocks

On the Siemens S7 control systems two system function blocks can be used for the acyclic communication:

- **SFB52 RDREC** (read record)
- **SFB53 WRREC** (write record)

The functions then contain, among other items, the Request and Response parameters as well as the index B02Eh as function parameters.

A Request parameter is transmitted to the encoder using **WRREC**. The reply, Response parameter, is then read using the function **RDREC**.

SICK function blocks

Function blocks for STEP 7 and the TIA Portal are available for download at www.sick.com.

- Enter the seven-digit part number for your encoder in the **I am looking for ...** field.

3.5.1 Structure of the parameter Request

A Request parameter has the following structure:

Byte	Name	Description	Value
0	Request reference	Request identification; should be unique for each request	00h Reserved 01h ... FFh
1	Request ID	Access type: 01h = Parameter request (read) 02h = Parameter change (write)	01/02h
2	Axis No./DO-ID	Not relevant	E.g. 01h
3	Number of parameters	Number of parameters accessed	00h Reserved 01h ... 27h 28h ... 28h Reserved
4	Parameter adress 1	Includes the address of the 1. parameter	See Table 25
4 + 6 × (n–1)	Parameter adress n	Includes the address of the nth parameter	See Table 25
4 + 6 × n	Parameter value 1	Includes the value of the 1. parameter	See Table 26
...	Parameter value n	Includes the value of the nth parameter	See Table 26

Table 24: Structure of the parameter Request

Byte	Name	Description	Value
0	Attribute	Information on the type of information (always 10h)	10h
1	Number of elements	Number of elements of the array 00/01h = Access to a specific variable 02h = Access to two variables etc.	00h ... EAh
2 ... 3	Parameter index	Index of the parameter e.g. FDE8h = 65,000	0000h Reserved 0001h ... FFFFh
4 ... 5	Subindex	Subindex for the first element that is accessed	0000h ... FFFEh

Table 25: Structure of the parameter address

Byte	Name	Description	Value
0	Format	Data type 41h = Byte 42h = WORD 43h = DOUBLE WORD	41h ... 43h
1	Number of elements	Number of values that follow	00h ... EAh
2 ... x	Values	Values of the parameter	

Table 26: Structure of the parameter value

3.5.2 Structure of the parameter Response

A Response parameter has the following structure:

Byte	Name	Description	Value
0	Request reference	Request identification; should be unique for each request	00h reserved 01h ... FFh
1	Request ID	Access type: 01h = Parameter request successful 02h = Parameter change successful 81h = Parameter request failed 82h = Parameter change failed	01/02h
2	Axis No./DO-ID	Returns the same value that the request contains	E.g. 01h
3	Number of parameters	Number of parameters accessed	00h reserved 01h ... 27h 28h ... 28h reserved
4	Parameter value 1	Includes the value of the 1. parameter or an error message	See Table 28
4 + n	Parameter value n	Includes the value of the nth parameter or an error message	See Table 28

Table 27: Structure of the parameter Response

Byte	Name	Description	Value
0	Format	Data type 0Ah = OCTET STRING 41h = Byte 42h = WORD 43h = DOUBLE WORD 44h = Error message	0Ah, 41h ... 44h
1	Number of elements	Number of values that follow	00h ... EAh
2 ... x	Values	Values of the parameter	–

Table 28: Structure of the parameter value

3.5.3 Examples on reading and writing a parameter

The following examples show the values for reading or writing the parameter 65,000, which contains the preset value for the encoder (see Table 35 on page 36).

Request to read the parameter

Byte	Description	Value
0	Request reference	01h
1	Request ID	01h
2	Axis No./DO-ID	00h
3	Number of parameters	01h
4	Attribute	10h
5	Number of elements	00h
6 ... 7	Parameter index (in this example FDE8h = 65,000)	FDE8h
8 ... 9	Parameter subindex	0000h

Table 29: Request example for reading a parameter

Response of parameter 65,000

Byte	Description	Value
0	Request reference returned	01h
1	Request ID	01h
2	Axis no./DO-ID returned	00h
3	Number of parameters	01h
4	Format	43h
5	Number of values	01h
6	Value (64h = 100)	00000064h

Table 30: Response example for reading a parameter

Request to write the parameter 65,000

Byte	Description	Value
0	Request reference	01h
1	Request ID	02h
2	Axis No./DO-ID	00h
3	Number of parameters	01h
4	Attribute	10h
5	Number of elements	00h
6 ... 7	Parameter index	FDE8h (= 65,000)
8 ... 9	Parameter subindex	0000h
10	Format	43h
11	Number of values	01h
12 ... 15	Value	0000000064h

Table 31: Request example to write a parameter

Response of parameter 65,000

Byte	Description	Value
0	Request reference returned	01h
1	Request ID	02h (= parameter change successful)
2	Axis no./DO-ID returned	00h
3	Number of parameters	01h

Table 32: Response example to write a parameter

3.5.4 PROFIdrive-specific parameters

Index **Subindex**	Description	Access[4)]	Data type Data values
922	Telegram currently used in the process data	R	UINT-16 81, 82, 83, 84
964	Device identification	R	Array [0 ... 5] UINT-16
.0	Manufacturer ID		01.01h (= 257)
.1	Object type (vendor specific)		41.46h
.2	Firmware version		xx.xx
.3	Firmware date (year)		yyyy
.4	Firmware date (day.month)		dd.mm
.5	Number of drive objects		Fixed to 00.01h
965	Encoder profile number Depending on the configuration of the parameter **Compatibility mode** (see section 3.6.6 on page 38)	R	UINT-16 3D.29h or 3D.1Fh
971	Data transfer to the non-volatile memory 00h = No save 01h = Parameters are saved (then the parameter 971 is set to 00h again)	W	UINT-16
975	Encoder object identification	R	Array [0 ... 6] UINT-16
.0	Manufacturer ID		01.01h 257
.1	Object type (vendor specific)		41.46h
.2	Firmware version		xx.xx
.3	Firmware date (year)		yyyy
.4	Firmware date (day.month)		dd.mm
.5	PROFIdrive DO type classification 5 = Encoder		00.05h
.6	PROFIdrive DO subclassification 1 Bit 14 = 1: Encoder Class 3		40.00h 01000000.0000000

4) R = Read access, W = Write access.

Index **SubIndex**	Description	Access[4)]	Data type Data values
979	Sensor format	R	Array [0 ... 5] UINT-32
.0	Structure header		00.00.51.11h
.1	Sensor type Advanced		00.00.00.02h or 80.00.00.02h
.2	Sensor resolution (18 bits)		00.04.00.00h
.3	Shift factor in telegram part G1_XIST1 (left-justified) 02h = Multiturn 0Eh = Singleturn		00.00.00.02h or 00.00.00.0Eh
.4	Shift factor in telegram part G1_XIST2 (right-justified)		00.00.00.00h
.5	Number of revolutions 10.00h = Multiturn 00.01h = Singleturn		00.00.10.00h or 00.00.00.01h
980	List of parameters	R	Array [0 ... 21] UINT-16
.0	Telegram		922
.1	Device identification		964
.2	Encoder profile number		965
.3	Data transfer to the non-volatile memory		971
.4	Encoder object identification		975
.5	Sensor format		979
.6	Sensor status (S_STAT_A, bit oriented)		1,000
.7	Sensor status (S_STAT_A, B and C, bit oriented)		1,001
.8	Diagnostics history, absolute		1,002
.9	Diagnostics history, absolute		1,003
.10	Counter of the diagnostics history		1,004
.11	Speed calculation		1,005
.12	Temperature limits		1,006
.13	Voltage limits		1,007
.14	Round axis functionality (endless shaft)		1,009
.15	Self-test		1,010
.16	MAC port 1		1,011
.17	MAC port 2		1,012
.18	FPGA version		1,013
.19	Operating temperature		1,014
.20	Name of the station (of the encoder)		61,000
.21	IP address of the station (of the encoder)		61,001

Index SubIndex	Description	Access[4)]	Data type Data values
.22	MAC address of the station (of the encoder)		61,002
.23	Default gateway of the station (of the encoder)		61,003
.24	Subnet mask of the station (of the encoder)		61,004
.25	Preset value (is saved in EEPROM)		65,000
.26	Operating status		65,001
.27	End of the list		0

Table 33: PROFIdrive-specific parameters

3.5.5 Vendor specific parameters

Index Subindex	Description	Access[5]	Data type Data values
1,000	Sensor status (bit oriented)	R	UINT-16
1,001	Sensor status (S_STAT_A, B and C, bit oriented)	R	Array [0 ... 2] UINT-16
.0	Contains the values of sensor status S_STAT-A		See Table 44 on page 57
.1	Contains the values of sensor status S_STAT-B		See Table 45 on page 58
.2	Contains the values of sensor status S_STAT-C		See Table 46 on page 59
1,002	Service log history information, absolute values	R	Array [0 ... 12] UINT-32
.0	Power up counter		1 ... n
.1	Operating time in seconds		0 ... n
.2	Maximum speed in rpm since the encoder has been in operation		1 ... 9,000
.3	Counter for forward rotation		1 ... n
.4	Counter for reverse rotation		1 ... n
.5	Counter for direction change The counter increments if the encoder changes direction of rotation.		1 ... n
.6	Motion time in seconds (is incremented in case of movement with at least 6 rpm)		0 ... n
.7	Current acceleration in rpm/s		0 ... n
.8	Maximum internal LED current for the sensor in µA		0 ... FF.FF.FF.FFh
.9	Minimum internal LED current for the sensor in µA		0 ... FF.FF.FF.FFh
.10	Maximum operating voltage in volts		0 ... FF.FF.FF.FFh
.11	Maximum operating temperature in °C		0 ... FF.FF.FF.FFh
.12	Minimum operating temperature in °C (must be interpreted as INT-32)		0 ... FF.FF.FF.FFh

[5] R = Read access, W = Write access.

Index **SubIndex**	Description	Access[5)]	Data type Data values
1,003	Service log history information, relative values The values of the parameter can be reset.	R	Array [0 ... 12] UINT-32
.0	Power up counter		1 ... n
.1	Operating time in seconds		0 ... n
.2	Maximum speed in rpm since the encoder has been in operation		1 ... 9,000
.3	Counter for forward rotation		1 ... n
.4	Counter for reverse rotation		1 ... n
.5	Counter for direction change The counter increments if the encoder changes direction of rotation.		1 ... n
.6	Motion time in seconds (is incremented in case of movement with at least 6 rpm)		0 ... n
.7	Current acceleration in rpm/s		0 ... n
.8	Maximum internal LED current for the sensor in µA		0 ... FF.FF.FF.FFh
.9	Minimum internal LED current for the sensor in µA		0 ... FF.FF.FF.FFh
.10	Maximum operating voltage in volts		0 ... FF.FF.FF.FFh
.11	Maximum operating temperature in °C		0 ... FF.FF.FF.FFh
.12	Minimum operating temperature in °C (must be interpreted as INT-32)		0 ... FF.FF.FF.FFh
1,004	Counter of the diagnostics history Counts the errors and warnings that have occurred in the individual bits of the sensor status S_STAT_A (see Table 44 on page 57)	R	Array [0 ... 15] UINT-16
.0	Bit 1		1 ... 255
.1	Bit 2		1 ... 255
.2	Bit 3		1 ... 255
.3	Bit 4		1 ... 255
.4	Bit 5		1 ... 255
.5	Bit 6		1 ... 255
.6	Bit 7		1 ... 255
.7	Bit 8		1 ... 255
.8	Bit 9		1 ... 255
.9	Bit 10		1 ... 255
.10	Bit 11		1 ... 255
.11	Bit 12		1 ... 255

Index **SubIndex**	Description	Access[5)]	Data type Data values
.12	Bit 13		1 ... 255
.13	Bit 14		1 ... 255
.14	Bit 15		1 ... 255
1,005	Speed calculation	R	Array [0 ... 15] UINT-16
.0	Mode for the speed calculation		**0** Not active **1** Active
.1	Speed measuring unit		**0** steps/s **1** steps/100ms **2** steps/10ms **3** rpm **4** rps
.2	T1 – Refresh time in ms		AFS60 = 2 AFM60 = 1 ... 50
.3	T2 – Integration time dependent of the refresh time The speed is calculated from the average of several measurements. The integration value T2 defines the number of values from which the average is calculated. The refresh time T1 defines the time between the individual measurements. **Example:** If T1 = 2 ms and T2 = 200, then the speed is calculated from the last 0.4 s.		1 ... 200
1,006	Limits of the operating temperature allowed	R/W	Array [0 ... 1] UINT-16
.0	Defines the lower limit for the operating temperature allowed in °C		–40 +80
.1	Defines the upper limit for the operating temperature allowed in °C		–20 +120
1,007	Limit of the supply voltage allowed	R/W	Array [0 ... 1] UINT-16
.0	Defines the lower limit for the supply voltage allowed in mV		9,000 24,000
.1	Defines the upper limit for the supply voltage allowed in mV		10,000 30,000

Index **SubIndex**	Description	Access[5)]	Data type Data values
1,009	Round axis functionality (endless shaft)	R/W	Array [0 ... 10] UINT-32
.0	Operating mode		**1** = Off **2** = On
.1	Input CNR_N Nominator for the number of revolutions		1 ... 00.01.00.00h
.2	Input CNR_D Divisor for the number of revolutions		1 ... 00.01.00.00h
.3	Input CMR Total resolution		1 ... 40.00.00.00h
.4	Range offset (saved in EEPROM)		1 ... 80.00.00.00h
.5	Internal shift value		1 ... FF.FF.FF.FFh
.6	Output CNR-N Nominator for the number of revolutions		See subindex .1
.7	Output CNR-D Divisor for the number of revolutions		See subindex .2
.8	Output CMR Total resolution		See subindex .3
.9	CPR Steps per revolution, digits before the decimal separator		Ex.: at 1.555 = 1
.10	CPR Steps per revolution, digits after the decimal separator		Ex.: at 1.555 = 555
1,010	Reserved	–	–
1,011	MAC address of Ethernet port 1	R	OCTET STRING [6]
1,012	MAC address of Ethernet port 2	R	OCTET STRING [6]
1,013	FPGA version	R	UINT-32
.0	Example: Value = 00010200h Version = 1.2.0	R	DWORD
1,014	Operating temperature	R	INT-16
.0	Current operating temperature in °C	R	WORD

Table 34: Vendor specific parameters

3.5.6 Encoder profile-specific parameters

Index/ **Subindex**	Description	Access[6)]	Data type Data values
61,000	Name of the station (of the encoder)	R	OCTET STRING [240]
61,001	IP address of the station (of the encoder)	R	UINT-32
61,002	MAC address of the station (of the encoder)	R	OCTET STRING [6]
61,003	Default gateway of the station (of the encoder)	R	UINT-32
61,004	Subnet mask of the station (of the encoder)	R	UINT-32
65,000	Preset value (can be saved in the EEPROM with the aid of parameter 971, see Table 33 on page 31)	R/W	UINT-32
65,001	Operating status	R	Array [0 ... 11] UINT-32
.0	Structure header		00.0B.01.01h 0B = 11 entries
.1	Operating status		See Table 36 on page 37
.2	Current errors		See Table 47 on page 60
.3	Supported error messages		See Table 48 on page 60
.4	Current warnings		See Table 49 on page 61
.5	Supported warnings		See Table 50 on page 61
.6	Version of the encoder profile		00.00.04.01h
.7	Operating time (value × 0.1 h)		1 ... 00.00.00.00h
.8	Offset value (saved in EEPROM)		1 ... 00.00.00.00h
.9	CPR Resolution per revolution		1 ... 00.04.00.00h 1 ... 262,144
.10	CMR Total resolution		1 ... 40.00.00.00h 1 ... 1,073,741,824
.11	Speed measuring unit		**0** = steps/s **1** = steps/100 ms **2** = steps/10 ms **3** = rpm

Table 35: Encoder profile-specific parameters

6) R = Read access, W = Write access.

Bit	Description
0	Code sequence 1 = counterclockwise 0 = Clockwise
1	Class 4 functionality 0 = Inactive 1 = Active
2	G1_XIST1 preset control 0 = Active 1 = Inactive
3	Scaling function control 0 = Inactive 1 = Active
4	Alarm channel control 0 = Inactive 1 = Active
5	Compatibility mode 0 = V3.1, backward compatible 1 = V4.1, not backward compatible
6 ... 31	Reserved

Table 36: Bits of the index 65.001.01

3.6 Configurable functions

The AFS60/AFM60 PROFINET is configured using the configuration tool for a PLC (e.g. Siemens TIA Portal V13).

NOTE

After changing the parameter, the encoder must remain energized for at least 1 sec. to save the parameter change(s).

3.6.1 Code sequence

The code sequence defines the direction of rotation, viewed on the shaft, in which the position value increases.

NOTE

The parameter can only be configured if the class 4 functionality is activated.

3.6.2 Class 4 functionality

The **class 4 functionality** is activated from the factory. This parameter permits or prevents changes to the parameters **Code sequence**, **Scaling** and **Implementation of the preset**.

If the parameter is deactivated (disable), the settings for the following parameters are fixed:

- Code sequence = clockwise
- Scaling = off
- No preset via telegram or preset pushbutton possible

3.6.3 G1_XIST1 preset control

The parameter defines whether the preset function affects the telegram part G1_XIST1. Otherwise the preset only acts on G1_XIST2.

NOTE

The parameter can only be configured if the class 4 functionality is activated.

3.6.4 Scaling

The parameter **Scaling** makes it possible to scale the resolution per revolution and the total resolution.

NOTE

Only if the **Scaling** parameter is activated (enable), the values entered for the resolution and total resolution are applied to the configuration. Otherwise the values will be ignored!

3.6.5 Alarm channel control

NOTE

The parameter can only be deactivated (disable) if the parameter **Compatibility mode** is activated (enable).

- Alarm channel control – active
  The diagnostic data are transmitted as per encoder profile V4.1.
- Alarm channel control – inactive
  No “Alarms” are transmitted.

3.6.6 Compatibility mode

Using this parameter the encoder can be configured such that it operates as per encoder profile **V3.1** and not as per V4.1. This parameter also affects the following functions:

- Alarm channel control
  The parameter can be configured inactive in the compatibility mode.
- In addition it is assumed that the bit Control by PLC in the telegram part STW2_ENC is permanently set to 1, as if the control system is constantly requesting control.

3.6.7 Measuring range per revolution

The measuring range per revolution is stated in two parameters, as *Least Significant Double Word (LSDW)* and as *Most Significant Double Word (MSDW)*.

The resolution is max. 262,144 steps per revolution. The resolution can be scaled from 1 ... 262,144 as an integer.

NOTE

The parameter is not used if the round axis functionality (see 3.6.12 on page 40) is activated.

3.6.8 Total measuring range

The total measuring range is stated in two parameters, as *Least Significant Double Word (LSDW)* and as *Most Significant Double Word (MSDW)*.

NOTE

On the singleturn variant AFS60 PROFINET the entire measuring range must match the measuring range per revolution (see section 3.6.7 on page 38). Both parameters must be configured with exactly the same value!

The total resolution, that is the measuring range, is max. 1,073,741,824 steps. The total resolution of the AFM60 PROFINET must be 2^n times the resolution per revolution.

Resolution per revolution	n	Total resolution
1,000	3	8,000
8,179	5	261,728
2,048	11	4,194,304

Table 37: Examples for the total resolution of the AFM60 PROFINET

NOTE

This restriction is not relevant if the round axis functionality (see 3.6.12 on page 40) is activated.

3.6.9 Speed measuring unit

Using this parameter you can define the unit with which the speed is transmitted in telegrams 82, 83 and 84 (message 81 does not contain any speed values).

Possible units are:

- steps/s
- steps/100 ms
- steps/10 ms
- rpm

The factory setting is **rpm**.

3.6.10 Save mode for the preset value

Using this parameter you can define the way in which the configuration parameters (1.006, 1.007, 65.000) are saved.

- **Auto save**: The values are written automatically to the EEPROM on each change.
- **P971**: The values must be written to the EEPROM using the parameter 971 (see section 3.5 “Acyclic process data” on page 24 and Table 33 on page 31).

3.6.11 Transmit preset value

Using this parameter you can define whether the preset value (see section 3.6.17 on page 40) is transmitted on switching on or initializing the encoder. You will find an example for setting a preset value in section 4.4.2 from page 48.

- **Enable**: The preset value is transmitted on switching on or initializing the encoder into the parameter 65.000. The preset value can be changed in operation via acyclic process data (see section 3.5 on page 24 and Table 35 on page 36).
- **Disable**: The parameter is not transmitted on switching on or initializing the encoder.

The preset value is only used when the related bits of the sensor 1 control word G1_STW are set (see Table 14 on page 20) and bit 10 in control word STW2_ENC is set (see Table 21 on page 23).

3.6.12 Round axis functionality

The round axis functionality removes the restriction that the total resolution must be 2^n times the Steps per revolution. The shaft is considered as an **endless shaft**.

The steps per revolution are not configured directly, instead the nominator and divisor for the number of revolutions are defined.

The total measuring range can be scaled from 1 ... 1,073,741,824 as an integer.

3.6.13 Number of revolutions, nominator for the round axis functionality

The nominator can be scaled from 1 ... 2,048 as an integer. The default factory setting for the nominator is 2,048.

3.6.14 Number of revolutions, divisor for the round axis functionality

The divisor can be scaled from 1 ... 65,535 as an integer. The default factory setting for the divisor is 1.

3.6.15 Speed filter, sampling interval

The speed value is calculated as an average value and output. The sampling interval defines the time between measurements and how measurements are made. It can be between 1 and 100 ms.

3.6.16 Speed filter, number of measurements

The number of measurements defines the number of measured values from which the average speed is calculated. The number can be 1 to 200.

3.6.17 Preset value

The **Preset value** parameter contains the value that is transmitted to the encoder with the parameter **Transmit preset value** (see section 3.6.11 on page 40).

3.7 Controls and status indicators

The AFS60/AFM60 PROFINET Absolute Encoder has five LEDs.

Three of the LEDs indicate the operating status (BF, SF and Encoder), two the status of the Ethernet interface (L/A1 and L/A2).

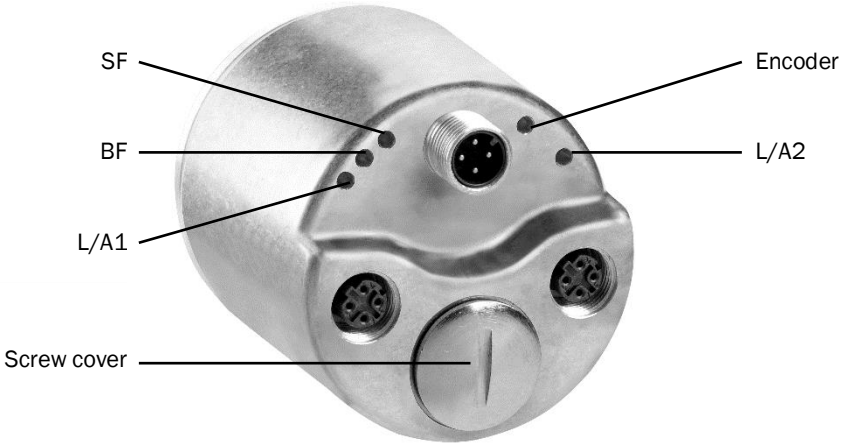


Figure 6: Position of the LEDs and the preset pushbutton

The LEDs are multi-colored. Table 40 on page 54 and Table 43 on page 55 show the meaning of the signals.

The preset push-button is under the screw cover.

4 Commissioning

This chapter provides information on the electrical installation, configuration and commissioning of the Absolute Encoder AFS60/AFM60 PROFINET.

- Please read this chapter before mounting, installing and commissioning the device.

4.1 Electrical installation

WARNING
Switch the power supply off!

The machine/system could unintentionally start up while you are connecting the devices.

- Ensure that the entire machine/system is disconnected during the electrical installation.

For the electrical installation you will need connection plugs and sockets (see the data sheet of the AFS60/AFM60 PROFINET).

4.1.1 Connections of the AFS60/AFM60 PROFINET

The connections of the AFS60/AFM60 PROFINET are on the back.

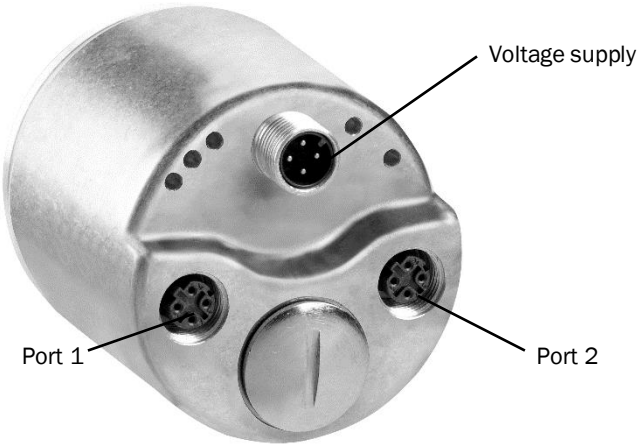


Figure 7: Position of the connections of the AFS60/AFM60 PROFINET

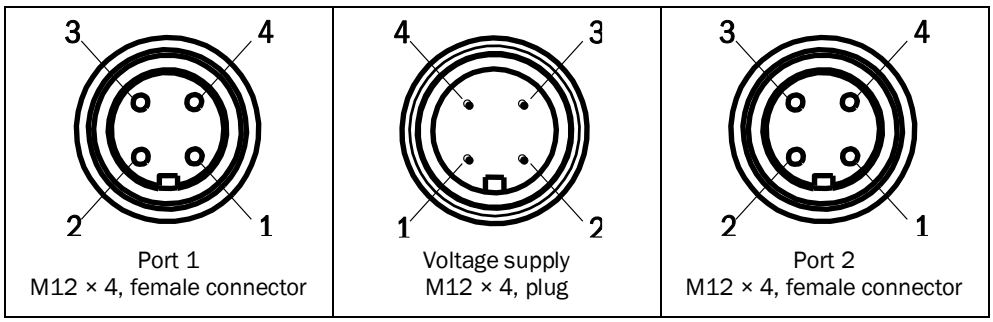


Figure 8: Connections of the AFS60/AFM60 PROFINET

Pin	Signal	Wire color[7)]	Function
1	V_S	Brown	Supply voltage 10 ... 30 V DC
2	–	White	Do not use
3	GND	Blue	0 V DC (Ground)
4	–	Black	Do not use

Table 38: Pin assignment for the connection of the voltage supply

NOTE

Pin 2 and 4 are **not allowed to be assigned**, otherwise irreparable damage could be caused to the AFS60/AFM60 PROFINET.

Pin	Signal	Wire color[7)]	Function
1	TxD+	Yellow	Ethernet
2	RxD+	White	Ethernet
3	TxD–	Orange	Ethernet
4	RxD–	Blue	Ethernet

Table 39: Pin assignment for the connections port 1 and port 2

NOTE

- **Connect the screen to the encoder's housing!**
- Pay attention to the maximum cable lengths.
- Mount all cables with strain relief.

7) On the usage of pre-wired cables.

4.2 Settings on the hardware

There are the following controls for making settings under the screw cover:

- Three address switches
- Preset push-button

▶ Open the screw cover using a screwdriver for slot-head screws with a blade width of min. 10.0 mm.

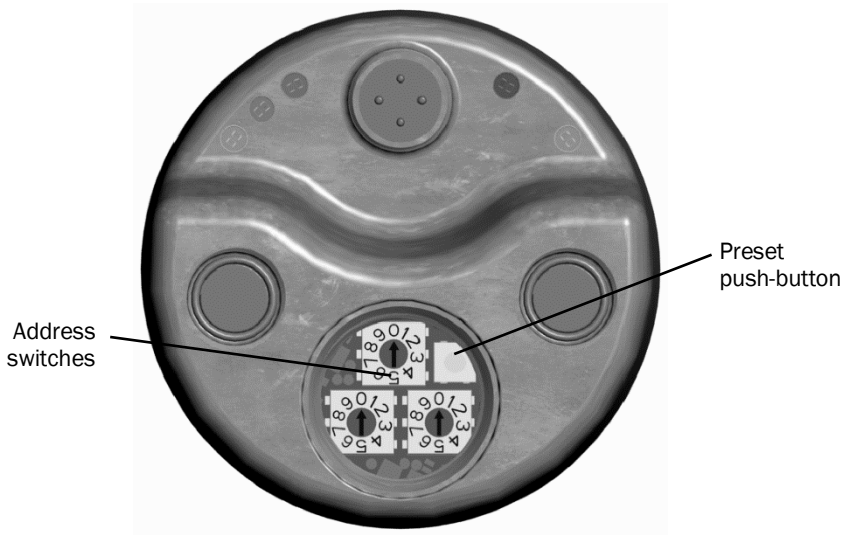


Figure 9: Position of the controls

4.3 Integration into the PLC

NOTE

All software instructions relate to the Siemens TIA Portal V13.

4.3.1 Installing the GSDML file (only once)

- Start the **TIA Portal** on your PLC.

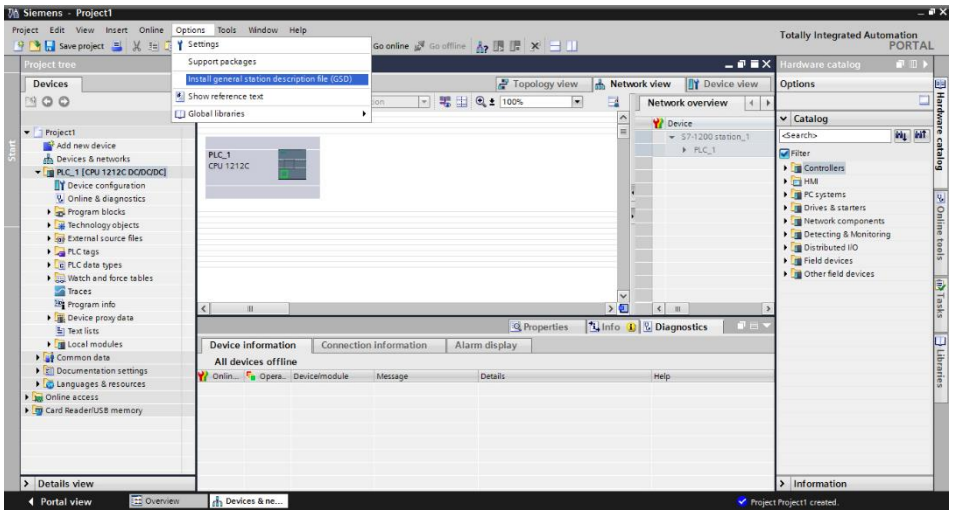


Figure 10: Installing device description file in the TIA portal

- Install the GSDML file GSDML-V2.25-SICK-AFx60-xxxxxxxx.xml for the AFS60/AFM60 PROFINET via the **Options** menu, **Install GSD file** command. The GSDML file for the encoder is available at www.sick.com for download.

4.3.2 Loading encoder in the user interface

- In the **Hardware catalog** open the **Other Field Devices**, **PROFINET IO**, **Encoders**, **SICK AG**, **SICK** folder and finally the **AFx60A** folder. Here there is a dedicated icon for each of the two variants of the encoder (see Table 3 on page 10).

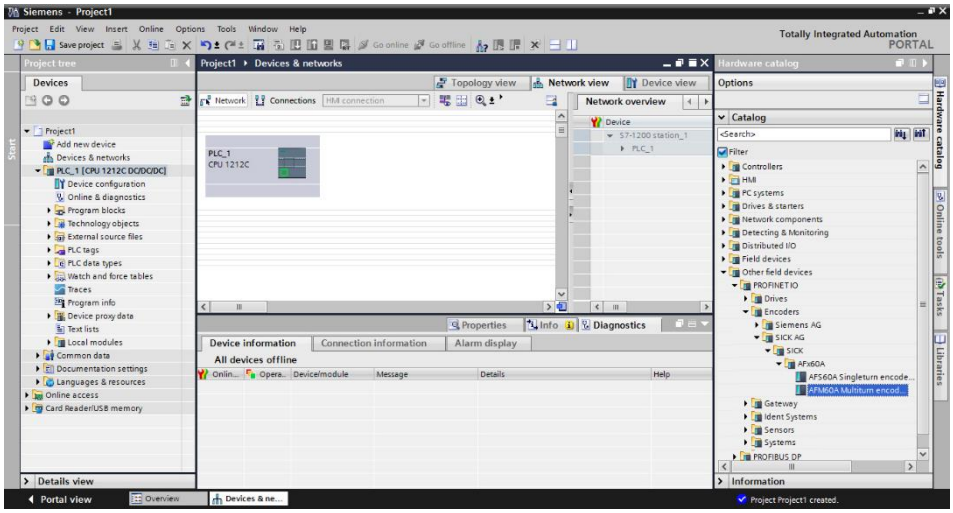


*Figure 11: AFS60/AFM60 PROFINET in **Other Field Devices***

- Add the device **AFS60A** or **AFM60A** to the **Network view** using drag-and-drop.

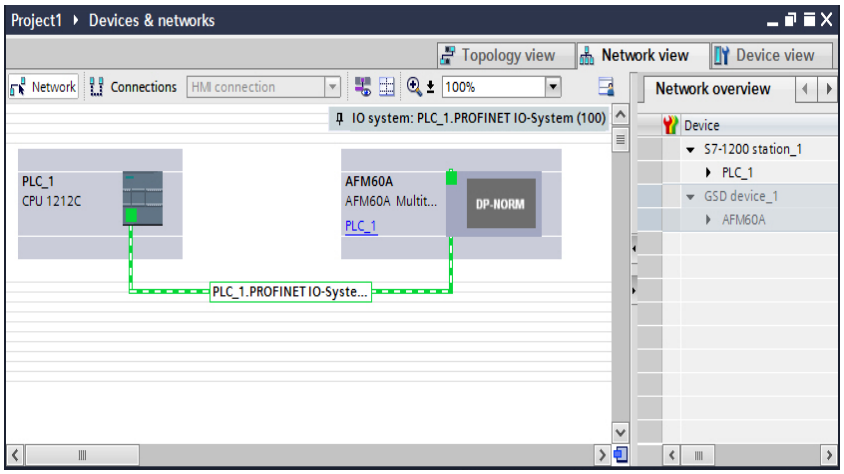


Figure 12: Connection from the PLC to AFS60A or AFM60A

- Using the mouse, drag a connection from the control system icon to the encoder icon.

4.4 Configuration of the encoder via the Parameter Access Point

Mark the encoder icon and in the **Device view**, change the configuration data and the vendor specific configuration data in the middle window at the bottom in **Parameter Access Point**. For the possible parameter settings, see section 3.6 on page 37.

Configuration data

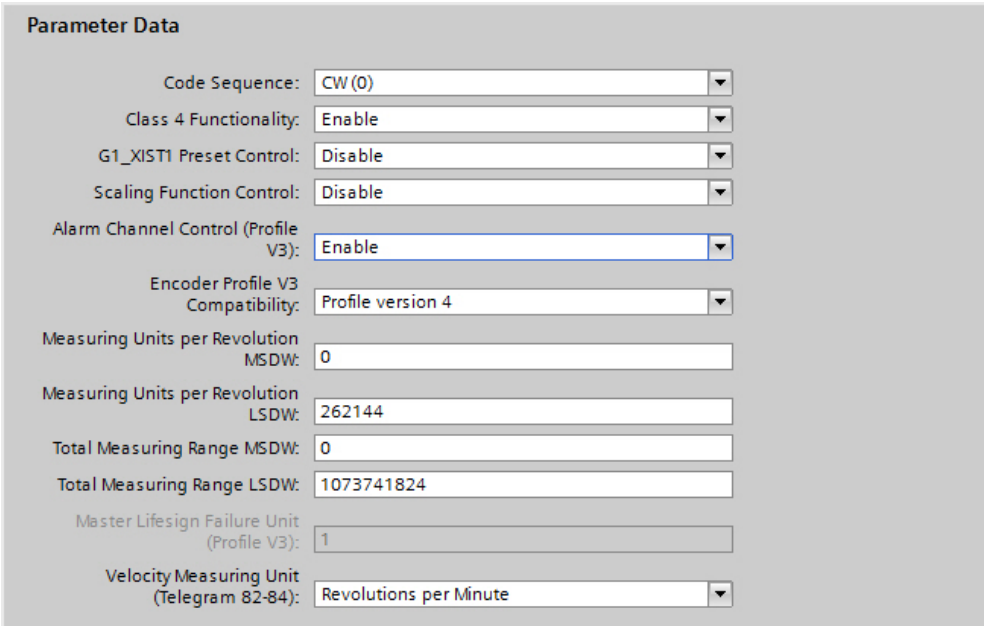


Figure 13: Configuration data

The AFS60/AFM60 PROFINET is supplied with the configuration data shown.

Vendor specific configuration data

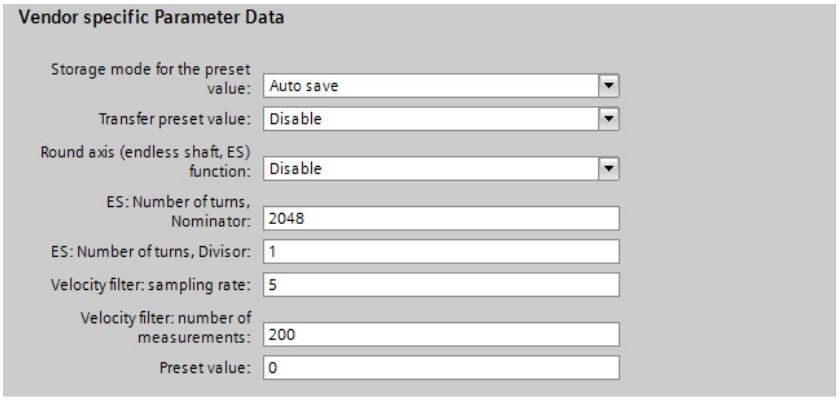


Figure 14: Vendor specific configuration data

The AFS60/AFM60 PROFINET is supplied with the vendor specific configuration data shown.

4.4.1 Reading the position

To read from position 2 (the right-justified position value) in the input data for telegrams 81 to 84, select **STW2_ENC** (encoder control word 2) and **G1_STW** (sensor 1 control word) (see section 3.4.2 on page 16).

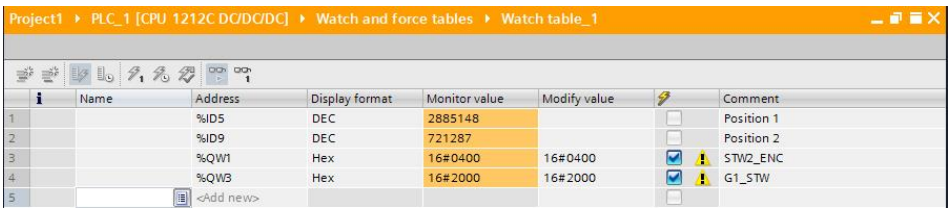


Figure 15: Reading the position

- Set bit 10 of the control word STW2_ENC to 1 (= 0400h, see Table 21 on page 23).
- Set bit 13 of the control word G1_STW to 1 (= 2000h). This results in the cyclic output of the position value in **G1_XIST2** (see Table 14 on page 20).

4.4.2 Setting preset value

A preset value only affects G1_XIST1 if the related parameters are set. For G1_XIST1 this is position 1 in the input data for telegrams 81 to 84 (see section 3.4.2 on page 16).

Configuration data

- Set the parameter **Class 4 functionality** to **Enable**.
- Set the parameter **G1_XIST1 Preset control** to **Enable**.

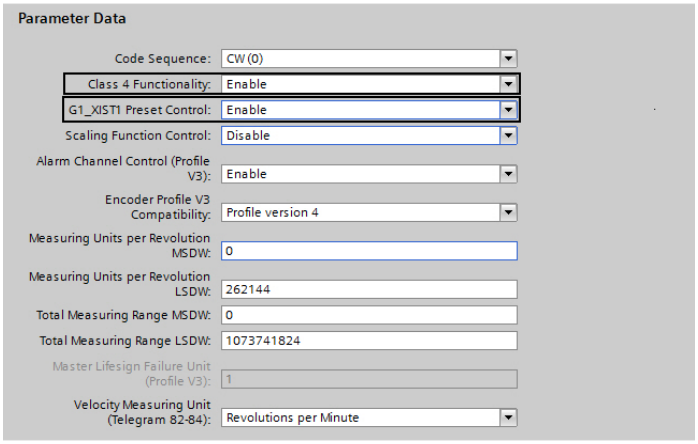


Figure 16: Configuration data for a preset value

Vendor specific configuration data

- Set the parameter **Transmit preset value** to **Enable**.
- Set the parameter **Preset value** e.g. to 600.

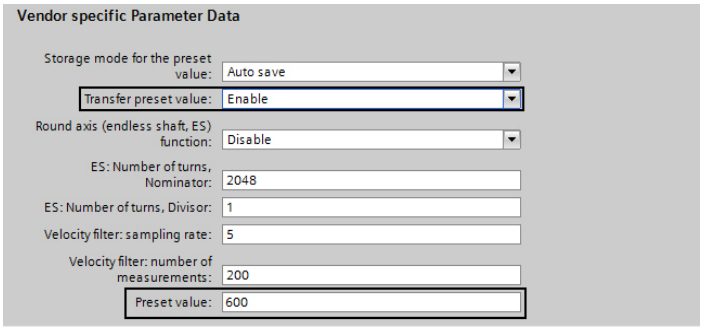


Figure 17: Vendor specific configuration data for a preset value

Control words

- Set Bit 10 of the control word STW2_ENC on 1 (=400h).
- Set Bit 12 of the control word G1_STW to 1 (= 1000h) (①).

With the edge change on bit 12 of G1_STW from 0 to 1, the preset value is set[8] and initially output only in **Position 1** (G1_XIST1 – left-justified) (②)[9].

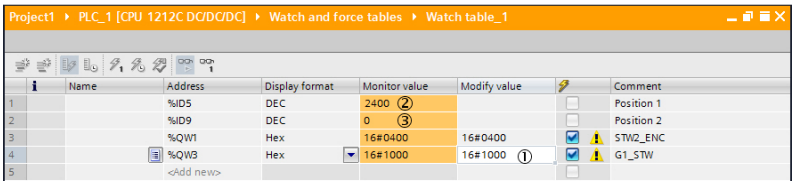


Figure 18: Setting bit 12 of G1_STW

Initially a position value is not output in **Position 2** (G1_XIST2 – right-justified (③).

- To output the position value in **Position 2** (G1_XIST2), you must set bit 12 to 0 and bit 13 of the control word G1_STW to 1 (= 2000h, ④).

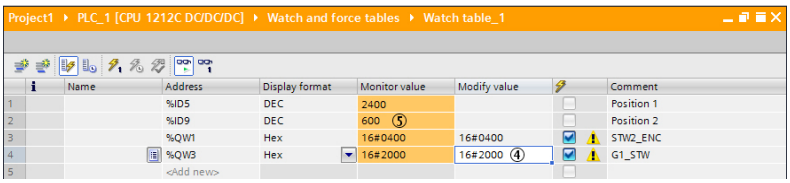


Figure 19: Setting bit 13 of G1_STW

The preset value set is then output in **Position 2** (G1_XIST2 (⑤).

8) To be able to set the preset value again, you must again set bit 12 of G1_STW to 0.
9) Due to the shift of two bits, in the decimal depiction the value is four times the preset value (in the example 2400 instead of 600).

4.5 Configuring encoder as technology object

The encoder can be configured as a technology object. It is a prerequisite that the encoder is integrated into the PLC (see section 4.3 on page 45).

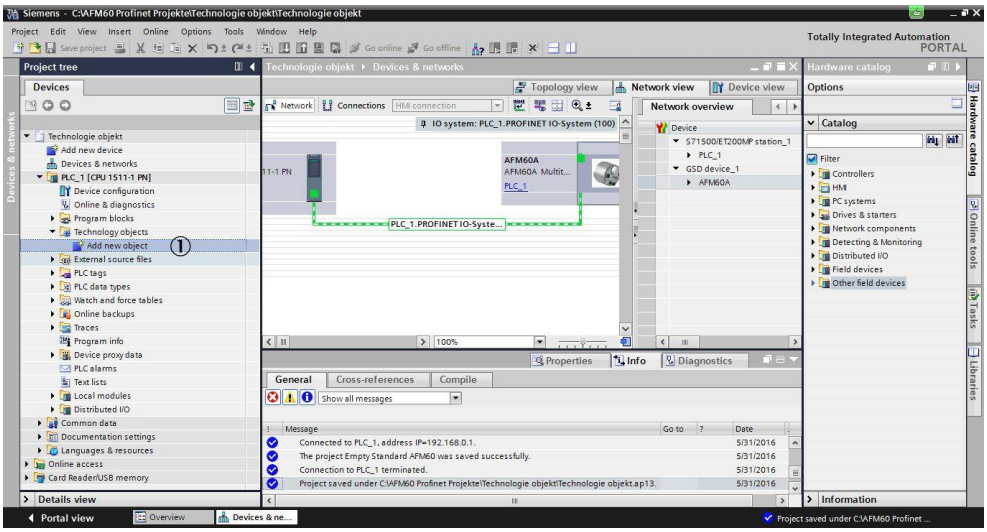


Figure 20: Project navigation in the TIA Portal

- In **Technology objects**, select the command **Add new object** (①).
  The **Add new object** dialog box is opened.

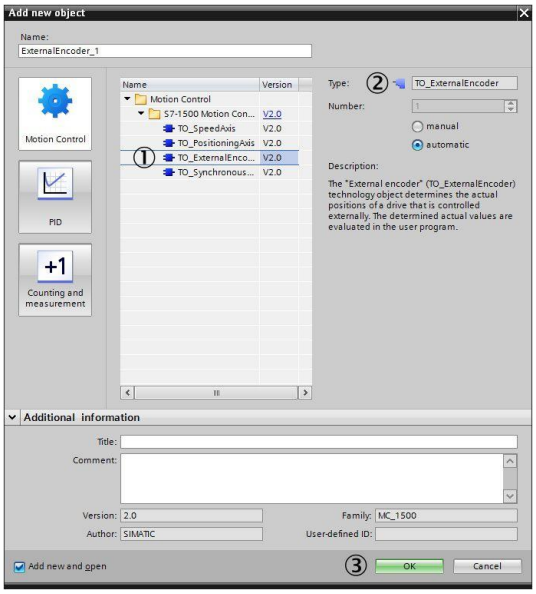


Figure 21: Add new object dialog box

- As Motion Control choose **TO_ExternalEncoder** (①) (for an external encoder).
- If necessary, enter a type code for the encoder in the **Type** field (②) (e.g. AFx60).
- Click **OK** (③).

The encoder is added as an **ExternalEncoder** in **Technology objects** in the **Project tree**.

- In the **Project tree** select the point **Configuration** (①) under the newly added encoder.
  The **Basic parameters** of the encoder are displayed.

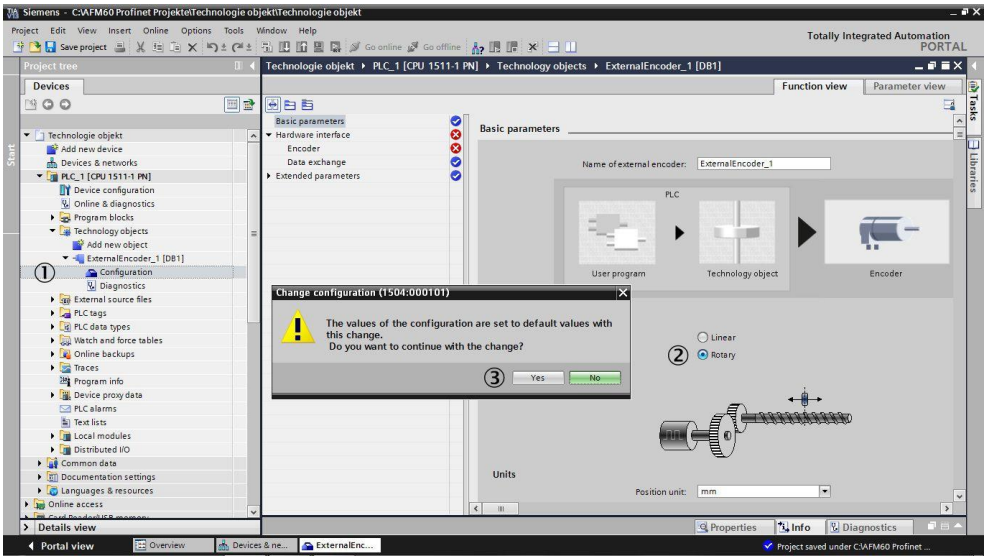


Figure 22: Configuring the basic parameters

- In **Basic parameters** select the option **Rotary** (②).
- Accept the message that the configuration will be set to the default values using **Yes** (③). As a consequence any parameters configured previously will be lost.

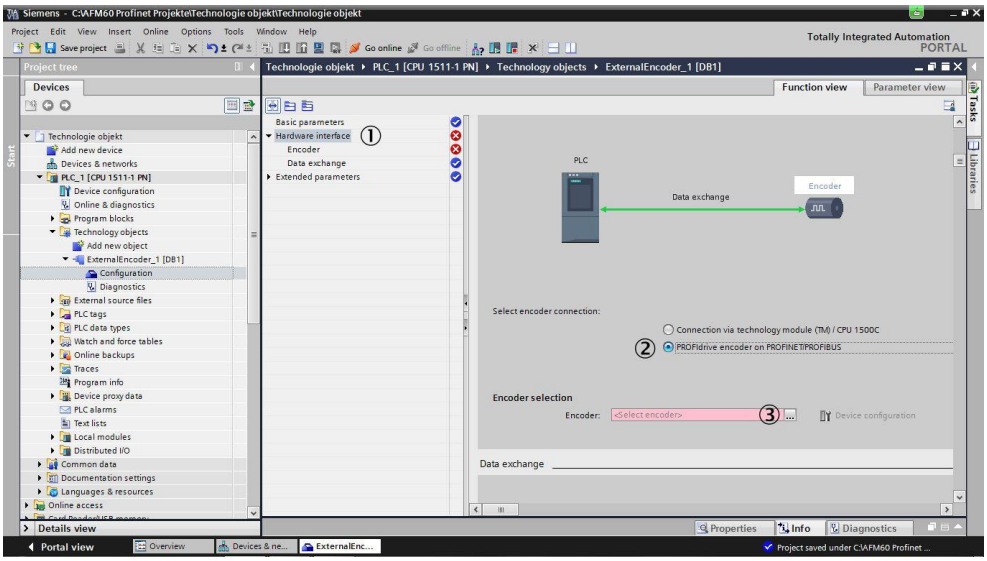


Figure 23: Configuring the hardware interface

- Select **Hardware interface** (①).
- Choose the **PROFIdrive encoder on PROFINET/PROFIBUS** option (②).
- Click the **Encoder...** list box (③).

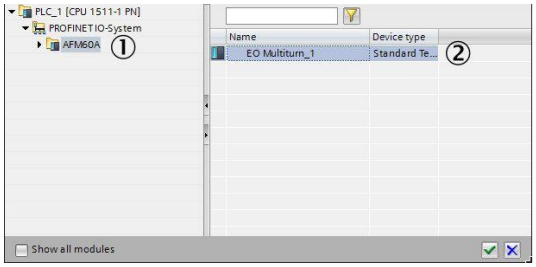


Figure 24: Selecting AFM60A

- Select **AFM60A** (①).
- Select **EO_Multiturn_1** (②).
- Click on the green checkmark (③).

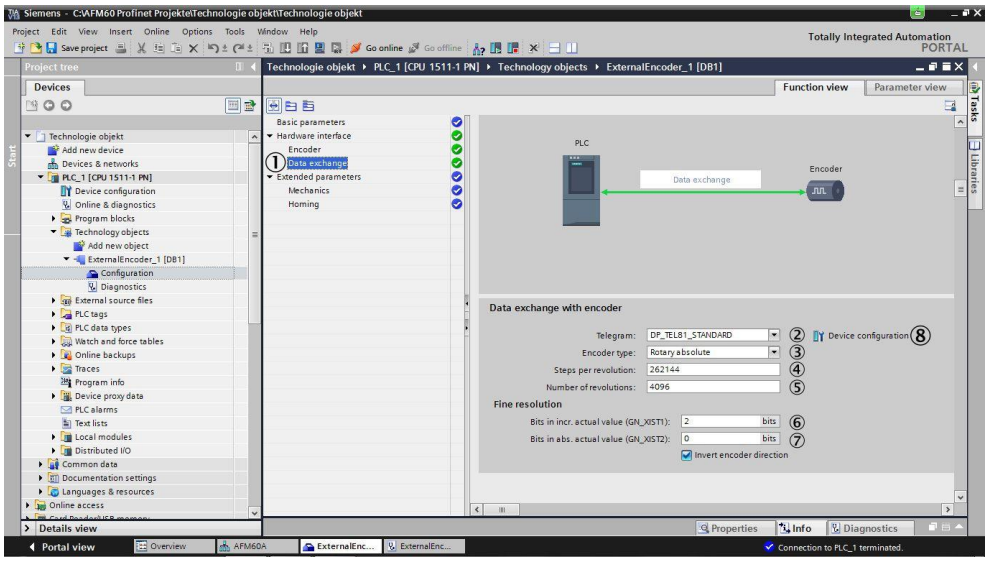


Figure 25: Data exchange

- Select **Data exchange** (①).
- In **Telegram** (②) select the telegram for the exchange of data. You must select the same telegram that was selected during the integration of the encoder. Only telegrams 81 and 83 are supported.
- In **Encoder type** (③) select the option **Rotary absolute**.
- In the **Steps per revolution** field enter 262144 (④) and in the **Number of revolutions** field enter 4096 (⑤).
- Enter the following values in the **Bits in incr. actual value (Gn_XIST1)** (⑥) field:
  - AFS60 = 14
  - AFM60 = 2
- In the **Bits in incr. actual value (Gn_XIST2)** (⑦) field enter the value **0**.
- Then click **Device configuration** (⑧).

The **Device view** opens.

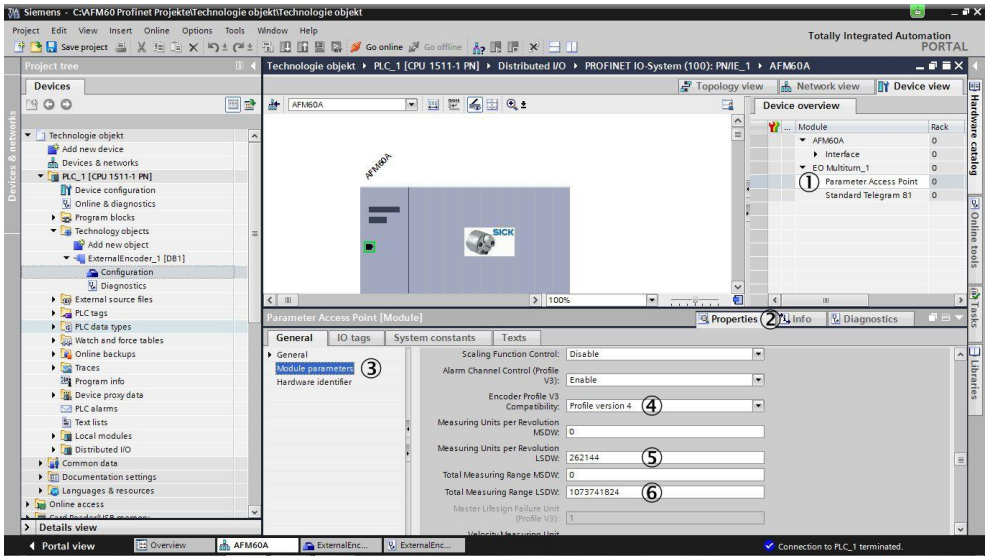


Figure 26: Device view

- Click **Parameter Access Point** (①), **Properties** (②) and then **Module parameters** (③).
- In the **Encoder Profile V3 Compatibility** field (④), choose the following options:
  - **Profile version 3** for the encoder with date code up to 1706
  - **Profile version 4** for the encoder with date code from 1707
- The value in the **Measuring Units per Revolution LSDW** field (⑤) must be the same as the value in the **Steps per revolution** field in **Data exchange** (see Figure 25 on page 52).
- The value in the **Total Measuring Range LSDW** field (⑥) must be the same as the product of the value in the **Steps pre revolution** and the **Number of revolutions** field in **Data exchange** (see Figure 25 on page 52).

4.6 Test notes

WARNING
Commissioning requires a thorough check by authorized personnel!

Before you operate a system equipped with the AFS60/AFM60 PROFINET for the first time, make sure that the system is first checked and released by authorized personnel. Please read the notes in chapter 2 “On safety” on page 8.

5 Troubleshooting

This chapter describes how to identify and rectify errors and malfunctions of the AFS60/AFM60 PROFINET Absolute Encoder.

5.1 In the event of faults or errors

WARNING
Cease operation if the cause of the malfunction has not been clearly identified!

Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely rectify the malfunction.

5.2 Support

If you cannot remedy an error with the help of the information provided in this chapter, please contact your local SICK representative.

5.3 Diagnostics

5.3.1 Error and status indications on the LEDs

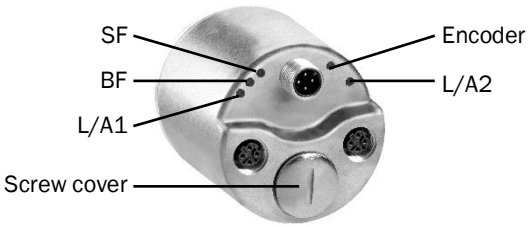


Figure 27: Position of the LEDs

Status LEDs System Failure (SF), Bus Failure (BF) and Encoder

Display	Description
☀ Red	Flash test of the controller
● Red	Encoder error, no data exchange

Table 40: Meaning of the status LED SF

Display	Description
○ Off	Data exchange with master, device in operation
● Green	Initialization
● Red	No connection to other devices, no data exchange

Table 41: Meaning of the status LED BF

Display	Description
○ Off	No operating voltage
● Red/green	Self-test/initialization
● Green	Encoder in operation
☼ Red/green	Below or above limits (speed, temperature, LED current, operating voltage)
● Red	Position or memory-related error
☼ Orange	Invalid preset value or invalid value for the configuration parameters
☼ Green	Encoder manually reset to factory settings (see section 5.5 on page 63). Necessary to switch off and switch on again the operating voltage

Table 42: Meaning of the status LED Encoder

Ethernet Link LEDs L/A1 and L/A2

The Ethernet Link LEDs L/A1 and L/A2 display the status of the physical connection on the Ethernet interfaces. L/A1 shows the status of the Ethernet interface 1, L/A2 the status of the Ethernet interface 2 (see Figure 7 on page 42).

Display	Description
○ Off	No operating voltage or No Ethernet connection
● Green	Ethernet connection established
☼ Green	Data transmission
● Orange	Data transmission at 100 Mbit/s

Table 43: Meaning of the LEDs L/A1 and L/A2

5.4 Error transmission via PROFINET

PROFINET provides diagnostics features that help you to locate a problem if the cause of the error is unclear or if there are availability problems. The following diagnostic features are available:

- Error messages via parameter 65,001
- Error messages via the alarm channel
- Error codes in telegram part G1_XIST2

NOTE

- The function of the encoder corresponds to encoder profile version 4.1 for PROFIBUS and PROFINET. Accordingly the encoder must enter an error state in the event of a brief fault on the bus. Such brief faults can be triggered by electromagnetic interference, particularly by transient overvoltages.
- An error state must be acknowledged by the control system, only then does the encoder output valid values in the telegram part G1_XIST2 on the bus.

▶ This aspect must be taken into account in the implementation of the control system.

After the error has been detected by the control system, it can be reset using bit 15 of the sensor 1 control word (G1_STW). This is only possible if the cause of the error has been rectified and the status of the encoder is within the defined limits.

5.4.1 Error message on vendor specific parameters

The status of the encoder can be read via the parameter 1,001. The individual bits in the subindex .0 to .2 indicate the nature of the error.

Subindex .0 – Sensor status (S_STAT-A)

Bit	Designation	Description
15	EEPROM_DATA_CHKS	Memory error: Invalid EEPROM checksum on initialization
14	I2C_COMM_SENS_DEV	Position error: Invalid communication with the I²C device[10] in the sensor module
13	–	Reserved
12	POS_SYNC_MULTCNT_UPDATE	Position error: Invalid EEPROM checksum or Invalid internal SSI communication (MFP4 signal[11])
11	POS_SYNC_MULTITURN	Position error: Invalid synchronization or no synchronization of MA sensor[12] with the LY singleturn position[13]
10	POS_CALC_SINGL	Position error: The error register in LY is activated (MFP5 signal[11]). or Invalid internal SSI communication (MFP4 signal[11])
9	POS_VECTORLEN_MULTI	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the multiturn stage
8	POS_VECTORLEN_SINGL	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the singleturn stage
7	I2C_COMM_EEPROM	Position and memory error: Invalid communication with the I²C device in the main unit
6	POS_AMPLITUDE_SINGL	Position error: Error on the calculation of the amplitude values Sin + Cos in the singleturn stage

10) Internal interface between EEPROM and sensor for the encoder.
11) Output signal from the encoder sensor.
12) Internal Hall sensor that determines the multiturn position magnetically.
13) LY = internal sensor for the singleturn position.

Bit	Designation	Description
5	ENC_SPEED_OUTSIDE_LIM	Warning in relation to the speed: Current measured value outside of the minimum or maximum limit
4	POS_AMPLITUDE_MULTI	Position error: Error on the calculation of the amplitude values Sin + Cos in the multiturn stage
3	ENC_VOLT_OUTSIDE_LIM	Warning in relation to the supply voltage: Current measured value outside of the minimum or maximum limit
2	ENC_LED_CURRENT_CRIT	Warning, sensor LED current critical: Current measured value outside of the minimum or maximum limit
1	ENC_TEMP_OUTSIDE_LIM	Warning in relation to the temperature: Current measured value outside of the minimum or maximum limit
0	–	Warning: General start-up error at power-on

Table 44: Subindex .0 – Sensor status (S_STAT-A)

Subindex .1 – Sensor status (S_STAT-B)

Bit	Designation	Description
15	INVALID_PARA_SENS_EEP	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization: • In the area of the sensor configuration data
14	INVALID_ARA_DEV_CONFIG	• In the area of the device configuration data
13	INVALID_DIAG_PROC_B	• In the area of the diagnostics of the basic process data
12	INVALID_DIAG_SERV_A	• In the area of the diagnostics of the service data
11	INVALID_PARA_COMM_X	• In the area of the user configuration, communication mapping
10	–	Reserved
9	–	Reserved
8	INVALID_PARA_BAS	• In the area of the user configuration, basic parameters
7	–	Reserved
6	–	Reserved
5	FREQUENCY_WARN	Warning, speed exceeds configured maximum value
4	INVALID_PRESET_OPER	Warning, triggered on executing the preset function. The preset value is outside the measuring range (CMR).
3	–	Reserved
2	–	Reserved
1	INVALID_PARAM_BAS	Warning, occurred on changing or writing parameter values: • In the area of the encoder profile specific objects
0	–	Reserved

Table 45: Subindex .1 – Sensor status (S_STAT-B)

Subindex .2 – Sensor status (S_STAT-C)

Bit	Designation	Description
15	OPER_RT-SYNC	Information: Encoder in the Synchronous operating mode. The formation of the position **is synchronized** with the process data cycle of the master
14	OPER_FREE-RUN	Information: Encoder in the Free Run operating mode. The formation of the position **is not synchronized** with the process data cycle of the master
13	–	Reserved
12	HOME_POS_ACK	Preset function has been triggered and accepted
11 ... 5	–	Reserved
4	FLICKER_MODE_1	Reserved
3	–	Status information on saving internal diagnostic data: Bit 3 = 1 and Bit 2 = 0: Save operation complete Bit 3 = 0 and Bit 2 = 1: Save operation requested and operation in progress
2		
1	–	Saving the configuration data using the Save command: Bit 1 = 1 and Bit 0 = 0: Save operation complete Bit 1 = 0 and Bit 0 = 1: Save operation requested and operation in progress
0		

Table 46: Subindex .2 – Sensor status (S_STAT-C)

5.4.2 Error messages on encoder profile specific parameters

The status of the encoder can be read via the parameter 65,001. The individual bits in the subindex indicate the nature of the error (see Table 47 to Table 50).

Subindex .2 – Current errors

Bit	Designation	Data values
31 ... 6	Reserved	–
5	Memory error	**0** = Not active **1** = Active
4	Diagnostics during commissioning	**0** = Not active **1** = Active
3	Reserved	–
2	Overvoltage	**0** = Not active **1** = Active
1	Undervoltage	**0** = Not active **1** = Active
0	Position error	**0** = Not active **1** = Active

Table 47: Subindex .2 – Current errors

Subindex .3 – Supported error messages

Bit	Designation	Data values
31 ... 6	Reserved	–
5	Memory error	**1** = Supported
4	Diagnostics during commissioning	**1** = Supported
3	Short-circuit	**0** = Not supported
2	Overvoltage	**1** = Supported
1	Undervoltage	**1** = Supported
0	Position error	**1** = Supported

Table 48: Subindex .3 – Supported error messages

Subindex .4 – Current warnings

Bit	Designation	Data values
31 ... 7	Reserved	–
6	Reserved	–
5	Reserved	–
4	Reserved	–
3	Reserved	–
2	Low power output from the light source for the optical scanning (LED)	**0** = Not active **1** = Active
1	Operating temperature exceeded	**0** = Not active **1** = Active
0	Maximum frequency exceeded	**0** = Not active **1** = Active

Table 49: Subindex .4 – Current warnings

Subindex .5 – Supported warnings

Bit	Designation	Data values
31 ... 7	Reserved	–
6	Reference point	**0** = Not supported
5	Battery voltage too low	**0** = Not supported
4	Operating time exceeded	**0** = Not supported
3	CPU watchdog status	**0** = Not supported
2	Low power output from the light source for the optical scanning (LED)	**1** = Supported
1	Operating temperature exceeded	**1** = Supported
0	Maximum frequency exceeded	**1** = Supported

Table 50: Subindex .5 – Supported warnings

The errors can, once they have been detected by the control system, be reset via bit 15 of the sensor 1 control word (G1_STW). This is only possible if the cause of the error has been rectified and the status of the encoder is within the defined limits.

5.4.3 Alarm channel

The AFS60/AFM60 PROFINET transmits the errors and warnings to the control system in the so-called alarm channel. The transmission contains the alarm IDs, the necessary address information and the so-called channel-related diagnosis.

Errors are signaled as diagnostic errors and warnings as maintenance prompts:

Code	Designation
9000h	Memory error
9011h	Diagnostics during commissioning
9001h	Overvoltage
9002h	Undervoltage
900Ah	Position error

Table 51: Possible errors in the alarm channel

Code	Designation
9010h	Maximum frequency exceeded
9005h	Operating temperature exceeded/dropped below
9006h	Low power output from the light source for the optical scanning (LED)

Table 52: Possible warnings in the alarm channel

5.4.4 Error codes in telegram part G1_XIST2

In the case of an error, an error code is output in the cyclic process data in the telegram part G1_XIST2 (see Table 7 on page 16 and Table 11 on page 18). These manufacturer-specific error codes permit detailed error analysis.

Error code	Designation	Description
0001h	Error of the encoder sensor	Error on the generation of the encoder signal that would lead to an invalid position value in Gx_XISTx (e.g. error in the electronics, invalid sensor signal etc.)
0F01h	Command not supported	Command (e.g. requested via a control word) is not supported
0F05h	Operating temperature exceeded	Maximum operating temperature exceeded
1001h	Memory error	Invalid checksum found in the EEPROM or EEPROM cannot be read
1003h	Undervoltage	Minimum operating voltage dropped below. The encoder is started again once the minimum operating voltage is reached.
1004h	Overvoltage	Maximum operating voltage exceeded

Table 53: Error codes in telegram part G1_XIST2

5.5 Replacement of an encoder in the PROFINET network

If a device in the PROFINET is replaced with a new device (e.g. after a fault), the new device must have the same device name as the old device.

You will need corresponding access rights on the PLC to configure the device name.

Replacement without corresponding access rights

The AFS60/AFM60 PROFINET supports the Link Layer Discovery Protocol (LLDP). With this protocol the configuration data for the old encoder are loaded onto the new encoder after the replacement of the encoder.

The following requirements must be met:

- All devices in the network support LLDP.
- LLDP is activated in the PLC.
- The new encoder has no device name.

NOTE

The device names AFS60A or AFM60A are pre-configured in the factory. For this reason the device name on the new encoder must be deleted using the following procedure.

How to replace the encoder:

- ▶ Remove all three connecting cables from the old encoder.
- ▶ Replace the encoder with a new encoder.
- ▶ Only connect the cable for the power supply to the new encoder.
- ▶ Set the three address switches to 888 (see 4.2 on page 44).
- ▶ Press the Preset push-button for 5 seconds.
  The encoder LED flashes green.
- ▶ Switch the voltage supply off and on again.
  The encoder is reset to the factory settings and the device name is deleted.
- ▶ Connect the two Ethernet cables to the encoder.
  The configuration from the old encoder is loaded onto the new encoder.

6 Annex

6.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

6.1.1 Compliance with EU directives

EU declaration of conformity (excerpt)

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

6.1.2 Compliance with UK statutory instruments

UK declaration of conformity (extract)

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

8015078/1EF3/2021-12-13 · LF_07 · A4 4c int49

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