OPERATING INSTRUCTIONS

AFS60 EtherCAT
AFM60 EtherCAT

Absolute Encoder

GB

SICK
Sensor Intelligence.

Contents

1 About this document

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

1.1 Function of this document

These operating instructions are 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 EtherCAT Absolute Encoder.

1.2 Target group

These operating instructions are addressed at the *planners*, *developers* and *operators* of systems in which one or more AFS60/AFM60 EtherCAT Absolute Encoders are to be integrated. They also address people who initialize the use of the AFS60/AFM60 EtherCAT or who are in charge of servicing and maintaining the device.

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

1.3 Information depth

These operating instructions contain information on the AFS60/AFM60 EtherCAT Absolute Encoder on the following subjects:

- product features
- electrical installation
- putting into operation and configuration
- fault diagnosis and troubleshooting
- conformity

The operating instructions do not contain any information on the mounting of the AFS60/AFM60 EtherCAT. You will find this information in the mounting instructions included with the device.

They also do 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 EtherCAT.

Planning and using measurement systems such as the AFS60/AFM60 EtherCAT 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 EtherCAT, the national, local and statutory codes and regulations must be observed.

Further information

- www.ethercat.org
- ETG.1000, 2 ... 6: Layer protocol & service definitions
- ETG.1020, EtherCAT Guidelines and Protocol Enhancements
- ETG.1300, EtherCAT Indicator & Labeling specification (as per IEC 61784-2)
- ETG.2000, EtherCAT Slave Information
- ETG.2200, EtherCAT Slave Implementation Guide
- CiA DS-406, Profile Encoder for CANopen
- CiA DS-301, CANopen communication profile
- ET1810/1812, Slave Controller IP Core for Altera FPGA

1.4 Scope

These operating instructions are original operating instructions.

Note These operating instructions apply to the AFS60/AFM60 EtherCAT Absolute Encoder with the following type codes:

- Singleturn Encoder Advanced = AFS60A-xxEx262144
- Multiturn Encoder Advanced = AFM60A-xxEx018x10

1.5 Abbreviations used

CMR Counts per Measuring Range

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

CoE CANopen over EtherCAT

CPR Counts Per Revolution

DC Distributed Clocks

EEPROM Electrically Erasable Programmable Read-only Memory

EoE Ethernet over EtherCAT

ESC EtherCAT Slave Controller

ESI EtherCAT Slave Information = electronic data sheet based on XML

ESM EtherCAT State Machine = controls the status of the EtherCAT slave

ETG EtherCAT Technology Group

EtherCAT® EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

PDO Process Data Object

PLC Programmable Logic Controller

PMR Physical Measuring Range

PRS Physical Resolution Span (per revolution)

SDO Service Data Object

1.6 Symbols used

Note Refer to notes for special features of the device.

● **Red**, ☼ **Yellow**, ○ **Green** LED symbols describe the state of a diagnostics LED. Examples:

● **Red** The red LED is illuminated constantly.

☼ **Yellow** The yellow LED is flashing.

○ **Green** The green 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.

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 EtherCAT or with the machine or system in which the AFS60/AFM60 EtherCAT is used.

2.1 Authorized personnel

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

Note Repairs to the AFS60/AFM60 EtherCAT are only allowed to be undertaken by trained and authorized service personnel from SICK STEGMANN GmbH.

The following qualifications are necessary for the various tasks:

Tab. 1: Authorized personnel

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 • Knowledge of EtherCAT® • Knowledge of automation software

2.2 Correct use

The AFS60/AFM60 EtherCAT 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 personnel and systems must be provided by the constructor of the system as per statutory regulations.

Due to its design, the AFS60/AFM60 EtherCAT can only be operated within an EtherCAT network. It is necessary to comply with the EtherCAT specifications and guidelines for setting up a EtherCAT network.

In case of any other usage or modifications to the AFS60/AFM60 EtherCAT, e.g. opening the housing during mounting and electrical installation, or in case of modifications to the SICK software, any claims against SICK STEGMANN GmbH 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 EtherCAT!

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 installing, operating or maintaining the device:

- The operating instructions 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 all applicable safety regulations 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.

Tab. 2: Disposal of the assemblies

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

3 Product description

This chapter provides information on the special features and properties of the AFS60/AFM60 EtherCAT Absolute Encoder. 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

Tab. 3: Special features of the encoder variants

Properties	Singleturn Encoder Advanced	Multiturn Encoder Advanced
Absolute Encoder in 60 mm design	■	■
Robust nickel code disk for harsh environments	■	■
High precision and reliability	■	■
Large ball bearing spacing of 30 mm	■	■
High level of freedom from vibration	■	■
Optimal rotational accuracy	■	■
Compact design	■	■
Face mount flange, servo flange, blind hollow shaft and through 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	–	■
EtherCAT interface (as per IEC 61 784-1)	■	■
Supports the encoder profile CiA DS-406	■	■

3.2 Operating principle of the encoder

The sensing system in the AFS60/AFM60 EtherCAT Absolute Encoder is based on absolute acquisition of revolutions without an external power supply or battery. As a consequence the encoder can immediately output its absolute position again after switching off and switching back on.

The AFS60/AFM60 EtherCAT acquires the position of rotating axes and outputs the position in the form of a unique digital numeric value. Optical acquisition is from an internal coded disk.

The AFS60 EtherCAT is a singleturn encoder

Singleturn encoders are used if the absolute position of the shaft for one revolution is required.

The AFM60 EtherCAT is a multiturn encoder

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

3.2.1 Scaleable resolution

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

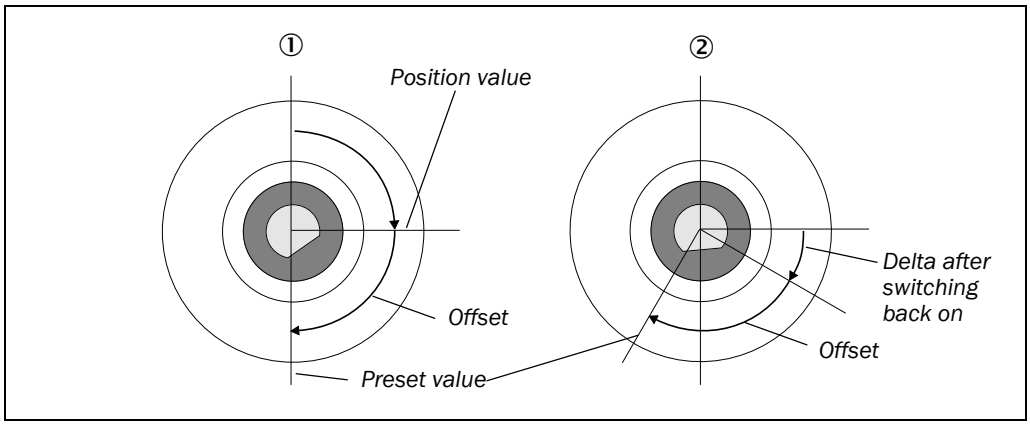
The resolution per revolution can be scaled from 1 ... 262,144 as an integer. The total resolution of the AFM60 EtherCAT must be 2^n times the resolution per revolution. This restriction is not relevant if the round axis functionality is activated.

3.2.2 Preset function

The position value for an encoder can be set with the aid of a preset value. I.e. the encoder can be set to any position within the measuring range. In this way, e.g., the encoder's zero position can be adjusted to the machine's zero point.

On switching off the encoder, the offset, the delta between the real position value and the value defined by the preset, is saved. On switching back on the new preset value is formed from the new real position value and the offset. Even if the position of encoder changes while it is switched off, this procedure ensures the correct position value is still output.

Fig. 1: Saving the offset



① = on switching off

② = on switching back on

3.2.3 Round axis functionality

The encoder supports the function for round axes. During this process, the steps per revolution are set as a fraction. 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 position value output is adjusted with the zero point correction, the counting direction set and the gearbox parameters entered.

Example:

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.

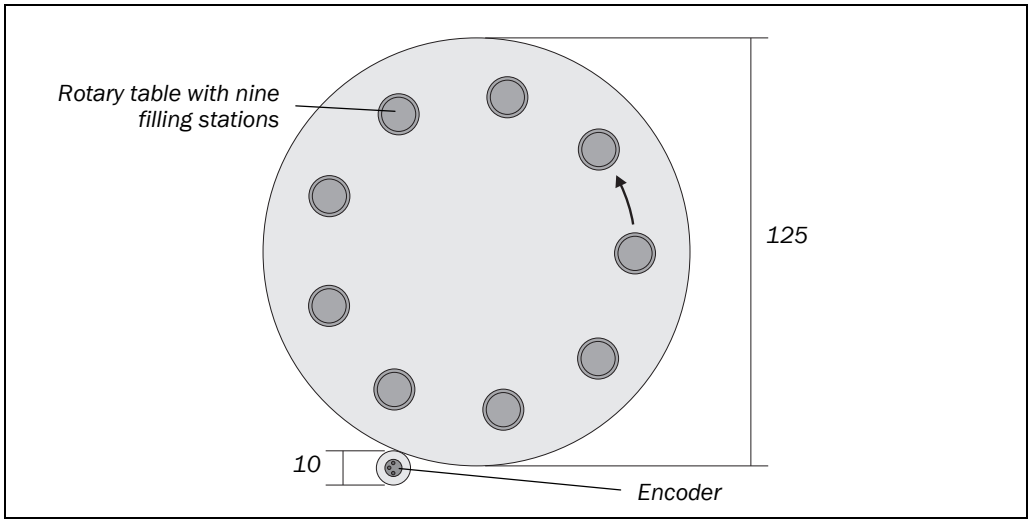


Fig. 2: Example round axis functionality for position measurement on a rotary table

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 resolution per revolution and the total resolution, as the total resolution is not 2^n times the resolution 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).

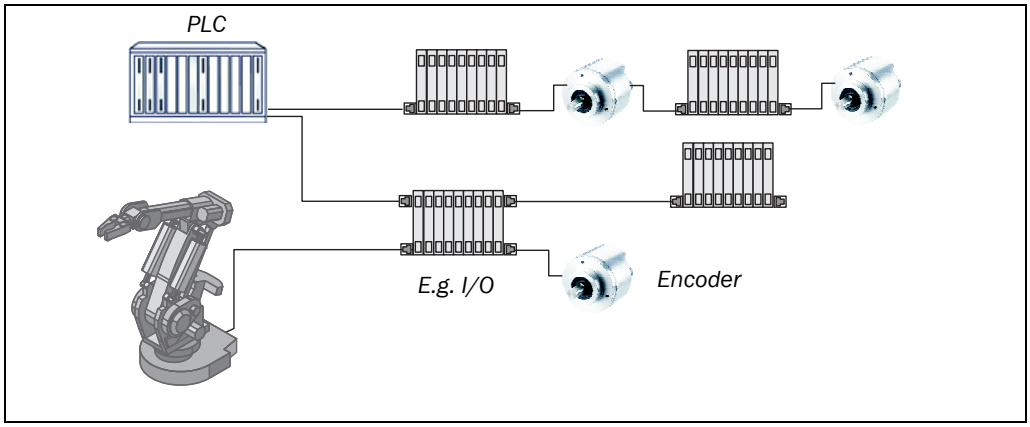
After 12.5 revolutions (that is after one complete revolution of the rotary table) the encoder reaches the total resolution of 9,000.

3.3 Integration in EtherCAT

3.3.1 EtherCAT topology

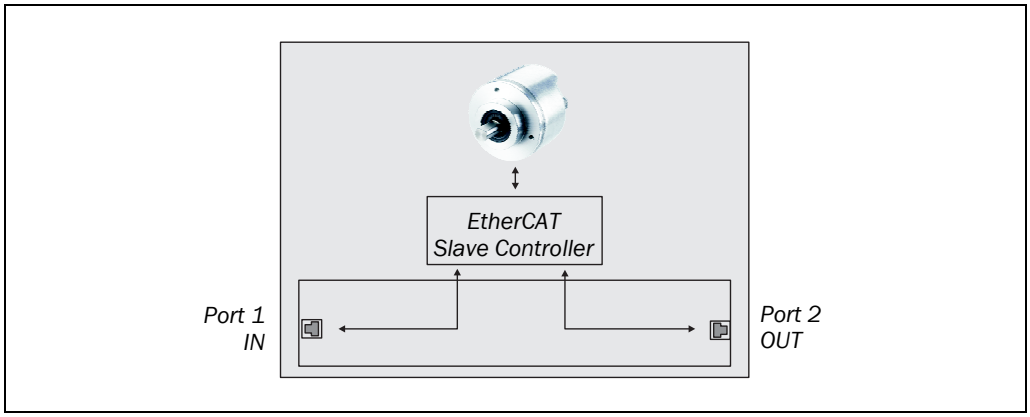
EtherCAT® supports a large variety of topologies such as line, tree, ring, star and their combinations.

Fig. 3: EtherCAT topology



For this reason the AFS60/AFM60 EtherCAT has two Ethernet interfaces for integration in an EtherCAT topology.

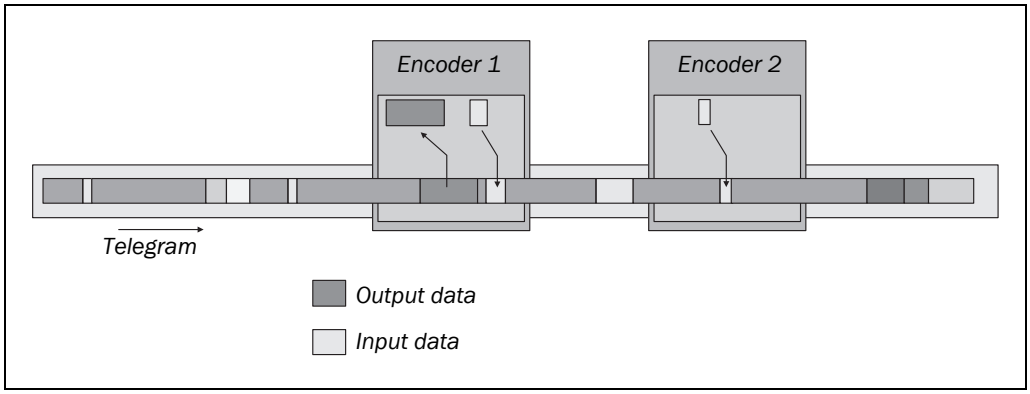
Fig. 4: Two Ethernet interfaces on the encoder



An EtherCAT connection comprises to a large extent standardized Ethernet components. The slaves (e.g. the AFS60/AFM60 EtherCAT) have an **EtherCAT Slave Controller** for the communication with the master.

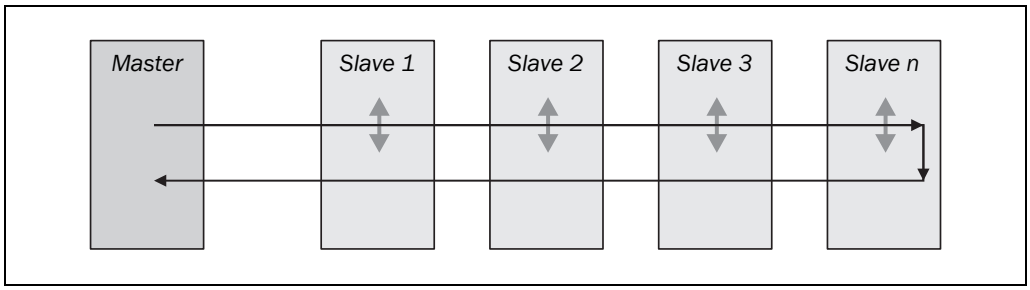
The EtherCAT Slave Controller in the AFS60/AFM60 EtherCAT reads the output data for the encoder and writes the input data for the PLC while the telegram is passing through. The process is implemented in hardware in the EtherCAT Slave Controller and is therefore independent of the software cycle times of the protocol stack or the processor's performance.

Fig. 5: Passage of the EtherCAT telegram



The last EtherCAT slave in the segment sends back the already completely processed telegram so that it is sent to the controller — as a quasi reply telegram.

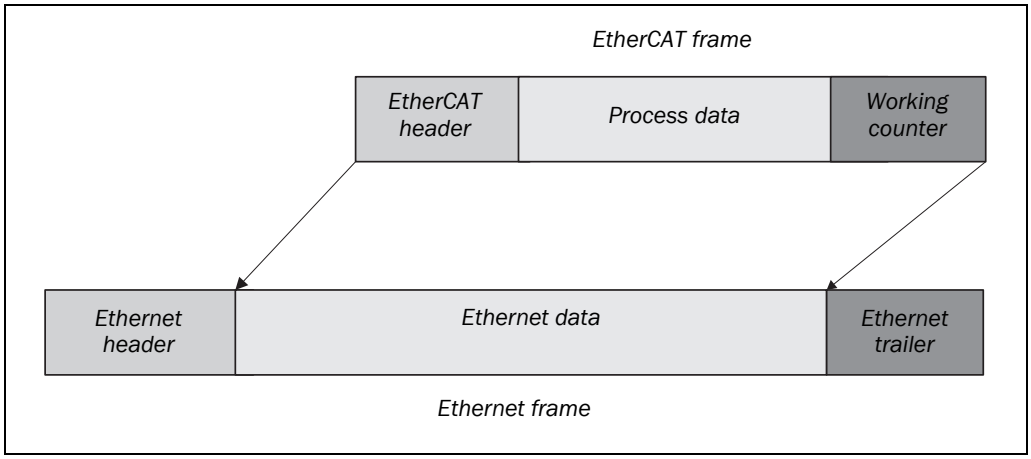
Fig. 6: Returning the EtherCAT telegram



3.3.2 EtherCAT telegram in the Ethernet frame

EtherCAT is based on the standard Ethernet frame. This contains the Ethernet header, the Ethernet data and the Ethernet trailer. The EtherCAT telegram is transported directly in the Ethernet data using a specially standardized EtherCAT frame.

Fig. 7: EtherCAT frame in the Ethernet frame



Data in the form of process data are exchanged between the master and slaves in the Ethernet frame. Each telegram has an address that refers to a specific slave or several slaves. The combination of data and address form an EtherCAT telegram.

- An Ethernet frame can contain several telegrams.
- Several Ethernet frames may be necessary for all the telegrams for a control cycle.

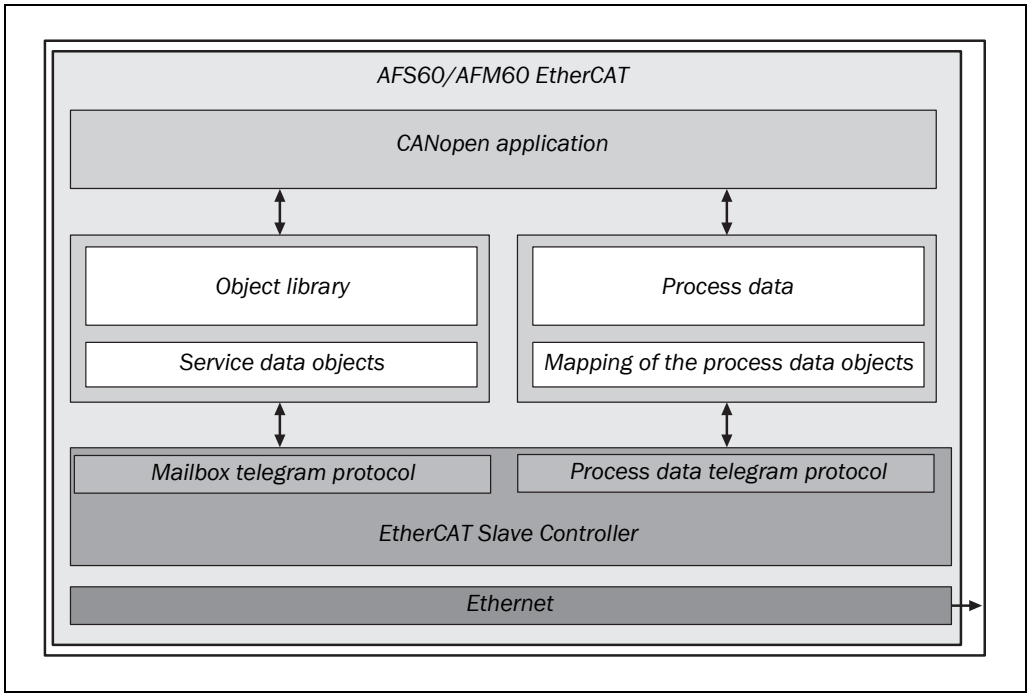
Each bus user has an addressable memory area of 64 kbyte in the telegram; data can be read, written or read and written simultaneously.

3.3.3 CANopen over EtherCAT (CoE)

EtherCAT® only defines a new protocol for the transport layer. It does not define its own user or device protocol. EtherCAT® is able to transmit various already existing, tried and tested user protocols and device protocols via the EtherCAT protocol (tunneling).

Of specific relevance for drive technology is, e.g., CANopen over EtherCAT (CoE). This protocol is supported by the AFS60/AFM60 EtherCAT. The CoE protocol makes it possible to use all CANopen profiles — and as a consequence also to utilize the encoder profile DS-406. You can see which objects are implemented in the AFS60/AFM60 EtherCAT in section 3.6.5 “Overview of the encoder profile-specific objects” on page 39.

Fig. 8: CANopen over EtherCAT



The EtherCAT protocol provides two different transfer rates for the transmission. These two transfer rates are the mailbox telegram protocol for acyclic data and the process data protocol for the transmission of cyclic data.

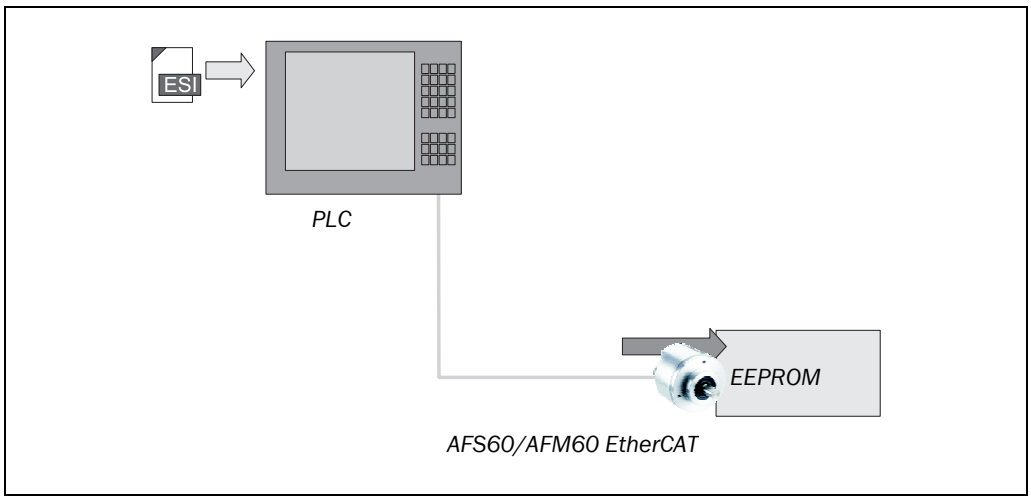
- Mailbox telegram protocol
  This transfer type is used to transmit the service data objects (SDO) defined under CANopen. The objects are transmitted in EtherCAT® in SDO frames.
  The service data objects form the communication channel for the transmission of device parameters (e.g. programming the encoder resolution). These parameters are transmitted acyclically (e.g. only once on starting the network).
- Process data telegram protocol
  This type of transfer is used to transmit the process data objects (PDO) defined under CANopen that are used to exchange cyclic data. The objects are transmitted in EtherCAT® in PDO frames.
  The process data objects are used for the fast, efficient exchange of real-time data (e.g. I/O data, desired or actual values).

3.3.4 ESI file

To be able to simply interface EtherCAT slave devices to an EtherCAT master, an ESI file must be available for each EtherCAT slave device. This file is in XML format and contains information on the following features of the AFS60/AFM60 EtherCAT.

- information on the manufacturer of the device
- name, type and version number of the device
- type and version number of the protocol used for this device
- default parameters of the AFS60/AFM60 EtherCAT and default configuration of the process data

Fig. 9: Integration via ESI file



- ➢ Copy the ESI file **SICK-AFx_vX-xxx** in the TwinCAT® folder to the folder **TwinCAT\IO\EtherCAT**.
- ➢ Restart the TwinCAT® system manager.
- ➢ Add the encoder in the device tree as a box.
- ➢ Then place the TwinCAT® system manager in the configuration mode.

Note A detailed description of the configuration can be found in section 4.3.2 “System configuration” on page 69.

3.4 Configurable functions

The AFS60/AFM60 EtherCAT is configured in the configuration tool TwinCAT® using various objects. The most important objects for the configuration of the functions are listed in the following. A complete list of the objects can be found in section 3.6 “Object library” on page 28.

WARNING

During the configuration of the encoder, make sure there are no persons in a system’s hazardous area!

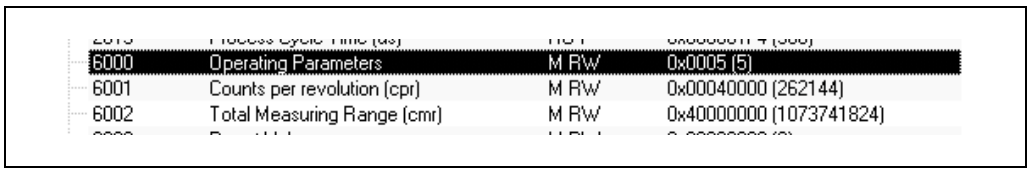
All parameter changes have a direct effect on the operation of the encoder. For this reason the position value may change during configuration, e.g. due to the implementation of a preset or change of scale. This could cause an unexpected movement that may result in a hazard for persons or damage to the system or other objects.

Note All functions described in the following for which parameters can be set can also be configured in the encoder’s start-up configuration.

3.4.1 Scaling parameters

The scaling parameters are configured by the objects 6000h, 6001h and 6002h.

Fig. 10: Objects 6000h, 6001h and 6002h in TwinCAT®



6000h – Operating Parameter

Using the object **6000h** (see Tab. 32 on page 40) the parameters **Support additional Error-Code**, **Scaling** and **Code sequence** are configured. The object is configured using a bit sequence 16 bits wide.

Example:

Bit 0 = code sequence ccw = 1

Bit 2 = Scaling on = 1

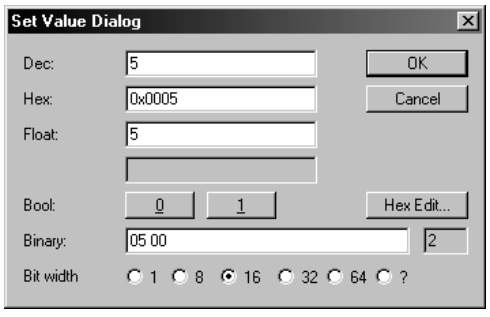
Tab. 4: Example for binary code

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

The binary value must be converted to a hexadecimal value and entered in the configuration dialog box.

101b = 5h

Fig. 11: Example for the parameterization of object 6000h



Scaling

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

Note Only if the parameter **Scaling** is configured to **1** are the values entered for the resolution and total resolution applied.

Code sequence

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

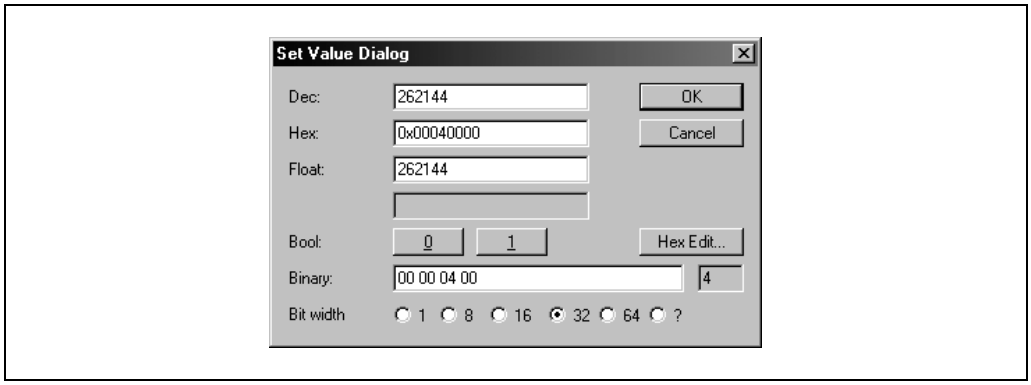
- clockwise (cw) = increasing position value on clockwise rotation of the shaft
- counterclockwise (ccw) = increasing position value on counter clockwise rotation of the shaft

6001h – Counts Per Revolution (CPR)

The resolution per revolution is configured using the object **6001h** (see Tab. 34 on page 40).

Note The parameter is not used if the round axis functionality is activated.

Fig. 12: Example for the parameterization of object 6001h

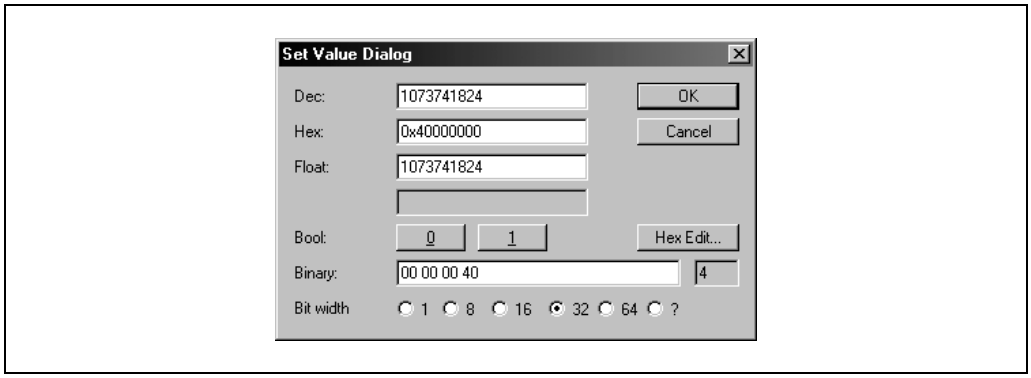


The resolution of the AFS60/AFM60 EtherCAT Advanced is max. 262,144 steps per revolution. The resolution can be scaled from 1 ... 262,144 as an integer.

6002h – Total Measuring Range (CMR)

The total resolution is configured using the object **6002h** (see Tab. 35 on page 40).

Fig. 13: Example for the parameterization of object 6002h



The total resolution, that is the measuring range of the AFS60 EtherCAT, is max. 262,144 steps. The total resolution of the AFM60 EtherCAT is max. 1,073,741,824 steps.

The total resolution must be 2^n times the resolution per revolution.

Note This restriction is not relevant if the round axis functionality is activated.

Tab. 5: Examples for total resolution

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

3.4.2 Preset function

The position value for an encoder can be set with the aid of the preset function. I.e. the encoder can be set to any position within the measuring range.

Notes

- Only set a preset value when the encoder is at standstill.
- The preset value must lie within the measuring range configured.

WARNING

Before triggering the preset function, check whether there is a hazard from the machine or system in which the encoder is integrated!

The preset function results in a change in the position value output by the encoder. This change could cause an unexpected movement that may result in a hazard for persons or damage to the system or other items.

The preset value can be set with the aid of the following methods:

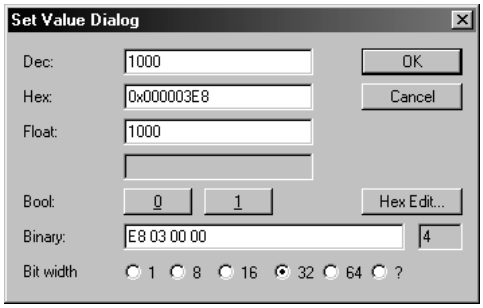
- Using acyclic communication (SDO) with the object 6003h
- Using cyclic communication (PDO) with the object 2000h. The value from object 2005h is used.
- Using the Preset pushbutton (see section 4.2 “Hardware settings” on page 68). The value from object 2005h is used.

Acyclic communication (SDO)

The preset value is transferred directly to the encoder using the object **6003h – Preset Value** (see Tab. 36 on page 41). The encoder immediately adopts the preset value that is written to the object as the new position value.

The function is available if the EtherCAT state machine is in the Operational or Pre-operational status.

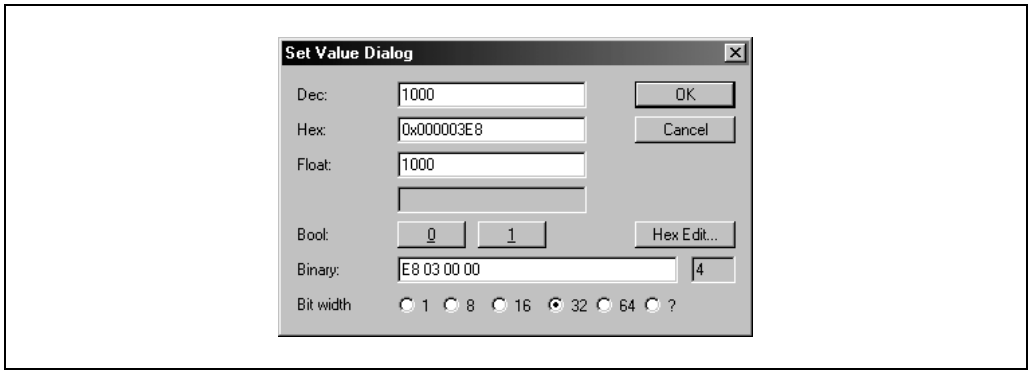
Fig. 14: Example for the parameterization of object 6003h



Cyclic communication (PDO)

The preset value is initially transferred to the encoder using the object **2005h – Configuration Preset Value** (see Tab. 74 on page 55).

Fig. 15: Example for the parameterization of object 2005h



The function is triggered using the object **2000h – Control Word 1** (see Tab. 68 on page 52).

The function is available if the EtherCAT state machine is in the Operational status.

The object is configured using a bit sequence 16 bits wide.

Example:

Bit 12 = Preset is set = 1

Bit 11 = Preset mode Shift Positive = 1

Tab. 6: Example for binary code

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

The binary value must be converted into a hexadecimal value and entered in the configuration dialog box.

1100000000000b = 1800h

3.4.3 Cyclic process data

The cyclic process data are defined using the process data objects **1A00h** and **1A01** (see 3.6.4 on page 34). Nine objects can be mapped in nine subindices.

Fig. 16: Default parameterization of object 1A00h

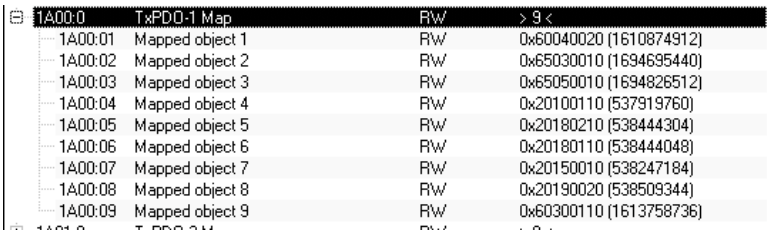
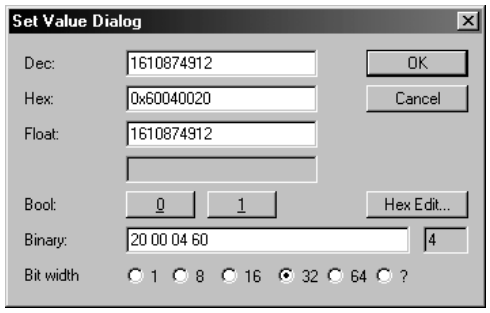


Fig. 17: Example for the parameterization of subindex 1A00.01h



The object to be integrated is entered with its object number, the subindex and the data length (see Tab. 26 on page 35).

Example:

60040020h

Object = 6004h

Subindex = 00h

Data length = 20h (32 bit)

3.4.4 Synchronization

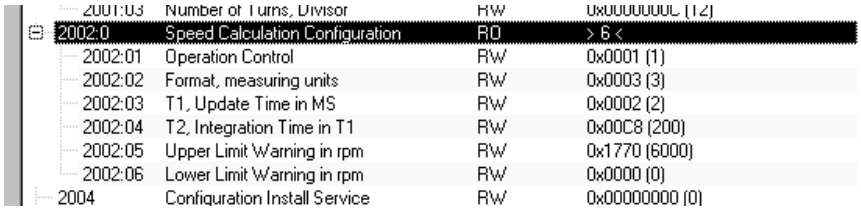
The default setting for the synchronization is synchronization using SM events; the setting can be changed to synchronization using DC sync events for high accuracy applications. This setting is made using the objects **1C32h** or **1C33h – SM-2/-3 Output Parameter** (see Tab. 30 on page 37).

➢ Choose the required operating mode (SM or DC) in your control system.

3.4.5 Velocity measurement

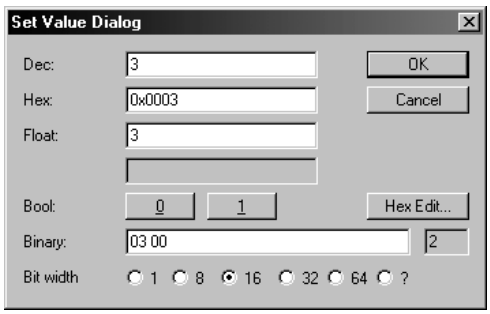
The velocity measurement is configured using the object **2002h –Speed Calculation Configuration** (see Tab. 71 on page 54).

Fig. 18: Subindices of the object 2002h



2001:03	Number of Turns, Divisor	RW	0x00000000L (12)
2002:0	Speed Calculation Configuration	RO	> 6 <
2002:01	Operation Control	RW	0x0001 (1)
2002:02	Format, measuring units	RW	0x0003 (3)
2002:03	T1, Update Time in MS	RW	0x0002 (2)
2002:04	T2, Integration Time in T1	RW	0x00C8 (200)
2002:05	Upper Limit Warning in rpm	RW	0x1770 (6000)
2002:06	Lower Limit Warning in rpm	RW	0x0000 (0)
2004	Configuration Install Service	RW	0x00000000 (0)

Fig. 19: Example for the parameterization of subindex 2002.02h



Using the subindex **2002.02h – Format Measuring Units** you can define the units in which the velocity is transmitted.

Possible units are:

- cps
- cp10ms
- cp100ms
- rpm
- rps

The factory setting is 3h = rpm.

Using the other subindices you can configure the refresh time as well as the maximum and minimum velocity (see Tab. 71 on page 54).

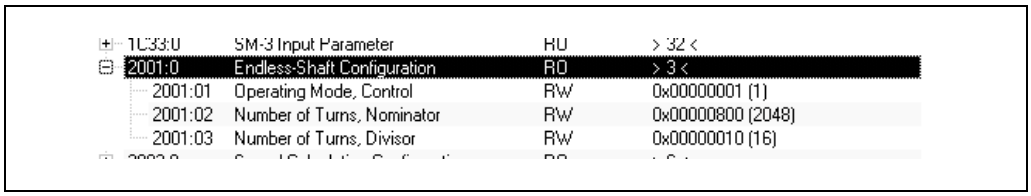
3.4.6 Round axis functionality

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

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

The round axis functionality is configured using the object **2001h – Endless-Shaft Configuration** (see Tab. 70 on page 53).

Fig. 20: Subindices of the object 2001h

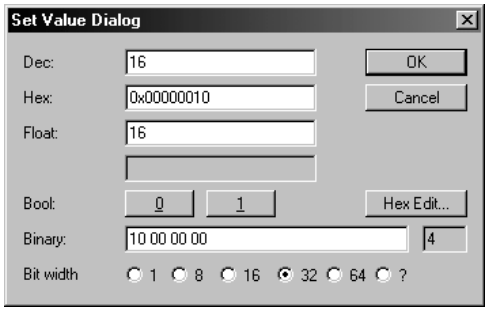


The total measuring range can be scaled from 1 ... 1,073,741,824 as an integer.

The nominator (2001.02h – Number of Revolutions, Nominator) can be scaled from 1 ... 2,048 as an integer. The default factory setting for the nominator is 2,048.

The divisor (2001.03h – Number of Revolutions, Divisor) can be scaled from 1 ... 2,048 as an integer. The default factory setting for the divisor is 1.

Fig. 21: Example for the parameterization of subindex 2001.03h



3.4.7 Electronic cam mechanism

An electronic cam mechanism can be configured using the encoder. Two so-called CAM channels with up to eight cam switching positions are supported. This is a limit switch for the position.

The electronic cam mechanism is configured using several objects (see section 3.6.7 “Detailed information on the electronic cam mechanism (CAM)” on page 42).

The cams are enabled using the object **6301h –CAM Enable Register**, the polarity is defined using the object **6302h – CAM Polarity Register**.

Each position parameter is defined by its minimum switching point (objects **6310h** to **6317h**), its maximum switching point (objects **6320h** to **6327h**) and its switching hysteresis (objects **6330h** to **6337h**).

Fig. 22: Objects for the electronic cam mechanism

Index	Name	Flags	Value
6300:0	Cam State Register	RO	> 2 <
6301:0	Cam Enable Register	RO	> 2 <
6301:01	Channel-1	RW	0xAA (170)
6301:02	Channel-2	RW	0x00 (0)
6302:0	Cam Polarity Register	RO	> 2 <
6310:0	Cam-1, Lower Limit	RO	> 2 <
6310:01	Channel-1	RW	0x00000000 (0)
6310:02	Channel-2	RW	0x00000000 (0)
6311:0	Cam-2, Lower Limit	RO	> 2 <
6312:0	Cam-3, Lower Limit	RO	> 2 <
6313:0	Cam-4, Lower Limit	RO	> 2 <
6314:0	Cam-5, Lower Limit	RO	> 2 <
6315:0	Cam-6, Lower Limit	RO	> 2 <
6316:0	Cam-7, Lower Limit	RO	> 2 <
6317:0	Cam-8, Lower Limit	RO	> 2 <
6320:0	Cam-1, Upper Limit	RO	> 2 <
6320:01	Channel-1	RW	0x3FFFFFFF (1073741823)
6320:02	Channel-2	RW	0x3FFFFFFF (1073741823)
6321:0	Cam-2, Upper Limit	RO	> 2 <
6322:0	Cam-3, Upper Limit	RO	> 2 <
6323:0	Cam-4, Upper Limit	RO	> 2 <
6324:0	Cam-5, Upper Limit	RO	> 2 <
6325:0	Cam-6, Upper Limit	RO	> 2 <
6326:0	Cam-7, Upper Limit	RO	> 2 <
6327:0	Cam-8, Upper Limit	RO	> 2 <
6330:0	Cam-1, Hysteresis	RO	> 2 <
6330:01	Channel-1	RW	0x0064 (100)
6330:02	Channel-2	RW	0x0064 (100)
6331:0	Cam-2, Hysteresis	RO	> 2 <
6332:0	Cam-3, Hysteresis	RO	> 2 <
6333:0	Cam-4, Hysteresis	RO	> 2 <
6334:0	Cam-5, Hysteresis	RO	> 2 <
6335:0	Cam-6, Hysteresis	RO	> 2 <
6336:0	Cam-7, Hysteresis	RO	> 2 <
6337:0	Cam-8, Hysteresis	RO	> 2 <
6500	Operating Status	RO	0x0005 (5)

3.5 Operating modes and synchronization

3.5.1 EtherCAT state machine

As in every EtherCAT slave, a so-called EtherCAT state machine is implemented in the AFS60/AFM60 EtherCAT. This machine adopts the following statuses:

Tab. 7: Statuses of the EtherCAT state machine

Status	Description
Initializing	The initialization starts, values saved are loaded.
Pre-operational	The encoder is ready for configuration, acyclic communication can take place via SDO.
Safe-operational	The EtherCAT master reads the position values from the encoder via PDO and SDO.
Operational	The EtherCAT master and encoder exchange data via PDO and SDO in real time.

Normally the PLC boots in the following sequence:

Initializing, Pre-operational, Safe-operational, Operational.

If the software TwinCAT® from Beckhoff Automation GmbH is used, these steps can be undertaken automatically in the system manager or also separately if necessary. Booting is automatic if a control program is started in the TwinCAT® PLC.

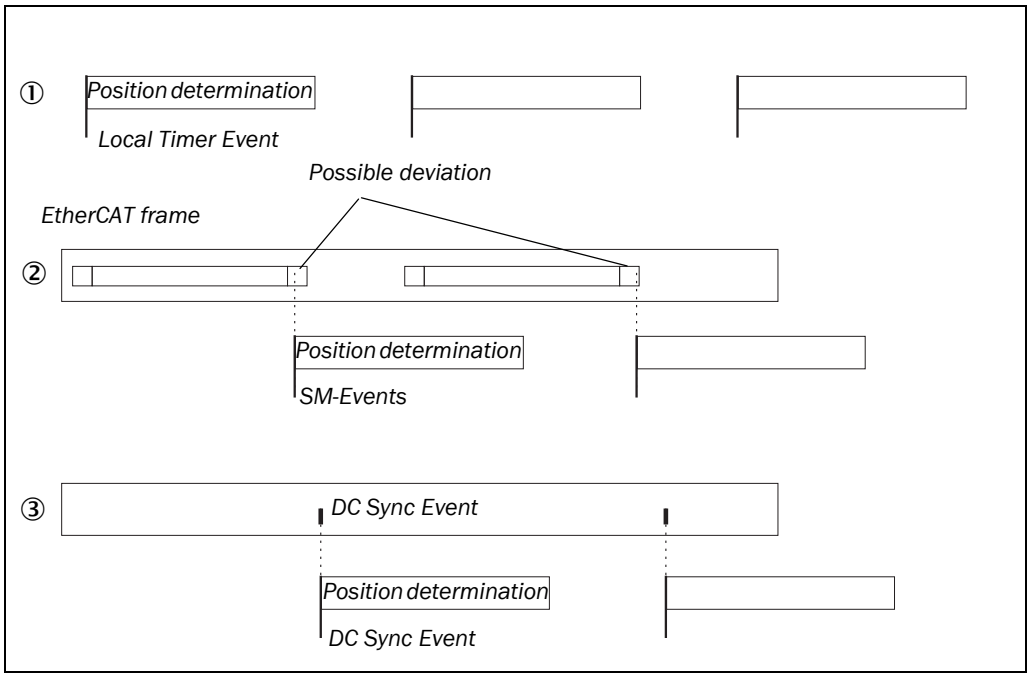
- The statuses of the EtherCAT state machine are indicated by the STAT status LED (see section 5.3.2 on page 74).
- Errors on the transition between statuses of the EtherCAT state machine are sent to the master via so-called emergency messages (see section 5.4.4 on page 78).

3.5.2 Operating modes

The AFS60/AFM60 EtherCAT supports three operating modes:

- **Free Run ①**
  The encoder is not synchronized. It operates autonomously using its own cycle.
  This operating mode is only used in the **Pre-operational** status.
- **Synchronous to SM-2/-3 event ②**
  The encoder is synchronized using the so-called SM events. The SM events are based on the reception time of the EtherCAT frame. This feature ensures synchronization in the range of microseconds.
- **DC Sync Mode ③**
  The encoder is synchronized using the so-called Sync0 event. The Sync0 event is based on the Distributed Clocks Unit. This feature ensures synchronization in the range of nanoseconds.

Fig. 23: Operating modes



3.5.3 Synchronous operating modes

In the **Operational** status the position is always determined in synchronism with the clock cycle for the bus communication. The default setting for the synchronization is synchronization using SM events; the setting can be changed to synchronization using DC sync events for high accuracy applications.

Notes

- At cycle times in the range from 125 µs ... 480 µs the Encoder status LED flashes green.
- If the system cycle time is outside the encoder's range limits (125 µs ... 100,000 µs), the encoder signals a bus communication error and the STAT status LED illuminates red (see section 5.3.2 on page 74).

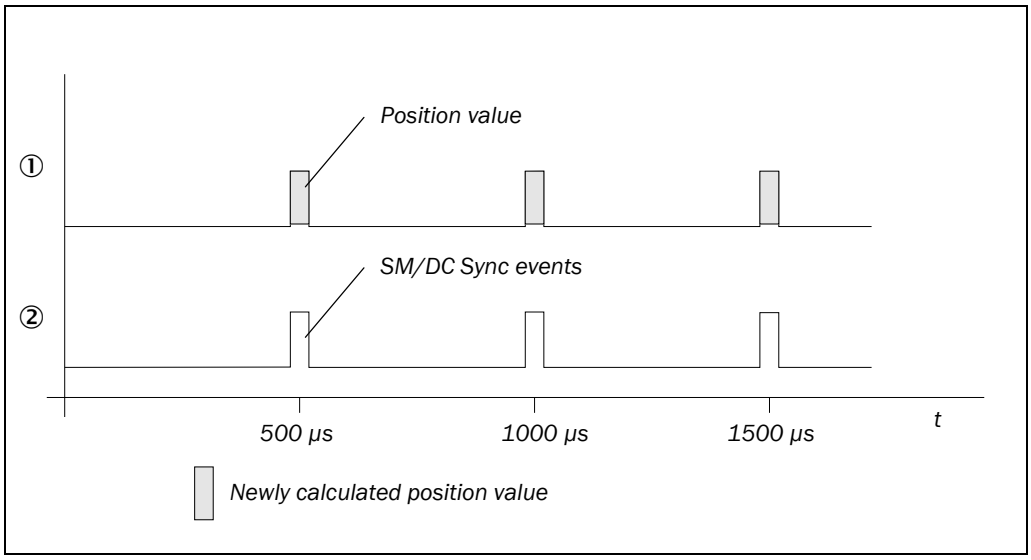
3.5.4 Cycle times

The AFS60/AFM60 EtherCAT supports master process data cycle times ≥480 µs. Shorter cycle times ≥125 µs are supported with certain restrictions.

The reason for this situation is that a new position value is only determined once every 480 µs. This time is required to convert the measured value acquired optically by the sensor, to scale the value and to process it for EtherCAT.

If shorter cycle times are necessary, although the encoder can be used with this cycle, a newly calculated position can only be provided every 2nd, 3rd or 4th cycle. The position value provided previously is sent for the other cycles.

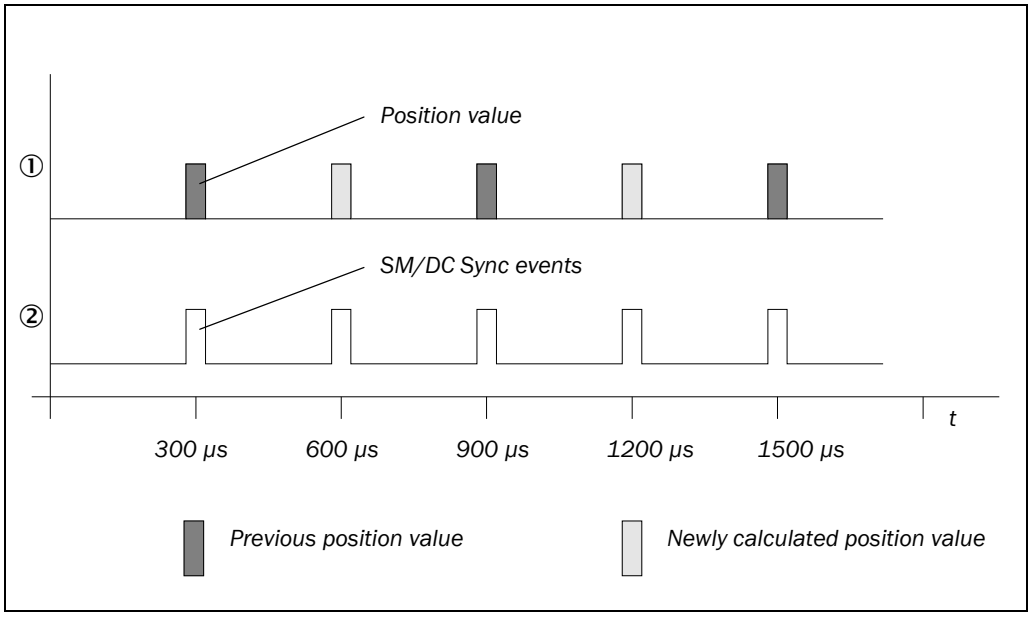
Fig. 24: Newly calculated position value for every cycle at 500 µs



① = cycle of the encoder

② = process cycle data of the master

Fig. 25: Newly calculated position value for every 2nd cycle at 300 µs



① = cycle of the encoder

② = process cycle data of the master

Tab. 8: Position value formation with varying cycle times

Process data cycle time of the master	Position value formation	Explanation
≥480 µs	≥480 µs	Encoder supplies a position value in synchronism for every SM or Sync0 event. Example: Cycle time of the master = 500 µs Cycle time of the encoder = 500 µs Newly calculated position value = 500 µs
240 ... 479 µs	480 ... 958 µs	Encoder supplies a newly calculated position value for every 2nd SM or Sync0 event. Example: Cycle time of the master = 300 µs Cycle time of the encoder = 300 µs Newly calculated position value = 600 µs
160 ... 239 µs	480 ... 717 µs	Encoder supplies a newly calculated position value for every 3rd SM or Sync0 event. Example: Cycle time of the master = 200 µs Cycle time of the encoder = 200 µs Newly calculated position value = 600 µs
125 ... 159 µs	500 ... 636 µs	Encoder supplies a newly calculated position value for every 4th SM or Sync0 event. Example: Cycle time of the master = 150 µs Cycle time of the encoder = 150 µs Newly calculated position value = 600 µs

3.6 Object library

The AFS60/AFM60 EtherCAT contains various types of objects:

- standard objects with 1000 series object numbers
- manufacturer-specific objects with 2000 series object numbers
- encoder profile-specific objects with 6000 series object numbers

3.6.1 Nomenclature

Tab. 9: Nomenclature of the access types and data types

Abbreviation	Meaning
R	Read = read only
R/W	Read/Write = read and write access
STRG	String = character string of variable length
BOOL	Boolean = logical value 0 or 1
INT	Integer value (negative/positive) (e.g. INT-8 = −128 ... +127)
UINT	Unsigned integer = integer value (e.g. UINT-32 = 0 ... 4.294.967.295)
Array	Series of data of one data type (e.g. Array UINT-8] = character string of data type UINT-8)
Record	Series of data with different data types (e.g. UINT-8, UINT-32, UINT-32, UINT-16)

3.6.2 Overview of the standard objects

Tab. 10: Implemented standard objects

Object Subindex	Access	Data type	Designation
1000h	R	UINT-32	Device Type
1008h	R	STRG	Device Name
1009h	R	STRG	Hardware Version Number
100Ah	R	STRG	Software Version Number
1010h .0 1	R/W	Array UINT-32	Save Parameters
1011h .0 1	R/W	Array UINT-32	Load/Restore Parameter
1018h .0 4	R	Record	Identity
10F3h .0 ... .25	R/W	Record	Diagnosis History
1600h .0 and .1	R/W	Record	1st Receive (Rx) PDO mapping
1A00h .0 9	R/W	Record	1st Transmit (Tx) PDO mapping
1A01h .0 9	R/W	Record	2nd Transmit (Tx) PDO mapping
1C00h .0 4	R	Array UINT-8	Sync Manager Communication Type
1C12h .0 2	R	Record	Sync Manager PDO Mapping for Sync channel 2
1C13h .0 2	R	Record	Sync Manager PDO Mapping for Sync channel 3
1C32h .0 ... .15	R	Record	Sync Manager parameter
1C33h .0 ... .15	R	Record	Sync Manager parameter

3.6.3 Detailed information on the standard objects

Note In the following only those objects are described in detail for which the content is not clear from the overview (see Tab. 10 on page 29).

Object 1000h – Device Type

This object specifies the device type and the device profile implemented.

Tab. 11: Object 1000h

Object	Access	Data type	Designation	Data values
1000h	R	UINT-32	Device Type	See Tab. 12

Tab. 12: Object 1000h – Details

Bit	Description	Data values
31 ... 24 23 ... 16	The device type is output in the bits 31 ... 16.	**01h** Singleturn encoder **02h** Multiturn encoder
15 ... 8 7 ... 0	The device profile supported is output in the bit 15 ... 0.	**01.96h** Device profile = Encoder

Object 1008h – Manufacturer Device Name

The object contains the device names dependent on the encoder type.

Tab. 13: Object 1008h

Object	Access	Data type	Designation	Data values
1008h	R	STRG 16-byte	Manufacturer Device Name	AFM60A-**E*18x12 AFS60A-**E*18x00

Object 1009h – Manufacturer Hardware Version

Tab. 14: Object 1009h

Object	Access	Data type	Designation	Data values
1009h	R	STRG 8-byte	Manufacturer Hardware Version	e.g. HW_01.01 (depending on the release)

Object 100Ah – Manufacturer Software Version

Tab. 15: Object 100Ah

Object	Access	Data type	Designation	Data values
100Ah	R	STRG 8-byte	Manufacturer Software Version	e.g. SW_01.01 (depending on the release)

Object 1010h – Save Parameter

Using this object the parameters are written to the EEPROM with the aid of the data value 65766173h = “save”.

WARNING

Check whether the parameters have actually been written to the EEPROM!

The data are only written to the EEPROM in the ESM status Pre-operational. The command is not executed in any other status, but it is also not identified as denied.

- Check the parameters have been saved using the object **2010h – Sensor Status S_STAT-C** (see Tab. 79 on page 59).

If the data are not saved in the EEPROM, the encoder loads the data last saved the next time the encoder is switched on. This situation can result in hazards for persons or damage to the system!

Tab. 16: Object 1010h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
1010h	R/W	Record	Save Parameter	–
.0	R/W	UINT-8	Number of entries	1
.1	R/W	UINT-32	Total Class Parameters The parameters for all object types (1000h ..., 2000h ... and 6000h ...) are saved.	See Tab. 17

Tab. 17: Object 1010h – Details

Bit	**Designation**	**Data values**
31 ... 24	Byte 3	65h = e
23 ... 16	Byte 2	76h = v
15 ... 8	Byte 1	61h = a
7 ... 0	Byte 0	73h = s

Object 1011h – Load/Restore Parameter

Using this object the parameters are reset to the factory settings with the aid of the data value 64616F6Ch = “load”.

Note

- The data are only reset to the factory settings in the Pre-operational status. The command is not executed in any other status, but it is also not identified as denied.
- Then the data must be saved in the EEPROM using the object **1010h – Save Parameter**, otherwise the encoder will load the data saved in the EEPROM the next time it is switched on.

Tab. 18: Object 1011h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
1011h	R/W	Record	Load/Restore Parameter	–
.0	R/W	UINT-8	Number of entries	1
.1		UINT-32	Total Class Parameters The parameters for all object types (1000h ..., 2000h ... and 6000h ...) are loaded.	See Tab. 19

Tab. 19: Object 1011h – Details

Bit	**Designation**	**Data values**
31 ... 24	Byte 3	64h = d
23 ... 16	Byte 2	61h = a
15 ... 8	Byte 1	6Fh = o
7 ... 0	Byte 0	6Ch = l

Object 1018h – Identity Object

Tab. 20: Object 1018h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
1018h	R	Record	Identity Object	–
.0	R	UINT-8	Number of entries	4
.1	R	UINT-32	Vendor ID	01000056h = SICK
.2	R	UINT-32	Product Code	00007711h = AFS60 00007712h = AFM60
.3	R	UINT-32	Revision Number	00010001 = 1.01 (depending on the release)
.4	R	UINT-32	Serial Number YYWWxxxx (year/week/sequential number)	Serial number

Object 10F1h – Diagnosis Error Reaction

Tab. 21: Object 10F1h

Object Subindex	Access	Data type	Designation Description	Data values
10F1h	R/W	Record	Diagnosis Error Reaction	–
.0	R	UINT-8	Number of entries	2
.1	R	UINT-32	Defines error handling	0
.2	R	UINT-32	Sync Error Count Limit Limit of the counter for synchronization errors	0

Object 10F3h – Diagnosis History

Tab. 22: Object 10F3h

Object Subindex	Access	Data type	Designation Description	Data values
10F3h	R/W	Record	Diagnosis History	–
.0	R	UINT-8	Number of entries	25
.1	R	UINT-8	Maximum Messages Number of entries in subindex .6 ... .25	20
.2	R	UINT-8	Newest Message Subindex of the newest entry	6 ... 25
.3	R	UINT-8	Newest Acknowledged Message Subindex for the last entry acknowledged	6 ... 25
.4	R/W	BOOL	New Message Available Shows that a new entry is available	0 = No new entry 1 = New entry
.5	R	UINT-16	Flags Flags for the indication of the transmission and storage of errors	0
.6 ... .25	R/W	OCTET-STR	Diagnostics message, defined as octet character string	See section 5.4.5 on page 82

3.6.4 PDO mapping objects

The PDO mapping objects are used to “map” other objects to the subindices and to transmit these to the controller or to receive them from the controller.

- Data are received cyclically from the PLC by the encoder using the Receive (Rx) PDO.
- Data are transmitted cyclically to the PLC by the encoder using the Transmit (Tx) PDO.

Note Parameter changes to the PDO mapping objects are only executed in the ESM status Pre-operational.

Object 1600h – 1st Receive (Rx) PDO mapping

Note It is only possible to map the object **2000h – Control Word 1** to the object 1600h.

Tab. 23: Object 1600h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
1600h	R/W	RECORD	1st Receive (Rx) PDO mapping	–
.0	R	UINT-8	Number of entries	1
.1	R/W	UINT-32	Control Word 1 See Tab. 68 on page 52	20.00.00.10

Object 1A00h – 1st Transmit (Tx) PDO mapping

Tab. 24: Object 1A00h – Default Subindices

Object Subindex	**Access**	**Data type**	**Designation**
1A00h	R/W	RECORD	1st Transmit (Tx) PDO mapping
.0	R/W	UINT-8	Number of entries
.1	R/W	UINT-32	6004h Position Value
.2	R/W	UINT-32	6503h Alarm Status
.3	R/W	UINT-32	6505h Warning Status
.4	R/W	UINT-32	2010.01h STW-1 – Device Status Word, S_STAT-A
.5	R/W	UINT-32	2018.02h Time Stamp Sec
.6	R/W	UINT-32	2018.01h Time Stamp MSec
.7	R/W	UINT-32	2015h Temperature Value
.8	R/W	UINT-32	2019h Process Cycle Time
.9	R/W	UINT-32	6030h Speed Value 16-Bit

Object 1A01h – 2nd Transmit (Tx) PDO mapping

Tab. 25: Object 1A01h – Default Subindices

Object Subindex	Access	Data type	Designation
1A01h	R/W	RECORD	2nd Transmit (Tx) PDO mapping
.0	R/W	UINT-8	Number of entries
.1	R/W	UINT-32	10F3.04h Diagnosis History, Diagnosis Flag
.2	R/W	UINT-32	2017h Speed Value 32-Bit
.3	R/W	UINT-32	2016h Position Value, Raw
.4	R/W	UINT-32	2010.02h STW-1 – Device Status Word, S_STAT-B
.5	R/W	UINT-32	2010.03h STW-1 – Device Status Word, S_STAT-C
.6	R/W	UINT-32	6300.01h CAM State Register, Channel 1
.7	R/W	UINT-32	6300.02h CAM State Register, Channel 2
.8	R/W	UINT-32	2014h Time Stamp MSec-32
.9	–	–	–

Objects and subindices that can be mapped to the objects 1A00h and 1A01h

Tab. 26: Objects and subindices that can be mapped

Object Subindex	Length [Bit]	Designation	Data values	Details see
6004h	32	Position Value	60040020h	Tab. 37, page 41
6030h .1	 16	 Speed Value	 60300110h	Tab. 38, page 41
6503h	16	Alarm Status	65030010h	Tab. 52, page 47
6505h	16	Warning Status	65050010h	Tab. 56, page 48
6300h .1 .2	 8 8	CAM State Register Channel 1 Channel 2	 63000108h 63000208h	Tab. 39, page 42
2010h .1 .2 .3	 16 16 16	STW-1 – Device Status Word S_STAT-A S_STAT-B S_STAT-C	 20100110h 20100210h 20100310h	Tab. 76, page 57
10F3h .4	 8	Diagnosis History Diagnosis Flag	 10F30408h	Tab. 22, page 33
2014h	32	Time Stamp Counter	20140020h	Tab. 83, page 64
2015h	16	Temperature Value	20150010h	Tab. 84, page 64
2016h	32	Position Value, Raw	20160020h	Tab. 85, page 64
2017h	32	Speed Value 32-Bit	20170020h	Tab. 86, page 64
2018h .1 .2	 16 16	Time Stamp Signals Time Stamp MSec Time Stamp Sec	 20180110h 20180210h	Tab. 87, page 64
2019h	32	Process Cycle Time	20190020h	Tab. 88, page 65

Object 1C00h – SyncManager (SM) Communication Type

The number of communication channels and the type of communication are defined using this object.

The entries are read-only. The communication channels are configured automatically on starting the EtherCAT master.

Tab. 27: Object 1C00h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
1C00h	R	Array	Sync Manager (SM) Communication Type	–
.0	R	UINT-8	Number of entries	4
.1	R	UINT-8	Communication type sync manager 0 Communication type of Sync Manager 0	1: Receive mailbox (master to slave)
.2	R	UINT-8	Communication type sync manager 1 Communication type of Sync Manager 1	2: Send mailbox (slave to master)
.3	R	UINT-8	Communication type sync manager 2 Communication type of Sync Manager 2	3: Receive (Rx) PDO
.4	R	UINT-8	Communication type sync manager 3 Communication type of Sync Manager 3	4: Transmit (Tx) PDO

Object 1C12h – SM RxPDO assign

This object is used to allocate sync channel 2 to a PDO (Channel 2 reserved for Receive PDOs).

Tab. 28: Object 1C12h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
1C12h	R	Record	SM RxPDO assign	–
.0	R	UINT-8	Number of entries	1
.1	R	UINT-16	PDO Mapping object index of assigned RxPDO Index of the RxPDO	1600h

Object 1C13h – SM TxPDO assign

This object is used to allocate sync channel 3 to a PDO (Channel 3 reserved for Transmit PDOs).

Tab. 29: Object 1C13h

Object Subindex	Access	Data type	Designation Description	Data values
1C13h	R	Record	SM TxPDO assign	–
.0	R	UINT-8	Number of entries	2
.1	R	UINT-16	PDO mapping Object Index of assigned TxPDO 1 Index of the 1. TxPDO	1A00h
.2	R	UINT-16	PDO mapping Object Index of assigned TxPDO 2 Index of the 2. TxPDO	1A01h

Objects 1C32h and 1C33h – SM-2/-3 Output Parameter

Tab. 30: Objects 1C32h and 1C33h

Object Subindex	Access	Data type	Designation Description	Data values
1C32h/ 1C33h	R	Record	SM-2/-3 Output Parameter	–
.0	R	UINT-8	Number of entries	32
.1	R/W	UINT-16	Sync Mode **00h** Free Run (no synchronization) **01h** Synchronous with SM-3 event **22h** Synchronous with SM-2 event **02h** DC mode, synchronous with Sync0 event	–
.2	R or R/W	UINT-32	Cycle Time Dependent of the sync mode Value in ns	–
.3	R	UINT-32	Shift Time	–
.4	R	UINT-16	Sync Modes Supported Supported synchronization types Bit 0: Free Run Bit 1: Sync SM event Bit 4 ... 2: Sync mode[1)] Bit 6 ... 5: Shift mode[2)] Bit 15 ... 7: Reserved	–

[1)] For Bit 4 ... 2 only the value 001 is supported = Sync0 event.
[2)] For Bit 6 ... 5 only the value 00 is supported = no shift.

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
.5	R	UINT-32	Minimum Cycle Time Minimum cycle time (in ns)	–
.6	R	UINT-32	Calc and Copy Time Time between reading the inputs and the availability of the inputs for the master (in ns, DC mode only)	–
.7		–	–	–
.8	R/W	UINT-16	Get Cycle Time	–
.9	R	UINT-32	Delay Time Time between Sync1 event and reading the inputs (in ns, DC mode only)	–
.10	R	UINT-32	Sync0 Cycle Time	–
.11	R	UINT-16	Cycle Time Too Small Number of cycle time infringements in the Operational status (cycle was not completed on time or the next cycle came too early)	–
.12	R	UINT-16	SM Event Missed Number of failed SM events in the Operational status (DC mode only)	–
.13	R	UINT-16	Shift Time Too Short Number of excessively short spaces between Sync0 and Sync1 events (DC mode only)	–
.14	R	UINT-16	RxPDO Toggle Failed	–
.15 ... .31		–	Reserved	–
.32	R	–	Sync Error	–

3.6.5 Overview of the encoder profile-specific objects

Tab. 31: Implemented encoder profile-specific objects

Object Subindex	Access	Data type	Designation
6000h	R/W	UINT-16	Operating Parameter
6001h	R/W	UINT-32	Counts Per Revolution (CPR)
6002h	R/W	UINT-32	Counts Per Measuring Range (CMR)
6003h	R/W	UINT-32	Preset Value
6004h	R	UINT-32	Position Value
6030h .0 1	R	Array of UINT-16	Velocity/Speed Value
6300h .0 2	R	Array of UINT-8	CAM State Register
6301h .0 2	R/W	Array of UINT-8	CAM Enable Register
6302h .0 2	R/W	Array of UINT-8	CAM Polarity Register
6310h ... 6317h .0 2	R/W	Array of UINT-32	CAM-1 ... 8 – Lower Limit setting
6320h ... 6327h .0 2	R/W	Array of UINT-32	CAM-1 ... 8 – Upper Limit setting
6330h ... 6337h .0 2	R/W	Array of UINT-16	CAM-1 ... 8 – Hysteresis setting
6500h	R	UINT-16	Operating Status
6501h	R	UINT-32	Physical Resolution Span (PRS) Single Turn Resolution
6502h	R	UINT-16	Number of Revolutions
6503h	R	UINT-16	Alarms
6504h	R	UINT-16	Supported Alarms
6505h	R	UINT-16	Warnings
6506h	R	UINT-16	Supported Warnings
6507h	R	UINT-32	Version Of Profile & Software
6508h	R	UINT-32	Operating Time
6509h	R	INT-32	Offset Value
650Ah .0 3	R	Array of UINT-32	Module Identification
650Bh	R	UINT-32	Serial Number

3.6.6 Detailed information on the encoder parameters

Object 6000h – Operating Parameter

Tab. 32: Object 6000h

Object	Access	Data type	Designation	Data values
6000h	R/W	UINT-16	Operating Parameter	See Tab. 33

Tab. 33: Object 6000h – Details

Bit	Designation Description	Data values
15 ... 13	Reserved	–
12	Support additional Error-Code If an error occurs, a negative value is output instead of the position value (see Tab. 77 on page 57).	**0** No **1** Yes
11 ... 3	Reserved	–
2	Scaling The bit enables scaling with objects 6001h and 6002h.	**0** Inactive **1** Active
1	Commissioning Diagnostic Control not supported	–
0	Code sequence (cw, ccw) The code sequence defines the direction of rotation, viewed on the shaft, in which the position value increases. • Clockwise = increasing position value on clockwise rotation of the shaft • Counterclockwise = increasing position value on counter clockwise rotation of the shaft	**0** cw **1** ccw

Object 6001h – Counts Per Revolution (CPR)

The resolution per revolution is configured using this parameter.

Note The parameter is not used if the round axis functionality is activated.

Tab. 34: Object 6001h

Object	Access	Data type	Designation Description	Data values
6001h	R	UINT-32	Counts Per Revolution (CPR) Number of steps per revolution	00000001h 00040000h (00040000h)

Object 6002h – Total Measuring Range (CMR)

The total resolution required is configured using this parameter.

Tab. 35: Object 6002h

Object	Access	Data type	Designation Description	Data values
6002h	R	UINT-32	Total Measuring Range (CMR) Total resolution	Depending on the type

Object 6003h – Preset Value

The position value of the encoder is set to a preset value using this parameter. In this way, e.g., the encoder's zero position can be adjusted to the machine's zero point.

Tab. 36: Object 6003h

Object	Access	Data type	Designation Description	Data values
6003h	R/W	UINT-32	Preset Value Preset value	–

Notes

- On writing the value to the object, it is immediately applied as a new position value.
- The preset value must lie within the measuring range configured.

Object 6004h – Position Value

The actual position value can be output using this object.

Tab. 37: Object 6004h

Object	Access	Data type	Designation Description	Data values
6004h	R	UINT-32	Position Value Current position value	–

Note An error code (Err_PosVal) can also be output instead of the position value (see Tab. 77 on page 57). The output of the Err_PosVal must be configured using the object 6000h (see Tab. 32 on page 40).

Object 6030h – Speed Value

The actual velocity can be read using this object.

Tab. 38: Object 6030h

Object Subindex	Access	Data type	Designation Description	Data values
6030h	R	Array INT-16	Speed Value	–
.0	R	INT-16	Number of entries	1
.1	R	INT-16	Speed Value Velocity in 16 Bit	–32,768 +32,767

3.6.7 Detailed information on the electronic cam mechanism (CAM)

A so-called electronic cam mechanism can be configured using the encoder. One CAM channel with up to eight cam switching positions is supported. Each position parameter is defined by its minimum switching point (objects 6310h to 6317h), its maximum switching point (objects 6320h to 6327h) and its switching hysteresis (objects 6330h to 6337h).

Object 6300h – CAM State Register

The cam switching states are output using the object 6300h.

Tab. 39: Object 6300h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6300h	R	Array UINT-8	CAM State Register	–
.0	R	UINT-8	Number of entries	2
.1	R	UINT-8	Channel 1	00h FFh
.2	R	UINT-8	Channel 2	00h FFh

Tab. 40: Object 6300h – Details

Bit	**Designation**	**Data values**
7	Cam 8	**0** Inactive **1** Active
6	Cam 7	**0** Inactive **1** Active
5	Cam 6	**0** Inactive **1** Active
4	Cam 5	**0** Inactive **1** Active
3	Cam 4	**0** Inactive **1** Active
2	Cam 3	**0** Inactive **1** Active
1	Cam 2	**0** Inactive **1** Active
0	Cam 1	**0** Inactive **1** Active

If, for instance, the value read is 01h (00000001b), then cam 1 is active. None of the other cams are active. If, for instance, the value read is 88h (10001000b), then cams 8 and 4 are active. None of the other cams are active.

Object 6301h – CAM Enable Register

Each cam switching position on the CAM channel must be enabled individually in the encoder. The individual cams are enabled by writing the appropriate value to the object 6301h, subindex .1 or subindex .2.

Every cam switching position that is to be used must be set to 1 in binary notation.

Tab. 41: Object 6301h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6301h	R/W	Array UINT-8	CAM Enable Register	–
.0	R	UINT-8	Number of entries	2
.1	R/W	UINT-8	Channel 1	00h FFh
.2	R/W	UINT-8	Channel 2	00h FFh

Tab. 42: Object 6301h – Details

Bit	**Designation**	**Data values**
7	Cam 8	**0** Not used **1** Used
6	Cam 7	**0** Not used **1** Used
5	Cam 6	**0** Not used **1** Used
4	Cam 5	**0** Not used **1** Used
3	Cam 4	**0** Not used **1** Used
2	Cam 3	**0** Not used **1** Used
1	Cam 2	**0** Not used **1** Used
0	Cam 1	**0** Not used **1** Used

If, for instance 4Ah (01001010b) is transmitted in the subindex, the cams 2, 4 and 7 are used. All other cams are not used.

Object 6302h – CAM Polarity Register

Using the CAM Polarity Register it can be defined whether the cams are output as *active high* or *active low*. By default the cams are defined as active high. They therefore output 1 when the cam switching position is reached.

Tab. 43: Object 6302h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6302h	R/W	Array UINT-8	CAM Polarity Register	–
.0	R	UINT-8	Number of entries	2
.1	R/W	UINT-8	Channel 1	00h FFh
.2	R/W	UINT-8	Channel 2	00h FFh

Tab. 44: Object 6301h – Details

Bit	**Designation**	**Data values**
7	Cam 8	**0** High active **1** Low active
6	Cam 7	**0** High active **1** Low active
5	Cam 6	**0** High active **1** Low active
4	Cam 5	**0** High active **1** Low active
3	Cam 4	**0** High active **1** Low active
2	Cam 3	**0** High active **1** Low active
1	Cam 2	**0** High active **1** Low active
0	Cam 1	**0** High active **1** Low active

Objects 6310h ... 6317h – CAM-1 ... 8, Lower Limit

The lower switching point of a cam switching position is defined using the Lower Limit. Each individual cam switching position (CAM 1 to CAM 8) has its own Lower Limit object (6310h = cam 1 ... 6317h = cam 8).

Notes

- The Lower Limit can only be configured, i.e., its value changed, if the Upper Limit for the same CAM has already been set (see Tab. 46 on page 45).
- The value for the Lower Limit must be lower than the value for the Upper Limit.

Tab. 45: Object 6310h ... 6317h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6310h ... 6317h	R/W	Array UINT-32	CAM-1 ... 8, Lower Limit	–
.0	R	UINT-32	Number of entries	2
.1	R/W	UINT-32	Channel 1	0 ... PMR[3] – 1 (0)
.2	R/W	UINT-32	Channel 2	0 ... PMR[3] – 1 (0)

Objects 6320h ... 6327h – CAM-1 ... 8, Upper Limit

The upper switching point for a cam switching position is defined using the Upper Limit. Each individual cam switching position (CAM 1 to CAM 8) has its own Upper Limit object (6320h = cam 1 ... 6327h = cam 8).

Tab. 46: Object 6320h ... 6327h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6320h ... 6327h	R/W	Array UINT-32	CAM-1 ... 8, Upper Limit	–
.0	R	UINT-32	Number of entries	2
.1	R/W	UINT-32	Channel 1	0 ... PMR[3] – 1 (PMR – 1)
.2	R/W	UINT-32	Channel 2	0 ... PMR[3] – 1 (PMR – 1)

Objects 6330h ... 6337h – CAM-1 ... 8, Hysteresis

The width of the hysteresis of the switching points can be defined using the CAM hysteresis. For each individual cam switching position (CAM 1 to CAM 8) a dedicated CAM hysteresis can be set (6330h = cam 1 ... 6337h = cam 8).

Tab. 47: Object 6330h ... 6337h

Object Subindex	**Access**	**Data type**	**Designation**	**Data values**
6330h ... 6337h	R/W	Array UINT-16	CAM-1 ... 8, Hysteresis	–
.0	R	UINT-16	Number of entries	2
.1	R/W	UINT-16	Channel 1	0000h FFFFh
.2	R/W	UINT-16	Channel 2	0000h FFFFh

[3] Physical measuring range, depending on encoder type.

3.6.8 Detailed information on the diagnostics

Object 6500h – Operating Status

Tab. 48: Object 6500h

Object	Access	Data type	Designation	Data values
6500h	R	UINT-16	Operating Status	See Tab. 49

Tab. 49: Object 6500h – Details

Bit	Designation	Data values
15 ... 13	Reserved	–
12	Support additional Error-Code	**0** No **1** Yes
11 ... 3	Reserved	–
2	Scaling	**0** Inactive **1** Active
1	Commissioning Diagnostic Control	**0** Inactive **1** Active
0	Code sequence (cw, ccw)	**0** cw **1** ccw

Object 6501h – PRS, Single Turn Resolution

Tab. 50: Object 6501h

Object	Access	Data type	Designation Description	Data values
6501h	R	UINT-32	PRS, Single Turn Resolution Singleturn resolution	00040000h

Object 6502h – Number of Revolutions

Tab. 51: Object 6502h

Object	Access	Data type	Designation Description	Data values
6502h	R	UINT-16	Number of Revolutions Multiturn resolution	AFS = 0001h AFM = 4,096

Object 6503h – Alarm Status

Tab. 52: Object 6503h

Object	Access	Data type	Designation Description	Data values
6503h	R	UINT-16	Alarm Status Alarms in case of encoder errors that could result in an incorrect position value	0000h FFFFh

Tab. 53: Object 6503h – Details

Bit	Designation	Data values
15 ... 13	Reserved	–
12	EEPROM error Dependent of Bit 15 and 7 of object 2010h .1 (see Tab. 77 on page 57)	**0** Inactive **1** Active
11 ... 1	Reserved	–
0	Position error Dependent of Bit 14, 12 ... 6 and 4 of object 2010h .1 (see Tab. 77 on page 57)	**0** Inactive **1** Active

Object 6504h – Supported Alarms

Tab. 54: Object 6504h

Object	Access	Data type	Designation Description	Data values
6504h	R	UINT-16	Supported Alarms Alarms implemented in the encoder	1001h

Tab. 55: Object 6504h – Details

Bit	Designation	Data values
15 ... 13	Manufacturer-specific	**0** Not supported
12	EEPROM error	**1** Supported
11 ... 2	Reserved	–
1	Commissioning diagnostics	**0** Not supported
0	Position error	**1** Supported

Object 6505h – Warning Status

Tab. 56: Object 6505h

Object	Access	Data type	Designation Description	Data values
6505h	R	UINT-16	Warning Status Warnings on deviation from operating parameters	0000h FFFFh

Tab. 57: Object 6505h – Details

Bit	Description	Data values
15	Operating voltage outside the permissible range	**0** Inactive **1** Active
14	Reserved	–
13	Operating temperature outside the permissible range	**0** Inactive **1** Active
12	Frequency/rotational speed outside the range allowed	**0** Inactive **1** Active
11 ... 2	Reserved	–
1	Sensor LED current too high	**0** Inactive **1** Active
0	Maximum frequency/rotational speed outside the range allowed	**0** Inactive **1** Active

Object 6506h – Supported Warnings

Tab. 58: Object 6506h

Object	Access	Data type	Designation Description	Data values
6506h	R	UINT-16	Supported Warnings Warnings implemented in the encoder	B003h

Tab. 59: Object 6506h – Details

Bit	Description	Data values
15	Operating voltage outside the permissible range	**1** Supported
14	Reserved	–
13	Operating temperature outside the permissible range	**1** Supported
12	Frequency outside the permissible range	**1** Supported
11 ... 6	Reserved	–
5	Reference point not reached	**0** Not supported
4	Battery voltage too low	**0** Not supported
3	Max. operating time exceeded	**0** Not supported
2	CPU watchdog status	**0** Not supported
1	Minimum internal LED current in the sensors reached	**1** Supported
0	Maximum frequency exceeded	**1** Supported

Object 6507h – Version Of Profile & Software

Tab. 60: Object 6507h

Object	Access	Data type	Designation Description	Data values
6507h	R	UINT-32	Version Of Profile & Software The first two bytes contain the software version, the next two the profile version.[4)]	00000000h FFFFFFFFh

Tab. 61: Object 6507h – Details

Bit	Description	Example values	
31 ... 24	First part of the software version	03h	3.1
23 ... 16	Last part of the software version	01h	
15 ... 8	First part of the profile version	01h	1.40
7 ... 0	Last part of the profile version	40h	

Object 6508h – Operating Time

Tab. 62: Object 6508h

Object	Access	Data type	Designation Description	Data values
6508h	R	UINT-32	Operating Time Operating time in units of 0.1 h	00000000h FFFFFFFFh

Object 6509h – Internal Offset Value

Tab. 63: Object 6509h

Object	Access	Data type	Designation Description	Data values
6509h	R	UINT-32	Internal Offset Value Offset value, calculated from the Preset function 6003h (see section 3.2.2 on page 11)	00000000h FFFFFFFFh

[4)] Internal manufacturer software version, can vary from the objects 100Ah and 1018h.

Object 650Ah – Module Identification

Tab. 64: Object 650Ah

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values** **[Default value]**
650Ah	R	Array	Module Identification	
.0	R	UINT-32	Number of entries	3
.1	R	UINT-32	Manufacturer Offset Value Manufacturer-specific offset	(0)
.2	R	UINT-32	Position Value Minimum Lowest position value	0
.3	R	UINT-32	Position Value Maximum Highest position value	PMR[5] – 1

Object 650Bh – Serial Number

Tab. 65: Object 650Bh

Object	**Access**	**Data type**	**Designation** **Description**	**Data values**
650Bh	R	UINT-32	Serial Number YYWWxxxx (year/week/sequential number)	Serial number

[5] Physical measuring range, depending on encoder type.

3.6.9 Overview of the manufacturer-specific objects

In the manufacturer-specific objects a differentiation is made between the following object types:

- objects for the encoder configuration
- objects that provide status information

Tab. 66: Implemented manufacturer-specific objects for the encoder configuration

Object Subindex	**Access**	**Data type**	**Designation**
2000h	R/W	UINT-16	Control Word 1
2001h .0 3	R/W	Array UINT-32	Endless shaft configuration
2002h .0 6	R/W	Array UINT-16	Speed Calculation Configuration
2004h	R/W	UINT-32	Configuration Install Service
2005h	R/W	UINT-32	Configuration Preset Value
2006h .0 4	R/W	Record	Physical Measuring Range Limits

Tab. 67: Implemented manufacturer-specific objects that provide status information

Object Subindex	**Access**	**Data type**	**Designation**
2010h .0 3	R	Array UINT-16	Sensor Status (STW-1)
2011h .0 8	R	Array UINT-32	Real Scaling Parameter Settings
2012h .0 ... .15	R	Record	Diagnosis Service Parameter
2013h .0 ... .15	R	Record	Diagnosis Error Logging Parameter
2014h	R	UINT-32	Time Stamp
2015h	R	UINT-16	Temperature Value
2016h	R	UINT-32	Position Value Raw
2017h	R	INT-32	Speed Value 32-Bit
2018h .0 2	R	Array UINT-16	Time Stamp Signals
2019h	R	UINT-32	Process Cycle Time

3.6.10 Detailed information on objects for the encoder configuration

Object 2000h – Control Word 1

This object sets the encoder to a preset value if necessary.

Tab. 68: Object 2000h

Object	Access	Data type	Designation	Data values
2000h	R/W	UINT-16	Control Word 1	See Tab. 69

Tab. 69: Object 2000h – Details

Bit	Designation Description	Data values
15 ... 13	Reserved	–
12	Preset Function Request (PreReq) Sets the preset value that is passed with the object 2005h (see Tab. 74 on page 55).	**0** Inactive **1** Active
11	Preset mode = Shift Positive The preset value is added to the current position value.	**0** Inactive **1** Active
10	Preset mode = Shift Negative The preset value is subtracted from the current position value.	**0** Inactive **1** Active
9 ... 1	Reserved	–
0	Preset mode = Preset zero Sets the position value to 0	**0** Inactive **1** Active

Notes

- If a preset mode is not specified with bit 11, 10 or 0, then the preset value from object 6003h is applied as the position value.
- Bits 11, 10 and 0 must be used exclusively. If several of these three bits have the value 1, then the preset function is not executed.
- The preset function is triggered with the rising edge (transition of bit 12 from 0 to 1). To set a preset value again, the bit must therefore be reset to 0.

Object 2001h – Endless-Shaft Configuration

Tab. 70: Object 2001h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
2001h	R/W	Array UINT-16	Endless shaft configuration	–
.0	R/W	UINT-16	Number of entries	3
.1	R/W	UINT-16	Control of Endless-Shaft Mode Activates round axis functionality	**2** Active **1** Inactive
.2	R/W	UINT-16	Number of Revolutions, Nominator Nominator for the number of revolutions (CNR_N)	1 ... 2,048 (2,048)
.3	R/W	UINT-16	Number of Revolutions, Divisor Divisor for the number of revolutions (CNR_D).	1 ... 2,048 (1)

Note The round axis functionality can only be used with the multiturn encoder. It is only executed if scaling has been enabled using object 6000h.

Object 2002h – Speed Calculation Configuration

Tab. 71: Object 2002h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values** **[Default value]**
2002h	R/W	Array UINT-16	Speed Calculation Configuration	–
.0	R/W	UINT-16	Number of entries	6
.1	R/W	UINT-16	Operation Control Controls the mode for the velocity calculation	**0** Inactive **1** Active
.2	R/W	UINT-16	Format Measuring Units Velocity measuring unit	**0** cps **1** cp100ms **2** cp10ms **3** rpm **4** rps
.3	R/W	UINT-16	T1 Update Time in MS Refresh time in ms	AFS60 = 2 AFM60 = 1 ... 50 [2]
.4	R/W	UINT-16	T2 Integration Time Integration time dependent of T1	1 ... 200 [200]
.5	R/W	UINT-16	Upper Limit Warning in rpm Maximum velocity, a warning is output if the velocity exceeds this value	1 ... 10,000 [6,000]
.6	R/W	UINT-16	Lower Limit Warning in rpm Minimum velocity, a warning is output if the velocity drops below this value	0 ... 9,000 [0]

The velocity is calculated from the average of several measurements. The integration time 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 velocity is calculated from the last 0.4 s.

Object 2004h – Configuration Install Service

Tab. 72: Object 2004h

Object Subindex	Access	Data type	Designation	Data values [Default value]
2004h	R/W	UINT-32	Configuration Install Service	See Tab. 73

Tab. 73: Object 2004h – Service Codes

Data values	Description
52454C31h	Loads the parameters last saved (manufacturer-specific parameters, parameters from the encoder profile and parameters for the communication)
44656632h	Loads the factory parameters for the communication (PDO mapping)
44656633h	Loads the factory manufacturer-specific parameters and the factory parameters for the encoder profile
70100100h	Reset-0, simulates switching on/off the encoder (Power on). Parameters will not be saved
70100101h	Reset-1, simulates switching on/off the encoder (Power on). Parameters (Offset, Preset value and Offset for round axis) will be saved

Object 2005h – Configuration Preset Value

A preset value is transferred to the encoder using this parameter. This preset value must be set using the object 2000h (see Tab. 68 on page 52).

Tab. 74: Object 2005h

Object Subindex	Access	Data type	Designation	Data values [default value]
2005h	R/W	UINT-32	Configuration Preset Value	0 ... CMR-1

Note The preset value must lie within the measuring range configured.

Object 2006h – Physical Measuring Range Limits

Tab. 75: Object 2006h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values** **[Default value]**
2006h	R/W	Record	Physical Measuring Range Limits	–
.0	R	UINT-8	Number of entries	4
.1	R/W	SINT-16	Temperature Lower Limit Defines the lower limit for the operating temperature allowed in °C	–40 +80 [–40]
.2	R/W	SINT-16	Temperature Upper Limit Defines the upper limit for the operating temperature allowed in °C	–20 +120 [+100]
.3	R/W	UINT-16	Operating Voltage Lower Limit Defines the lower limit for the operating voltage allowed in mV	9000 24000 [10,000]
.4	R/W	UINT-16	Operating Voltage Upper Limit Defines the upper limit for the operating voltage allowed in mV	10,000 30,000 [30,000]

3.6.11 Detailed information on objects that provide status information

Object 2010h – STW-1 – Device Status Word

Tab. 76: Object 2010h

Object Subindex	Access	Data type	Designation	Data values
2010h	R	Array UINT-16	STW-1 – Device Status Word	–
.0	R	UINT-16	Number of entries	3
.1	R	UINT-16	S_STAT-A, Sensor State	0000h ... FFFFh
.2	R	UINT-16	S_STAT-B, State Flag 2	0000h ... FFFFh
.3	R	UINT-16	S_STAT-C, State Flag 3	0000h ... FFFFh

Tab. 77: Object 2010h – Sensor Status (S_STAT-A)

Bit	Description	Position value (Err_PosVal)
15	Memory error: Invalid EEPROM checksum on initialization	–12
14	Position error: Invalid communication with the I^2C device[6] in the sensor module	–11
13	Reserved	–
12	Position error: Invalid EEPROM checksum or Invalid internal SSI communication (MFP4 signal[7])	–9
11	Position error: Invalid synchronization or no synchronization of MA sensor[8] to the LY singleturn position[9]	–8
10	Position error: The error register in LY is activated (MFP5 signal[7]). or Invalid internal SSI communication (MFP4 signal[7])	–7
9	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the multiturn stage	–6
8	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the singleturn stage	–5
7	Position and memory error: Invalid communication with the I^2C device in the main unit	–4

6) Internal interface between EEPROM and sensor of the encoder.
7) Output signal from the encoder sensor.
8) Internal Hall sensor that determines the multiturn position by means of magnetic scanning.
9) LY = internal sensor for the singleturn position.

Bit	Description	Position value (Err_PosVal)
6	Position error: Error on the calculation of the amplitude values Sin + Cos in the singleturn stage	–3
5	Warning in relation to the velocity: Current measured value outside of the minimum or maximum limit	–
4	Position error: Error on the calculation of the amplitude values, Sin + Cos in the multiturn stage	–2
3	Warning in relation to the operating voltage: Current measured value outside of the minimum or maximum limit	–
2	Warning, sensor LED current critical: Current measured value outside of the minimum or maximum limit	–
1	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	–

Note

- If several errors occur, the position value –16 is output.
- The Err_PosVal is output instead of the position value and makes it possible to detect an error based on the cyclic process data (see Tab. 37 on page 41).
- The output of the Err_PosVal must be configured using the object 6000h (see Tab. 32 on page 40).

Tab. 78: Object 2010h – Sensor Status (S_STAT-B)

Bit	Description
15	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Sensor Config Data)
14	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Device Configuration)
13	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis Process Data Basic)
12	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis/Service Data)
11	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration parameter or communication mapping)
10	Reserved
9	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'CAM' parameter)
8	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'Basic xxx' parameter)

Bit	Description
7	Reserved
6	Cycle time set for the system <480 µs
5	Reserved
4	Warning, triggered on executing the preset function: The preset value, defined by the scaling parameter, is outside the measuring range (CMR)
3	Warning, occurred on changing or writing parameter values: Invalid values for objects in the area of the manufacturer-specific objects
2	Warning, occurred on changing or writing parameter values: Invalid values for objects in the area of the encoder profile, basic
1	Warning, occurred on changing or writing parameter values: Invalid values for objects in the area of the encoder profile, electronic cam mechanism
0	Warning, occurred on changing or writing parameter values: Invalid values for objects in the area of the PDO configuration

Tab. 79: Object 2010h – Sensor Status (S_STAT-C)

Bit	Description
15	Information: Encoder in the Synchronous operating mode. The formation of the position **is synchronized** with the process data cycle of the master
14	Information: Encoder in the Free Run operating mode. The formation of the position **is not synchronized** with the process cycle data of the master
13	Reserved
12	Preset function has been triggered and confirmed by object 2000h (see Tab. 68 on page 52)
11 ... 4	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 (Object 1010h, see Tab. 16 page 31): 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	

Object 2011h – Real Scaling Parameter Settings

Tab. 80: Object 2011h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
2011h	R	Array UINT-32	Real Scaling Parameter Settings	–
.0	R	UINT-32	Number of entries	8
.1	R	UINT-32	Endless shaft operating mode	**1** Inactive **2** Active
.2	R	UINT-32	Endless shaft offset Offset of the endless shaft function	00000000h 40000000h
.3	R	UINT-32	Internal PMR Shift Value Internal PMR shift value	
.4	R	UINT-32	CNR_N, Number of Revolutions, Nominator Nominator for the number of revolutions	1 ... 2,048
.5	R	UINT-32	CNR_D, Number of Revolutions, Divisor Divisor for the number of revolutions	1 ... 2,048
.6	R	UINT-32	CMR, Counts per Measuring Range Total resolution	1 ... 40000000h
.7	R	UINT-32	CPR, Counts Per Revolution (Integer) Steps per revolution, digits before the decimal separator	Ex.: at 1.555 = 1
.8	R	UINT-32	CPR, Counts Per Revolution (Fract) Steps per revolution, digits after the decimal separator	Ex.: at 1.555 = 555

Object 2012h – Diagnosis Service Parameter

Tab. 81: Object 2012h

Object Subindex	Access	Data type	Designation Description	Data values
2012h	R	Record	Diagnosis Service Parameter	–
.0	R	UINT-8	Number of entries	15
.1	R	UINT-32	Number of Switch-On Power up counter	–
.2	R	UINT-32	Operating Time Moving Operating time in s, the time during which the encoder has moved is output[10)]	–
.3	R	UINT-16	Max. Operating Speed Maximum velocity in RpM since the encoder has been in operation	–
.4	R	UINT-32	Starts with Direction Forward Counter for movements of the encoder in forward rotation[10)]	–
.5	R	UINT-32	Starts with Direction Backward Counter for start of the encoder in reverse rotation[10)]	–
.6	R	UINT-32	Starts with Alternating Directions Counter for start of the encoder in alternating rotation[10)]	–
.7	R	UINT-32	Operating Hours counter Operating hours counter (× 0.1 h)	–
.8	R	INT-16	Min. Operating Temperature Minimum operating temperature in °C	–
.9	R	INT-16	Max. Operating Temperature Maximum operating temperature in °C	–

[10)] From movements with a velocity >12 rpm.

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
.10	R	INT-16	Min. Operating LED-Current Minimum internal LED current in µA	–
.11	R	INT-16	Max. Operating LED-Current Maximum internal LED current in µA	–
.12	R	INT-16	Min. Operating Voltage Minimum operating voltage in mV	–
.13	R	INT-16	Max. Operating Voltage Maximum operating voltage in mV	–
.14	R	UINT-32	Internal FPGA Revision Number FPGA revision number	–
.15	R	UINT-32	Counter of Diagnosis Storage Counter for the save processes in the EEPROM	–

Object 2013h – Diagnosis Error Logging Parameter

Tab. 82: Object 2013h

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
2013h	R	Record	Diagnosis Error Logging Parameter	–
.0	R	UINT-8	Number of entries	16
.1	R	UINT-32	Temperature out of range Operating temperature outside of the configured minimum or maximum limit	–
.2	R	UINT-32	LED-Current out of range Sensor LED current outside the minimum or maximum limit configured	–
.3	R	UINT-32	Voltage out of range Operating voltage outside of the configured minimum or maximum limit	–

Object Subindex	**Access**	**Data type**	**Designation** **Description**	**Data values**
.4	R	UINT-32	Amplitude multi Error on the calculation of the amplitude values Sin + Cos in the multiturn stage	–
.5	R	UINT-32	Frequency out of range Velocity outside the minimum or maximum limit configured	–
.6	R	UINT-32	Amplitude single Error on the calculation of the amplitude values Sin + Cos in the singleturn stage	–
.7	R	UINT-32	Communication EEPROM - I^2C Invalid communication with the I^2C device	–
.8	R	INT-16	Vector length single Error on the calculation of the vector length Sin^2 + Cos^2 in the singleturn stage	–
.9	R	INT-16	Vector length multi Error on the calculation of the vector length Sin^2 + Cos^2 in the multiturn stage	–
.10	R	INT-16	Singleturn position Wrong calculation of the singleturn position	–
.11	R	INT-16	Invalid synchronization or no synchronization of MA sensor with the LY singleturn position	–
.12	R	INT-16	Invalid internal SSI communication (MFP4 signal)	–
.13	R	INT-16	Synchronization error multiturn/singleturn stage	–
.14	R	UINT-32	Invalid communication with the I^2C device in the sensor module	–
.15	R	UINT-32	Invalid EEPROM checksum on initialization	–

Object 2014h – Time Stamp MSec-32

Tab. 83: Object 2014h

Object	Access	Data type	Designation Description	Data values
2014h	R	UINT-32	Time Stamp MSec-32 Time stamp in ms, overall range 4,290,200 seconds or 136 years	00000000h FFFFFFFFh

Object 2015h – Temperature Value

Tab. 84: Object 2015h

Object	Access	Data type	Designation Description	Data values
2015h	R	UINT-16	Temperature Value Operating temperature in °C	–

Object 2016h – Position Value, Raw

Tab. 85: Object 2016h

Object	Access	Data type	Designation Description	Data values
2016h	R	UINT-32	Position Value, Raw Position value independent of any preset value	AFS60 = 0 ... 0003FFFFh AFM60 = 0 ... 3FFFFFFFh

Object 2017h – Speed Value 32-Bit

Tab. 86: Object 2017h

Object	Access	Data type	Designation Description	Data values
2017h	R	INT-32	Speed Value 32-Bit Velocity value in 32 Bit	–

Object 2018h – Time Stamp Signals

Tab. 87: Object 2018h

Object Subindex	Access	Data type	Designation Description	Data values
2018h	R	Array UINT-16	Time Stamp Signals	
.0	R	UINT-16	Number of entries	2
.1	R	UINT-16	Time Stamp MSec Time stamp in milliseconds	0000h FFFFh
.2	R	UINT-16	Time Stamp Sec Time stamp in seconds	0000h FFFFh

Object 2019h – Process Cycle Time

Either the internal or the external cycle time is output via this object. In the **Free Run** operating mode the internal cycle time is defined by the encoder and is always 500 µs. In the **Synchronous to SM-2/-3 event** or **DC Sync Mode** operating mode the external cycle time is defined by the master and is between 125 µs ... 100,000 µs.

Tab. 88: Object 2019h

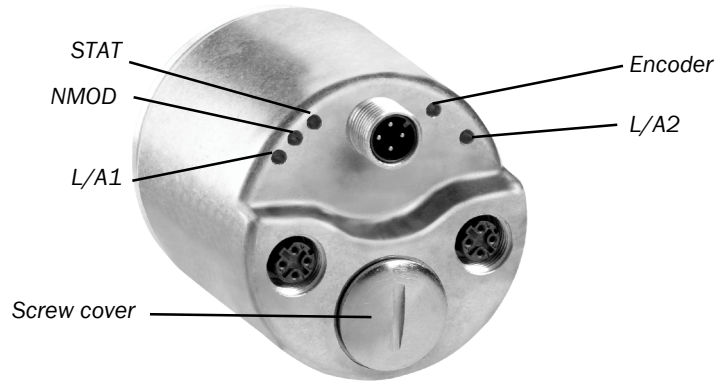
Object	Access	Data type	Designation Description	Data values
2019h	R	UINT-32	Process Cycle Time Cycle time in µs	125 100,000

3.7 Controls and status indicators

The AFS60/AFM60 EtherCAT Absolute Encoder has five LEDs.

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

Fig. 26: Position of the LEDs, the decade switches and the preset push-button



The LEDs are multi-colored. Tab. 91 on page 74 and Tab. 92 on page 75 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 AFS60/AFM60 EtherCAT Absolute Encoder.

➢ 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 EtherCAT).

4.1.1 Connections of the AFS60/AFM60 EtherCAT

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

Fig. 27: Position of the connections of the AFS60/AFM60 EtherCAT

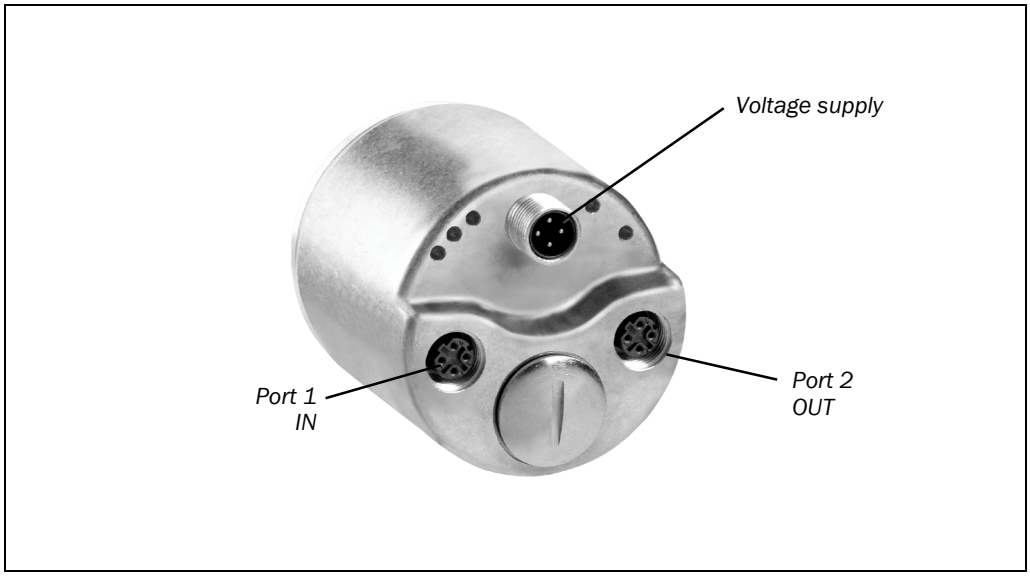
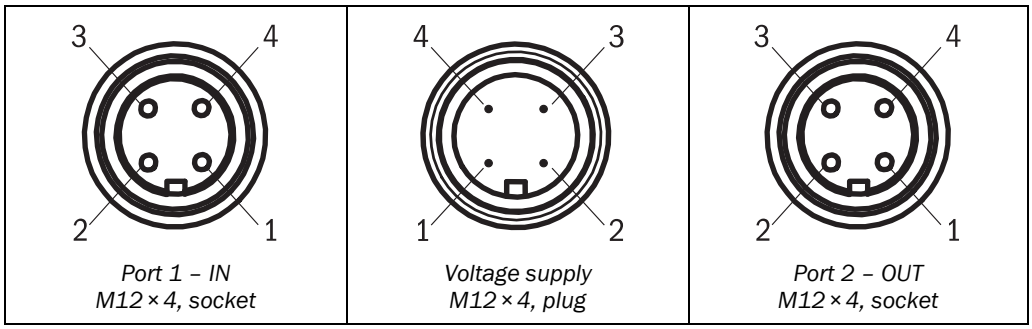


Fig. 28: Connections of the AFS60/AFM60 EtherCAT



Tab. 89: Pin assignment for the connection of the voltage supply

Pin	Signal	Wire color[11)]	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

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

Tab. 90: Pin assignment for the connections port 1 and port 2

Pin	Signal	Wire color[11)]	Function
1	TxD+	Yellow	Ethernet
2	RxD+	White	Ethernet
3	TxD–	Orange	Ethernet
4	RxD–	Green	Ethernet

Notes

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

[11)] On the usage of pre-wired cables.

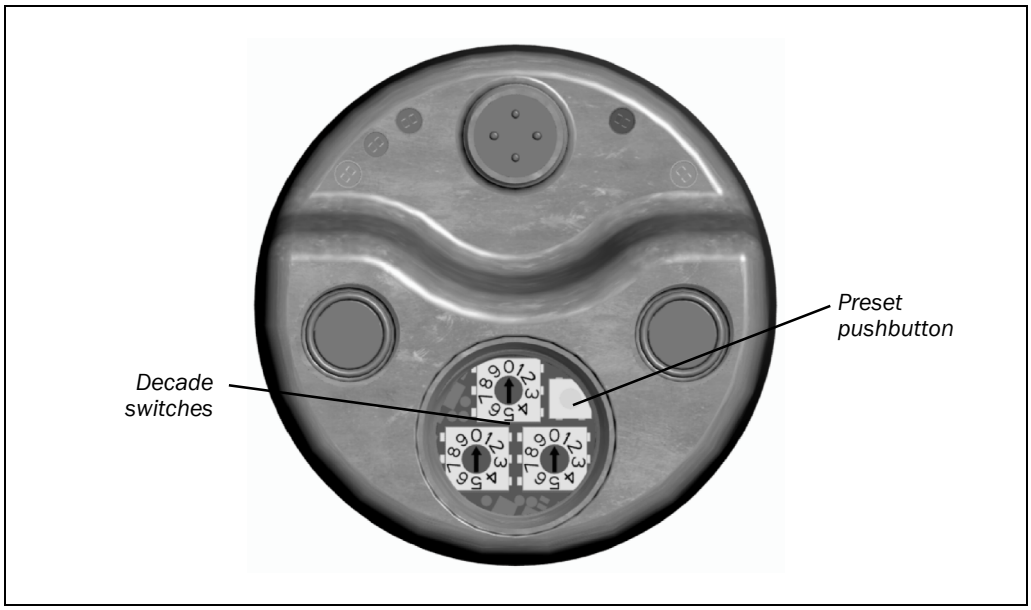
4.2 Hardware settings

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

- three decade switches
- preset pushbutton

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

Fig. 29: Position of the controls



Note The three DEC switches do not have any function on the AFS60/AFM60 EtherCAT.

Preset pushbutton

The preset function is available in every status of the EtherCAT state machine.

➢ To trigger the preset, press the preset pushbutton.
The value from object 2005h is used as the new position value.

Notes

- Only set a preset value when the encoder is at standstill.
- The preset value must lie within the measuring range configured.

WARNING

Before triggering the preset function, check whether there is a hazard from the machine or system in which the encoder is integrated!

The preset function results in a change in the position value output by the encoder. This change could cause an unexpected movement that may result in a hazard for persons or damage to the system or other items.

4.3 Configuration

The AFS60/AFM60 EtherCAT can be integrated into a Beckhoff control system. For this purpose an ESI file is loaded into the system.

Notes

- All software notes are displayed in English.
- All software notes are related to the TwinCAT® system manager.

4.3.1 Default delivery status

The AFS60/AFM60 EtherCAT is supplied with the following parameters:

- code sequence = clockwise
- scaling = none
- resolution per revolution = 262,144
- total resolution AFS60 = 262,144
- total resolution AFM60 = 1,073,741,823
- preset = 0
- velocity measuring unit = rpm
- round axis functionality = not activated
- nominator for round axis functionality = 2,048
- divisor for round axis functionality = 1

4.3.2 System configuration

Note All configuration information relates to Beckhoff controllers that are configured and diagnostics undertaken using the configuration tool TwinCAT®.

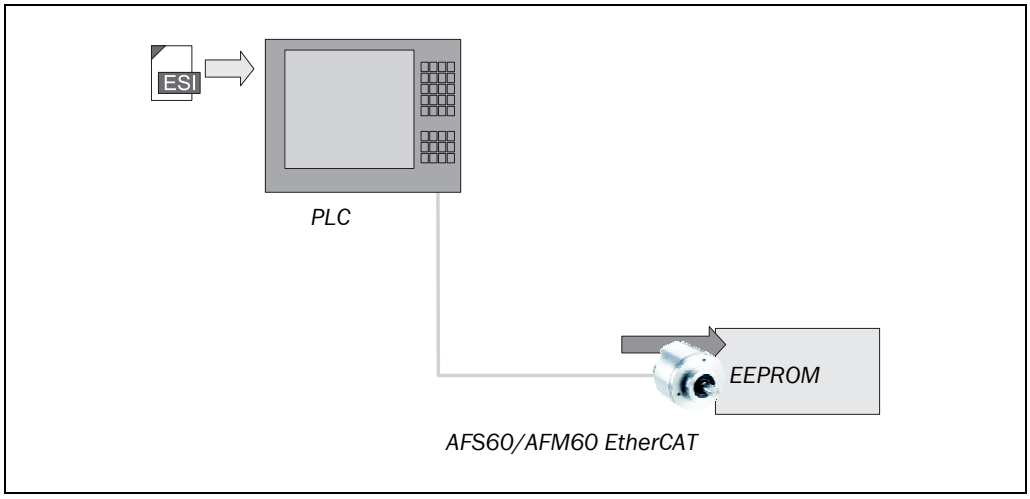


Fig. 30: Integration in TwinCAT® with ESI file

- ➢ Copy the ESI file **SICK-AFx_vX-xxx** in the TwinCAT® directory to the folder **TwinCAT\IO\EtherCAT**.
- ➢ Then restart the TwinCAT® system manager.
- ➢ Add the encoder in the device tree as a box.

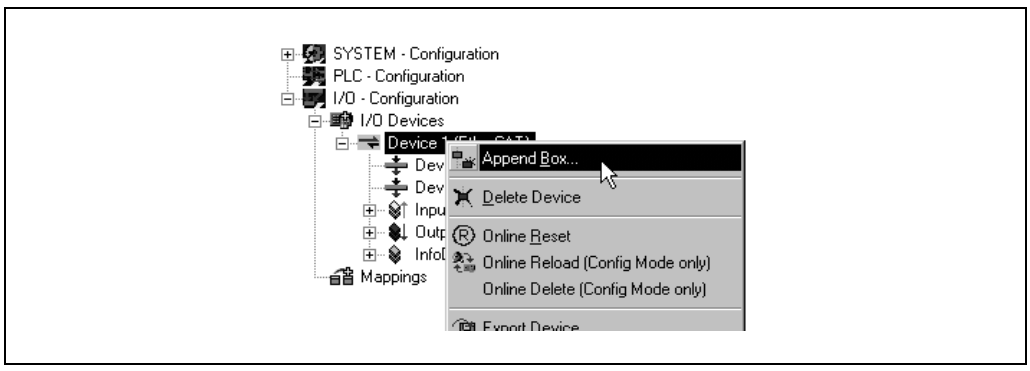
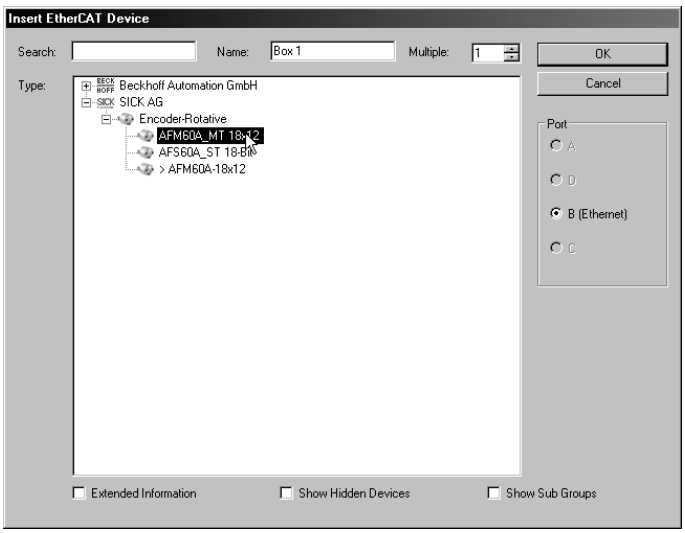


*Fig. 31: **Append Box...** context menu command*

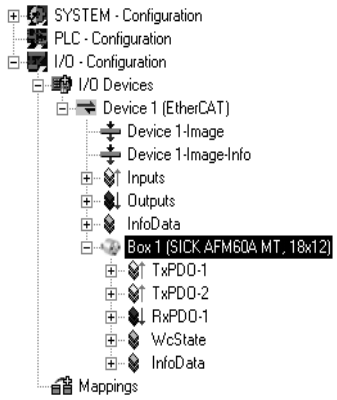
➢ Choose the required encoder type under SICK AG.
(... MT = Multiturn, ... ST = Singleturn)

Fig. 32: Dialog box for adding an EtherCAT device



The encoder is displayed in the device tree as **Box n**.

Fig. 33: Encoder in the device tree



➢ Then place the TwinCAT® system manager in the configuration mode.

Fig. 34: Configuration mode button

Prompts are displayed as to whether the TwinCAT® system manager is to be placed in the configuration mode, whether the data are to be loaded from the I/O device and whether the system is to be placed in the Free Run operating mode.

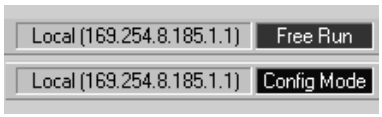
Fig. 35: Configuration mode prompt

Fig. 36: Load I/O Devices prompt

Fig. 37: Free Run prompt

➢ Click **OK** or **Yes**.

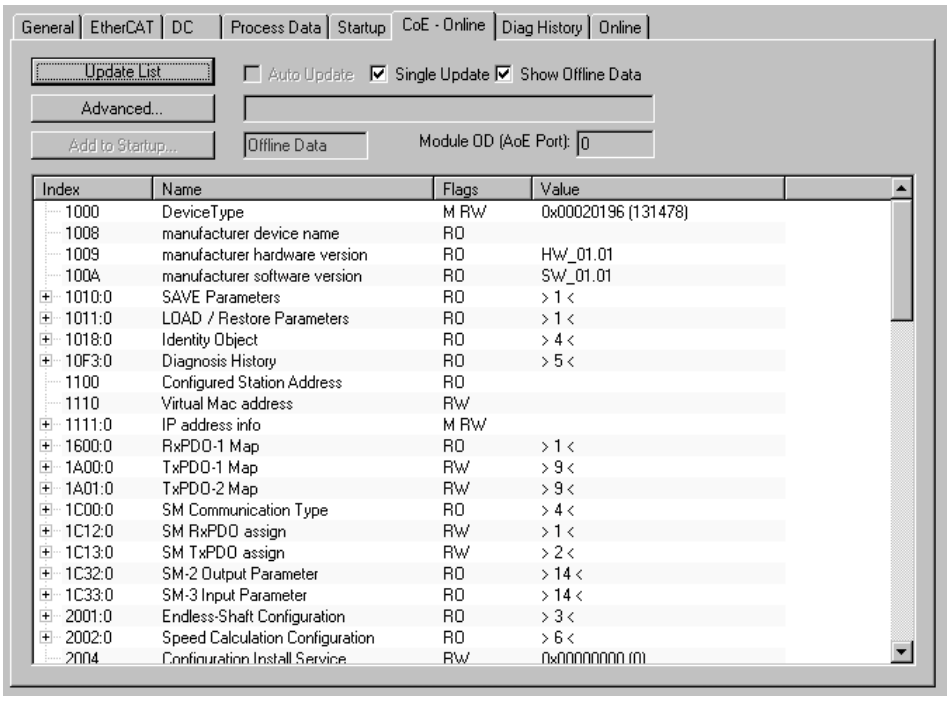
Fig. 38: Status indication of the Free Run or configuration mode



The status indication at the bottom right changes between **Free Run** in red and **Config Mode** in blue.

Note The Free Run mode of the TwinCAT® system manager described here is not be confused with the encoder's Free Run operating mode.

Fig. 39: CoE - Online tab



All object parameters can now be read or configured on the **CoE - Online** tab (see section 3.4 "Configurable functions" on page 17).

4.4 Test notes

WARNING

Commissioning requires a thorough check by authorized personnel!

Before you operate a system equipped with the AFS60/AFM60 EtherCAT 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 Fault diagnosis

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

5.1 In the event of faults or errors

WARNING

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

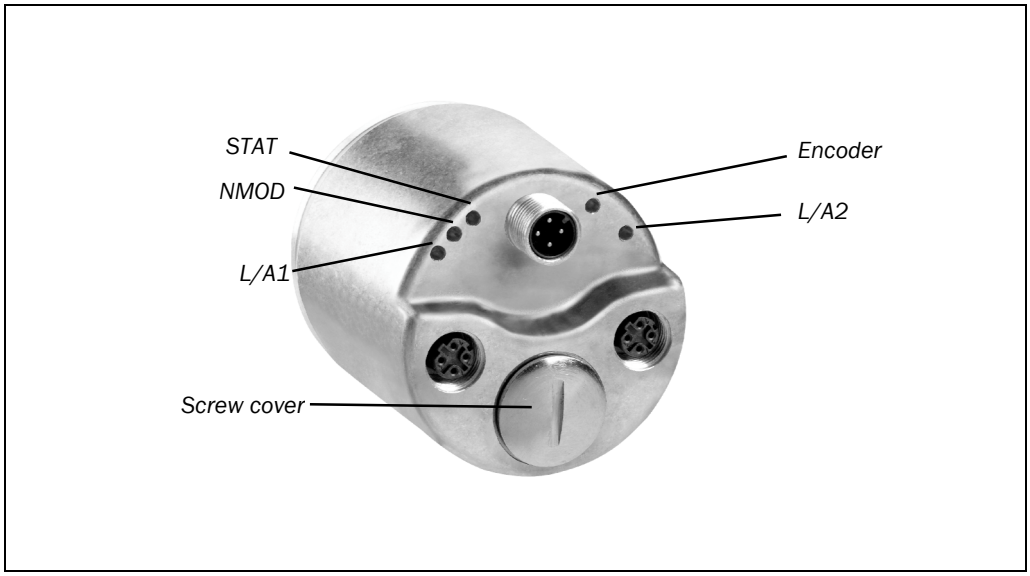
Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely rectify the malfunction.

5.2 SICK STEGMANN support

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

5.3 Error and status indications on the LEDs

Fig. 40: Position of the LEDs



5.3.1 Identification of the encoder

Recommendation

Place the encoder (e.g. in a system with several sensors) in the Pre-operational status using the TwinCAT® system manager. As a result the STAT status LED flashes green every 200 ms and the encoder can be identified more easily.

5.3.2 NMOD, STAT and Encoder status LEDs

Tab. 91: Meaning of the NMOD, STAT and Encoder status LEDs

Display	Description
NMOD LED	
○ Off	No operating voltage or Network module not initialized
● Green	Network module in operation
● Red	Error in the network module
STAT LED run status	
Run status (green)	
○ Off	Status Initializing or No operating voltage
☼ 200 ms	Pre-operational status The encoder is ready for configuration, SDO transfer can take place Can be used for identification
☼ 200/1000 ms	Pre-operational status EtherCAT master reads the position values from the encoder
●	Operational status EtherCAT master reads the position values from the encoder in real-time
Error status (red)	
○ Off	No error or No operating voltage
☼ 200 ms	Faulty configuration
☼ 200/1000 ms	Local error The encoder has changed the EtherCAT status independently.
☼ 2 × 200/1000 ms	Watchdog time-out
●	Application error
Encoder LED	
Initialization phase	
○ Off	No operating voltage
☼ Red/green	Self-test at power-on
● Green	Initialization complete/no error
☼ Green	Initialization completed incorrectly

Display	Description
Operational status	
● Green	Bus operates correct
☼ Red	Warning due to exceeding/dropping below frequency/rotational speed, exceeding/dropping below operating temperature or exceeding/dropping below sensor LED current (see also object 2010h – Sensor Status (S_STAT-A) on page 57)
● Red	Alarm due to an EEPROM error or invalid communication with I^2C device (see also object 2010h – Sensor Status (S_STAT-A) on page 57)
☼ Orange	EtherCAT or CoE-specific communication error (see also object 2010h – Sensor Status (S_STAT-B) on page 58)
☼ Green	Cycle time (SM/DC sync event) set for the system <480 µs (see also Object 2010h – Sensor Status (S_STAT-B) on page 58)

5.3.3 Ethernet Link LEDs L/A1 and L/A2

The LEDs L/A1 and L/A2 display the status of the physical connection on the two Ethernet interfaces.

Tab. 92: Meaning of the LEDs L/A1 and L/A2

Display	Description
○ Off	No operating voltage or No connection established, internal ESC-Port closed
● Green	Connection established, internal ESC port open, **no** data transmission active
● Yellow	Interface port locked
☼ Green	Connection established, internal ESC port open, data transmission active
☼ Yellow	Data collisions

5.4 Diagnostics via EtherCAT

5.4.1 Error types

The following error types can occur:

- encoder-specific errors, caused by the encoder's measuring system
- application protocol-specific (CoE) errors
- network protocol-specific (EtherCAT) error

5.4.2 Encoder specific errors

Encoder-specific errors must be retrieved by the master. The diagnostics messages can be read from the following objects:

- 1F03h – Diagnosis History (see Tab. 22 on page 33)
- 6503h – Alarms (see Tab. 52 on page 47)
- 6505h – Warnings (see Tab. 56 on page 48)
- 2010h – STW-1 – Device Status Word (see Tab. 76 on page 57)

Note If a new diagnostics message has occurred, it is indicated via the subindex .4 "Diagnosis Flag" of the object 10F3h. By default this object is transferred cyclically via the process data object 1A01h.

5.4.3 CoE specific errors

In the case of an error during the SDO transfer, a so-called Abort-SDO-Transfer-Request is transmitted with an error code. The following errors are possible:

Tab. 93: CoE specific errors

Value	Description
05030000h	Toggle bit has not changed
05040000h	SDO protocol time-out
05040001h	Client/server command invalid or unknown
05040005h	Memory too small
06010000h	Object access not supported
06010001h	Read access to an object that can only be written
06010002h	Write access to an object that can only be read
06020000h	Object not present in the object directory
06040041h	The object cannot be mapped in the PDO.
06040042h	The number and length of the mapped objects exceed the PDO length.
06040043h	General parameter incompatibility
06040047h	General incompatibility in the device
06060000h	Access error due to a hardware error
06070010h	Incorrect data type, length of the service parameters is incorrect
06070012h	Incorrect data type, length of the service parameters too long
06070013h	Incorrect data type, length of the service parameters too short
06090011h	Subindex does not exist
06090030h	Parameter value range exceeded, only on write access
06090031h	Parameter value written too long
06090032h	Parameter value written too short
06090036h	Maximum value is smaller than minimum value
08000000h	Generic error
08000020h	Data can not be transferred or saved in the application
08000021h	Data can not be transferred or saved in the application. Reason: local control system
08000022h	Data can not be transferred or saved in the application. Reason: actual device status
08000023h	Dynamic object directory creation error or object directory does not exist

5.4.4 EtherCAT specific errors

EtherCAT-specific errors can be transmitted in the following ways:

- Emergency messages
- AL status information
- Sync Manager Watchdog
- NMOD status LED (see section 5.3.2 on page 74)
- STAT status LED (see section 5.3.2 on page 74)

Emergency messages

Emergency messages are automatically transmitted from the encoder to the master. The data transfer is undertaken via the EtherCAT mailbox service.

Structure of the emergency messages

Tab. 94: Mailbox service with emergency message

Description	Mailbox header	CoE header	Emergency message
Data length	6 byte	2 byte	8 byte

Tab. 95: Structure of the emergency messages

Byte							
0	1	2	3	4	5	6	7
Emergency error code		Error registry	Additional Error Field (Diagnosis Information)				
LsB	MsB	–	Diag 0	Diag 1	Diag 2	Diag 3	Diag 4

The emergency messages comprise the emergency error code, the error register and the additional error field.

The emergency error code defines at which transition of the status of the EtherCAT state machine the error occurred (see Tab. 96 on page 78).

The error register defines the status of the EtherCAT state machine (see Tab. 97 on page 79).

The additional error field comprises five bytes (Diag 0 to 4). The **Diag 0** byte indicates the actual error (see Tab. 98 on page 79). The values in the bytes **Diag 1** to **Diag 4** are dependent on the code in the byte **Diag 0**. You will find detailed information in document ETG.1006, chapter “ESM Transition Error”.

Error messages via the EtherCAT state machine

Tab. 96: Emergency error codes

Emergency error code	Meaning
0000h	No error
A000h	Transition from Pre-operational to Safe-operational status was not successful
A001h	Transition from Safe-operational to Operational status was not successful

Note If an error condition is rectified, a new emergency message is sent with the emergency error code 0000h.

Tab. 97: Error registry

Error registry	Meaning
01h	Status of the EtherCAT state machine = Initializing
02h	Status of the EtherCAT state machine = Pre-operational
03h	Status of the EtherCAT state machine = Safe-operational
04h	Status of the EtherCAT state machine = Operational
05h	SDO write function failed

The value in byte 3 (Diag 0) shows which error has occurred in which Sync Manager:

Tab. 98: Additional Error Field Byte 3 (Diag 0)

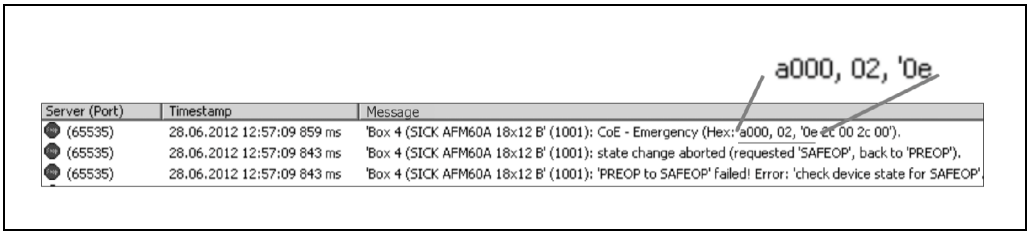
Additional Error Field Byte 3 (Diag 0)	Meaning	
00h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 0 (Write mailbox)
01h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
02h	PDO Length Error The PDO length is incorrect.	
03h	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	
04h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 1 (Read mailbox)
05h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
06h	PDO Length Error The PDO length is incorrect.	
07h	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	
08h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 2 (Process data out)
09h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
0Ah	PDO Length Error The PDO length is incorrect.	
0Bh	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	

Additional Error Field Byte 3 (Diag 0)	Meaning	
0Ch	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 3 (Process data in)
0Dh	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
0Eh	PDO Length Error The PDO length is incorrect.	
0Fh	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	

Note The values in the bytes **Diag 1** to **Diag 4** are dependent on the code in the byte **Diag 0**. You will find detailed information in document ETG.1006, chapter “ESM Transition Error”.

Display of an error message in TwinCAT®

Fig. 41: Display of an error message in TwinCAT®



Example:

The example shows a row in the TwinCAT® system manager. The hexadecimal values are to be interpreted as follows:

- A000h: Invalid transition from the Pre-operational to Safe-operational status
- 02h: Status of the EtherCAT state machine = Pre-operational
- 0Eh: The PDO length in Sync Manager 3 is incorrect.

Note The four other values are needed, for instance, for SICK Support.

AL status information

Tab. 99: AL status information

Value	Designation	Description
0000h	No error	No error
0001h	Unspecified error	Error that cannot be specified
0002h	No memory	More than data memory
0011h	Invalid requested state change	The requested status change is not valid (e.g. from “Initializing” to “Operational”).
0012h	Unknown requested state	The requested status is unknown or not defined in the state machine.
0013h	Bootstrap not supported	The slave does not support the “Bootstrap” status.
0014h	No valid firmware	The data loaded to the slave are not valid firmware.
0015h	Invalid mailbox configuration	The configuration of the Mailbox Sync Manager is invalid. The error occurred during the bootstrap.

Value	Designation	Description
0016h	Invalid mailbox configuration	The configuration of the Mailbox Sync Manager is invalid. The error occurred in the Pre-operational status.
0017h	Invalid sync manager configuration	The configuration of the Sync Manager is invalid.
0018h	No valid inputs available	The application cannot provide any valid input data.
0019h	No valid outputs available	The application cannot receive any valid output data.
001Ah	Synchronization error	The encoder is not synchronized. It is not possible to define any specific cause of the error.
001Bh	Sync manager watchdog	Error detected by the watchdog. It has not been possible to receive any data or to receive data within the time-out.
001Ch	Invalid sync manager types	–
001Dh	Invalid output configuration	The Sync Manager configuration for output data is incorrect.
001Eh	Invalid input configuration	The Sync Manager configuration for input data is incorrect.
001Fh	Invalid watchdog configuration	The watchdog configuration is incorrect (e.g. if the watchdog is activated, but a time-out is not configured).
0020h	Slave needs cold start	Encoder must be restarted (Power on/off)
0021h	Slave needs “INIT”	The encoder must be set to the “Initializing” status.
0022h	Slave needs “PREOP”	The encoder must be set to the “Pre-operational” status.
0023h	Slave needs “SAFEOP”	The encoder must be set to the “Safe-operational” status.
0024h	Invalid input mapping	The data mapping of the input data does not match the expected mapping.
0025h	Invalid output mapping	The data mapping of the output data does not match the expected mapping.
0026h	Inconsistent settings	General error
0027h	Free Run not supported	The Free Run operating mode is not supported.
0028h	Synchronization not supported	The synchronous operating modes are not supported.
0029h	Free Run needs 3 Buffer mode	–
002Ah	Backround watchdog	–
002Bh	No valid inputs or outputs	–
002Ch	Fatal Sync error	The Sync0 or Sync1 events can no longer be received by the encoder.

Value	Designation	Description
002Dh	No sync error	It was not possible for the encoder to receive the Sync0 or Sync1 events during the status change from “Safe-operational” to “Operational”.
0030h	Invalid DC “SYNC” configuration	The DC configuration is invalid.
0031h	Invalid DC latch configuration	The DC-latch configuration is invalid.
0032h	PLL error	Master not synchronized, however at least one DC event has been received
0033h	Invalid DC I/O error	Several synchronization errors possible, no synchronization
0034h	Invalid DC time-out error	Several synchronization errors possible, too many DC events “missed”
0042h	MBX_EOE	–
0043h	MBX_COE	–
0044h	MBX_FOE	–
0045h	MBX_SOE	–
004Fh	MBX_VOE	–
0050h	EEPROM no access	–
0051h	EEPROM error	No access to the EEPROM of the encoder
0060h	Slave restarted locally	–
0061h	Device Identification value updated	The encoder’s identification value has been successfully renewed.
00F0h	Application controller available	–

5.4.5 Error messages

The error messages are output via the object **10F3h – Diagnosis History** (see Tab. 22 on page 33).

Tab. 100: Error messages based on the S_STAT-A flags

Text ID	Flag (type)	Description
115	0002h Error	Memory error: Invalid EEPROM checksum on initialization
114	0002h Error	Position error: Invalid communication with the I^2C device in the sensor module
113	0002h Error	Reserved

Text ID	Flag (type)	Description
112	0002h Error	Position error: Invalid EEPROM checksum or Invalid internal SSI communication (MFP4 signal)
111	0002h Error	Position error: Invalid synchronization or no synchronization of MA sensor with the LY singleturn position
110	0002h Error	Position error: The error register in LY is activated (MFP5 signal). or Invalid internal SSI communication (MFP4 signal)
109	0002h Error	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the multiturn stage
108	0002h Error	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the singleturn stage
107	0002h Error	Position and memory error: Invalid communication with the I^2C device in the main unit
106	0002h Error	Position error: Error on the calculation of the amplitude values $Sin^2 + Cos^2$ in the singleturn stage
105	0001h Warning	Warning in relation to the velocity: Current measured value outside of the minimum or maximum limit
104	0001h Warning	Position error: Error on the calculation of the amplitude values $Sin^2 + Cos^2$ in the multiturn stage
103	0001h Warning	Warning in relation to the operating voltage: Current measured value outside of the minimum or maximum limit
102	0001h Warning	Warning, sensor LED current critical: Current measured value outside of the minimum or maximum limit
101	0001h Warning	Warning in relation to the temperature: Current measured value outside of the minimum or maximum limit
100	0001h Warning	Warning: General start-up error at power-on

Tab. 101: Error messages based on the S_STAT-B flags

Text ID	Flag (type)	Description
215	0201h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Sensor Config Data)
214	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Device Configuration)
213	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis Process Data Basic)
212	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis/Service Data)
211	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration parameter or communication mapping)
210	–	Reserved
209	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'CAM' parameter)
208	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'Basic xxx' parameter)
207	–	Reserved
206	0001h Warning	Cycle time set for the system <480 µs
205	0001h Warning	Reserved
204	0001h Warning	Warning, triggered on executing the preset function: The preset value, defined by the scaling parameter, is outside the measuring range (CMR).
203 ... 200	0001h Warning	Warning, occurred on changing or writing parameter values

Tab. 102: Error messages based on the S_STAT-C flags

Bit	Flag (type)	Description
315	0000h Information	Information: Encoder in the Free Run operating mode. The formation of the position **is synchronized** with the process data cycle of the master.
314	0000h Information	Information: Encoder in the Synchronous operating mode. The formation of the position **is not synchronized** with the process data cycle of the master.
313	0000h Information	Reserved
312	0001h Warning	Preset function has been triggered and confirmed by object 2000h (see Tab. 68 on page 52)
311 ... 304	–	Reserved
3	0000h Information	Status information on saving internal diagnostic data: Save operation requested and operation in progress or Save operation complete
302	0000h Information	Status information on saving internal diagnostic data: Save operation requested and operation in progress or Save operation complete
301	0000h Information	Saving the configuration data using the Save command (Object 1010h, see Tab. 16 page 31): Save operation requested and operation in progress or Save operation complete
300	–	Reserved

6 Annex

6.1 EC declaration of conformity

Fig. 42: EC declaration of conformity

SICK

EC Declaration of conformity

en

Ident-No. : 9175428 WL61

The undersigned, representing the following manufacturer

SICK Stegmann GmbH
Dürrheimer Straße 36
78166 Donaueschingen
Germany

herewith declares that the product

AFS / AFM60 EtherNet/IP, PROFINET, EtherCAT

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Donaueschingen, 27.09.2012

ppa. Trevor Stewart
(Manager Research & Development)

i.V. Eberhard Klein
(Manager Production)

Note You can obtain the complete EC declaration of conformity via the SICK homepage on the Internet at www.sick.com.

6.2 List of tables

6.3 List of illustrations

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