Absolute Rotary Encoder

with redundant CANopen Interface

Manual

CANopen®

Your automation, our passion.

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2024-02

2024-02

2024-02

2024-02

1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.

Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Functional safety manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note

This symbol brings important information to your attention.

Action

1. This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

2 Declaration of conformity

2.1 CE conformity

This product was developed and manufactured under observance of the applicable European standards and guidelines.

Note

A declaration of conformity can be requested from the manufacturer.

3 Safety

3.1 Symbols relevant to safety

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

3.2 Intended Use

Absolute rotary encoders detect the rotation angle -and, in the case of a multiturn absolute rotary encoder, the revolutions of the rotary encoder shaft- with high precision and resolution. The absolute position value derived from this is provided by the rotary encoder via the CANopen interface in accordance with the standard DS406. The rotary encoder has to be integrated into a CANopen network and should be used only in this way.

The CANopen rotary encoder is equipped with independent optical and magnetic sampling built up in one housing and flange with shaft. This redundancy makes the rotary encoder suitable for safety-relevant applications.

Caution!

User is responsible for integration into safety applications!

Note that this product is not safety certified. It is the responsibility of the user to integrate the product into a safety application and meet all necessary safety requirements.

Typical applications include positioning tasks and length measurement, for example for cranes, construction machinery, elevators, and packaging machines.

Read through this manual carefully. Familiarize yourself with the device before installing, mounting, or operating.

Always operate the device as described in these instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and the plant is guaranteed only if the device is operated in accordance with its intended use.

2024-02

3.3 General safety instructions

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Installation and commissioning of all devices may be performed only by trained and qualified personnel.

It is dangerous for the user to make changes and/or repairs. Additionally, doing so voids the warranty and excludes the manufacturer from any liability. In the event of any serious errors, stop using the device. Secure the device against unintended operation. To have the device repaired, return it to your local Pepperl+Fuchs representative or your sales center.

Note

Disposal

Electronic waste is dangerous. When disposing of the equipment, observe the current statutory requirements in the relevant country of use and local regulations.

4 General Information on System Integration

4.1 Overview

This manual explains how to install and configure the absolute rotary encoders ENA58PL*** CANopen redundant, applicable for industrial applications with CANopen interface.

The CANopen rotary encoder is equipped with an independent photoelectric and magnetic encoder built up in one housing and flange with shaft. This redundancy makes the rotary encoder ideal for safety-relevant applications. The 2 sampling systems measure the position value absolute also in non-powered mode. No rechargeable battery is used. This makes the rotary encoder also suitable for harsh ambient conditions.

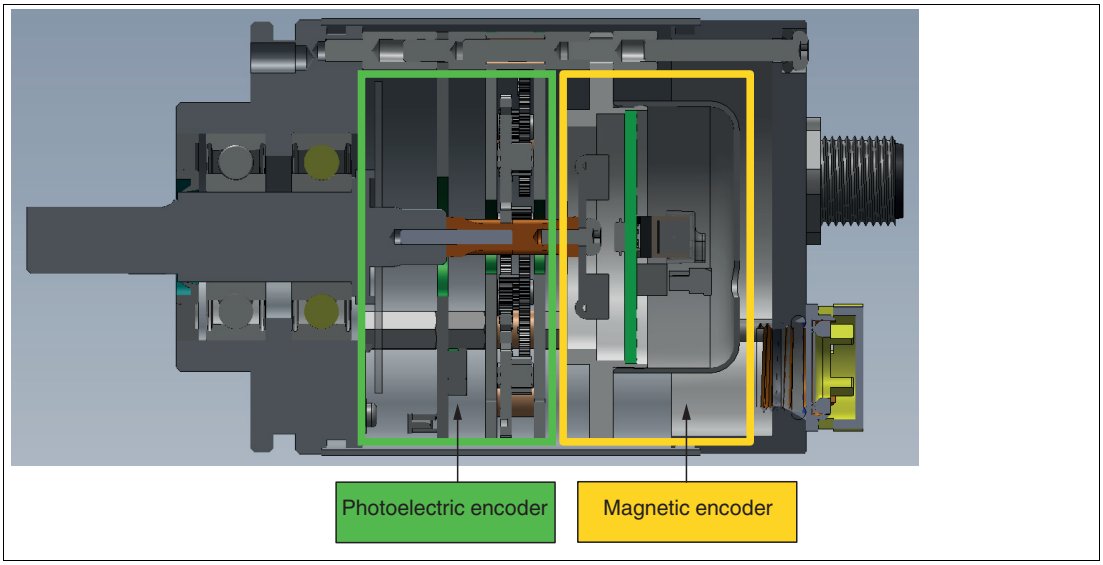


Figure 4.1

Both encoder parts each have different microcontrollers, different compilers, different software modules and different power supply. There is no connection between both encoders apart from the CAN interface. There are models with one connector or with 2 connectors.

Therefore, all settings of the encoder parts have to be configured separately.

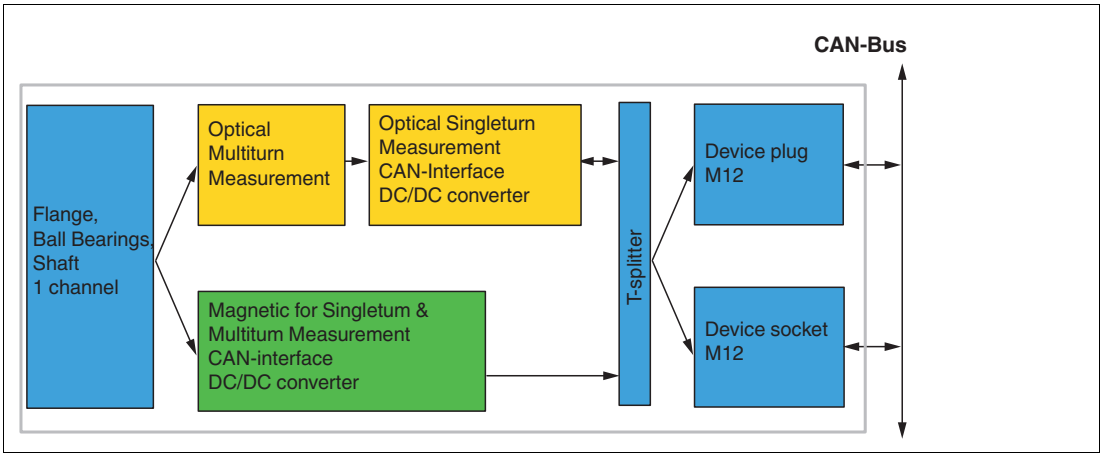


Figure 4.2

Caution!

User is responsible for integration into safety applications!

Note that this product is not safety certified. It is the responsibility of the user to integrate the product into a safety application and meet all necessary safety requirements.

2024-02

Magnetic absolute rotary encoders are fully compliant with standard DS406.3.2

Photoelectric absolute rotary encoders are fully compliant with following CiA standards:

- DS301V402 CANopen Application Layer
- DR303-1 cabling and connector pin assignment
- DS305V200 CANopen Layer Setting Service
- DS306V1R3 Electronic datasheet specification
- DS406V32 Device Profile for Encoders

Measuring System for Photoelectric Absolute Rotary Encoders

The measuring system consists of a light source, a code disc pivoted in a precision ball bearing and an opto-electronic scanning device. An LED is used as a light source which shines through the code disc and onto the screen behind. The tracks on the code disk are evaluated by an opto array behind the reticle.

With every position, another combination of slashes in the reticle is covered by the dark spots on the code disk and the light beam on the photo transistor is interrupted. That way the code on the disc is transformed into electronic signals. Fluctuations in the intensity of the light source are measured by an additional photo transistor and another electronic circuit compensates for these. After amplification and conversion, the electronic signals are available for evaluation.

Measuring System for Magnetic Absolute Rotary Encoders

Magnetic rotary encoder determines positions using the Hall effect sensor technology developed for the automotive mass market. A permanent magnet fixed to the shaft generates a magnetic field that is sampled by the Hall sensor, which translates the measured value into a unique absolute position value.

To register revolutions, even when no voltage is applied, energy from the turning of the shaft must suffice for proper operation. An innovative, patented technology makes this feasible, even at low rotational speeds and through long standstill periods – a Wiegand wire ensures that the magnetic field can only follow the turning of the shaft in discrete steps. A coil wound on the Wiegand wire receives only brief, strong voltage spikes, which prompt the reliable recognition of each revolution.

Note

Further information on technical data, mechanical data, connection layouts, and available connection lines for the relevant absolute rotary encoder types can be found in the corresponding datasheet.

4.2 General CANopen Information

The CANopen system is used in industrial applications. It is a multiple access system (maximum: 127 participants), which means that all devices can access the bus. In simple terms, each device checks whether the bus is free, and if the device is able to send messages. If two devices try to access the bus at the same time, the device with the higher priority level (lowest ID number) has permission to send its message.

Devices with the lowest priority level must delay their data transfer and wait before retrying to send their message. Data communication is carried out via messages. These messages consist of 1 COB-ID followed by a maximum of 8 bytes of data. The COB-ID, which determines the priority of the message, consists of a function code and a node number. The node number corresponds to the network address of the device. It is unique on a bus. The function code varies according to the type of message being sent:

- Management messages (LMT, NMT)
- Messaging and service (SDOs)
- Data exchange (PDOs)
- Layer Setting Services (LSS)
- Predefined messages (synchronization, emergency messages)

The absolute rotary encoder supports the following operating modes:

- Polled mode: The position value is only sent on request.
- Cyclic mode: The position value is sent cyclically (regular, adjustable interval) on the bus.
- SYNC mode: The position value is sent after a synchronization message (SYNC) is received. The position value is sent every n SYNCs ($n \geq 1$).

Other functions (offset values, resolution, etc) can be configured. The absolute rotary encoder corresponds to the class 2 encoder profile (DS 406 in which the characteristics of encoders with CANopen interface are defined). The node number and speed in bauds are determined by their corresponding object dictionary entries.

The transmission speed can range from 20 kBaud up to 1Mbaud (30 m cable for a maximum speed of 1Mbaud, 1000 m cable for a maximum speed of 20 kbaud). Various software tools for configuration and parameter-setting are available from different suppliers. It is easy to align and program the rotary encoders using the EDS (electronic data sheet) configuration file provided on the Pepperl+Fuchs website, see www.pepperl-fuchs.com

Further Information is available at:

CAN in Automation (CiA) International Users and Manufacturers Group e.V.

Kontumazgarten 3

DE-90429 Nurenberg

(*) Reference: CAN Application Layer for Industrial Applications

- CiA Draft Standard 201 ... 207, Version 1.1

CAL-based Communication Profile for Industrial Systems

- CiA Draft Standard 301
- CiA Draft Standard 305 Layer Setting Services
- CiA Draft Standard 406 Device Profile for Encoders

Note

All datasheets and manuals can be downloaded for free from our website **www.pepperl-fuchs.com**

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

2024-02

4.3 MTTF Values for Encoder Parts

In the following table you find the denotation of $MTTF_d$ for each channel related to the $MTTF_d$ of each channel. By limitation of $MTTF_d$ to maximum of 100 years in the standard ISO 13849-1 it shall be prevented, that with one very high MTTF value another other bad channel is compensated.

Denotation of $MTTF_d$ of each channel	Range of $MTTF_d$ of each channel
Low	3 years ≤ $MTTF_d$ < 10 years
Medium	10 years ≤ $MTTF_d$ < 30 years
High	30 years ≤ $MTTF_d$ < 100 years

Table 4.1

Related to $MTTF_d$ a maximum value of 100 years can be used, even if the calculated value is higher.

- MTTF for photoelectric multiturn encoder with connector version: 250 years @ 40*C ambient temperature
- MTTF for magnetic multiturn encoder with connector version: 380 years @ 40° C ambient temperature

In the following you can see the calculation of a parallel hardware structure. The absolute rotary encoder achieves a $MTTF_d$ value of 133 years at 40°C ambient temperature.

$MTTF_d = 2/3 \times [MTTF_{dC1} + MTTF_{dC2} - (1/ (MTTF_{dC1} + MTTF_{dC2}))]$

- Calculation formula for 2 redundant channels above is used to calculate $MTTF_d$ for redundant diverse encoder
- Photoelectric multiturn encoder with connector version: $MTTF_{dC1}$ = 100 years @40*C ambient temperature
- Magnetic multiturn encoder with connector version: $MTTF_{dC2}$ = 100 years @40*C ambient temperature
- $MTTF_d$ for redundant encoder: $MTTF_d = 2/3 \times [100 \text{ years} + 100 \text{ years} - (1/ (100 \text{ years} + 100 \text{ years}))]$
  $MTTF_d$ = 133 years at 40 °C ambient temperature

4.4 Diagnostic Coverage DC

A diagnostic coverage value "DC value" can be achieved in the customer control system via the cross comparison of magnetic and optical sampling.

5 Installation

5.1 Signal Assignment of Connectors

The rotary encoder is designed in accordance to CiA normative DR303-1 connector pin assignment.

The absolute rotary encoder is equipped with an independent photoelectric and magnetic sampling. Optionally a combined or separate connector outlet for each sampling technology is available. The following scheme illustrates the relationships for the electrical connection.

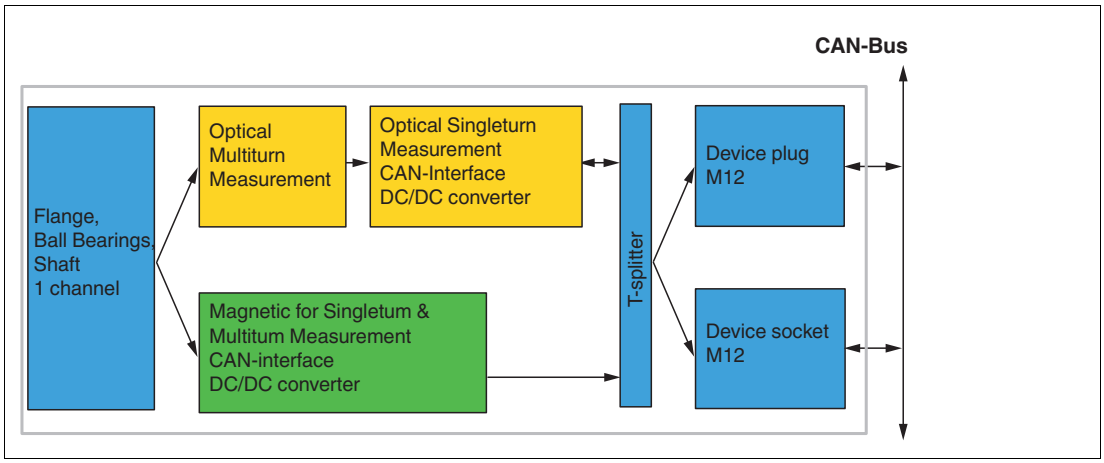


Figure 5.1

The following table shows the pin assignment of the 2 available connection types (dependent on the ordered connection type).

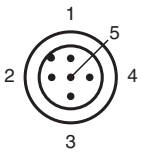
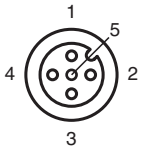
Signal	Device plug M12 x 1, 5-pin, A-coded	Device socket M12 x1, 5-pin, A-coded
	always present	only with connection type BN
CAN GND	1	1
$+V_S$	2	2
GND	3	3
CAN-High	4	4
CAN-Low	5	5
Shielding	Housing	Housing
Pinout		

Table 5.1

5.2 Activation of the Terminator

There is a terminator provided in rotary encoder which must be used as a line termination on the last device. The terminator can be acitvated or deactivated by programming Object 3002h.

Caution!

Activated bus termination works only when device is powered.

Non-observance causes interferences on the CANopen bus.

If you activate the bus termination by programming Object 3002h on the rotary encoder ensure that the rotary encoder is the last CANopen node in the bus line. The resistor is only activated when rotary encoder is powered. If there are more CAN nodes on the CAN Bus ensure to power them ca. 700 ms after the rotary encoder with the programmed terminator.

5.3 Setting of Node Numbers and Baud Rates

Caution!

Different node numbers are required!

For communication in CANopen network, photoelectric and magnetic encoder must have different node numbers. Otherwise the rotary encoder is not useable anymore.

Note

Setting of node numbers and baud rate has to be done via software by programming the relevant SDO objects.

Setting Node Number

The default node numbers are:

- Magnetic encoder 31 decimal (1Fh)
- Photoelectric encoder 32 decimal (20h)

To set the node number, object 3000h has to be programmed. For details see chapter 8.5.37.

Possible device address 0 ... 255.

Note

It is useful to set the node number for magnetic and photoelectric encoder close to each other like 32 & 31 or 10 & 9 to reduce effects during transmission by message priority.

Note

Internally the CANopen rotary encoder adds 1 to the adjusted device address.

Setting Baud Rate

Baud rate for photoelectric and magnetic encoder has to be set separately. The magnetic encoder part is equipped with auto baud detection which is activated by default, whereas the photoelectric encoder has no auto baud detection.

For magnetic encoder the manufacturer default setting for baud rate is 125 kBd. If auto baud detection is deactivated or not successful conducted within the time-out period or if the device was started in the past successful, then the last stored configuration setting is used.

For both encoder parts, setting of baud rate is possible via SDO objects 3001h.

- Baud rate is set manually by programming object 3001h (for details).
- Auto baud detection is activated/deactivated by programming object 3003h (for details see chapter 8.5.40).

6 Quick Start Guide

Intention of this chapter is to help the user getting an absolute rotary encoder easy and fast to operate. The user is still responsible to configure the absolute rotary encoder in the right way and reading the whole manual carefully.

With the following sequence, a normal procedure is described to configure a device for standard applications. It shall guide you roughly through this process.

6.1 Configure the Absolute Rotary Encoder for Integration into a CAN Network

Caution!

Check requirements of baud rate and node numbers of your network before configuration!

Default setting of node number is 32 decimal (20h) for photoelectric encoder and 31 decimal (1Fh) for magnetic encoder. For photoelectric sensor, the default setting of baud rate is 125 kBaud. For magnectic encoder auto baud detection is activated. If auto baud detection is not sucessful the encoder part uses 125 kBaud as a fall back scenario.

If your running network uses a different baud rate or the node number is already in use, then you shall make a point-to-point connection to the rotary encoder with a configuration tool to prevent a crash of the different configured running network. If auto baud feature is used in the rotary encoder, it simplifies installation.

First Steps of Configuration

1. Connect the encoder with a configuration tool and set the baud rate you need for each encoder part.
2. Power on the encoder.

   ↳ You see a boot up message if there is a trace tool is used.
3. If necessary activate the terminator of the encoder by writing "01h" into object "3002h".
4. Continue by reading and writing data into the relevant following objects in this chapter.

Note

Note that an object modification only takes effect after a power cycle or NMT reset.

Message received from Encoder on Boot up

Example for photoelectric encoder with node number 20h (32 decimal).

Identifier	Service/Process data							
NN = 20h	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
700h + NN = 720h	00							

Table 6.1

NN = node number of encoder

2024-02

Example for magnetic encoder with node number 1Fh (31 decimal).

Identifier	Service/Process data							
NN = 20h	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
700h + NN = 71Fh	00							

Table 6.2

NN = node number of encoder

Configuration of Node Number

Object 3000h

Caution!

Different node numbers are required for photoelectric and magnetic encoder!

The node numbers for photelectric and magnetic encoder shall be different, otherwise the whole absolute rotary encoder is not usable. We also recommend defining neighboring node addresses.

Example:

The current node number of the photoelectric encoder is 20h and the magnetic encoder is 1Fh. They will be modified so that the new node numbers of the photoelectric encoder is Bh and the magnetic encoder is Ch.

Resulting node number = Value in object 3000h + 1h = Ah + 1h = Bh

Resulting node number = Value in object 3000h + 1h = Bh + 1h = Ch

The encoder itself adds the value 1 to the configured node number. This method is used to prevent an identifier value of 0.

Message sent to Photoelectric Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 20h		Download	3000h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 620h	8h	22h	00h	30h	00h	**0Ah**	00h	00h	00h

Table 6.3

Message received from Photoelectric Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 20h		Download	3000h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 580h	8h	60h	00h	30h	00h	00h	00h	00h	00h

Table 6.4

Message sent to Magnetic Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1Fh		Download	3000h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 61Fh	8h	22h	00h	30h	00h	**0Bh**	00h	00h	00h

Table 6.5

Message received from Magnetic Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1Fh		Download	3000h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 59F	8h	60h	00h	30h	00h	00h	00h	00h	00h

Table 6.6

Note

The following sequences show the configuration of a photoelectric encoder as an example. They should be conducted for both, photoelectric and magnetic encoder if default settings are not suitable for the running network.

Configuration of Baud Rate (only if auto baud feature is not used)

Object 3001h

Example: 500 kBd >> 05

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 20h		Download	3001h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 620h	8h	22h	01h	30h	00h	**05h**	00h	00h	00h

Table 6.7

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	3001h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 5A0h	8h	60h	01h	30h	00h	00h	00h	00h	00h

Table 6.8

Store Configuration

Object 1010h, Subindex 01

Signature "save" >> "73617665"

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 20h		Download	1010h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 620h	8h	22h	10h	10h	01h	**73h**	**61h**	**76h**	**65h**

Table 6.9

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	1010h		01h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 5A0h	8h	60h	10h	10h	01h	00h	00h	00h	00h

Table 6.10

The new network configuration of the encoder will be activated with a power cycle or NMT reset.

End of Configuration or further Configurations

1. Add the encoder to the network or go ahead with the configuration.

6.2 Configure application-specific Encoder Parameters

For adaption of the encoder in your application you may use objects to configure the resolution per revolution and the total resolution for each encoder part. Especially the preset value is relevant to adjust the position value of the encoder to a desired value in the machine after mechanical installation. It is useful to store the configuration in the device and not to reconfigure the different parameters after each power cycle or NMT reset. In the following tables the new configured node number is assumed.

Configuration of Measuring Units per Revolution

Object 6001h

Example: 3600 dec >> 00000E10h

Explanation: The encoder will output 3600 steps per revolution that means 0.1° resolution.

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = Bh		Download	6001h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 60Bh	08h	22h	01h	60h	00h	**10h**	0Eh	00h	00h

Table 6.11

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	6001h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 58Bh	08h	60h	01h	60h	00h	00h	00h	00h	00h

Table 6.12

Configuration of total Measuring Range

Object 6002h

Example: 7200 dec >> 00001C20h

Explanation: The encoder will output 7200 steps within 2 revolutions and starts again with 0. There is no mechanical limitation, if the encoder is driven continuously in one direction. Value must be lower or equal than given on the nameplate.

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = Bh		Download	6002h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 60Bh	08h	22h	02h	60h	00h	**20h**	1Ch	00h	00h

Table 6.13

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	6002h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 58Bh	08h	60h	02h	60h	00h	00h	00h	00h	00h

Table 6.14

Configuration of Preset Value

Object 6003h

Example: 10 dec >> 0000000Ah

Explanation: You set the encoder output position value to a desired position value in your machine. The value is set in the encoder, when the telegram is sent and confirmed. Do this operation during standstill of the encoder shaft to increase the accuracy, because the device is calculating itself an offset value. If you set the preset dynamically, which is not recommended, then you have also to take bus latency time into consideration and encoder internal cycle time.

It is recommended to set different preset values for photoelectric and magnetic encoder at the same location to generate diverse data.

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = Bh		Download	6003h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 60Bh	08h	22h	03h	60h	00h	**0Ah**	00h	00h	00h

Table 6.15

2024-02

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	6003h		00h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 58Bh	08h	60h	03h	60h	00h	00h	00h	00h	00h

Table 6.16

Note

If preset value is used, then please execute the store configuration, otherwise you will see a position jump after power cycle. It is in general recommended to store after a changed configuration.

Transmission of Position Value: cyclic

If you want, that the encoder transmits its position value cyclically without request from the PLC/CAN master, then configure the following object used for TPDO2.

Remark: By default the value is set to 1, that means the position value is transmitted after each SYNC message, so you have to do no modifications and you can skip this step.

Object 1801h, Subindex 02h

Example: 1 dec >> 01h

Explanation: The encoder will end each 100 ms its position value after receiving a NMT start command in status operational.

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = Bh		Download	1800h		05h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 60Bh	08h	22h	01h	18h	02h	**01h**	00h	00h	00h

Table 6.17

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	1801h		05h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 58Bh	08h	60h	01h	18h	02h	00h	00h	00h	00h

Table 6.18

Store Configuration

Object 1010h, Subindex 01

Signature "save" >> "73617665"

Message sent to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 20h		Download	1010h		00h	Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 620h	08h	22h	10h	10h	01h	**73h**	**61h**	**76h**	**65h**

Table 6.19

Message received from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN		Download	1010h		01h	Byte 4	Byte 5	Byte 6	Byte 7
580h + NN = 5A0h	08h	60h	10h	10h	01h	00h	00h	00h	00h

Table 6.20

The new network configuration of the encoder will be activated with a power cycle or NMT reset.

End of basic Configurations

1. Add the encoder to the network.

↳ The encoder is now configured for standard applications. Further and more specific configuration is possible. Regard for this chapter "Configuration".

7 Configuration

The following chapter describes the configuration of photoelectric and magnetic absolute rotary encoders with CANopen interface.

7.1 Operating Modes

7.1.1 General

The rotary encoder accesses the CAN network after power-up in preoperational mode: Bootup message: 700 hex + node number

It is recommended that the parameters can be changed by the user when the rotary encoder is in pre-operational mode. Pre-operational mode entails reduced activity on the network, which simplifies the checking of the accuracy of the sent/received SDOs. It is not possible to send or receive PDOs in pre-operational mode.

7.1.2 Mode: Pre-operational

To set a node to pre-operational mode, the master has to send the following message:

Identifier	Byte 0	Byte 1	Description
0h	80h	00h	NMT-PreOp, all nodes
0h	80h	NN	NMT-PreOp, NN

Table 7.1

NN: node number

It is possible to set all nodes (Index 0) or a single node (Index NN) to pre-operational mode.

7.1.3 Mode: Start - Operational

To put one or all nodes in the operational state, the master has to send the following message:

Identifier	Byte 0	Byte 1	Description
0h	01h	00h	NMT-Start, all nodes
0h	01h	NN	NMT-Start, NN

Table 7.2

NN: node number

It is possible to set all nodes (Index 0) or a single node (Index NN) to pre-operational mode.

7.1.4 Mode: Stopped

To put one or all nodes in the stopped state, the master has to send the following message:

Identifier	Byte 0	Byte 1	Description
0h	02h	00h	NMT-Stop, all nodes
0h	02h	NN	NMT-Stop, NN

Table 7.3

NN: node number

It is possible to set all nodes (Index 0) or a single node (Index NN) to pre-operational mode.

7.1.5 Reinitialization of the Rotary Encoder

If a node is not operating correctly, it is advisable to carry out a reinitialization:

Identifier	Byte 0	Byte 1	Description
0h	82h	00h	Reset communication
0h	81h	NN	Reset node

Table 7.4

NN: node number

It is possible to set all nodes (Index 0) or a single node (Index NN) to pre-operational mode.

Note

After reinitialization, the encoder accesses the bus in pre-operational mode.

7.1.6 Recommended Communication Process

The following figure shows a signal time diagram displaying a simple bus cycle.

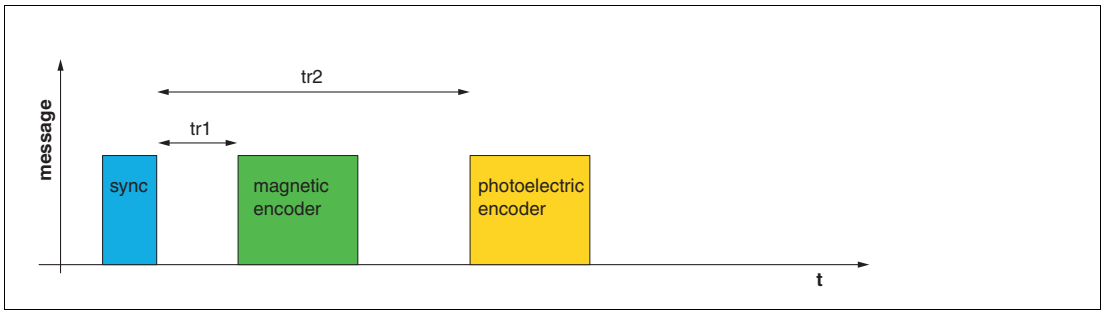


Figure 7.1

tr1 response time magnetic encoder

tr2 response time of photoelectric encoder

We generally recommend using the SYNC operation mode, because then the bus load is reduced for reading the sensor data. Also the synchronization of communication is done network wide by usage of this broadcast message type.

Note that the response time of the devices is depending on several conditions such as:

- device internal handling time of CAN messages
- priority of message
- general bus load

Furthermore the sequence of responses is not guaranteed related to above reasons. This has to be taken into consideration on the PLC side for evaluation of the position values. Remember that for diagnostic coverage DC reason a plausibility check shall be done for the difference of both position values in the PLC.

Within the photoelectric and magnetic encoder parts the position value is measured asynchronous to the bus communication. Processing time for position measurement is for both encoder parts below 100 µs. Usually the bus cycle time is in applications even higher like 1 ms or 10, 20 ms. But the encoder needs to handle in parallel to position processing also the bus communication via the CAN stack and this cycle time is below 1 ms for both encoder parts inside the absolute rotary encoder. In worst cases the bus cycle time for photoelectric and magnetic encoder parts are complete asynchronous and the time deviation could be up to 2 ms for updated position value. This has to be considered for position difference evaluation on PLC side.

2024-02

Example

Time difference of transmitted values: 2 ms

Shaft speed: 10 rpm

Position difference = v x t,

v = velocity of encoder shaft

t = time difference

Position difference = [10 rpm x 65536 steps/revolution x (min/60 s) x (1 s/1000 ms)] x 2 ms ≈ 22 steps

This is the minimum position difference between both position values, which can be increased by topics mentioned above leading to higher response times like priority or bus load.

Note

It is the application engineer responsibility to determine the allowed position difference in his application!

In the following figure you can see 2 bus cycles.

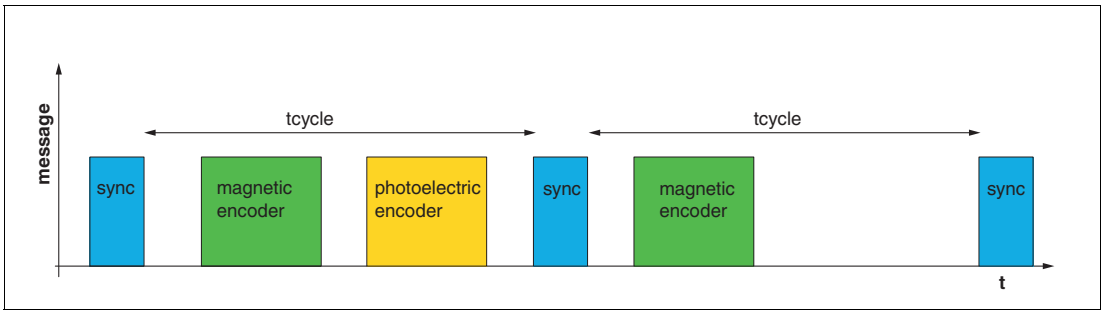


Figure 7.2

In the first cycle both encoder parts are transmitting their position data. PLC is sending its sync message and both encoder parts are responding like displayed.

In the second cycle the answer from photoelectric encoder part is missing. The PLC shall also evaluate, if the answers from both channels are transmitted and how many bus cycles are tolerated with unsuccessful or Incomplete transmissions. It is the responsibility of the application engineer to take this into account as well. This covers safety requirements and availability of the machine.

7.2 Normal Operating

CAN Transmission Mode Description

Modes	Description
Polled Modes	By a remote-transmission-request telegram the connected host calls for the current process value. The encoder reads the current position value, calculates eventually set-parameters and sends back the obtained process value by the same identifier.
Cyclic Mode	The encoder transmits cyclically – without being called by the host – the current process value. The cycle time can be programmed in milliseconds for values between 1 ms and 65536 ms.
Sync Mode	After receiving a sync telegram by the host, the encoder answers with the current process value. If more than one node number (encoder) shall answer after receiving a sync telegram, the answer telegrams of the nodes will be received by the host in order of their node numbers. The programming of an offset-time is not necessary. If a node should not answer after each sync telegram on the CAN network, the parameter sync counter can be programmed to skip a certain number of sync telegrams before answering again.

Table 7.5

7.3 Storing Parameter

7.3.1 List of storable Parameters

Object Index	Object Description
1005h	COB-ID Sync
100Ch	Guard Time
100Dh	Life Time Factor
1016h	Consumer Heartbeat Time
1017h	Producer Heartbeat Time
1020h	Verify configuration
1800h	Communication parameter PDO 1
1801h	Communication parameter PDO 2
1A00h	Transmit PDO1 Mapping Parameter
1A01h	Transmit PDO2 Mapping Parameter
2100h	Operating Parameters
2101h	Resolution per Revolution
2102h	Total Resolution
2103h	Preset Value
2104h	Limit Switch, min.
2105h	Limit Switch, max.
2160h	Customer Storage
2200h	Cyclic Timer
3000h	Node Number
3001h	Baud rate
3002h	Terminator
3003h	Auto Baud Detection
3005h	Auto Boot Up
3030h	Backward Compatibility Mode
4010h	PPR Incremental Encoder
4020h	A/B Phase Shift
6000h	Operating Parameter
6001h	Steps per Revolution
6002h	Total Resolution
6003h	Preset Value
6200h	Cyclic Timer

Table 7.6

7.3.2 Storing Procedure

The parameter settings can be stored in a non-volatile E^2PROM. The parameter settings are stored in RAM when being programmed. When all the parameters are set and proved, they can be transferred in one burn cycle to the E^2PROM by the parameter memory transfer.

Note

The stored parameters are copied after a RESET (Power on, NMT-Reset) from the E^2PROM to the RAM (volatile memory).

Storing without Reset

By using the object 1010h from the communication profile-related object dictionary you can store the parameters into the non-volatile memory without a reset.

Storing with Reset

By using the object 2300h from the manufacturer-specific object dictionary you can store the parameters into the non-volatile memory. After storing the parameters, a reset of the device is performed.

7.4 Restoring Parameters

The default parameters can be restored by using the object 1011h from communication profile-related object dictionary. The already in the non-volatile memory programmed parameters are not overwritten. Only after a new store command the default parameters are stored in the non-volatile memory. To restore the default parameter the following telegram is used. The restored parameters are equal for every type of CANopen encoder and might not fit with the status after delivery. Please check the restored parameters before you store them to the non-volatile memory.

7.5 Usage of Layer Setting Services (LSS)

To configure the encoder via LSS the encoder will be the LSS slave device and the control has to support LSS master device functionality. The LSS master device requests services, that are performed by the LSS slave devices (encoder). The LSS master device requests the LSS address (vendor-id, product-code, revision-number, serial-number) from the LSS slave device. After receiving this information the control can unequivocally identify the encoder and the node number and baud rate can be set.

8 Programmable Parameters

Objects are based on the CiA 406 DS V3.2: CANopen profile for encoders (www.can-cia.org)

General Command Byte Description

Command	Function	Telegram	Description
22h	Domain Download	Request	Parameter to Encoder Recommended Method
23h, 27h, 2Bh, 2Fh (*)	Domain Download	Request	Parameter to Encoder (Bytes indicated)
60h	Domain Download	Confirmation	Parameter received
40h	Domain Upload	Request	Parameter request Recommended Method
43h, 47h, 4Bh, 4Fh (*)	Domain Upload	Reply	Parameter to Master (Bytes indicated)
80 h	Warning	Reply	Transmission error

Table 8.1

(*)The value of the command byte depends on the data length of the called parameter:

Detailed Command Byte Description

Command	Data length	Data type	Command	Data length	Data type
43h	4 Byte	Unsigned 32	23h	4 Byte	Unsigned 32
47h	3 Byte	Unsigned 24	27h	3 Byte	Unsigned 24
4Bh	2 Byte	Unsigned 16	2Bh	2 Byte	Unsigned 16
4Fh	1 Byte	Unsigned 8	2Fh	1 Byte	Unsigned 8

Table 8.2

Object Dictionary

The data transmission according to CAL is realized exclusively by object-oriented data messages. The objects are classified in groups by an index record. Each index entry can be subdivided by sub-indices. The overall layout of the standard object dictionary is shown below:

Overview Object Dictionary

Index (hex)	Object
0000	not used
0001-001F	Static Data Types
0020-003F	Complex Data Types
0040-005F	Manufacturer Specific Data Types
0060-0FFF	Reserved for further use
1000-1FFF	Communication Profile Area
2000-5FFF	Manufacturer Specific Profile Area
6000-9FFF	Standardized Device Profile Area
A000-FFFF	Reserved for further use

Table 8.3

8.1 Programming example: Preset Value

If a CANopen device is connected and configured with the right baud rate and also configured to an unused node number, it will start up into the pre-operational mode and send a bootup massage to the master.

8.1.1 Set Encoder Preset Value

Master to Encoder with Node Number 1.

Setting Preset Value (Value 1000h)

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1h		Download	6003h			Byte 4	Byte 5	Byte 6	Byte 7
601h	8h	22h	03h	60h	00h	00h	10h	00h	00h

Table 8.4

Answer of the Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1h		Download	6003h		00h	Byte 4	Byte 5	Byte 6	Byte 7
581h	8h	43h	03h	60h	00h	00h	00h	00h	00h

Table 8.5

Read Preset Value from Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1h		Download	6003h			Byte 4	Byte 5	Byte 6	Byte 7
601h	8h	40h	03h	60h	00h	00h	00h	00h	00h

Table 8.6

Answer of the Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1h		Download	6003h		00h	Byte 4	Byte 5	Byte 6	Byte 7
581h	8h	43h	03h	60h	00h	00h	10h	00h	00h

Table 8.7

Save Preset Values

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN = 1h		Download	6003h		00h	Byte 4	Byte 5	Byte 6	Byte 7
601h	8h	22h	10h	10h	01h	73h	61h	76h	65h

Table 8.8

2024-02

8.2 Communication Profile DS301 specific objects from 1000h – 1FFFh

In this manual we refer to the communication profile DS301 V4.02.

Object Dictionary 1000h - 1FFFh

Object	Object Description	Supported by Magnetic Encoder	Supported by Photoelectric Encoder
1000h	Device Type	x	x
1001h	Error Register	x	x
1003h	Pre-Defined Error Field	x	x
1005h	COB-ID SYNC	x	x
1006h	ComCyclePeriode	x	x
1008h	Device Name	x	x
1009h	Hardware Version	x	x
100Ah	Software Version	x	x
100Ch	Guard Time	x	x
100Dh	Life Time Factor	x	x
1010h	Store parameters	x	x
1011h	Restore default parameters	x	x
1012h	COB-ID Time Stamp	x	x
1013h	High Resolution Time Stamp	x	x
1014h	COB-ID Emergency	x	x
1016h	Consumer Heartbeat Time	x	x
1017h	Producer Heartbeat Time	x	x
1018h	Identy Object	x	x
1020h	Verify Configuration	x	x
1029h	Error Behavior	x	x
1800h	Communication Parameter PDO 1	x	x
1801h	Communication Parameter PDO 2	x	x
1A00h	Transmit PDO1 Mapping Parameter	x	x
1A01h	Transmit PDO2 Mapping Parameter	x	x
1F50h	Download Program Area	x	
1F51h	Program Control	x	

Table 8.9

8.3 Manufacturer specific objects from 2000h – 5FFFh

Object Dictionary 2000h - 5FFFh

Object	Object Description	Supported by Magnetic Encoder	Supported by Photoelectrical Encoder
2000h	Position Value	x	x
2100h	Operating Parameters	x	x
2101h	Resolution per Revolution	x	x
2102h	Total Resolution	x	x
2103h	Preset Value	x	x
2104h	Limit Switch, min.	x	x
2105h	Limit Switch, max.	x	x
2160h	Customer Storage	x	x
2200h	Cyclic Timer PDO1	x	x
2300h	Save Parameter with reset	x	x
2600h	Raw Position Value (identical with 6008h)	x	
3000h	Node Number	x	x
3001h	Baudrate	x	x
3002h	Terminator	x	x
3003h	Auto Baud Detection	x	
3005h	Auto Boot Up	x	
3010h	Speed Control	x	x (only speed enable)
3011h	Speed Value	x	x
3020h	Acceleration Control	x	x
3021h	Acceleration Value (not supported)	x	x
3030h	Backward Compatible Mode	x	
3040h	Life Cycle Counter	x	
3050h	Time Stamp Position Value	x	
4000h	Bootloader Control	x	
4010h	PPR Incremental Encoder	x	
4020h	A/B Phase shift Incremental Encoder	x	

Table 8.10

8.4 Application specific objects from 6000h – 67FEh

Object Dictionary 6000h - 6FFFh

Object	Object Description	Supported by Magnetic Encoder	Supported by Photoelectric Encoder
6000h	Operating Parameters	x	x
6001h	Measuring Units per Revolution	x	x
6002h	Total Measuring Range in Measuring Units	x	x
6003h	Preset Value	x	x
6004h	Position Value	x	x
6008h	High Precision Position Value	x	
6030h	Speed Value	x	x
6040h	Acceleration Value	x	x
6200h	Cyclic Timer	x	x
6300h	Cam State Register	x	x
6301h	Cam Enable Register	x	x
6302h	Cam Polarity Register	x	x
6310h - 6317h	Cam 1-7 Low Limit	x	x
6320h - 6327h	Cam 1-7 High Limit	x	x
6330h - 6337h	Cam 1-7 hysteresis	x	x
6400h	Area State Register	x	x
6401h	Work Area Low Limit	x	x
6402h	Work Area High Limit	x	x
6500h	Operating Status	x	x
6501h	Singleturn Resolution	x	x
6502h	Number of Distinguishable Revolutions	x	x
6503h	Alarms	x	x
6504h	Supported Alarms	x	x
6505h	Warnings	x	x
6506h	Supported Warnings	x	x
6507h	Profile and Software Version	x	x
6508h	Operating Time	x	x
6509h	Offset Value	x	x
650Ah	Module Identification	x	x
650Bh	Serial Number	x	x

Table 8.11

8.5 Object Descriptions

In the following chapter you will find detailed information of the object dictionary related to the encoder device.

To provide a brief and clear presentation the objects are described in object tables containing the following abbreviations:

Abbreviation	Description
ro	read only: Parameter that is only accessible in read mode.
romap	read only mapable: Parameter that can be polled by the PDO.
rw	read/write: Parameter that can be accessed in read or write mode.
wo	write only: Parameter that is only accessible in write mode.

Table 8.12

8.5.1 Object 1000h: Device Type

The object at index 1000h describes the type of device and its functionality. It is composed of a 16-bit field which describes the device profile that is used and a second 16-bit field which gives additional information about optional functionality of the device. The additional information parameter is device profile specific.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 32	N/A	ro	no

Table 8.13

Absolute rotary encoder single turn: 10196h

Absolute rotary encoder multi turn: 20196h

8.5.2 Object 1001h: Error Register

This object is used by the device to display internal faults. When a fault is detected, the corresponding bit is therefore activated.

Bit	Description	Comments
0	Generic Error	The generic error is signaled at any error situation.

Table 8.14

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 8	N/A	ro	no

Table 8.15

8.5.3 Object 1003h: Pre-Defined Error Field

The object holds the errors that have occurred on the device and have been signaled via the Emergency Object.

- The error code is located in the least significant word.
- Additional information is located in the most significant word.
- Subindex 0 contains the number of recorded errors.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of recorded errors	Unsigned 8	0	rw	no
1h	Most recent errors	Unsigned 32	-	ro	no
2h	Second to last error	Unsigned 32	-	ro	no
...					
10h					

Table 8.16

Clearing Error Log

The error log can be cleared by writing 0 to subindex 0 of object 1003h.

8.5.4 Object 1005h: COB-ID Sync

This object contains the synchronization message identifier.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 32	80000080h	rw	no

Table 8.17

8.5.5 Object 1008h: Manufacturer Device Name

This object contains the device name.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	String	-	ro	no

Table 8.18

8.5.6 Object 1009h: Manufacturer Hardware Version

This object contains the article name of the circuit board.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	String	-	ro	no

Table 8.19

8.5.7 Object 100Ah: Manufacturer Software Version

This object contains the manufacturer software version. Currently the version is as data type string “1.xx”, whereby x stands as place holder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	String		ro	no

Table 8.20

8.5.8 Object 100Ch: Guard Time

This object contains the guard time in milliseconds.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 16	0	rw	yes

Table 8.21

8.5.9 Object 100Dh: Life Time Factor

This object contains the life time factor parameters. The life time factor multiplied with the guard time gives the life time for the node guarding protocol.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 8	0	rw	yes

Table 8.22

8.5.10 Object 1010h: Store Parameters

This object is used to store device and CANopen related parameters to nonvolatile memory.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	2	ro	no
1h	Store all parameters	Unsigned 32	"save"	rw	no

Table 8.23

Storing procedure

To save the parameters to non volatile memory the access signature “save” has to be sent to the corresponding subindex of the device.

	Most significant word		Least significant word	
ASCII	e	v	a	s
Hex Value	65h	76h	61h	73h

Table 8.24

Note

The restoration of parameters will only be taken into account after a power up or reset command. Please check all parameters before you store them to the nonvolatile memory.

2024-02

8.5.11 Object 1011h: Restore Parameters

This object is used to restore device and CANopen related parameters to factory settings.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	2	ro	no
1h	Store all parameters	Unsigned 32	"load"	rw	no

Table 8.25

Storing procedure

To save the parameters to nonvolatile memory the access signature “load” has to be sent to the corresponding subindex of the device.

	Most significant word		Least significant word	
ASCII	d	a	o	l
Hex Value	64h	61h	6Fh	6Ch

Table 8.26

Note

The restoration of parameters will only be taken into account after a power up or reset command. Please check all parameters before you store them to the nonvolatile memory.

8.5.12 Object 1012h: COB-ID Time Stamp Object

This object contains the COB-ID of the Time Stamp object.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 32	100h	rw	no

Table 8.27

8.5.13 Object 1013h: High Resolution Time Stamp

This object contains a time stamp with a resolution of 1µs.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 32	0	rw	no

Table 8.28

8.5.14 Object 1014h: COB-ID Emergency Object

This object contains the EMCY emergency message identifier.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 32	80h + Node ID	rw	no

Table 8.29

8.5.15 Object 1016h: Consumer Heartbeat Time

The consumer heartbeat time defines the expected heartbeat cycle time in ms. The device can only monitor one corresponding device. If the time is set to 0 the monitoring is not active. The value of this object must be higher than the corresponding time (object 1017) of the monitored device.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of indices	Unsigned 8	1	ro	no
1h	Consumer heartbeat time	Unsigned 32	0	rw	yes

Table 8.30

The context of subindex 1 is as follows:

Bit	31 to 24	23 to 16	15 to 0
Value	0h (reserved)	Address of monitored device	Monitoring time (ms)

Table 8.31

8.5.16 Object 1017h: Producer Heartbeat Time

The object contains the time interval in milliseconds in which the device has to produce a heartbeat message.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	-	Unsigned 16	0	rw	yes

Table 8.32

8.5.17 Object 1018h: Identity Object

This object contains the device information.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of entries	Unsigned 8	4	ro	no
1h	Vendor ID	Unsigned 32	42h	ro	no
2h	Product Code	Unsigned 32		ro	no
3h	Revision Number	Unsigned 32		ro	no
4h	Serial Number	Unsigned 32		ro	no

Table 8.33

8.5.18 Object 1020h: Verify Configuration

This object indicates the downloaded configuration date and time.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of entries	Unsigned 8	2h	ro	no
1h	Configuration date	Unsigned 32		rw	no
2h	Configuration time	Unsigned 32		rw	no

Table 8.34

8.5.19 Object 1029h: Error Behavior

This object indicates the error behavior.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of entries	Unsigned 8	1h	ro	no
1h	Communication error	Unsigned 8		rw	no

Table 8.35

8.5.20 Object 1800h: 1st Transmit PDO Communication Parameter

This object contains the communication parameter of the 1st transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	5	ro	yes
1h	COB-ID	Unsigned 32	180h + Node ID	rw	yes
2h	Transmission Mode	Unsigned 8	FEh	rw	yes
3h	Inhibit Time	Unsigned 32	0	rw	yes
4h	Not available				
5h	Event Timer	Unsigned 32	0	rw	yes

Table 8.36

8.5.21 Object 1801h: 2nd Transmit PDO Communication Parameter

This object contains the communication parameter of the 2nd transmit PDO

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	5	ro	yes
1h	COB-ID	Unsigned 32	280h + Node ID	rw	yes
2h	Transmission Mode	Unsigned 8	1	rw	yes
3h	Inhibit Time	Unsigned 32	0	rw	yes
4h	Not available				
5h	Event Timer	Unsigned 32	0	rw	yes

Table 8.37

Transmission Mode

The transmission mode can be configured as described below:

Transfer Value (decimal)	Transmission Mode					Notes
	Cyclic	Acyclic	Synchr.	Asynchr.	RTR only	
0		x	x			Send PDO on first Sync message following an event
1-240	x		x			Send PDO every x Sync messages
241-251	reserved					
252			x		x	Receive SYNC message and send PDO on remote request
253					x	Update data and send PDO on Remote Request
254				x		Send PDO on event
255				x		Send PDO on event

Table 8.38

Inhibit Time

For "Transmit PDOs", the "inhibit time" for PDO transmission can be entered in this 16-bit field. If data is changed, the PDO sender checks whether an "inhibit time" has expired since the last transmission. A new PDO transmission can only take place if the "inhibit time" has expired. The "inhibit time" is useful for asynchronous transmission (transmission mode 254 and 255) to avoid overloads on the CAN bus.

Event Timer

The "event timer" only works in asynchronous transmission mode (transmission mode 254 and 255). If the data changes before the "event timer" expires, a temporary telegram is sent. If a value > 0 is written in this 16-bit field, the transmit PDO is always sent after the "event timer" expires. The value is written in subindex 5 of a transmit PDO. The data transfer also takes place with no change to data. The range is between 1 - 65536 ms.

2024-02

8.5.22 Object 1A00h: 1st Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 1st transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	2	ro	yes
1h	1st mapped object	Unsigned 32	60040020h	rw	yes

Table 8.39

8.5.23 Object 1A01h: 2nd Transmit PDO Mapping Parameter

This object contains the mapping parameter of the 2nd transmit PDO.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	2	ro	yes
1h	2nd mapped object	Unsigned 32	60040020h	rw	yes

Table 8.40

8.5.24 Object 1F50h: Download Program Area

This is a special object that has functionality for the bootloader feature.

Use this entry to download your Intel hex file with the programming data. Detailed information about Domain download and Block transfer in CiA Draft Standard 301 Application Layer and communication Profile.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of entries	Unsigned 8	2h	ro	yes
1h		DOMAIN		wo	yes

Table 8.41

8.5.25 Object 1F51h: Program Control

This is a special bootloader object, to update the firmware.

This array controls the programs residing at index 0x1F50.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of program control entries	Unsigned 8	2h	ro	yes
1h		Unsigned 32		rw	yes

Table 8.42

Sub-index 1h and higher control the memory block functionality. They can have the following values for writing:

- 1 - start downloaded programm
- 4 - erase flash

8.5.26 Object 2000h: Position Value

This object contains the position value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Position Value	Unsigned 32		ro	n. a.

Table 8.43

8.5.27 Object 2100h: Operating Parameters

As operating parameters the code sequence (complement) can be selected and the limit switches can be turned on or off.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Operating Parameters	Unsigned 8	0h	rw	yes

Table 8.44

The parameter code sequence (complement) determines the counting direction, in which the output process value increases or decreases (CW = clockwise, CCW = counterclockwise). The code sequence is determined by Bit 0 in Index 2100h. Additionally, the two limit switches, Min. and Max. can be turned on or off in Index 2100h.

Bit 0	Code sequence	Code	Bit 1	Limit switch, min.	Bit 2	Limit switch, max.
0	CW	increasing	0	off	0	off
1	CCW	increasing	1	on	1	on

Calculation Example: Target: Absolute rotary encoder with direction CCW increasing, limit switch min enabled and limit switch max disabled.

Bitmatrix:

- Bit 0 = 1 Direction increasing CCW
- Bit 1 = 1 Limit switch min. enabled
- Bit 2 = 0 Limit switch max. disabled

Result = 011b = 3h

8.5.28 Object 2101h: Resolution per Revolution

This object contains the desired steps per revolution of the encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Resolution per Revolution	Unsigned 32	see type lable	rw	yes

Table 8.45

If the desired value exceeds the hardware resolution of the encoder, it will be out of range and the error code is used "06090030h: Value range of parameter exceeded" will appear.

2024-02

8.5.29 Object 2102h: Total Resolution

This object contains the desired total resolution of the encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Total Resolution	Unsigned 32	see name plate	rw	yes

Table 8.46

This parameter is used to program the desired number of measuring units over the total measuring range. This value must not exceed the total resolution of the absolute rotary encoder, which is printed on the type sign of the encoder.

Attention

Following formula letters will be used:

- PGA Physical total resolution of the encoder >> (see type sign)
- PAU Physical resolution per revolution >> (see type sign)
- GA Total resolution (customer parameter)
- AU Resolution per revolution (customer parameter)

Please use the following formula to calculate the total resolution of the encoder:

GA = (PGA * AU)/ PAU AU ≤ PAU

k = PGA/Ga k = positive integer

If the desired resolution per revolution is less than the really physical resolution per revolution of the encoder, then the total resolution must be entered as follows:

Total resolution

Calculation example:

- Customer handicap: AU = 2048
- Encoder type sign: PGA = 24 bit, PAU = 12 bit

GA = (167772216 * 2048) / 4096 >> GA = 8388608

If the total resolution of the encoder is less than the physical total resolution, the parameter total resolution must be a multiple of the physical total resolution.

8.5.30 Object 2013h: Preset Value

The preset value is the desired position value, which should be reached at a certain physical position of the axis. The position value is set to the desired process value by the parameter preset. The preset value must not exceed the parameter total resolution to avoid run-time errors. If the parameter value exceeds the total resolution of the encoder a SDO “Out of range” message is generated.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Preset Value	Unsigned 32	0h	rw	yes

Table 8.47

8.5.31 Object 2104h: Limit Switch, min.

Two position values can be programmed as limit switches. By reaching this value, one bit of the 32 bit process value is set to high. Both programmed values must not exceed the parameter total resolution to avoid run-time errors. If the parameter value exceeds the total resolution of the encoder a SDO "Out of range" message is generated.

Bit 30 = 1 Limit Switch, minimum reached or passed under

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Limit Switch, min.	Unsigned 32	0h	rw	yes

Table 8.48

The limit switch, Min sets Bit 30=1 with the next message telegram, if the process value reaches or passes under the value of the limit switch:

Function	Status bits		Process value
Bit	31	30	29 ... 0
	0	1	x ... x

Table 8.49

8.5.32 Object 2105h: Limit Switch, max.

Two position values can be programmed as limit switches. By reaching this value, one bit of the 32 bit process value is set to high. Both programmed values must not exceed the parameter total resolution to avoid run-time errors. If the parameter value exceeds the total resolution of the encoder a SDO "Out of range" message is generated.

Bit 31 = 1 Limit Switch, maximum reached or passed under

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Limit Switch, max.	Unsigned 32	0h	rw	yes

Table 8.50

The limit switch, max sets Bit 31=1 with the next message telegram, if the process value reaches or passes under the value of the limit switch:

Function	Status bits		Process value
Bit	31	30	29 ... 0
	1	0	x ... x

Table 8.51

8.5.33 Object 2160h: Customer Storage

This object provides for the customer the possibility to store any value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	4h	ro	
1h	Customer Storage 1	Unsigned 32		rw	
2h	Customer Storage 2	Unsigned 32		rw	
3h	Customer Storage 3	Unsigned 32		rw	
4h	Customer Storage 4	Unsigned 32		rw	

Table 8.52

8.5.34 Object 2200h: Cyclic Timer PDO

This object contains cyclic time of the event timer in ms (of PDO 1).

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Event Time in ms	Unsigned 16	0h	ro	yes

Table 8.53

The object 2200h is hard-wired to the objects 1800h subindex 5h and 6200h and provide the cycle time for the cyclic mode. (See chapter Cycle Timer and Event Timer)

8.5.35 Object 2300h: Save Parameter with Reset

With this object all parameters can be stored in the nonvolatile memory. After storing the parameters a reset is executed.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Access code	Unsigned 32	55AAAA55h	wo	no

Table 8.54

8.5.36 Object 2600h: High-Resolution Position Value

This object contains a high-resolution position value up to 16 bit for single-turn and 30 bit for multi-turn measurement. See nameplate to get the information about the maximum resolution of your device.

Note

The object 2600h is not influenced by the object 2102h total resolution or object 6002h Total measuring range, because of their limited data type of unsigned 32 bit.

But object 2101h resolution per revolution and object 6001h measuring units per revolution affect the high-resolution position value

But object 2101h resolution per revolution and object 6001h measuring units per revolution affect the high-resolution position value. With object 2103h / 6003h Preset value a desired position can be also set for the high resolution position value, but only within the value range of unsigned 32 bit. With this method the user has a downward compatible device, but also in parallel a device with higher capability of resolution and the existing software in the PLC can be kept.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	High Resolution Position Value	Unsigned 64		romap	

Table 8.55

8.5.37 Object 3000h: Node Number

This object contains the node number of the device. The Pepperl+Fuchs standard node number is 32 decimal.

Note

Ensure, that the node number exist unique in the network, otherwise unexpected behavior of the devices will occur. This conflict can't be detected in a CAN network by protocol. This is valid for all CANopen devices!

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Node Number	Unsigned 8	1Fh	rw	no

Table 8.56

Note

To avoid the node number 0, one will be added to the value of this object!. For example: 1Fh +1h = 20 h = 32 dec

8.5.38 Object 3001h: Baud Rate

This object contains the baud rate of the device.

Note

For devices with active Auto Baud Detection this setting is not relevant, if the baud rate is detected within the Time Out interval. See object 3003h. The successful result of the auto baud mode is stored automatically in this object.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Baud rate	Unsigned 8	1Fh	rw	no

Table 8.57

Eight different baud rates are provided. To adjust the baud rate only one byte is used.

Baud rate kBit/s	Byte
20	00h
50	01h
100	02h
125	03h
250	04h
500	05h
800	06h
1000	07h

8.5.39 Object 3002h: Terminator

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Terminator	Unsigned 8		rw	no

Table 8.58

By writing 01h to this object the internal galvanic isolated terminator is activated.

Note

Note that the terminator is only activated when the device is powered. If you have more CAN nodes on the bus be sure to power them approx. 700ms after the device with the programmed terminator. Otherwise reflections could occur and network quality is probably reduced.

8.5.40 Object 3003h: Auto Baud Detection

This object controls the baud rate measurement of the device after power-up or NMT reset. With this feature the user can add the encoder to a network without knowing the baud rate. Just the specified baud rates in CANopen are supported and also 100 kBbd as listed in object 3001h baud rate.

If the auto baud detection is enabled, then after power-up the encoder is just listening to the network and tries to identify within the Time Out (3003h, 2h) a valid CAN message. When this is done successfully, then the device is sending the boot up message and enters the pre-operational state.

For devices with LED in the M12 connector the active auto baud mode is indicated by flickering alternative a red and green LED.

Reason for non-successful baud rate detection

- Time out: Within the time-out period no valid CAN message is sent.
  Corrective action: increase the time-out value to a value that for minimum 1 message is sent or better more. Check, if power-up time of the other devices is synchronously switched on like for the encoder. Perhaps you have to take this different power-up time also into consideration.
- EMC effects: If a non valid CAN frame is detected, then the encoder retries to measure a valid CAN frame within the time-out period.
  Corrective action: check the shielding of the cables, connections, termination in the CAN network. If no improvement is realized, then deactivate temporary the auto baud detection and set the baud rate by use of object 3001h. Then further investigations are possible to find the root cause in combination with a trace tool.
- Error frames: Disturbances in the CAN network communication.
  Corrective action: Find the communication problem in the network by selective use of nodes and consecutive adding further one.

Reaction in case of non-successful baud rate detection

When the baud rate can't be measured within the time-out period, then the encoder is using the last "known" baud rate:

- If the encoder is used out of the box, then the value is 125 kBbd.
- If the encoder was already in use, then the last successful baud rate is stored automatically in object 3001h and taken in this case.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of sub indices	Unsigned 8	2h	ro	
1h	Enable	Unsigned 8	1h	rw	yes
2h	Enable	Unsigned 8	2BF20	rw	yes

Table 8.59

Subindex 1: Enable

- Value 0h: Auto Baud Mode is disabled.
- Value 1h: Auto Baud Mode is enabled

Subindex 2: Time Out:

Value in ms defines the time period after power-up or NMT reset for finding a valid CAN message to measure the baud rate. If the value 0 is used, then an infinite time period is used.

8.5.41 Object 3005h: Auto Boot up

With this flag the start-up behavior of the encoder is defined.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Auto Boot Up	Boolean	0h	rw	yes

Table 8.60

True: Encoder enters after power-up autonomously the state operational without receiving an NMT start command.

False: Encoder enters after power-up the state Pre-Operational. This is the standard behavior of CANopen devices.

8.5.42 Object 3010h: Speed Control

This object contains the speed control. The speed measurement is disabled by default.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	2h	ro	
1h	Speed Unit	Unsigned 8	0h	rw	yes
2h	Speed Filter	Unsigned 8	0h	rw	yes

Table 8.61

Subindex 1: Speed Unit

- Value 0h: Disabled, no measurement
- Value 1h: Speed measurement enabled and unit in steps per second
- Value 2h: Speed measurement enabled and unit in RPM
- Value 3h, 4h: reserved.

Subindex 2: Speed Filter

- Value 0h: Filter mode is moving average filter with length of 10 values
- Value 1h: Filter mode is moving average filter with length of 100 values
- Value 2h: Filter mode is moving average filter with length of 1000 values

8.5.43 Object 3011h: Speed Value

This object contains the speed value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Speed Value	Integer 32		romap	no

Table 8.62

8.5.44 Object 3020h: Acceleration Control

This object contains the acceleration control. Acceleration output is not supported by this device. This object is present only for compatibility reasons.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	2h	ro	
1h	Enable Acceleration	Unsigned 8	0h	rw	yes
2h	Acceleration modus	Unsigned 8	0h	rw	yes

Table 8.63

8.5.45 Object 3021h: Acceleration Control

Acceleration output is **not** supported by this device. This object is present only for compatibility reasons.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Acceleration Value	Integer 32	0h	romap	

Table 8.64

8.5.46 Object 3030h: Backward Compatible Mode

This object contains the acceleration control. Acceleration output is not supported by this device. This object is present only for compatibility reasons.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	2h	ro	
1h	Security Code	Unsigned 32	0h	rw	yes
2h	MCD Mode	Unsigned 32	0h	rw	yes

Table 8.65

Note

Security Code

A specific signature has to be written first to this subindex to access 2nd subindex MCD Mode.

- Sequence is used to prevent misusage by unintended access.
- Signature = "MBYT" (high >> low byte)

MCD Mode

In the MCD mode new objects implemented in UCD can’t be accessed and will be responded with abort code "object does not exist".

Signature = "BCM" (high >> low byte)

Signature +"0": UCD mode with all features accessible

Signature +"1": MCD mode with old features available.

Example: BCD + "1" >> 0x42434D01 , MCD mode is active

Example for accessing object 3030h

Setting Security Code (Value “MBYT” -> 4D425954h)

Telegram master to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN =1h		Download	3030h			Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 601h	8h	22h	30h	30h	01h	54h	59h	42h	4Dh

Table 8.66

Setting MCD Mode (Value “BCM”+1 -> 42434D01h)

Telegram master to Encoder

Identifier	DLC	Command	Index		Subindex	Service/Process data			
NN =1h		Download	3030h			Byte 4	Byte 5	Byte 6	Byte 7
600h + NN = 601h	8h	22h	30h	30h	02h	01h	4Dh	43h	42h

Table 8.67

8.5.47 Object 3040h: Life Cycle Counter

Diagnostic value to monitor, if the position value is updated compared to last transmission. This feature is interesting for safety applications to detect for example, if the value in the CAN controller is frozen. The value starts at power up with 0 and is continuously incremented. When overflow is reached, then it starts again with 0. It is not expected, that the transmitted value is incremented, because the life cycle counter is handled in the function when the position value is measured and this process is asynchronous to the CAN communication.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Life Cycle Counter	Unsigned 32		romap	o

Table 8.68

8.5.48 Object 3050h: Time Stamp Position Value

This time stamp is generated when the position value is measured. Like the life cycle counter this value can be used for safety purposes to detect stuck at effects. Another feature is to calculate the velocity on PLC side with accurate time stamp values to achieve high accuracy for individual requirements. It offers more flexibility than the encoder internal pre-defined velocity measurement.

Time resolution is 1 µs.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Time Stamp Position Value	Unsigned 32		romap	

Table 8.69

8.5.49 Object 4000h: Bootloader Control

This object controls the Bootloader functionality. Writing the security code to this object causes erasing the EEPROM and application information in the flash memory and resets the device. After a power-up, the Bootloader checks the user application and detects no more information. The Bootloader starts up with a pre-defined CANopen node ID of 1 (0x1) and a fixed CAN baud rate of 125 kbits.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Bootloader Control	Unsigned 32		wo	

Table 8.70

Note

Activating the Bootloader leads to a deep reset of the device. After this only a few objects are still available, the device does not behave like an encoder and waits for new programming. That is the reason why the security code is not published in this document. Please contact Peppel+Fuchs to obtain the code.

8.5.50 Object 4010h: PPR Incremental Encoder

The incremental pulses are only provided by the magnetic encoder part inside the absolute rotary encoder.

This object controls the incremental resolution per revolution as pulses per channel for A and B.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	PPR Incremental Encoder	Unsigned 16	400h	rw	yes

Table 8.71

If a value of 400h is configured, then you will see 1024 decimal pulses on each channel A and B per revolution. Maximum possible value is 14 bit, which means 16384 pulses per revolution PPR. The type key specifies different physical level of the incremental interface.

Note

The configuration of this object with respect to the output signals only takes place after NMT reset or power cycle.

8.5.51 Object 4020h: A/B Phase Shift

This object controls the incremental resolution per revolution as pulses per channel for A and B.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	A/B Phase Shift	Unsigned 8	400h	rw	yes

Table 8.72

Value 0: Channel A before B

Value 1: Channel B before A

Note

The configuration of this object with respect to the output signals only takes place after NMT reset or power cycle.

8.5.52 Object 6000h: Operating Parameters

This object shall indicate the functions for code sequence, commissioning diagnostic control and scaling function control.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Operating Parameter	Unsigned 16	0h	rw	yes

Table 8.73

Code sequence: The code sequence defines, whether increasing or decreasing position values are output, in case the encoder shaft rotates clockwise or counter clockwise as seen from the point of view of the shaft.

Scaling function control: With the scaling function the encoder numerical value is converted in software to change the physical resolution of the encoder. The measuring units per revolution (object 6001h) and total measuring range in measuring units (object 6002h) are the scaling parameters. The scaling function bit is set in the operating parameters. If the scaling function bit is set to zero, the scaling function is disabled.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Use	MS	MS	MS	MS	R	R	R	R	R	R	R	R	MD	SFC	CD	CS

Table 8.74

MS Manufacturer Specific Function (not available)

R Reserved for future use

MD Measuring direction (not available)

SFC Scaling function (0 = disable, 1 = enable)

CD Commissioning diagnostic control (not available)

CS Code sequence (0 = CW Up, 1 = CCW Up)

Code Sequence (CS Bit 0) is hardwired to Code Sequence (CS Bit 0) in object 2100h.

8.5.53 Object 6001h: Measuring Units per Revolution

This object shall indicate the number of distinguishable steps per revolution.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Measuring Units per Revolution	Unsigned 32	See nameplate	rw	yes

Table 8.75

8.5.54 Object 6002h: Total Measuring Range in Measuring Units

This object shall indicate the number of distinguishable steps over the total measuring range.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Total measuring steps	Unsigned 32	See nameplate	rw	yes

Table 8.76

8.5.55 Object 6003h: Preset Value

This object indicates the preset value for the output position value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Preset Value	Unsigned 32	0h	rw	yes

Table 8.77

8.5.56 Object 6004h: Position Value

This object contains the process value of the encoder.

This object is hardwired with Object 2000h.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Process Value	Unsigned 32		romap	yes

Table 8.78

8.5.57 Object 6008h: High Resolution Position Value

This object contains a high-resolution position value up to 16 bit for single-turn and 31 bit for multi-turn measurement. See nameplate to get the information about the maximum resolution of your device.

Multiturn encoder with resolution 32 bits is available upon request at Pepperl+Fuchs GmbH but there are the following functional restrictions: Preset function and scaling function are not possible.

Note

The object 6008h is not influenced by the object 2102h total resolution or object 6002h Total measuring range, because of their limited data type of unsigned 32 bit.

But object 2101h resolution per revolution and object 6001h measuring units per revolution will affect the high-resolution position value. With object 2103h / 6003h Preset value a desired position can be also set for the high-resolution position value, but only within the value range of unsigned 32 bit. With this method the user has a downward compatible device, but also in parallel a device with higher capability of resolution and the existing software in the PLC can be kept.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	HighResolution Position Value	Unsigned 64		romap	

Table 8.79

8.5.58 Object 6030h: Speed Value

This object contains the speed value of the encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Speed value channel 1	Integer 16		romap	yes

Table 8.80

If the velocity exceeds the data type, the speed value is frozen to the maximal possible value. The customer can use the 3010h (32 bit) object.

8.5.59 Object 6040h: Acceleration Value

This object contains the acceleration value of the encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Acceleration value channel 1	Integer 16		romap	yes

Table 8.81

8.5.60 Object 6200h: Cyclic Timer

This object contains the value of the event timer of the corresponding TPDOs. The value can be changed between 1-65538 ms.

The object 6200h is hardwired to the objects 1800h subindex 5h and 2200h and provide the cycle time for the cyclic mode.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Cyclic Timer	Unsigned 16	64h	rw	yes

Table 8.82

8.5.61 Object 6300h: Cam State Register

This object contains the cam state register. The subindices 1h to FEh contain the cam state of channel 1 to 254.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Cam state channel 1	Unsigned 8	4h	romap	yes

Table 8.83

8.5.62 Object 6301h: Cam Enable Register

This object contains the cam enable register.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Cam enable channel 1	Unsigned 8		rw	yes

Table 8.84

8.5.63 Object 6302h: Cam Polarity Register

This object contains the cam polarity register.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Cam polarity channel 1	Unsigned 8	0h	rw	yes

Table 8.85

List of Cam Objects

Index	Subindex	Type	Description	Data Type	Access	Value
6310h			Cam1 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 32	ro	1h
	1h	VAR	Cam1 low limit channel 1		rw	
6311h			Cam2 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 32	ro	1h
	1h	VAR	Cam2 low limit channel 1		rw	
6312h			Cam3 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam3 low limit channel 1		rw	
6313h			Cam4 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam4 low limit channel 1		rw	
6314h			Cam5 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam5 low limit channel 1		rw	
6315h			Cam6 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h		Cam6 low limit channel 1		rw	
6316h			Cam7 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam7 low limit channel 1		rw	
6317h			Cam8 low limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h

Index	Subindex	Type	Description	Data Type	Access	Value
	1h	VAR	Cam8 low limit channel 1		rw	
6320h			Cam1 high limit		rw	
	0h		Highest subindex supported	Unsigned 8	ro	1h
	1h		Cam1 high limit channel 1		rw	
6321h			Cam2 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam2 high limit channel 1		rw	
6322h			Cam3 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h		Cam3 high limit channel 1		rw	
6323h			Cam4 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam4 high limit channel 1		rw	
6324h			Cam5 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam5 high limit channel 1			
6325h			Cam6 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h		Cam6 high limit channel 1		rw	
6326h			Cam7 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam7 high limit channel 1		rw	
6327h			Cam8 high limit		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam8 high limit channel 1		rw	
6330h			Cam1 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam1 hysteresis channel 1		rw	

2024-02

Index	Subindex	Type	Description	Data Type	Access	Value
6331h			Cam2 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam2 hysteresis channel 1		rw	
6332h			Cam3 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam3 hysteresis channel 1		rw	
6333h			Cam4 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam4 hysteresis channel 1		rw	
6334h			Cam5 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam5 hysteresis channel 1		rw	
6335h			Cam6 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam6 hysteresis channel 1		rw	
6336h			Cam7 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam7 hysteresis channel 1		rw	
6337h			Cam8 hysteresis		rw	
	0h	VAR	Highest subindex supported	Unsigned 8	ro	1h
	1h	VAR	Cam8 hysteresis channel 1		rw	

Table 8.86

8.5.64 Object 6400h: Area State Register

This object contains the area state register. The object provides the actual area status of the encoder position.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Unsigned 8	1h	ro	
1h	Cam state channel 1	Unsigned 8	4h	romap	yes

Table 8.87

The following 2 tables specify the object structure and the value definition.

7	6	5	4	3	2	1	0
res	res	res	res	res	Range under-flow	Range overflow	Out of range
MSB							LSB

Table 8.88

Signal	Value	Definition
Out of range	0h 1h	Position between low and high limit Position out of range (refer to module identification object, 650Ah) is reached
Range overflow	0h 1h	No range overflow Position is lower than the position value set in object 6402h "work area low limit"
Out of range	0h 1h	No range underflow Position is higher than the position value set in object 6401h "work area high limit"
res	0h	reserved

Table 8.89

8.5.65 Object 6401h: Work Area Low Limit

This object indicates the position value, at which bit 2 of the according work area state channel in object 6400h shall flag the underflow of the related work area.

This object is hardwired with 2104h (Limit Switch Min).

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Integer 32	1h	ro	
1h	Work area low limit channel 1	Integer 32	0h	rw	yes

Table 8.90

8.5.66 Object 6402h: Work Area High Limit

This object indicates the position value, at which bit 1 of the according work area state channel in object 6400h shall flag the overflow of the related work area.

This object is hardwired with 2105h (Limit Switch Max).

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of subindices	Integer 32	1h	ro	
1h	Work area high limit channel 1	Integer 32	0h	rw	yes

Table 8.91

8.5.67 Object 6500h: Operating Status

This object shall provide the operating status of the encoder. It gives information on encoder internal programmed parameters.

The operating status object corresponds to the value of the object 6000h and 2100h.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Operating status	Unsigned 16		ro	no

Table 8.92

8.5.68 Object 6501h: Singleturn Resolution

The object contains the physical measuring steps per revolution of the absolute rotary encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Singleturn Resolution	Unsigned 32	See nameplate	ro	no

Table 8.93

8.5.69 Object 6502h: Number of Distinguishable Revolutions

This object contains number of revolutions of the absolute rotary encoder.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Number of Revolutions	Unsigned 16	See nameplate	ro	no

Table 8.94

8.5.70 Object 6503h: Alarms

Additionally to the emergency messages in CiA301, this object shall provide further alarm messages. An alarm shall be set if a malfunction in the encoder could lead to incorrect position value. If an alarm occurs, the according bit shall indicate the alarm til the alarm is cleared and the encoder is able to provide an accurate position value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Alarms	Unsigned 16		romap	no

Table 8.95

Bit structure of the alarms

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Use	MS	MS	MS	MS	R	R	R	R	R	R	R	R	R	R	CD	PE

Table 8.96

MS Manufacturer Specific Function (not available)
R Reserved for future use
CD Commissioning diagnostic control (not supported)
PE Position Error (not supported)

Code Sequence (CS Bit 0) is hardwired to Code Sequence (CS Bit 0) in object 2100h.

8.5.71 Object 6504h: Supported Alarms

The object shall provide the supported alarms of the device. Please refer to the bit structure table to find more details about the supported alarms.

The CA-encoder supports the position error alarm.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Supported alarms	Unsigned 16	1000h	ro	no

Table 8.97

8.5.72 Object 6505h: Warnings

This object shall provide the warnings. Warnings indicate that tolerance for certain internal parameters of the encoder have been exceeded. In contrast to alarm and emergency messages warnings do not imply incorrect position values. All warnings shall be cleared if the tolerances are again within normal parameters.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Warnings	Unsigned 16		rw	yes

Table 8.98

Bit structure of the warnings

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Use	MS	MS	MS	MS	R	R	R	R	R	R	RP	BC	OT	CP	LC	FE

Table 8.99

MS Manufacturer Specific Function (not available)
R Reserved for future use
RP Reference point reached/not reached (not supported)
BC Battery charge (not supported)
OT Operating Time limit (not supported)
CP CPU watchdog status (not supported)
LC Light control reserve (not supported)
FE Frequency warning (not supported)

8.5.73 Object 6506h: Supported warnings

The object provides the supported warnings of the device. Please refer to the bit structure table to find more details about the supported warnings.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Supported warnings	Unsigned 16	1000h	ro	no

Table 8.100

Currently there are not supported warnings available for an optocode absolute rotary encoder.

The CA-encoder supports the manufacture specific warning (Bit 12).

8.5.74 Object 6507h: Profile and Software Version

This object provides the implemented encoder device profile version and the manufacturer-specific software version.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Profile and Software Version	Unsigned 32	04040302h	ro	no

Table 8.101

The value is divided into the profile version part and the Software version part. Each part is divided in upper version and lower version.

MSB		LSB	
Software Version 4.4		Profile Version 3.2	
Upper Software Version	Lower Software Version	Upper Profile Version	Lower Profile Version
04	04	03	02

8.5.75 Object 6508h: Operating Time

This object indicates the operating time of the device. Currently the operating time is not supported and the value of this object will always be FFFFFFFFh.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Operating time	Unsigned 32	FFFFFFFFh	ro	no

Table 8.102

8.5.76 Object 6509h: Offset Value

This object contains the offset value. It is been calculated by the preset function and shifts the physical position value with the desired value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Offset value	Integer 32		ro	no

Table 8.103

8.5.77 Object 6509h: Module identification

This object shall provide the manufacturer-specific offset value, the manufacturer-specific minimum and maximum position value.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Highest supported subindex	Integer 32	3	ro	no
1h	Manufacturer offset value	Integer 32		ro	no
2h	Man. min. position value	Integer 32		ro	no
3h	Man. max. position value	Integer 32		ro	no

Table 8.104

8.5.78 Object 650Bh: Serial Number

This object contains the serial number of the device. The serial number is also supported in object 1018h subindex 4h.

Subindex	Description	Data Type	Default Value	Access	Restore after Boot up
0h	Serial number	Unsigned 32	see nameplate	ro	no

Table 8.105

9 Troubleshooting

9.1 What to Do in Case of a Fault

In case of a fault, check whether an encoder fault can be remedied according to the following checklist.

Checklist

Problem	Description	Possible Solution
Power on – encoder doesn't respond	The bus is active but the installed encoder transmitted no boot up message.	• The encoders have the default baud rate 125 kBaud. Adapt your PLC setting accordingly. • Reprogram the encoders baud rate • Restart encoder so the new baud rate setting will be valid.
Malfunction of the position value during transmission	During the transmission of the position value occasional malfunction occurs. The CAN bus can be temporary in the bus off state also.	Check, if the last bus node has switched on the terminator.
Too much ERROR-Frames	The bus load is too high in case of too much error frames.	Check if all bus node have the same baud rate. If one node has another baud rate error frames are produced automatically.
Limit switches without function	The encoder didn't transmit the bits for the limit switches.	The limit switch functionality has to be activated once. Please follow the description you can find at chapter "Usage of Layer Setting Services (LSS)".

Note

Baud rate and node number changes

The changing of baud rate and node number are only valid after a new power-up, NMT Reset or the store parameters command.

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