
User manual

Magnetic absolute-value rotary encoders

with **CANopen** - interface

WV58M, WH58M



Table of contents

1.	General remarks	4
1.1.	Definitions	4
1.2.	Documentation	5
1.3.	Intended use	5
2.	Product Family of Magnetic Angle Encoders	5
3.	General information on the CAN Bus	5
3.1.	CAN bus features	6
3.2.	CANopen	6
3.3.	The Encoder Device Profile (CiA Draft Standard 406)	7
4.	Data Transmission according to the CANopen Communication Model	7
4.1.	CANopen message setup	8
4.1.1	Function code	8
4.1.2	Node number (Node ID)	9
4.2.	Transmission of process data	9
4.2.1	Synchronous data transfer	9
4.2.2	Asynchronous data transfer	10
4.3.	Transmission of the SDO data (parameterization)	10
4.4.	Emergency Service	12
4.5.	Network management Services (NMT)	13
4.5.1	Description of the NMT commands	14
4.5.2	Command byte	14
4.5.3	NMT status	14
4.5.4	The individual NMT states	15
4.5.5	Status change	15
4.5.6	Heartbeat	16
5.	Directory of objects	16
5.1.	Overview of objects	17
5.2.	Detailed description of objects	19
5.2.1	Object 1000h (Device Type)	19
5.2.2	Object 1001h (Error Register)	19
5.2.3	Object 1002h (Manufacturer Status Register)	20
5.2.4	Object 1003h (Pre-defined Error Field)	20
5.2.5	Object 1005h (COB ID SYNC message)	21
5.2.6	Object 1008h (Manufacturer Device Name)	21
5.2.7	Object 1009h (Manufacturer Hardware Version)	21
5.2.8	Object 100Ah (Manufacturer Software Version)	22
5.2.9	Object 1010h (Store Parameters)	22
5.2.10	Object 1011h (Load Default Parameters)	23
5.2.11	Object 1014h (COB ID Emergency Object)	24
5.2.12	Object 1017h (Producer Heartbeat Time)	24
5.2.13	Object 1018h (Identity Object)	25



5.2.14	Object 1800h (Transmit PDO1 Parameter, asynchronous operation mode)	25
5.2.15	Object 1801h (Transmit PDO12 parameter, synchronous operation mode)	26
5.2.16	Object 1A00h (Transmit PDO1 Mapping Parameter)	27
5.2.17	Object 1A01h (Transmit PDO2 Mapping Parameter)	28
5.2.18	Object 2001h (Manufacturer Offset)	28
5.2.19	Object 2002h (Zeroing of encoder value)	28
5.2.20	Object 2800h (Send repeat counter for PDO1)	29
5.2.21	Object 2801h (Send repeat counter for PDO2)	29
5.2.22	Object 6000h (Operating Parameters)	29
5.2.23	Object 6001h (Measuring Units per Revolution [Encoder Resolution])	30
5.2.24	Object 6002h (Total Measuring Range [Total Step Number])	31
5.2.25	Object 6003h (Preset value)	31
5.2.26	Object 6004h (Position value)	32
5.2.27	Object 6200h (Cycle Timer)	32
5.2.28	Object 6500h (Operating Status)	33
5.2.29	Object 6501h (SingleTurn resolution)	33
5.2.30	Object 6502h (Number of distinguishable revolutions)	33
5.2.31	Object 6503h (Alarms)	33
5.2.32	Object 6504h (Supported Alarms)	34
5.2.33	Object 6505h (Warnings)	34
5.2.34	Object 6506h (Supported Warnings)	35
5.2.35	Object 6507h (Profile and Software Version)	35
5.2.36	Object 6508h (Operating Time)	36
5.2.37	Object 6509h (Encoder Zeroing Value)	36
5.2.38	Object 650Ah (Module Identification)	36
5.2.39	Object 650Bh (Serial Number)	37
6.	Setting and diagnosing elements	38
6.1.	Setting of the Node Identifier (Node ID)	38
6.2.	Setting the baud rate	38
6.3.	Diagnosis LEDs	39
7.	Commissioning	39
7.1.	Switching on the supply voltage	39
7.2.	Sending the position value	40
	Asynchronous (cyclic) transmission	40
	Synchronous transmission	40
7.3.	Stopping Transmission of the Position Value	41

1. General remarks

This user manual is valid with effect from firmware version **2.00!** It describes the software, parameterization and commissioning of the rotary encoder.

1.1. Definitions



This symbol precedes passages in the text that should be read particularly carefully to ensure flawless use and to exclude dangers.



This symbol indicates important information for proper handling of the rotary encoder. Disregard of these hints may result in failures of functioning of the rotary encoder or its environment.



This symbol indicates instructions for actions.

CAL	CAN Application Layer. Application layer (layer 7) in the CAN communication model.
CAN	Controller Area Network
CiA	CAN in Automation. International Association of Users and Producers of CAN products.
COB	Communication Object. Transport unit in the CAN network (CAN message). Data is sent within a COB via the network.
COB ID	COB Identifier. Unambiguous identification of a CAN message The identifier determines the priority of the COB in the network.
ID	Identifier, see COB ID
LSB	Least significant bit/byte
MSB	Most significant bit/byte
NMT	Network Management. Service element of CAL, responsible for initialization, configuration and error handling in the network.
PDO	Process Data Object. Object for exchanging process data.
RTR	Remote Transmission Request; data request telegram
SDO	Service Data Object; communication object that enables the master to access the directory of objects of a node.
SYNC	Synchronization telegram. Bus stations respond to the SYNC command by sending their process values.

Figures

if not explicitly stated otherwise, decimal values are given as figures without an extension (e.g., 1234), binary values are marked with a **b** after the figure (e.g., 10011b), hexadecimal values with an **h** (e.g., 280h).

1.2. Documentation

This user manual is valid for the absolute, magnetic angle encoders WV58M or WH58M, respectively, and is intended to give the necessary information for handling these instruments.

For information regarding guarantee, safety and mechanical mounting of the angle encoders WV/WH58M please refer to the User information accompanying these encoders.

1.3. Intended use



The said angle encoders are high-precision measuring instruments. They serve exclusively for sensing angle positions and revolutions, processing and providing measured values as electrical output signals for the slave unit. The angle encoders must be used exclusively for this purpose.

2. Product Family of Magnetic Angle Encoders

At present, the product family of magnetic, absolute angle encoders consists of the following 4 types:

- **10-bit Singleturn (1024 steps/revolution)**
- **12-bit Singleturn (4096 steps/revolution),**
- **10+12-bit Multiturn (1024 steps/revolution, 4096 revolutions),**
- **12+12-bit Multiturn (4096 steps/revolution, 4096 revolutions),**

They are available either in solid shaft or in (blind hole) hollow shaft design, standard size with a diameter of 58mm. Although designed with a bus interface, the angle encoders are very compact.

The angle encoders are available with the following interfaces:

- **SN3 (serial RS485 interface with SIKONETZ3 protocol)**
- **SSI (synchronous serial interface)**
- **PB (Profibus-DP interface)**
- **CAN (CANopen interface)**

Below, only the angle encoder WV/WH58M with CANopen interface will be described.

3. General information on the CAN Bus

Originally, the CAN bus (CAN: Controller Area Network) was developed by Bosch and Intel for fast and low-cost data transmission in the car industry. Nowadays, the CAN bus is also used in industrial automation.

The CAN bus is a field bus (the standards are defined by the association CAN in Automation (CiA)), which enables communication of devices, actuators and sensors of different manufacturers.

3.1. CAN bus features

- Bus medium is a shielded twisted-pair cable,
- The CAN bus is a multi-master bus, i.e., several CAN stations can request the bus at the same time. The message with the highest priority (determined by the identifier) prevails.
- Data rate up to 1Mbit/s permissible (with 40m network range).
- Closed network on both sides.
- Theoretically, up to 127 stations possible on one bus; however, practically only up to 32 stations due to the driver.
- Message-oriented communication: The message is marked with message identification (identifier). By means of the identifier, all bus stations check whether the message is relevant for each of them.
- All bus stations receive each message at the same time. Therefore, synchronization is possible.
- The identifier determines the priority of the message. The lower the value of the identifier, the higher is the priority of the message. This enables fast transmission of important messages via the bus.
- High transmission safety thanks to various error identification mechanisms, which complement each other.
- Localization of faulty or disabled bus stations. The CAN protocol includes function monitoring of bus stations. The functionality of the latter will be limited or disconnected from the network if they are faulty.

3.2. CANopen

The CANopen profile was developed on the basis of the layer 7 specification CAL (CAN Application Layer) under the direction of the Steinbeis Transferzentrum für Automatisierung (Transfer centre for automation). Compared to CAL, only the functions suitable for this use are included in CANopen. Thus, CANopen is a subset of CAL optimised for the application enabling a simplified system design as well as the use of simplified devices. CANopen has been optimised for fast data exchange in real-time systems.

The organization CAN in Automation (CiA) is responsible for the applicable standards of the respective profiles

The angle encoder WV/WH58M with CANopen interface fulfils the conditions specified in the "CANopen Application Layer and Communication Profile" (CiA Draft Standard 301, version 4.02) and in the "CANopen Device profile for encoders" (CiA Draft Standard 406, version 3.1).

CANopen enables:

- easy access to all device and communication parameters,
- synchronization of various devices,
- automatic configuration of networks
- cyclic and event-triggered data traffic

CANopen consists of four communication objects (COB) with different features:

- Process Data Objects (PDOs) for real-time data.
- Service Data Objects (SDOs) for parameter and program transmission.

- Network Management (NMT).
- Predefined objects (for synchronization, emergency message).

The description of the device functionality via an directory of objects is the central element of the CANopen standard. The directory of objects is subdivided into an area containing general information on the device (device identification, manufacturer's name, etc.) and communication parameters, and an area describing the specific device functionality.

An entry ("object") of the directory of objects is identified via a 16-bit index and an 8-bit sub-index. By means of these entries, the "application objects" of a device (e.g., position value in the case of encoders) are made accessible in a standardised form via the network.

The functionality and features of a CANopen device can be described as a standardised "Electronic Data Sheet" (**EDS**) in the ASCII format.

The EDS files allocated to the individual encoder versions can be downloaded from the SIKO GmbH homepage (www.siko.de) under the following file names. Moreover, they are supplied on the accompanying CD:

- Wx58MCAN_1012.eds (EDS file for 10+12Bit Multiturn)
- Wx58MCAN_1212.eds (EDS file for 12+12Bit Multiturn)
- Wx58MCAN_10ST.eds (EDS file for 10Bit-Singleturn)
- Wx58MCAN_12ST.eds (EDS file for 12Bit-Singleturn)

3.3. The Encoder Device Profile (CiA Draft Standard 406)

This profile describes a manufacturer-independent and mandatory specification of the interface for rotary encoders. The profile defines, which CANopen functions are used and how they should be used. This standard enables the creation of an open and manufacturer-independent bus system.

The device profile is divided into two object classes:

- The standard class C1 describes all basic functions, which the encoder must contain.
- The extended class C2 contains a wide range of additional functions that must either be supported by these encoders (mandatory) or are optional. Thus, devices of the C2 class contain all the C1 and C2 mandatory functions as well as – manufacturer-dependent – additional, optional functions.

Additionally, an addressing range is defined in the profile for assignment of special proprietary functions.

The WV/WH58M supports class C2.

4. Data Transmission according to the CANopen Communication Model

The communication model underlying CANopen provides two types of communication mechanisms:

- Unconfirmed transmission of data having a length of 4bytes (**Process Data Objects, PDO**). These data is transmitted with high priority (low COB identifier). PDOs are broadcast messages and provide their data to all receivers on the bus at the same time.
- Confirmed transfer also of longer data sets (parameters) between two stations with direct access to the entries of the addressed station's directory of objects (**Service Data Objects, SDO**). As a rule,

these parameters are transmitted acyclically (e.g., only once when the system is started) and have, therefore, low priority (= high COB identifier).



The priority of the message objects is determined via the COB identifier.

4.1. CANopen message setup



For easier management of the identifiers, CANopen uses the “Pre-Defined Connection Set” Here, all identifiers are defined in the directory of objects with standard values. However, the customer has the possibility of changing these identifiers via SDO access to meet his requirements.

The 11-bit identifier (COB identifier) consists of a 4-bit function code and a 7-bit node number.

Bit no.	10	9	8	7	6	5	4	3	2	1	0
Type	Function code				Node number (Node ID)						
Assignment	x	x	x	x	0	0	x	x	x	x	x

Hint: Bits 5 and 6 are always set to 0 with the WV/WH58. Thus, a maximum of 31 different node numbers can be set (node number 0 is illegal!).



The function code informs about the type of message and its priority. The higher the value of the identifier, the lower the priority.

4.1.1 Function code

The following function codes have been defined in the “Pre-defined Connection Set” (only the function codes used by the WV/WH58M are represented):

Object	Function code	Resulting COB ID	assigned communication parameter for index
NMT	0000b	0	-
SYNC	0001b	128 (80h)	1005h
EMERGENCY	0001b	128 (80h) + Node ID	1014h
PDO1 (tx) ¹	0011b	384 (180h) + Node ID	1800h
PDO2 (tx) ¹	0101b	640 (280h) + Node ID	1801h
SDO (tx) ¹	1011b	1408 (580h) + Node ID	1200h
SDO (rx) ¹	1100b	1536 (600h) + Node ID	1200h
HEARTBEAT	1110b	1792 (700h) + Node ID	1017h

¹ (tx) and (rx) seen from the rotary encoder

4.1.2 Node number (Node ID)

The 7-bit node number is set via the 5 DIP switches on the hardware of the encoder. After removing the screw cap on the encoder hood, this DIP switch can be accessed (see chapter 6.1, *Setting the Node Identifier (Node ID)*, page **38**).

The 5 DIP switches determine bits 0 to 4. Bits 5 and 6 have always the value 0 and cannot be changed.



Node number 0 is reserved and must not be used by any node. Therefore, resulting node numbers are in the range of 1 .. 31. With the WV/WH58M, the setting of the node number 0 on the DIP switch is automatically assigned to node number 1! Any freshly set node number is only taken over after the next reset/power-on of the encoder.

Ex works, the rotary encoder is delivered with node number 1.

4.2. Transmission of process data

Two PDO services, PDO1 (tx) and PDO2 (tx), are available. Any PDO transmission can be initiated as a result of various events:

- Asynchronous (event-triggered) via internal device timer or change of the position value.
- Synchronous as a response to a SYNC telegram.
- As a response to a RTR telegram.

Both PDOs provide the current position of the encoder and are determined via objects 1800h, 1801h, 1A00h, 1A01h, 2800h, 2801h and 6200h.

With the WV/WH58M, PDO1 is assigned to asynchronous and PDO2 to synchronous process data transmission. As a standard, PDO2 is disabled after each power-on of the encoder and must be released on request via SDO.

Request of the position value via RTR telegram is also only possible via PDO2.

The PDO message is set up as follows:

COB ID	Process data in binary code			
	Byte 0 (LSB)	Byte 1	Byte 2	Byte 3 (MSB)
PDO1: 180h+Node ID	Position value in two's complement representation			
PDO2: 280h+Node ID				

4.2.1 Synchronous data transfer

To be able to send process data synchronously, a value between 1 and F0h (=240) must be written in object 1801h, sub-index 2.

If the value is 3, the PDO2 is sent after every third SYNC telegram (with value 1 it is sent after every SYNC telegram), as long as a 0 is written in object 2801h. For example, if a 5 has been written in there, the PDO2 is sent after every third telegram as above, but only 5 times altogether. Accordingly, the 15th SYNC telegram is followed by the last PDO.

The counter for the amount of PDOs to be transmitted is reset in case of position change or by the NMT reset command; i.e., if the position does not change it will be sent 5 times. If the position changes it will be sent 5 times again.

In synchronous operation, the PDO2 is requested by a master via the SYNC telegram (SYNC-COB ID = 80h).

If the PDO2 is to be requested via an RTR telegram, then the value 253 (=FDh) must be written in object 1801h, sub-index 2.

4.2.2 Asynchronous data transfer

If a PDO is to be sent cyclically, then the cycle time must be entered into object 1800h, sub-index 5, in milliseconds. The PDO will not be sent if the value 0ms is written. The function is disabled. The minimum value to be set is 1 (=1ms).

Object 2800h offers another possibility: Cyclic sending is as described above if the value is 0. If the value is 1, then cyclic checking occurs whether the position value has changed. If not, nothing will be sent. For example, if the value is 4, the PDO1 will be sent four times with every cycle if a change has occurred.



Sending the PDO1 due to a change in the position value works only when the timer-controlled transmission has been disabled, that means, when a 0 has been written in sub-index 5, object 1800h.

4.3. Transmission of the SDO data (parameterization)

The directory of objects of the rotary encoder can be accessed via an SDO message. All device parameters are stored in this directory of objects under standardised addresses (indexes) and can be written and read by means of SDOs. SDOs are exchanged between two stations using the request/response method.

Two SDO services are available:



- SDO (tx) (encoder → master): **580h** + Node ID
- SDO (rx) (master → encoder): **600h** + Node ID

The SDO identifiers cannot be changed!

SDO messages are set up as follows:

COB ID	Command	Index		Sub-index	Service data (parameters)			
SDO + Node ID	Byte 0	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3	Byte 4 (LSB)	Byte 5	Byte 6	Byte 7 (MSB)

For the meaning of index, sub-index and data please refer to *chapter 5, "Directory of objects"*.

The command byte specifies the length of the service data (parameters). In the case of the WV/WH58M the following command bytes are valid:

Command byte	Type	Function
23h	SDO (rx), Initiate Download Request	Send parameter to rotary encoder (data length = 4bytes)
60h	SDO (tx), Initiate Download Response	Acknowledgement of data acquisition to master
40h	SDO (rx), Initiate Upload Request	Request parameter from rotary encoder
42h	SDO (tx), Initiate Upload Response	Parameter to master (data length = 4bytes)
80h	SDO (tx), Abort Domain Transfer	Rotary encoder reports error code to master



- An error message (command 80h) replaces the normal response in case of an error.
- The error message includes communication protocol errors as well as directory of objects access errors (e.g., Write attempt on Read-Only object, etc.).

The error codes are described in the CANopen profile (DS 301) or in the encoder profile (DSP 406), respectively. The table below shows the error codes used with the WV/WH58M:

Error code	Description
06010000h	Wrong access to an object.
06010001h	Read access to Write-Only
06010002h	Write access to Read-Only.
06020000h	Object doesn't exist in the directory of objects.
06040043h	General parameter incompatibility
06070010h	Wrong data type, incorrect data length.
06090011h	Sub-index does not exist
06090030h	Wrong value range of selected parameter.
06090036h	Maximum value smaller than minimum value.
08000020h	Parameters cannot be transmitted to application or stored.
08000022h	Parameters cannot be transmitted to application or stored due to the current device status.

SDO examples:

Request of a value by a master from a slave ➔ Operating Status (Object 6500h):

COB ID	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
600h + Node ID	40h	00h	65h	00h	x	x	x	x

Response to the request by the slave

COB ID	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
580h + Node ID	42h	00h	65h	00h	a	b	c	d

Writing a value from master to a slave → object 1800, sub-index 5 (Event Timer):

COB ID	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
600h + Node ID	23h	00h	18h	05h	E8h	03h	00h	00h

Response from slave to writing the value:

COB ID	Command	Index L	Index H	Sub-index	Data 0	Data 1	Data 2	Data 3
600h + Node ID	60h	00h	18h	05h	00h	00h	00h	00h

4.4. Emergency Service

Internal device errors or bus problems trigger an emergency message. The corresponding telegram is set up as follows:

COB ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
80h + Node ID	Error Code		Error Register	Alarms (Object 6503h)		Warnings (Object 6505h)		free

As with the SDO error messages, pre-defined error messages are assigned to the EMERGENCY object as well. The WV/WH58M uses a subset of these error codes as described in the CAN Application Layer DS301. They are contained in the table below:

Byte 0 .. Byte 1: Error Code

Error Codes	Description
0000h	no error
8001h	CANbus communication error: → Acknowledgement Error
8002h	CANbus communication error: → Form Error
8003h	CANbus communication error: → CRC Error
8004h	CANbus communication error: → Stuff Error
8120h	encoder is in the Error Passive Mode
8140h	recovered from Bus Off
FF10h	encoder-specific error: → communication with basic encoder card disabled

FF20h	encoder-specific error: ➔ battery warning; battery charge near lowest permissible limit
FF30h	encoder-specific error: ➔ battery discharged
FF40h	encoder-specific error: ➔ checksum error in communication with basic encoder card
FF50h	encoder-specific error: ➔ timeout error in communication with basic encoder card

Byte 2: Error Register

Bit no.	Description
0	set bit indicates general error condition; is set with every error occurring.
4	communication error; is set when a CANbus communication error occurs (acknowledgement, form, C, and stuff error).

Byte 3 .. Byte 4: Alarms

Bit no.	Description
0	position value invalid.
12	communication with basic encoder card disabled
13	timeout error in communication with basic card.
14	battery warning
15	battery alarm

Byte 5 .. Byte 6: Warnings

Bit no.	Description
4	battery status critical
12	Faults in data traffic with basic encoder card (checksum error).
13	communication with basic encoder card was interrupted manually via DIP switch 1.

Byte 7: not used

4.5. Network management Services (NMT)

The network management can be subdivided into two groups:

- NMT service for device control; serves for initialising, starting and stopping of the encoder,
- NMT service connection monitoring ("Heartbeat").

4.5.1 Description of the NMT commands

The commands are transmitted as unconfirmed objects (broadcast messages) and are set up as follows:

Byte 0	Byte 1	Byte 2
COB ID = 0	Command byte	Node number (node ID)

The COB ID for NMT commands is always zero (highest priority). The node ID is transmitted in byte 2 of the NMT command.

The node number corresponds with the node ID of the desired station. With node number = 0, all bus stations are addressed.

4.5.2 Command byte

Command byte	Description	State transition (see Status diagram, fig. 1)
01h	Start_Remote_Node; change from state "Pre-Operational" or "Stopped" to "Operational"	1
02h	Stop_Remote_Node; change to state "Stopped"	2
80h	Enter_PRE-OPERATIONAL_State; change to state "Pre-Operational"	3
81h	Re-initialization of CAN parameters	4
82h	Re-initialization of CAN card	5

4.5.3 NMT status

After initialising, the encoder is in the "Pre-Operational" state. SDO parameters can be read and written in this state. To request PDOs, the encoder must first be switched to the "Operational" state.

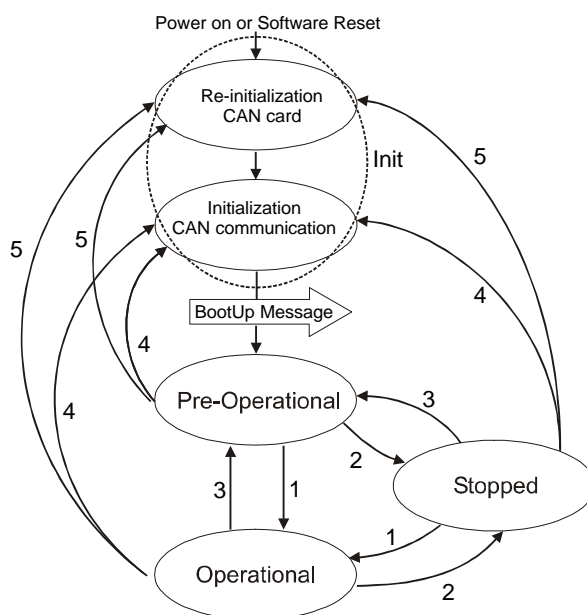


Fig. 1: CAN status diagram

4.5.4 The individual NMT states

Init:

After initialization, the encoder logs in at the CAN bus with a boot-up message. Afterwards, the encoder changes automatically to the “Pre-operational” state.

The COB ID of the boot-up message is made up of 700h and the Node ID.

COB ID	Byte 0
700h + Node ID	00h

Pre-Operational Mode:

SDOs can be read and written in the Pre-Operational Mode.

Operational Mode:

In the Operational Mode state, the encoder sends the desired PDOs. Additionally, SDOs can be read and written.

Stopped Mode:

Only NMT communication is enabled in the Stopped Mode. No SDO parameters can be read or written.

4.5.5 Status change

Start Remote Node (1)

With the “Start_Remote_Node” command, the encoder is set to the “Operational Mode” status.

COB ID	Command byte	Node number
0h	1h	0h .. 1Fh (0 .. 31)

Stop Remote Node (2)

With the “Stop_Remote_Node” command, the encoder is set to the “Stopped” status.

COB ID	Command byte	Node number
0h	2h	0h .. 1Fh (0 .. 31)

Enter_PRE-OPERATIONAL-Mode (3)

Change to the “Pre-Operational” status.

COB ID	Command byte	Node number
0h	80h	0h .. 1Fh (0 .. 31)

Re-initialisation of CAN parameters (4)

COB ID	Command byte	Node number
0h	81h	0h .. 1Fh (0 .. 31)

Re-initialisation of the CAN card (5)

COB ID	Command byte	Node number
0h	82h	0h .. 1Fh (0 .. 31)

4.5.6 Heartbeat

There are two optional monitoring mechanisms intended for ensuring proper functioning of the CANopen network nodes: Each network node can be monitored by a higher-order master via the so-called "Node Guard" or, alternatively, announce its ability to communicate by cyclic sending of a so-called "Heartbeat" message.

With the WV/WH58M, the "Heartbeat" method is used exclusively.

This message can be received by one or several network subscribers and, thus, monitor the assigned subscriber.

In object 1017h, "Producer Heartbeat Time", the time of the heartbeat interval can be deposited. The value 0 disables heartbeat.

The heartbeat message consists of the COB ID and an additional byte. In this byte, the current NMT state is deposited.

COB ID	Byte 0
700h + Node ID	NMT status

NMT status:

- 0: Boot-Up
- 4: Stopped
- 5: Operational
- 127: Pre-Operational

5. Directory of objects

In the directory of objects of a CANopen device, all features and parameters of the respective device are deposited.



Specific parameters of the directory of objects are deposited in a power-failure-safe memory of the encoder and are copied into the main memory during power-on or re-initialization.

The directory of objects is accessed via the SDO services described in *chapter 4.3, "Transmission of the SDO data (Parameterization)"*.

The directory of objects is subdivided into three separate areas:

- Standard objects applicable to all CANopen instruments, 1h .. 1FFFh, (CiA DS 301)
- Manufacturer-specific objects, 2000h .. 5FFFh
- Device-specific objects, 6000h .. BFFFh, (CiA DS 406)

The address (index) pointing to each entry in the directory of objects is also standardised in the profiles except for the manufacturer-specific area. This fact ensures that all instruments always provide the functions described in the profile (standard and optional functions) under the same index. This is a precondition of an open system and of exchangeability of the instruments.

The entries of the directory of objects are addressed by a 16-bit index. Each index can be further subdivided by a sub-index.

5.1. Overview of objects

Index	Name	Description	see page
1000h	Device Type	indicates the device profile and the encoder type	19
1001h	Error Register	indicates error states of the encoder	19
1002h	Manufacturer Status Register	indicates the contents of the CAN bus-specific "TransmitErrorCounter" or "ReceiveErrorCounter", respectively, and the firmware version of the basic card	20
1003h	Pre-Defined Error Field	the object stores the 8 error states that have occurred last	20
1005h	COB ID SYNC message	setting of the COB ID of the SYNC object.	21
1008h	Manufacturer Device Name	short designation of the device type	21
1009h	Manufacturer Hardware Version	hardware version of the encoder	21
100Ah	Manufacturer Software Version	software version of the encoder	22
1010h	Store Parameters	the object indicates non-volatile storage of parameters by the encoder with no user input.	22
1011h	Restore Parameters	the object indicates that the encoder automatically loads parameters from the non-volatile memory.	23
1014h	COB ID Emergency Object	COB ID of the Emergency object	24
1017h	Producer Heartbeat Time	setting of the cycle time of the heartbeat timer	24
1018h	Identity Object	contains the manufacturer number assigned by CiA	25
1800h	Transmit PDO1 Communication Parameter	Transmit PDO for the asynchronous operation mode (timer or position-value-controlled)	25
1801h	Transmit PDO2 Communication Parameter	Transmit PDO for the synchronous operation mode, including output of the position value via RTR	26

Index	Name	Description	see page
1A00h	Transmit PDO1 Mapping Parameter		27
1A01h	Transmit PDO2 Mapping Parameter		28
2001h	Manufacturer Offset	manufacturer-specific offset value (is added to the position value encoder-internally)	28
2002h	Zero encoder	set position value to value 0 (condition: pre-set value 0)	28
2800h	Send repeat counter for PDO1	indicates how often the PDO1 is sent	29
2801h	Send repeat counter for PDO2	indicates how often the PDO2 is sent	29
6000h	Operating Parameters	setting of sense of rotation and scaling function	29
6001h	Measuring units per Revolution	parameterization of the resolution in steps / revolution of the encoder	30
6002h	Total measuring range in measuring units	parameterization of the total measuring range of the encoder	31
6003h	Preset Value	parameterization of a pre-set (calibration) value	31
6004h	Position Value	position value (offset with pre-set and manufacturer offset value)	32
6200h	Cycle Timer PDO1	value in ms, identical with object 1800h, sub-index 5	32
6500h	Operating Status	indicates the sense of rotation and scaling function currently set	33
6501h	Singleturn Resolution	indicates the maximum possible resolution in steps / revolution	33
6502h	Number of distinguishable Revolutions	indicates the maximum possible number of revolutions	33
6503h	Alarms	indication of error states	33
6504h	Supported Alarms	indicates which alarm messages are supported	34
6505h	Warnings	indication of warnings	34
6506h	Supported Warnings	indicates which warnings are supported	35
6507h	Profile and Software Version	indicates the version number of the device profile used and the version number of the encoder's firmware	35
6508h	Operating Time	outputs the value FFFFFFFFh (function is not yet supported at present)	36
6509h	Offset Value	corresponds with the encoder's zero point value	36

Index	Name	Description	see page
650Ah	Module Identification	device-specific parameters (Manufacturer Offset, Manufacturer min position value, Manufacturer max position value) can be represented via sub-indexes	36
650Bh	Serial Number	outputs the value FFFFFFFFh (function is not yet supported at present)	37

5.2. Detailed description of objects

5.2.1 Object 1000h (Device Type)

Sub-index	00h			
Description	Information on device type and device profile			
Access	ro			
Data type	UNSIGNED 32			
EEPROM	no			
Default	Multiturn: 00030196h Singleturn: 00010196h			
Data content	Device profile number		Encoder type	
	Byte 0	Byte 1	Byte 2	Byte 3
	96h	01h	03h	00h

0196h (= 406): CANopen Device Profile for Encoders, version 3.01

0003h: Single-turn angle encoder, absolute, with battery-buffered electronic revolution counter (multi-turn)

0001h: Single-turn angle encoder, absolute

5.2.2 Object 1001h (Error Register)

Sub-index	00h	
Description	device errors occurring are indicated here	
Access	ro	
Data type	UNSIGNED 8	
EEPROM	no	
Default	no	
Data content	Bit	Meaning
	0	set bit indicates the occurrence of any error condition
	4	set bit indicates communication error on the CAN bus (acknowledgement-, form-, CRC- and stuffbit)
	1-3, 5-7	not used

5.2.3 Object 1002h (Manufacturer Status Register)

Sub-index	00h			
Description	<p>The counts of the registers "Transmit Error Counter" and "Receive Error Counter" can be read via this object.</p> <p>The contents of these registers provide information on the transmission faults present at the mounting site of the encoder.</p> <p>Additionally, the version status of the basic card firmware is output.</p>			
Access	ro			
Data type	UNSIGNED 32			
EEPROM	no			
Default (multi-turn encoder)	02070000h			
Default (single-turn encoder)	02080000h			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	Receive Error Counter	Transmit Error Counter	Firmware status basic card LOW	Firmware status basic card HIGH

For details on the above-mentioned counters refer to the relevant CAN bus publications.

5.2.4 Object 1003h (Pre-defined Error Field)

- The object stores the 8 error states that have occurred last
- the entry under sub-index 0 indicates the number of errors stored.
- Each newly added error state is stored under sub-index 1. Previous error messages "slip" downward in their position by one digit.
- The whole error list is deleted by writing the value 0 at sub-index 0.
- The entries in the error list have the format described in *chapter 4.4, Emergency Service*.

Sub-index	00h
Description	number of error messages stored
Access	rw
Data type	UNSIGNED 8
EEPROM	no
Default	0
Value range	0 – 8

Sub-index	01h .. 08h
Description	error messages that occurred
Access	r0
Data type	UNSIGNED 32
EEPROM	no
Default	0

5.2.5 Object 1005h (COB ID SYNC message)

Sub-index	00h	
Description	Defines the COB ID of the synchronization object (SYNC)	
Access	rw	
Data type	UNSIGNED 32	
EEPROM	yes	
Default	80h	
Data content	Bit 31:	not defined
	Bit 30:	0: encoder generates no SYNC message 1: encodes generates SYNC messages
	Bit 29:	0: 11-bit identifier (CAN 2.0A) 1: 29-bit identifier (CAN 2.0B)
	Bit 28..11	0: if bit 29 = 0, X: if bit 29 = 1: bits 28 – 11 of the 29-bit SYNC-COB ID
	Bit 10.0.0	X: bits 10 – 0 of the SYNC-COB ID

5.2.6 Object 1008h (Manufacturer Device Name)

Sub-index	00h			
Description	short encoder designation in ASCII			
Access	const			
Data type	Visible_String			
EEPROM	no			
Default	W58M			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	4Dh ('M')	38h ('8')	35h ('5')	57h ('W')

5.2.7 Object 1009h (Manufacturer Hardware Version)

Sub-index	00h			
Description	hardware version in ASCII			
Access	const			
Data type	Visible_String			
EEPROM	no			
Default	"1.00"			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	30h ('0')	30h ('0')	2Eh = '.'	31h ('1')

5.2.8 Object 100Ah (Manufacturer Software Version)

Sub-index	00h			
Description	software version in ASCII			
Access	const			
Data type	Visible_String			
EEPROM	no			
Default	"2.00"			
Data content	Byte 0	Byte 1	Byte 2	Byte 3
	30h ('0')	30h ('0')	2Eh ('.')	32h ('2')

5.2.9 Object 1010h (Store Parameters)

This object serves exclusively for information that the encoder automatically stores specific parameters in the EEPROM. The "Store Parameter" command is not required for this purpose!

Sub-index	00h		
Description	describes the number of entries present in sub-index 1.		
Access	ro		
Data type	UNSIGNED 8		
EEPROM	no		
Default	1h		

Sub-index	01h		
Description	describes the behaviour of the encoder, how parameters are stored in the EEPROM.		
Access	ro		
Data type	UNSIGNED 32		
EEPROM	no		
Default	2h		
Data content	Bit 31 -2	0	
	Bit 1:	0: encoder does not store parameters automatically 1: encoder stores parameters automatically following write access to relevant object	
	Bit 0:	0: encoder does not store parameter by command 1: encoder stores parameter after command	

The following table represents the parameters stored in the EEPROM:

Object	Sub-index	Description	Default value
1005h	0h	SYNC-ID	80h
1014h	0h	EMCY-ID	80h + Node ID
1017h	0h	Producer Heartbeat Time	0h
1800h	1h	PDO1-ID	40000180h + Node ID
1800h	2h	PDO1 Transmission Type	FEh (= 254)
1800h	5h	PDO1 Event Timer	0h
1801h	1h	PDO2-ID	80000280h + Node ID
1801h	2h	PDO2 Transmission Type	1h
2001h	0h	Manufacturer Offset	0h
2800h	0h	PDO1 send repeat counter	0h
2801h	0h	PDO1 send repeat counter	0h
6000h	0h	Operating Parameters	0h
6001h	0h	Encoder resolution	10-bit encoder 1024 12-bit encoder 4096
6002h	0h	Total measurement range	10-bit encoder 4194304 12-bit encoder 16777216
6003h	0h	Preset value	0h
6200h	0h	PDO1 Event Timer	see object 1800-5

5.2.10 Object 1011h (Load Default Parameters)

This object serves for setting the encoder to its default values (see 5.2.9). To be safeguarded against unintended loading of the default values, the string "load" must be written in sub-index 1h.

COB ID	Command	Index Low	Index High	Sub-index	Data 0 (LSB)	Data 1	Data 2	Data 3 (MSB)
600h + Node ID	23h	11h	10h	01h	'l' (6Ch)	'o' (6Fh)	'a' (61h)	'd' (64h)

A read access to the respective sub-indexes results in the values represented below:

Sub-index	00h
Description	indicates the largest supported sub-index
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	1h

Sub-index	01h	
Description	all default values are loaded	
Access	ro	
Data type	UNSIGNED 32	
EEPROM	no	
Default	0h	
Data content	Bit 31 -1	0
	Bit 0:	0: encoder does not permit loading of default parameters. 1: encoder permits loading of default parameters.

5.2.11 Object 1014h (COB ID Emergency Object)

Sub-index	00h	
Description	defines the COB ID of the Emergency object (EMCY)	
Access	rw	
Data type	UNSIGNED 32	
EEPROM	yes	
Default	80h + Node ID	
Data content	Bit 31:	0: EMCY object exists / is valid 1: EMCY object does not exists / is invalid
	Bit 30:	always 0
	Bit 29:	0: 11-bit identifier (CAN 2.0A) 1: 29-bit identifier (CAN 2.0B)
	Bit 28..11	0: if bit 29 = 0, X: if bit 29 = 1: bits 28 -11 of the 29-bit EMCY-COB ID
	Bit 10.0.0	X: bits 10 – 0 of the EMCY-COB ID

5.2.12 Object 1017h (Producer Heartbeat Time)

Sub-index	00h
Description	defines the cycle time of the heartbeat monitoring service
Access	rw
Data type	UNSIGNED 16
EEPROM	yes
Default	0h
Value range	10 .. 65535 (Ah .. FFFFh); the numerical value corresponds with a multiple of 1ms. The service is disabled by writing the value 0. The writing of values in the range of 1 .. 9 trigger an error message!

5.2.13 Object 1018h (Identity Object)

Sub-index	00h
Description	number of entries
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	2h

Sub-index	01h
Description	The manufacturer identification number (vendor ID) for the company SIKO GmbH allocated by the CiA (see www.can-cia.org)
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	195h

Sub-index	02h			
Description	indicates the encoder version in ASCII.			
Access	ro			
Data type	UNSIGNED 32			
EEPROM	no			
Default	10+12-bit version: "1012" 12+12-bit version: "1212" 10-bit SingleTurn "10ST" 12-bit SingleTurn "12ST"			
Data content (example: 12+12 bits version):	Byte 0	Byte 1	Byte 2	Byte 3
	32h ('2')	31h ('1')	32h ('2')	31h ('1')
Example: 10+12 bits version	32h ('2')	31h ('1')	30h ('0')	31h ('1')
Example: 10 bits single-turn	54h (,T')	53h (,S')	30h ('0')	31h ('1')
Example: 12 bits single-turn	54h (,T')	53h (,S')	32h ('2')	31h ('1')

5.2.14 Object 1800h (Transmit PDO1 Parameter, asynchronous operation mode)

Sub-index	00h
Description	largest subindex supported
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	5h

Sub-index	01h
Description	COB ID of the PDO1
Access	rw
Data type	UNSIGNED 32
EEPROM	yes
Default	40000180h + Node ID bit30 = 1: RTR for this PDO not released, bit is always set

Sub-index	02h
Description	Transmission Type
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	FEh (254) PDO has asynchronous characteristics (PDOs are sent depending on the "Event Timer"). This value cannot be changed!

Sub-index	03h (is not used, access attempt generates error message)
------------------	--

Sub-index	04h (is not used, access attempt generates error message)
------------------	--

Sub-index	05h
Description	Event Timer
Access	rw
Data type	UNSIGNED 16
EEPROM	yes
Value range	1 .. 65535 (1h .. FFFFh); the numerical value corresponds with a multiple of 1ms. The service is disabled by writing the value 0. The content of this object is identical with object 6200h.

5.2.15 Object 1801h (Transmit PDO12 parameter, synchronous operation mode)

Sub-index	00h
Description	largest subindex supported
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	5h

Sub-index	01h	
Description	COB ID of the PDO2	
Access	rw	
Data type	UNSIGNED 32	
EEPROM	yes	
Default	80000280h + Node ID	bit31 = 1: PDO2 is always disabled after Power-On (Init); must be explicitly enabled via SDO service.

Sub-index	02h	
Description	Transmission Type	
Access	rw	
Data type	UNSIGNED 8	
EEPROM	yes	
Default	1h	PDO has synchronous characteristics;
Value range	1h .. n .. F0h (240)	The PDO is sent after every nth SYNC command, also depending on the value in object 2801h.
	FDh (253):	encoder responds to RTR request.

Sub-index	03h (is not used, access attempt generates error message)	
------------------	--	--

Sub-index	04h (is not used, access attempt generates error message)	
------------------	--	--

Sub-index	05h (is not used, access attempt generates error message)	
------------------	--	--

5.2.16 Object 1A00h (Transmit PDO1 Mapping Parameter)

Sub-index	00h	
Description	number of objects mapped	
Access	ro	
Data type	UNSIGNED 8	
EEPROM	no	
Default	1h	

Sub-index	01h	
Description	writes in the content of the PDO1 message	
Access	ro	
Data type	UNSIGNED 32	
EEPROM	no	
Default	60040020h	

5.2.17 Object 1A01h (Transmit PDO2 Mapping Parameter)

Sub-index	00h
Description	number of objects mapped
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	1h

Sub-index	01h
Description	Writes in the content of the PDO2 message
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	60040020h

5.2.18 Object 2001h (Manufacturer Offset)

Sub-index	00h
Description	The offset enables the shifting of the scaled value range. The offset value is added to the position value in the encoder. Positive as well as negative values are permitted. NOTE: This object is not available for the single-turn versions of the WV/WH58M!
Access	rw
Data type	SIGNED 32
EEPROM	yes
Default	0h
Value range	The minimum or maximum values to be entered depend on the values entered in object 650Ah, sub-index 2 or sub-index 3, respectively. The latter depend on the parameterised value of the total step number: $lower_limit = - 1/2 \text{ total step number}$, $upper_limit = 1/2 \text{ total step number} - 1$ $lower_limit < offset < upper_limit$

5.2.19 Object 2002h (Zeroing of encoder value)

Sub-index	00h
Description	This object enables "zeroing" of the encoder value, i.e., setting the position value to 0 (condition: pre-set value = 0).
Access	rw
Data type	UNSIGNED 8
EEPROM	no
Default	no
Value range	0 .. 1; writing the value 1 on sub-index 0 sets the position value to 0. Renewed zeroing is only enabled after writing a 0 before.

Example:

COB ID	Command	Index Low	Index High	Sub-index	Data 0 (LSB)	Data 1	Data 2	Data 3 (MSB)
600h + Node ID	23h	02h	20h	00h	01h	00h	00h	00h

5.2.20 Object 2800h (Send repeat counter for PDO1)

Sub-index	00h
Description	The value of the send repeat counter for PDO1 determines how often this PDO will be sent (see <i>chapter 4.2, asynchronous data transfer</i>)
Access	rw
Data type	UNSIGNED 8
EEPROM	yes
Default	0h
Value range	0 .. 100 (64h) Value = 0: Repeat counter is switched off

5.2.21 Object 2801h (Send repeat counter for PDO2)

Sub-index	00h
Description	The value of the send repeat counter for PDO2 determines how often this PDO will be sent (see <i>chapter 4.2.1, synchronous data transfer</i>)
Access	rw
Data type	UNSIGNED 8
EEPROM	yes
Default	0h
Value range	0 .. 100 (64h) Value = 0: Repeat counter is switched off

5.2.22 Object 6000h (Operating Parameters)

Sub-index	00h				
Description	This object influences the encoder's code sequence and the scaling function.				
Access	rw				
Data type	UNSIGNED 16				
EEPROM	yes				
Default	0h				
Bit definition		Bit 14 .. Bit 3:	Bit 2:	Bit 1:	Bit 0:
	Function	not used	Scaling	not used	Code sequence
	Bit = 0	-	disabled	-	Sense of rot. I (CW)
	Bit = 1	-	enabled	-	Sense of rot. E (CCW)

Explanation of the functions:



- Sense of rotation I: ascending position values with clockwise (CW) encoder rotation (look at the encoder shaft)
- Sense of rotation E: ascending position values with counter-clockwise (CCW) encoder rotation (look at the encoder shaft)
- Scaling disabled: The encoder works with its full resolution (1024 steps/revolution and 4096 revolutions or 4096 steps/revolution and 4096 revolutions, respectively)
- Scaling enabled: The encoder can be parameterised via objects 6001h (Measuring units per revolution), 6002h (Total Measuring range), 6003h (Preset) and 2001h (Manufacturer Offset).

Setting the scaling bit results in resetting the preset and the manufacturer offset values to 0.

The scaling bit is stored non-volatily. Thus, all settings are still present after restarting the encoder.

If the scaling bit is reset from 1 to 0, settings made with object 6001h and 6002h are overwritten by the default values (resolution = 1024 or 4096 steps/revolution and 4096 revolutions). The values for Preset and ManufacturerOffset remain unchanged.

5.2.23 Object 6001h (Measuring Units per Revolution [Encoder Resolution])

Sub-index	00h	
Description	This parameter sets the desired resolution per revolution.	
Access	rw	
Data type	UNSIGNED 32	
EEPROM	yes	
Default	WV/WH58M-10bit: 1024	WV/WH58M-12bit: 4096
Value range	1 .. 1024	(WV/WH58M-10-bit)
	1 .. 4096	(WV/WH58M-12-bit)



Any Preset and/or ManufacturerOffset values are reset to 0 when the resolution is changed!

5.2.24 Object 6002h (Total Measuring Range [Total Step Number])

Sub-index	00h	
Description	This parameter sets the total number of measuring steps.	
Access	rw	
Data type	UNSIGNED 32	
EEPROM	yes	
Default	WV/WH58M-10-bit: 4194304	
	WV/WH58M-12-bit: 16777216	
Value range	4096 .. 4194304	(WV/WH58M-10-bit)
	4096 .. 16777216	(WV/WH58M-12-bit)

The Total Measuring Range must be a number divisible by 4096 without a remainder!



Any Preset and/or ManufacturerOffset values are reset to 0 when the total number of steps is changed!

Any attempt to write on this object in a SingleTurn encoder will result in an error message (error code: 06040043h).

5.2.25 Object 6003h (Preset value)

Sub-index	00h	
Description	The position value of the encoder is set to this preset value.	
Access	rw	
Data type	SIGNED 32	
EEPROM	yes	
Default	0h	
Value range	<p>The value range of the preset value depends on the settings made with objects 6001h and 6002. In the default setting of these two objects, the value range covers the following range:</p> <p>WV/WH58M-10-bit: -2097152 .. 0 .. +2097151</p> <p>WV/WH58M-12-bit: -8388608 .. 0 .. +8388607</p> <p>The maximum value range to be represented can be read with the object 650Ah, sub-index 2 and sub-index 3 and depends always on the settings made with objects 6100h and 6002h!</p>	



The preset value is reset to 0 when the scaling bit is set and when the encoder resolution or the total step number is changed.

5.2.26 Object 6004h (Position value)

Sub-index	00h
Description	This object provides the position value of the encoder offset with the scaling factors, preset and ManufacturerOffset.
Access	ro
Data type	SIGNED 32
EEPROM	no

The position value of the WV/WH58M is calculated by using the following formula:

$$\text{Position value} = (\text{encoder value} - \text{encoder zeroing value}) * RF + \text{preset value} + \text{ManufacturerOffset}$$

Encoder value: absolute value calculated by the encoder sensor system,

Encod. zeroing value: absolute value at the time of zeroing,

RF: Calculation (scaling) factor = encoder resolution / 1024, (10-bit),
Calculation (scaling) factor = encoder resolution / 4096, (12-bit),

Preset value: see Object 6300h

ManufacturerOffset: see Object 2100h

With the WV/WH58M, the total measuring range is subdivided into a negative and positive value range:

$$-1/2 \text{ total measuring range} \dots 0 \dots +1/2 (\text{total measuring range} - 1)$$

Therefore, the representation of the position value is in the 2-complement format in a signed 32-bit number.

5.2.27 Object 6200h (Cycle Timer)

Sub-index	00h
Description	Defines the cycle time with which the PDO1 is output. The value is fixed-linked (identical) with the value indicated under object 1800h, sub-index 5. The timer-controlled output is activated as soon as a cycle time was parameterised within the value range and the encoder switched over to the Operational Mode.
Access	rw
Data type	UNSIGNED 16
EEPROM	no
Default	0h
Value range	0: Cycle timer is disabled, 1 .. 65535: Cycle time in ms

5.2.28 Object 6500h (Operating Status)

Sub-index	00h
Description	The object indicates the settings programmed with object 6000h.
Access	ro
Data type	UNSIGNED 16
EEPROM	yes
Default	no
Bit definition	see Object 6000h

5.2.29 Object 6501h (SingleTurn resolution)

Sub-index	00h
Description	The object indicates the maximum possible encoder resolution.
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	WV/WH58M (10+12-bit): 1024 WV/WH58M (10-bit ST): 1024 WV/WH58M (12+12-bit): 4096 WV/WH58M (12-bit ST): 4096

5.2.30 Object 6502h (Number of distinguishable revolutions)

Sub-index	00h
Description	The object indicates the maximum possible number of encoder revolutions.
Access	ro
Data type	UNSIGNED 16
EEPROM	no
Default	4096

5.2.31 Object 6503h (Alarms)

Sub-index	00h
Description	In addition to the errors reported via the emergency messages, this object provides further, encoder-specific error messages. In the case of an error, the associated bit is set to 1.
Access	ro
Data type	UNSIGNED 16
EEPROM	no
Default	0h

Bit definition:

Bit	Function	Value = 0	Value = 1
0	position error	no error	position value invalid
1 .. 11	not used	-	-
12	connection with basic card	connection established	no basic card recognised
13	timeout error in connection to basic card	no fault	connection failure
14	battery warning	battery voltage OK	battery voltage near lowest tolerable value
15	battery error	battery OK or still in tolerable range	battery discharged

5.2.32 Object 6504h (Supported Alarms)

Sub-index	00h
Description	The object indicates which alarm messages are supported.
Access	ro
Data type	UNSIGNED 16
EEPROM	no
Default	F001h

Bit 0:	Position error
Bit 12:	Connection with basic card
Bit 13:	Communication error with basic card (timeout)
Bit 14:	Battery warning
Bit 15:	Battery alarm

5.2.33 Object 6505h (Warnings)

Sub-index	00h
Description	Warnings indicate that tolerances of internal encoder parameters have been exceeded. However, unlike with alarm messages, the position value can be valid in case of a warning.
Access	ro
Data type	UNSIGNED 16
EEPROM	no
Default	0h

Bit definition:

Bit	Function	Value = 0	Value = 1
0 .. 3	not used	-	-
4	battery warning	battery voltage OK	battery voltage near lowest tolerable value
5 .. 11	not used	-	-
12	faults in data traffic with the basic card	no faults	checksum error occurred
13	switch position of DIP switch 1	switch is at OFF	switch is at ON; communication with basic card was interrupted manually
14, 15	not used	-	-

5.2.34 Object 6506h (Supported Warnings)

Sub-index	00h
Description	The object indicates which warnings are supported.
Access	ro
Data type	UNSIGNED 16
EEPROM	no
Default	3010h

Bit 4: Battery warning is supported

Bit 12: Communication warning (checksum error)

Bit 13: State of DIP switch 1

5.2.35 Object 6507h (Profile and Software Version)

Sub-index	00h
Description	The object indicates the encoder profile used (CANopen Device profile for encoders) and the version number of the firmware state.
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	02010301h

Data content:

Profile Version		Firmware Version	
Byte 0 (Low)	Byte 1 (High)	Byte 2 (Low)	Byte 3 (High)
01h	03h	00h	01h

5.2.36 Object 6508h (Operating Time)

Sub-index	00h
Description	Operation time counter (not implemented in the encoder)
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	FFFFFFFFh (shows that the function is not supported)

5.2.37 Object 6509h (Encoder Zeroing Value)

Sub-index	00h
Description	The difference between encoder value and the position value scaled and offset with preset and/or ManufacturerOffset is output via this object.
Access	ro
Data type	SIGNED 32
EEPROM	yes

$$\text{Encoder zeroing value} = \text{encoder value} - \frac{(\text{Position value} - \text{Preset value} - \text{ManufacturerOffset})}{\text{Scaling factor}}$$

5.2.38 Object 650Ah (Module Identification)

The Manufacturer Offset value (sub-index 1), the smallest (sub-index 2) and the largest (sub-index 3) position value that can be displayed can be read out via this object.

Sub-index	00h
Description	contains the number of additional sub-indexes.
Access	ro
Data type	UNSIGNED 8
EEPROM	no
Default	3h

Sub-index	01h
Description	manufacturer-specific offset value (is added to the position value)
Access	ro
Data type	SIGNED 32
EEPROM	yes
Default	0h

Sub-index	02h
Description	Minimum position value that can be displayed (is influenced by the scaling objects 6001h and 6002h).
Access	ro
Data type	SIGNED 32
EEPROM	no
Default	WV/WH58M (10+12-bit): -2097152 WV/WH58M (10-bit ST): 0 WV/WH58M (12+12-bit): -8388608 WV/WH58M (12-bit ST): 0

Sub-index	03h
Description	Maximum position value that can be displayed (is influenced by the scaling objects 6001h and 6002h).
Access	ro
Data type	SIGNED 32
EEPROM	no
Default	WV/WH58M (10+12-bit): 2097151 WV/WH58M (10-bit ST): 1024 WV/WH58M (12+12-bit): 8388607 WV/WH58M (1-bBit ST): 4096

5.2.39 Object 650Bh (Serial Number)

Sub-index	00h
Description	Provides the serial number of the encoder (not supported with the WV/WH58M).
Access	ro
Data type	UNSIGNED 32
EEPROM	no
Default	FFFFFFFFh (function is not implemented)

6. Setting and diagnosing elements

6.1. Setting of the Node Identifier (Node ID)

After removing the screw cap on the encoder hood, an 8-pin DIP switch as well as two diagnosis LEDs (yellow and green) are visible.

Switches 4 to 8 serve for setting the Node Identifier. The adjustable range is between 1 and 31. Although switches 4 to 8 can be set to ON, the setting is converted to Node ID 1 encoder-internally since the identifier 0 is illegal!

The Node ID via switches 4 to 8 is encoded in the binary format. This is illustrated in the following table:

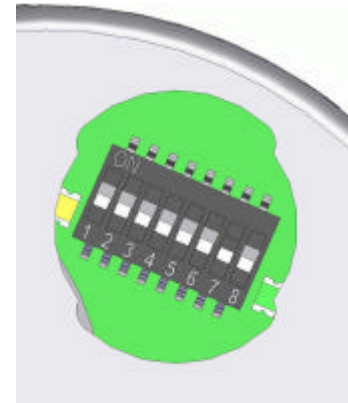


Fig. 2: DIP switches and diagnosis LEDs

Switch 4	Switch 5	Switch 6	Switch 7	Switch 8	Node ID set
ON	ON	ON	ON	ON	1 (!)
ON	ON	ON	ON	OFF	1
ON	ON	ON	OFF	ON	2
ON	ON	ON	OFF	OFF	3
:	:	:	:	:	:
OFF	OFF	OFF	ON	OFF	29
OFF	OFF	OFF	OFF	ON	30
OFF	OFF	OFF	OFF	OFF	31



The DIP-switch settings are only read when the encoder is started (power-on or during new initialization via an NMT command). Changing the switch position during operation of the encoder has no effect. (Exception: DIP switch 1)

The ex works standard setting is Node ID 1 (DIP switch 8 = OFF).

6.2. Setting the baud rate

The CAN baud rate is set via DIP switches 2 and 3. Four different baud rates can be selected. The following table shows the allocation:

Switch 2	Switch 3	Baudrate
ON	ON	125 Kbit/s
ON	OFF	250 Kbit/s
OFF	ON	500 Kbit/s
OFF	OFF	1000 Kbit/s



The DIP-switch settings are only read when the encoder is started (power-on or during new initialization via an NMT command). Changing the switch position during operation of the encoder has no effect. (Exception: DIP switch 1)

The ex works standard setting is baud rate 125 Kbit/s.



DIP switch 1 is exclusively intended for service purposes and must remain at the ON position.

6.3. Diagnosis LEDs

Beside the DIP switch there is each a green and yellow LED. They serve for signalling different operational states:

	LED	Meaning
Power (green)	OFF	voltage supply missing
	ON	voltage supply is OK
Status (yellow)	blinking (pulse duty factor 1:4)	encoder is in the Pre-Operational Mode
	ON	encoder is in the Operational Mode
	fast blinking (pulse duty factor 1:1)	encoder is in the Stopped Mode

7. Commissioning

Prior to commissioning of the encoder the following work should be performed:

- Setting of the Node ID (must be present in the system only once),
- setting of the CAN baud rate valid for the system,
- correct connection of the supply and bus lines

7.1. Switching on the supply voltage

After switching on the supply voltage, the encoder initialises as indicated by blinking of the yellow LED twice (only visible after the screw plug on the encoder hood has been removed).

After completing the initialization procedure, the encoder sends a specific NMT command, the **Boot-Up Message**, to inform the system about the presence of the encoder. During initialization, the parameters of the directory of objects are loaded from the non-volatile memory to the main memory of the controller.

If the encoder has not been programmed yet, all parameters are set to their default values, otherwise the encoder operates with the latest parameterised data.

The encoder is now in the **Pre-Operational Mode**. In this state, the encoder can be parameterised via SDO commands in accordance with the requirements of the application. This applies particularly to the way the encoder makes available its position values to the system (asynchronous or synchronous data transmission)



NOTE: If the numerical value 7FFFFFFFh is read out as the position value, this indicates that the encoder-internal CAN controller was unable to establish the connection to the basic encoder card! Possible causes are: 1) the DIP switch 1 (see figure 2, chapter 6.1) is not at the ON position or 2) contact problems of this switch prevent communication of the CAN controller with the basic card.

7.2. Sending the position value

Before the encoder is able to send its position value, the encoder must be switched to the **Operational Mode** via the **Node Start** NMT command.

COB ID	Command byte	Node number
0h	1h	0h .. 1Fh (0 .. 31)

If the Node ID of the encoder is specified, then this encoder only will start. If the value 0 is transmitted for the node number, then all devices connected to the bus will start.

Now the encoder can transmit its position value as specified via PDO1 or PDO2, respectively.

7.2.1. Asynchronous (cyclic) transmission

The PDO1 is responsible for this type of transmission. The position value is sent cyclically in accordance with the time parameterised in object 1800h, sub-index 5.

Object 2800h offers another possibility: If this object is parameterised with the value 1, then the position value is sent once with every change of the same. The value 3 will cause the position value to be sent three times with each change.

7.2.2. Synchronous transmission

To enable synchronous transmission of the position value, the PDO2 must first be enabled (set bit31 of the COB ID PDO2 to 0). Furthermore, a value between 1 and 240 (= F0h) must be written in object 1801h, sub-index 2.

For example, if the value is 3, the PDO2 is sent after every third SYNC telegram (with value 1 it is sent after every SYNC telegram), as long as a 0 is written in object 2801h.

If the object 2800h has been parameterised with the value 4, the PDO2 is still sent following each third SYNC telegram, but only four times in all. Accordingly, the 12th SYNC telegram is followed by the last PDO2.

The counter for the amount of PDOs to be transmitted is reset in case of position change or by the **Reset** NMT command; i.e., if the position does not change it will be sent 4 times. If the position changes it will be sent 4 times again.

Another possibility of transmitting the PDO2 consists in the response to a RTR request. For this purpose, the value 253 (=FDh) must be written to object 1801, sub-index 2.

7.3. Stopping Transmission of the Position Value

To stop data transmission from the encoder, the encoder can be switched back to the **Stopped Mode** or to the **Pre-Operational Mode**.

Stop Mode command

COB ID	Command byte	Node number
0h	2h	0h .. 1Fh (0 .. 31)

Pre-Operational Mode command:

COB ID	Command byte	Node number
0h	80h	0h .. 1Fh (0 .. 31)

All devices connected to the bus are addressed via node address 0.