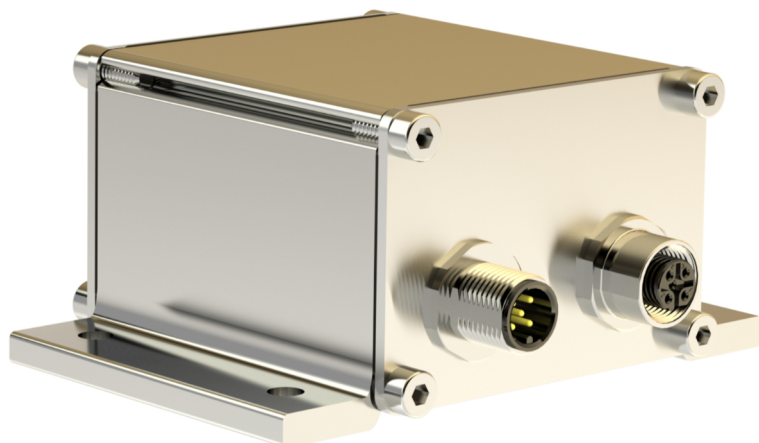




Handbook / CANopen specifications

NBN66 - D

with
CANopen interface
CAN profile C3

Specifications for NBN66-D



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Specifications for NBN66-D

1 Intended use

The hub sensor contains two different MEMS sensors:

- MEMS acceleration sensor for angular position
- MEMS gyroscope sensor for angular velocity

This device is meant for measuring angular position and angular speed in a rotating application.

Based on our model series NBN inclinometer, this hub sensor is suitable for registering the inclination - also referred to as position here - over 360°. In addition to the MEMS accelerometer, a MEMS gyroscope is used to precisely measure the angular velocity / rotation rate with a high refresh rate. **This hub sensor behaves like a rotary encoder with a speed signal.** It's CANopen profile is therefore a rotary encoder profile.

With this sensor, it is therefore possible to register the position and speed of continuous rotational processes - the rotation of a wind turbine rotor, for example. To do this, the sensor does not have to be positioned precisely in the centre of the axis of rotation. The deviation (eccentricity) is automatically determined and used to correct the signal. See handbook [NBT15982](#) for performance data taken on an operational wind turbine.

Special digital filters and digital processing of the measurement signals result in high position and speed precision even in the event of disturbances caused by vibrations, tilt angles from the axis of rotation and eccentricity versus the axis of rotation.

In contrast to a rotary encoder, no fixed shaft attachment is required. This enables simplified and therefore inexpensive installation in a rotating application.

Data output is carried out via the CANopen interface.

The robust hub sensor has a stable aluminium housing. Electrical connection is carried out using M12 connectors. The protection class extends up to IP67.

2 Design

Mechanical dimensions

are specified in data sheet [NBN15268](#) or in related drawings due to special mechanical designs.

Electrical requirements

are specified in data sheet [NBN15268](#) and in the connecting diagram TYxxxxx which is delivered with every device.

Environmental specifications

are mentioned in data sheet [NBN15268](#) and/or in special test reports which are available on request.

CANopen features

- CANopen Application Layer and Communication Profile, CiA Draft Standard 301, Version 4.2
- CANopen Layer setting Services and Protocol (LSS), CiA DSP 305, Version 1.1.1
- Device Profile for Encoders CiA Draft Standard Proposal 406, Version 4.0.2
- CiA Draft Recommendation Proposal 303-1, Version 1.1.1 CANopen Cabling and Connector Pin Assignment
- NMT slave
- One SDO per communication direction for accessing the object directory
- Two transmit PDOs
- PDO identifier adjustable via SDO
- SYNC message
- EMERGENCY message
- Simple boot-up according to DS 301
- Transmission types can be set for all PDOs
- Node number and Baud rate setting via Layer Setting Service (LSS)

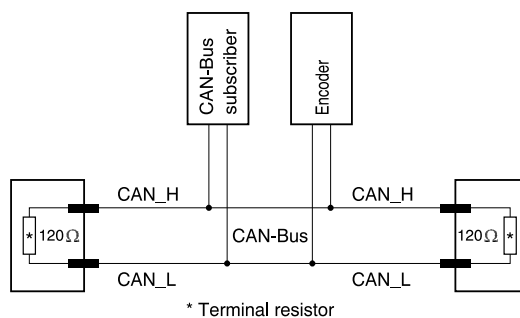
Specifications for NBN66-D

3 Electrical connection

CiA Draft Recommendation Proposal 303-1, Version 1.1.1 CANopen Cabling and Connector Pin Assignment /3/ must be adhered to when connecting the encoder. This particularly applies with regard to the terminal resistors, the lead characteristics, the length of the branch lines and the transmission length.

The bus terminal resistors must be implemented externally. The precise connector assignment is enclosed with each device.

Principle bus structure



Connection

Communication profile

Full CAN Part A (11-bit) CANopen 301 V 4.2

Encoder CANopen DS 406 V 4.0.2

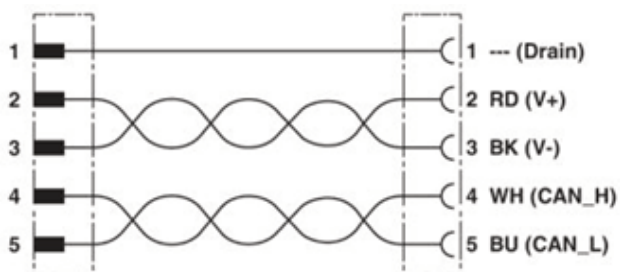
Connection assignment: 5-pin M12 male/female, coding A

With galvanic bus separation

Pin number	Signal designation
1	CAN_GND
2	+Vs / GND
3	-Vs / GND
4	CAN high
5	CAN low

The pin assignment of the device has to be checked by the connection assignment TYxxxxx which is enclosed with each device - especially at special versions of NBN66.

Recommended type of CANopen/power supply connecting cable:



Specifications for NBN66-D

4 CANopen functionality

4.1 Baud rate

The baud rates are implemented according to the following table. The baud rate 250 kBit/s is defined as the default setting.

Baud rate table

Oscillator [MHz]	Baud rate [kBit/s]	Number of the units	Sample point	BRPR	SJW	PRS	PHS1	PHS2
50	1000	10	6	5	1	2	4	4
	800	10	6	10	1	2	4	4
	500	10	6	10	1	2	4	4
	250	10	6	20	1	2	4	4
	125	16	9	25	1	2	6	7
	100	16	9	25	1	2	6	7
	50	10	6	100	1	2	4	4
	20	10	6	250	1	2	4	4

Baud rates and lead lengths

Baud rate [kBaud]	20	50	125	250	500	800	1000
Lead length [m]	2500	1000	500	250	100	50	25

4.2 Setting the address and Baud rate

The node address (node number) and the Baud rate are set via the LSS - Layer Setting Service (see CiA DS 305). In this case, each node has a unique LSS address, via which it can be identified in the network. This is comprised of the following:

Manufacturer ID:	0000 010D_h	(TWK manufacturer ID)
Product number:	0000 6001_h	(TWK product number)
Revision number:	0001 0001_h	(current revision number)
Serial number:	xxxx xxxx_h	(relevant serial number of the sensor)

In addition to the option of setting the node address and Baud rate via the LSS, the parameters can also be changed via objects 2000_h and 2001_h (see manufacturer-specific object range, Chapter 5.5). See example in Chapter 10.3 for baud rate.

The default values are: Baud rate: **250 kBaud**

Node address: **1**

4.3 EDS file

The EDS file is enclosed on a diskette in order to integrate the sensor into a project planning tool. This file clearly and completely describes the characteristics of the CANopen subscriber in a defined format.

After integrating the EDS file into the project planning tool (e.g. CANsetter from Vektor-Informatik), the encoder's parameters can be comfortably set and diagnostic information can be read.

4.4 Process data exchange

In the case of CANopen, I/O data traffic takes place via the PDO (Process Data Object) message. The T Series encoders provide two PDOs. Their transmission behaviour (transmission type) can be set independently of each other.

Specifications for NBN66-D

4 CANopen functionality

4.5 Operating modes

The following operating modes can be set:

Polling Mode (asynchronous-RTR):

The encoder transmits the current, actual position value, after the current position value has been polled via a „Remote Frame“ message by the master.

Asynchronous Mode (cyclic / acyclic):

Without being requested to do so by the master, the encoder transmits the current, actual position value following a value change and following the expiry of a cyclic time (cyclic timer > 0). The cycle time can be parameterised for values between 1 ms and 65,535 ms.

Synchronous Mode (synchronous-cyclic):

After receiving a SYNC message transmitted by a master, the encoder transmits the current, actual position value. The encoder's SYNC counter can be parameterised in such a way that the position value is only transmitted following a defined number of SYNC messages.

Acyclic Mode (synchronous-acyclic):

After receiving a SYNC message, the encoder only transmits the current, actual position value if the position value has changed since the last transmission.

In the case of CANopen, the operating modes (transmission types) and all other parameters are set via so-called SDOs (Service Data Object). The transmission types for PDO1 and PDO2 can be found under the indices 1800_h and 1801_h.

The following Table shows the relevant values for the parameters transmission type.

Transmission Type					
Code	Transmission type				
	Cyclic	Acyclic	Synchron	Asynchronous	RTR
0		x	x		
1-240	x		x		
241-251	Reserved				
252			x		x
253				x	x
254				x	
Meaning					
0	After SYNC, but only if the value has changed since the last SYNC.				
1-240	Transmit value after 1st or 240th SYNC message.				
252	Cycle Timer = 0	Position integration on SYNC; output of the stored position following request (Remote Frame).			
	Cycle Timer ≠ 0	Current position is transmitted in the timer's cycle. Position integration on SYNC; output of the stored position following request (Remote Frame) remains active.			
253	Cycle Timer = 0	Current position is transmitted upon request (Remote Frame).			
	Cycle Timer ≠ 0	Current position is transmitted in the timer's cycle. Current position is also transmitted following request (Remote Frame).			
254	Cycle Timer = 0	Data output occurs in the event of a position change. Current position is also transmitted following request (Remote Frame).			
	Cycle Timer ≠ 0	Current position is transmitted in the timer's cycle. Data output also occurs in the event of a position change. Current position is also transmitted following request (Remote Frame).			

Specifications for NBN66-D

4 CANopen functionality

4.6 Error behaviour

4.6.1 General

All errors that occur are displayed and stored in a hierarchical structure. In the error register (object 1001 and 1003) is the error type of the whole system coded. In object 6503 the error type is coded. The error code gives a detailed error description depending on the error type. Sensor errors affect both the cam controller as well as the data output of the CANopen Safety system. Both systems are no longer able to work in case a sensor error occurs. Errors in the cam switch put the faulty cam in the safe state. The functional cam continues to be active.

Errors in the cam switch are reported via the CANopen interface with an alarm message to the controller. Through the error_behaviour object 1029 the CAN interface can be set up to be operated independently from the status of the cam switch.

Nevertheless the alarm messages of the cam switch will always be sent.

See Chapter 11 **Recognition aid for error / emergency messages** at the end of this document as well.

4.6.2 Fatal errors

Errors which place the functional capability of the controller in doubt - ROM or RAM CRC errors, oscillator drift and watchdog triggering - are not answered with a CAN message. Immediately after detecting the error and shutting off the cams, the controller assumes a secure state (endless loop without actions). This error must be detected and processed by the control system (e.g. hardware device error).

4.6.3 CANopen emergency message

If the encoder has discovered an error, an emergency message is transmitted unless the node is set to STOP state. The error code is additionally entered in the error register and in object 6503. The behaviour in the event of an error is defined in object 1029 error behaviour. In the event of an error, the sensor switches to the NMT state PRE-OPERATIONAL. If an error disappears (CAN channel error), an EMC message is transmitted again with a deleted error bit. The time interval between emergency messages is determined by object 1015 Inhibit Time EMCY. The absolute encoder's error states remain set until reset or power on occurs.

The emergency message has the following structure:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
EMC error code		Error register	Object 6503		Extended (custom) error code		

EMC error codes:

0x FFFF	Customer-specific error; error in the sensor system or cam switch
0x8120	Passive state error
0x8140	Return from bus off state
0x8110	Overrun error, not all messages can be transmitted by the sensor

Error register codes, see object 1001 and 1003.

A distinction is made between communication errors (bit 4) and vendor-specific errors (bit 7).

Object 6503: Type of error in case of errors in the sensor system

Error code: Detailed error code depending on the type of error in object 6503

The data are output on the bus in Intel format.

A distinction is made between two types of error:

1. Errors in the sensor system (error code 0xFFFF)
All errors which render proper sensor operation impossible.
2. Communication errors (error code 0x81xx)
Errors due to the bus system; these are not usually caused by the sensor but indicate a malfunction in the bus system.

All sensor errors are critical errors.

Specifications for NBN66-D

4 CANopen functionality

Examples:

EEPROM CRC error

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error register	Device-specific error		(Custom) error code		
0xFF	0xFF	0x81	0x00	Obj. 6503 0x20	0x00	0x00	0x00

Passive error

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error register	Device-specific error		(Custom) error code		
0x20	0x81	0x11	0x00	0x00	0x00	0x00	0x00

Return from bus off

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error register	Device-specific error		(Custom) error code		
0x40	0x81	0x11	0x00	0x00	0x00	0x00	0x00

Expiry of the inhibit time is followed by the message "correct operation":

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error register	Device-specific error		(Custom) error code		
0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

See chapter 11 (Error recognition aid) for a better understanding of the error code structure.

4.7 (Custom) Error codes

4.7.1 Sensor error

Bit 7 is set in the alarm object 6503.

Detailed error description is given in Byte 5, 6 and 7. See below.

Error code

Byte 5	Byte 6	Byte 7
Channel number	Error type	Error code

As the sensor system is redundant, the two channels need to be distinguished in the channel number.

Specifications for NBN66-D

4 CANopen functionality

Byte 5: Channel number:

No error	0x00
Error channel 1	0x01
Error channel 2	0x02
Error: No channel	0x03

Byte 6: Error type:

No error	0x00
Error communication	0x01
Error sensor	0x02
Error speed overflow	0x03
Error synchronisation	0x04

Byte 7: Error code:

(Error in communication)

No error	0x00
Error time out	0x01
Error CRC	0x02
Error MSG_NBR	0x03
Error position	0x04

(Error of sensor)

CRC error code range	0x06
Chip error of detection ICs	0x0A
Error in gear detection	0x12
Error of parameter	0x42
Error of calibration parameters	0x82

4.7.2 Supply voltage

Bit 6 in object 6503 is set to alarm.

Error code: Too high voltage

Byte 5	Byte 6	Byte 7
00	00	01

Error code: Too high voltage

Byte 5	Byte 6	Byte 7
00	00	02

4 CANopen functionality

4.7.3 Device error

Bit 3 in object 6503 is set to alarm.

Runtime error / safety hard beat

Byte 5	Byte 6	Byte 7
01	01	01

Hard error (fatal error)

Byte 5	Byte 6	Byte 7
08	AB	01

See end of document for further explanations concerning error behaviour and definition (chapter 11).

Specifications for NBN66-D

5 CANopen profile definition

5.1 Overview

Table of all objects contained in the encoder profile.

Index	Data type	Designation	Data length	Memory type	M / O
Communication Profile Area					
1000	VAR	device_type	LONG	ro	M
1001	VAR	error_register	BYTE	ro	M
1003	ARRAY	pre_defined_error_field	-	ro	O
1005	VAR	COB-ID_SYNC	LONG	rw	O
1008	VAR	manufacturer_device_name	STRING	ro	O
1009	VAR	manufacturer_hardware_version	STRING	ro	O
100A	VAR	manufacturer_software_version	STRING	ro	O
1010	ARRAY	store_parameters	LONG	rw	O
1011	ARRAY	restore_default_parameters	LONG	rw	O
1014	VAR	COB-ID-EMCY	LONG	rw	O
1015	VAR	inhibit_time_EMCY	LONG	rw	O
1017	VAR	producer_heartbeat_time	WORD	rw	O
1018	RECORD	identity object		ro	M
1023					
1029	ARRAY	Error behaviour	BYTE	rw	M
Transmit PDO communication parameters					
1800	RECORD	PDO1_communication_parameters	-	rw	
1801	RECORD	PDO2_communication_parameters	-	rw	
Transmit PDO mapping objects					
1A00	RECORD	PDO1_mapping_objects	-	ro	
1A01	RECORD	PDO2_mapping_objects	-	ro	
Encoder objects					
6000	VAR	operating parameters	(WORD)	rw	M
6001	VAR	measuring units per revolution	LONG	ro	M 2
6002	VAR	total measuring range in measuring units	LONG	ro	M 2
6003	VAR	preset value	LONG	rw	M 2
6004	VAR	position value	LONG	ro	M
600C	VAR	raw_position_value			
6030	RECORD	speed_value		ro	O
6031	RECORD	speed parameters	-	ro	O

Specifications for NBN66-D

5 CANopen profile definition

Index	Data type	Designation	Data length	Memory type	M / O
Objects for achieving compatibility					
6200		cyclic_timer	WORD	rw	
Encoder diagnosis objects					
6500	VAR	Operating status	(WORD)	ro	M
6501	VAR	Single-turn resolution	LONG	ro	M
6502	VAR	Number of distinguishable revolutions	WORD	ro	M
6503	VAR	Alarms	WORD	ro	M
6504	VAR	Supported alarms	WORD	ro	M
6506	VAR	Supported warnings	WORD	ro	M
6507	VAR	Profile and software version	LONG	ro	M
6508	VAR	Operating time	LONG	ro	M
6509	VAR	Offset value	LONG	ro	M
650A	RECORD	Module identification		ro	M
650B	VAR	Serial number	LONG	ro	M
650D	VAR	Absolute accuracy	BYTE	ro	M
650E	VAR	Device capability	LONG	ro	M
LMT objects					
2000	VAR	node ID	BYTE	rw	O
2001	VAR	bit_rate	BYTE	rw	O

rw Read/write

ro Read only

Table 1 Overview of CANopen objects

Specifications for NBN66-D

5 CANopen profile definition

5.2 Process data objects PDOs

The measured position and speed values are output in these objects.

Data Byte 0								Data Byte 1								Data Byte 2								Data Byte 3								Data Byte 4								Data Byte 5							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LSB								MSB								LSB								MSB								LSB								MSB							
Position of x or y or z axis								free								velocity of rotation																															

Format position: unsigned 16 Bits. Significant data bits: 15 Bits = 32,768 steps for 360° → 0.010986 ° / step

Format velocity: signed 16 Bits. Significant data bits: 16 Bits (sign included) → 0.01 ° / s / step (25 rpm max.)

5.3 Communication service data objects (SDO)

For every modification of the encoder via SDO communication the device must be set pre-operational first.

It is recommended to wait for the response message of the encoder before sending another SDO message. Then you can be sure that the SDO message (e.g. parameterization) is worked out properly, save procedure (1010) as well. Or implement a time constant between the SDO commands which is long enough (e.g. 50 ms).

Please don't make a reset of the device (power OFF/ON or NMT reset) before all values are transmitted and/or saved properly > wait for response of encoder after saving or wait at least 500 ms.

5.3.1 Object 1000 device_type

The encoder types are defined as follows:

Coding	Device type designation
1	Single-turn absolute rotary encoder
2	Multi-turn absolute rotary encoder
3	Single-turn absolute rotary encoder with electronic turn count
4	Incremental rotary encoder
5	Incremental rotary encoder with electronic counting
6	Incremental linear encoder
7	Incremental linear encoder with electronic counting
8	Absolute linear encoder
9	Absolute linear encoder with cyclic coding
10	Multi-sensor encoder interface

Device_type structure:

	Byte 0	Byte 1	Byte 2	Byte 3
Device type	Device profile number		Encoder type	
NBN (→TBN)	0x96	0x01	0x01	0x00

device_type

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1000	0	Device_type	Long	Long	ro	ROM	0x00010196	-	-

Specifications for NBN66-D

5 CANopen profile definition

5.3.2 Object 1001 error_register

Bit	M / O	Designation
0	M	generic error
1	O	current
2	O	voltage
3	O	temperature
4	O	communication error (overrun, error state)
5	O	device profile specific
6	O	Reserved (always 0)
7	O	manufacturer-specific

The error register is the global error register. It summarises all errors in bit 0.

Generic, communication and manufacturer-specific errors are supported. In the event of an error, the generic error bit is always set. The error which has occurred can be read off in object 6503 Alarms.

error_register

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1001	0	error_register	Byte	Byte	ro	RAM	0, 0x11, 0x81	-	-

5.3.3 Object 1003 pre_defined_error_field

All alarm messages transmitted via emergency messages are stored in this object. Sub-index 0 contains the error code of the last emergency message stored. Overwriting sub-index 0 with ZERO deletes the stored messages. This object contains 20 entries at maximum. When this number is exceeded no further error will be stored.

pre-defined error field

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1003	0	Last_error_entry	Byte	Byte	rw	RAM	0, ... 20	-	-
	1	one_stored_error_msg.							
	2	two_stored_error_msg.							
		...							

Structure_pre_defined_error_field

Byte 0	Byte 1	Byte 2	Byte 3
Alarm code (object 6503 high byte)	Custom error code		

The error codes are listed in Chapter 4.6 *Error behaviour* and in chapter 11 at the end of this document.

Specifications for NBN66-D

5 CANopen profile definition

5.3.4 Object 1005 COB-ID-SYNC

Identifier of the sync message transmitted by the master.

No range or plausibility check takes place. 29-bit identifiers are not supported.

COB-ID-SYNC

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1005	0	COB-ID-SYNC	Long	Long	rw	E ² ROM	1...0x7FF	-	0x80

5.3.5 Object 1008 manufacturer_device_name

The name of the device is stored as a string and is output via SDO segment transfer.

"NBN66-D"

manufacturer_device_name

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1008	0	manufacturer_device_name	String	String	ro	ROM	NBN66-D	-	-

5.3.6 Object 1009 manufacturer_hardware_version

Hardware version of the device. It is stored as a string e.g. "P-0793"

It is output via SDO segment transfer.

manufacturer_hardware_version

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1009	0	manufacturer_hardware_version	String	String	ro	ROM	P-0793	-	-

5.3.7 Object 100A manufacturer_software_version

Software version of the device. It is stored as a string e.g. "NBN66_D_N40"

It is output via SDO segment transfer.

manufacturer_software_version

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
100A	0	manufacturer_software_version	String	String	ro	ROM	NBN66_D_N40	-	-

Specifications for NBN66-D

5 CANopen profile definition

5.3.8 Object 1010 store_parameters

By inputting "save" (0x65766173hex resp. 1702257011dez) as a password in the relevant sub-index, the writable objects are saved to the E²PROM or flash memory.

The object cannot be changed on writing. Reading the object is possible.

1 (saving through command, Page 93 CiA 30) is returned.

Which parameters are stored is defined by specifying the sub-index.

- Sub-index 01** Storage of all parameters except the 0x2000 to 0x2FFF range.
- Sub-index 02** Storage of communication parameters 0x1000 to 0x1FFF.
- Sub-index 03** Storage of parameters 0x6000 to 0x9FFF defined in the profile.
- Sub-index 04** Storage of the manufacturer-specific range 0x2000 to 0x2FFF (common).
- Sub-index 05** Storage of the manufacturer-specific range 0x3000 to 0x3FFF (cams).

store_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1010	0	largest_supported-sub-index	-	-	ro	ROM	5	-	-
	1	save_all_parameters (except node ID and baud rate)	Long	Long	rw	ROM	"save" =0x65766173	*	1
	2	save_communication_parameters	Long	Long	rw		"save"	*	1
	3	save_application_parameters	Long	Long	rw		"save"	*	1
	4	save_LMT_parameters (only node ID, baud rate)	Long	Long	rw		"save"	*	1
	5	Save_manufacturer_parameters	Long	Long	rw		"save"	*	1

* Parameters are backed-up in the E²PROM on inputting the correct password (s a v e = 73 61 76 65).

→ **Wait for response of NBN after saving before resetting the device or wait 0.5 to 1 second.**

5.3.9 Object 1011 restore_default_parameters

On inputting "load" (0x646166Chex resp. 1684107116dez) as the password in the relevant sub-index, the default parameters are loaded into the objects of the number group selected with the sub-index in the RAM. Reading the object is possible.

The device has to be set "pre-operational" at first.

When load default is done, the zero point of position value (0°, zero error included) of NBN (factory setting) is adopted.

1 (device restores parameters) is returned.

Which parameters are loaded is defined by specifying the sub-index.

- Sub-index 01** Loading of all parameters except the 0x2000 to 0x2FFF range.
- Sub-index 02** Loading of communication parameters 0x1000 to 0x1FFF.
- Sub-index 03** Loading of parameters 0x6000 to 0x9FFF defined in the profile.
- Sub-index 04** Loading of the manufacturer-specific range 0x2000 to 0x2FFF.
- Sub-index 05** Loading of the manufacturer-specific range 0x3000 to 0x3FFF.

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restore_default_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1011	0	largest_supported-sub-index	-	-	ro	ROM	5	-	-
	1	load_all_default_parameters (except node ID and baud rate)	Long	Long	rw	ROM	"load" =0x64616F6C	*	1
	2	load_communication_parameters	Long	Long	rw		"load"	*	1
	3	load_application_parameters	Long	Long	rw		"load"	*	1
	4	load_LMT_parameters (only node ID, baud rate)	Long	Long	rw		"load"	*	1
	5	load_manufacturer_parameters	Long	Long	rw		"load"	*	1

- * On inputting the correct password (l o a d = 6C 6F 61 64), the default parameters are loaded from the ROM. In case for a complete load default (COB IDs included): Sub index 1 and 4 have to be executed.

5.3.10 Object 1014 COB-ID-EMCY

Identifier for the emergency message which the encoder transmits on occurrence of an alarm.

After "Load default", the identifier is COB-ID-EMCY + node ID.

If the user changes the COB ID, the node address is no longer added.

No range or plausibility check takes place.

29-bit identifiers are not supported.

COB-ID-EMCY

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1014	0	COB-ID-EMCY	Long	Long	rw	E ² PROM	-	*	0x80+node ID

- * Default state evaluation, then addition of the node address.

5.3.11 Object 1015 inhibit_time_EMCY

Blocking time to limit the bus load in the event of EMCY messages in quick succession. The resolution is 100 µs per digit.

inhibit_time_EMCY

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1015	0	inhibit_time_EMCY	Word	Word	rw	E ² PROM	0...0xFFFF	-	1000

Specifications for NBN66-D

5 CANopen profile definition

5.3.12 Object 1017 producer_heartbeat_time

If a value greater than zero is entered here, the heartbeat message is transmitted on the identifier guard COB ID + node ID in the producer_heartbeat_time interval in ms.

producer_heartbeat_time

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1017	0	producer_heartbeat_time	Word	Word	rw	E ² PROM	0...0xFFFF	-	0

The format of the heartbeat message:

Bit No.	7	6	5	4	3	2	1	0
Content	0	Subscriber status						

0: BOOT-UP

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

5.3.13 Object 1018 identity_object

This object contains data assigned to the individual encoder. The object is the address for the Layer Setting Service (LSS).

The following data must be entered:

1. Manufacturer ID Assigned by CiA
2. Product code TWK-internal
3. Revision number TWK software revision number
4. Serial number

The serial number can be written via LSS in factory programming state.

identity_object

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1018	0	largest_supported_sub-index	-	-	ro	ROM	4	-	-
	1	vendor ID	Long	Long	ro	ROM	0x0000 010D	-	-
	2	product_code	Long	Long	ro	ROM	0x0000 6001	-	-
	3	revision_number	Long	Long	ro	ROM	0x0001 0001	-	-
	4	serial_number	Long	Long	ro(rw)	E ² PROM	0	*	-

* Written in factory programming state.

Specifications for NBN66-D

5 CANopen profile definition

5.3.14 Object 1029 error behaviour_object

This object defines the behaviour in the event of an error. The sub-indices are assigned to the error types as follows:

Sub-index	Error type	Bit in error register 1001	Bit in alarm object 6503
1	Communication error	4	-
2	CRC error	7	5
	Supply out of range	7	6
	Sensor error	7	7
3 *	Cam error	7	4
4 *	Redundancy error	7	3

The following settings in object 1029 are possible for the behaviour in the event of an error:

Value	Description
0x00	Switch from OPERATIONAL to PRE-OPERATIONAL
0x01	No NMT status switch
0x02	Switch to STOP state
0x03	Reserve
.....	
0x7F	Reserve
0x80	Manufacturer-specific
.....	
0xFF	Manufacturer-specific

error_behaviour

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1029	0	largest_supported-sub-index	-	-	ro	ROM	3	-	-
	1	communication_error	Byte	Byte	rw	E ² PROM	0, 1, 2	-	0x00
	2	internal_device_error	Byte	Byte	ro	E ² PROM	0	-	0x00
*	3	cam_error	Byte	Byte	ro	E ² PROM	1	-	-
*	4	redundancy_error	Byte	Byte	rw	E ² PROM	0, 1, 2	-	-

*Objects are not used for the rotor hub sensor NBN66-D.

Specifications for NBN66-D

5 CANopen profile definition

5.4 CANopen process data objects

5.4.1 Object 1800 Transmit PDO asynchronous

All asynchronous and cyclical events are processed by this object.

The cycle timer, object 6200, acts on this PDO and is logically equivalent to the event timer.

Transmission type 252 enables synchronous data acceptance.

No plausibility check is undertaken for the COB ID.

The inhibit time has a resolution of 100 μ s. The event timer has a resolution of 1 ms.

first_transmit_PDO_parameter

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1800	0	largest_supported-sub-index	-	-	ro	ROM	5	-	-
	1	COB ID	Long	Long	rw	E ² PROM	-	*	0x180+ID
	2	transmission type	Byte	Byte	rw	E ² PROM	252, 253, 254	-	253
	3	inhibit time	Word	Word	rw	E ² PROM	0..65,535 [ms]	-	0
	4	reserved	-	-	-	-	-	-	-
	5	event_timer	Word	Word	rw	E ² PROM	0..65,535 [ms]	-	0

* On reading (upload), the node address is added to the selected identifier.

252: Value is picked-up with sync and transmitted with remote frame (cyclic transmission via object 6200)

253: Value is picked-up and transmitted with remote frame (cyclic transmission via object 6200)

254: Value is picked-up and transmitted with every change of value

Disable PDO1 with 0x80000180+ID as COB ID

5.4.2 Object 1801 Transmit PDO synchronous

All **synchronous** events are processed via this PDO.

The inhibit timer is not implemented for this PDO, as no bus overload can occur in the case of synchronous data output.

No plausibility check is undertaken for the COB ID.

Nor is the event_timer implemented, as it is not necessary for synchronous data output.

second_transmit_PDO_parameter

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1801	0	largest_supported-sub-index	-	-	ro	ROM	2	-	-
	1	COB ID	Long	Long	rw	E ² PROM	-	*	0x280+ID
	2	Transmission type	Byte	Byte	rw	E ² PROM	0....240 **	-	1

* On reading (upload), the node address is added to the selected identifier.

** $0 \leq n \leq 240$: Every nth sync-message the PDO2 is transmitted.

Disable PDO2 with 0x80000280+ID as COB ID

Specifications for NBN66-D

5 CANopen profile definition

5.4.3 Object 1A00 first_transmit_PDO_mapping

The parameter contains the following coding for each "mapping" object:

Byte 0	Byte 1	Byte 2	Byte 3
Index		Sub-index	Length

The length is specified as the number of bits in hex coded form.

first_transmit_PDO_mapping

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1A00	0	largest_supported-sub_index	-	-	ro	ROM	2	-	-
	1	PDO_mapping-for_the_first_object	Long	Long	ro	ROM	0x6004 0020	-	-
	2	PDO Mapping Entry_2	Long	Long	ro	ROM	0x6030 0110	-	-

5.4.4 Object 1A01 second_transmit_PDO_mapping

Byte 0	Byte 1	Byte 2	Byte 3
Index		Sub-index	Length

The length is specified as the number of bits in hex coded form.

second_transmit_PDO_mapping

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1A01	0	largest_supported-sub_index	-	-	ro	ROM	2	-	-
	1	PDO_mapping-for_the_first_object	Long	Long	ro	ROM	0x6004 0020	-	-
	2	PDO Mapping Entry_2	Long	Long	ro	ROM	0x6030 0110	-	-

Specifications for NBN66-D

5 CANopen profile definition

5.5 LMT objects

5.5.1 Object 2000 node ID

The node address of the encoder.

The parameter only becomes effective after saving with object 1010, sub 04 and a power on / NMT reset.

Remark: It is not possible to save this parameter with object 1010, sub 01 (save all parameters).

The parameter is not reset to the default value with load_default 1011, sub 01 but with 1011, sub 04.

node ID

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
2000	0	node ID	Byte	Byte	rw	E ² PROM	1 ...127	-	0x01

5.5.2 Object 2001 bit_rate

Baud rate of the CAN bus.

This object can also be changed using the Layer Setting Service.

The bit rate index is set according to the following table:

Index	Baud rate [kBaud/s]
0	1000
1	800
2	500
3	250
4	125
5	100
6	50
7	20

The parameter only becomes effective after saving with object 1010, sub 04 and a power on reset.

Remark: It is not possible to save this parameter with object 1010, sub 1 (save all parameters).

The parameter is not reset to the default value with load_default 1011, sub 01 but with 1011, sub 04.

bit_rate

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
2001	0	bit_rate	Byte	Byte	rw	E ² PROM	0 ...7	-	3

Specifications for NBN66-D

5 CANopen profile definition

5.6 Objects according to profile definition

5.6.1 Object 6000 operating_parameters

Operating mode byte for the sensor. The scaling_function_control-bit has to be set to 1 before modifying parameter in object 6003.

The state table:

Bit	M / O	Designation	0	1
0	M	Code direction	CW	CCW
1	O	Set firmly to zero		
2	O	scaling_function_control *	Inactive	Active
3-7	O	Set firmly to zero		

operating_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6000	0	operating_parameters	Word	Word	rw	E ² PROM	0x0, 0x01, 0x04, 0x05 *	Sen	0x04

* 0x0=CW and inactive, 0x01=CCW and inactive, 0x04=CW and active (standard), 0x05= CCW and active
Active and inactive resp. determines that 6003 (preset) can be written.

5.6.2 Object 6001 measuring_units_per_revolution

Number of steps per rotation (360°).

The parameter is firmly set. No changes are possible.

measuring_units_per_revolution

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6001	0	measuring_units_per_revolution	Long	Data	ro	E ² PROM	32768 = 0x8000	Sen	-

5.6.3 Object 6002 total_measuring_range_in_measuring_units

Total measuring range in measuring units.

This parameter cannot be changed.

total_measuring_range_in_measuring_units

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6002	0	total_measuring_range_in_measuring_units	Long	Data	ro	ROM	32768 0x8000	Sen	-

Specifications for NBN66-D

5 CANopen profile definition

5.6.4 Object 6003 preset_value

Sets the encoder to the value specified in object 6003.

By using load default, the zero point of position value of NBN (factory setting) is adopted.

preset_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6003	0	preset_value	Word	Word	rw	E ² PROM	0...(obj. 6002)-1	Sen	0

5.6.5 Object 6004 position_value

Position value. This value is the measured position value.

The parameter is provided as a position value by the sensor (0 ... 360°). This object is updated cyclically.

position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6004	0	position_value	Word	Word	ro	RAM	0 ... 65,535 (0..32767 used for 360°, 1 digit = 0.010986°)	-	-

5.6.6 Object 600C raw_position_value

Raw position value. The same value as in 6004 at the time.

raw_position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
600C	0	raw_position_value	Word	Word	ro	RAM		-	-

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5.6.7 Object 6030 speed_value

Speed value. The dimension is $0.01^\circ / \text{s}$. Data format signed 16 Bits.

This object is updated cyclically. No raw data object available. Maximum speed (gyroscope output): 40 rpm. Maximum measurement range NBN66-D: 25 rpm.

speed_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6030	0	largest_supported_sub_index	Byte	Byte	ro	ROM	1	-	-
	1	speed_value_channel1	Word	Word	ro	RAM	0 ... 65,535 (1 digit = $0.01^\circ/\text{s}$)	-	-

5.6.8 Object 6031 speed_parameter

This object is read only. The velocity (speed) is set to a resolution of $0.01^\circ/\text{s}$. The speed is refreshed every 2 ms and is calibrated to $0.01^\circ/\text{s}$ via sub 03 and sub 04. Subindex 02 is irrelevant because speed is not calculated by the position signal but is provided directly by the gyroscope.

speed_parameter

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6031	0	largest_supported_sub_index	Byte	Byte	ro	ROM	4	-	-
	1	speed_source_selector	Byte	Byte	ro	ROM	1	-	1
	2	speed_integration_time	Word	Word	ro	RAM	1 ... 65,535	-	1000
	3	speed_multiplier	Word	Word	ro	RAM	1 ... 65,535	-	36,000
	4	speed_divider	Word	Word	ro	RAM	1 ... 65,535	-	32,768

5.7 Objects for achieving compatibility

5.7.1 Object 6200 Cyclic Timer

In the case of values > 0 , the object position value 6004 is transmitted cyclically with the value of the cyclic timer in ms on PDO1. This object is logically set equal to event_timer of PDO1.

Cyclic_timer

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6200	0	cyclic_timer	Word	Word	rw	XRAM	0...0xFFFF	-	0

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5.8 Diagnosis objects

5.8.1 Object 6500 operating_status

Current sensor status. This is a representation of object 6000.

The parameter is provided by the sensor. Active means 'scaling function = on'. Preset value can be set.

operating_status

Index	Sub	Description	Length	Memory	Range/value	Action	Default
6500	0	operating_status	Word	ro	Object 6000*	-	0x04

* 0x00=CW and inactive, 0x01=CCW and inactive, 0x04=CW and active (standard), 0x05= CCW and active

5.8.2 Object 6501 singleturn_resolution

Maximum single turn resolution

singleturn_resolution

Index	Sub	Description	Length	Memory	Range/value	Action	Default
6501	0	singleturn_resolution	Long	ro	32768	-	-

5.8.3 Object 6502 number_of_distinguishable_revolutions

Maximum number of distinguishable revolutions.

This parameter cannot be changed.

number_of_distinguishable_revolutions

Index	Sub	Description	Length	Memory	Range/value	Action	Default
6502	0	number_of_distinguishable_revolutions	Long	ro	1	-	-

5.8.4 Object 6503 alarms

Internally, there is only one error byte. If an alarm occurs, an emergency message is transmitted. During SDO upload, the error byte is loaded into the object's MSB.

The following errors are evaluated:

Bit	Error type
0	Not used
1	Not used
2	Not used
3	Device error
4	Cam error (not relevant)
5	CRC parameter error
6	Supply out of range
7	Sensor error

Specifications for NBN66-D

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Extended error coding is available for certain errors in this byte in the emergency message and in object 1003 pre_defined_error_field (see point 8.4 error codes).

- CRC error: The alignment parameters and the CAN interface parameters are monitored by CRC. In the case of an error in one of the areas, this flag is set.
- Sensor error: Position sensor error or the measured values of the sensors read-in in redundant form lie too far apart. Or the position controller discovers a scanning error.
- Device error: In case of full redundant systems each systems controls the other system. If one system recognises that the other system doesn't work anymore this error will be generated and transmitted via CAN. A hardware error (look at fatal errors) is not transmitted via CAN.

alarms

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6503	0	alarms	Word	Word	ro	RAM	-	See above	-

5.8.5 Object 6504 supported_alarms

Supported alarm messages.

This is a representation of the error displays possible in the case of index 6503.

supported_alarms

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6504	0	supported_alarms	Word	Word	ro	ROM	0xF800	-	-

5.8.6 Object 6506 supported_warnings

Supported warning messages.

No warnings are supported. Object 6505 can therefore be omitted.

supported_warnings

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6506	0	supported_warnings	Word	Word	ro	ROM	0	-	-

5.8.7 Object 6507 profile_and_software_version

The profile and software version of the encoder.

The versions are each BCD-coded in bytes.

Example: Version 2.5.12 results in 0x2512.

The current version of the encoder profile and the software version are entered.

Profile version		Software version	
Byte 0	Byte 1	Byte 2	Byte 3
Bits 7 - 0	Bits 15 - 8	Bits 7 - 0	Bits 15 - 8

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profile_and_software_version

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6507	0	profile_and_software_version	Long	Long	ro	ROM	0x0x02014002	-	-

5.8.8 Object 6508 operating_time

Not supported.

operating_time

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6508	0	operating_time	Long	Long	ro	ROM	0xFFFF FFFF	-	-

5.8.9 Object 6509 offset_value

Output offset position. When preset (6003) was done you can see here the offset: zero customer <> zero factory. The parameter is evaluated by the sensor (only used internally).

offset_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6509	0	offset_value	Long	Long	ro	E ² PROM	0..(obj 6002) -1	SEN	0

5.8.10 Object 650A module_identification

The manufacturer offset is used to calibrate zero point 0° (it remains the 'zero error' mentioned in the data-sheet) This parameter is written via the factory programming during system alignment.

module_identification

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
650A	0	largest_supported-sub-index	-	-	ro	ROM	1	-	-
	1	manufacturer_offset_value	Long	Word	ro	ROM	0..(obj 6001) -1	-	0 *

* Written in factory programming state.

5.8.11 Object 650B serial_number

The serial number is written with the factory programming.

serial_number

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
650B	0	serial_number	Long	Long	wp	XRAM	0x.....	*	-

* Written in factory programming state.

Specifications for NBN66-D

5 CANopen profile definition

5.8.12 Object 650D absolute_accuracy

Object according to CANopen Profile. No value is displayed. See data sheet 15268 for specifications.

absolute_accuracy

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
650D	0	absolute_accuracy	Byte	Byte	ro	E ² PROM		SEN	0

5.8.13 Object 650E device_capability

Defines the operating capability of the encoder. The entry is carried out according to the following table:

Name	Bit	Value	Definition
ec: Encoder class	2:0	0b000 (b=binary)	Reserved
		0b001	Class 1
		0b010	Class 2
		0b011	Class 3
		0b100 to 0b111	Reserved
rsl: Resolution	3	0	Low
		1	High
r: Reserved	4	Reserved (always 0)	
saf: Safety	5	0	Safety not supported
		1	Safety supported
st: Safety type	7:6	0b00	CANopen Safety
		0b01 to 0b11	Reserved
r: Reserved	11:8	Reserved (always 0)	
msc1 to 4: Manufacturer-specific capability 1 to 4	15:12	0	Manufacturer-specific capability 1 to 4 disabled
		1	Manufacturer-specific capability 1 to 4 enabled

Bit assignment parameter definition

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
msc4	msc3	msc2	msc1	r				st		saf	r	rsl	ec		

device_capability

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
650E	0	device_capability	Long	Long	ROM	ROM	0x00000003		-

Class 3 encoder with CANopen Safety, no manufacturer-specific definitions.

Specifications for NBN66-D

6 Installation steps

- Be aware of installation orientation TOP (see type plate on NBN-D)
- Find an installation place near at rotating axis A_R
- Rotating axis of application and NBN-D centre rotating axis should not differ more than $\sim 10^\circ$.
- Set NBN-D under power and establish CANopen communication
- Set preset and / or code sense (CW/CCW) if desired (save these parameter via 1010/04)
- Start PDO read out for position and velocity
- Let application rotate

Specifications for NBN66-D

7 Object listing

Name	Index	Sub	Len	Value dez	Value hex	Remark
device_type	1000		4	65942	0x00010196	
error_register	1001		1	0	0x00	
PredefinedErrorField	1003					
NumberOfErrors		0	1	0	0xX	
StandardErrorField		1	4			
StandardErrorField_2		2	4			
StandardErrorField_3		3	4			
StandardErrorField_4		4	4			
StandardErrorField_5		5	4			
StandardErrorField_6		6	4			
StandardErrorField_7		7	4			
StandardErrorField_8		8	4			
StandardErrorField_9		9	4			
StandardErrorField_a		0A	4			
StandardErrorField_b		0B	4			
StandardErrorField_c		0C	7			
StandardErrorField_d		0D	7			
StandardErrorField_e		0E	7			
StandardErrorField_f		0F	7			
StandardErrorField_10		10	7			
StandardErrorField_11		11	7			
StandardErrorField_12		12	7			
StandardErrorField_13		13	7			
COB-ID_SYNC	1005		4	128	0x00000080	
manufacturer_device_name	1008		18	-	-	NBN66-D
manufacturer_hardware_version	1009		13	-	-	P-0793
manufacturer_software_version	100a		15	-	-	NBN66_D_N40
store_parameters	1010					
largest_supported_sub-index		0	1	5	0x05	
save_all_parameters		1	4	1	0x00000001	
SaveCommunicationParameters		2	4	1	0x00000001	
SaveApplicationParameters		3	4	1	0x00000001	
SaveLMTDefinedParameters		4	4	1	0x00000001	
SaveManufacturerDefinedParameters		5	4	1	0x00000001	
restore_default_parameters	1011					
largest_supported_sub-index		0	1	5	0x05	
restore_all_default_parameters		1	4	1	0x00000001	
RestoreCommunicationDefaultParameters		2	4	1	0x00000001	
RestoreApplicationDefaultParameters		3	4	1	0x00000001	
RestoreLMTDefinedDefaultParameters		4	4	1	0x00000001	
RestoreManufacturerDefinedDefaultParameters		5	4	1	0x00000001	
COB-ID_EM CY	1014		4		0x80+node ID	
EMCY_inhibit_time	1015		2	1000	0x03E8	

Specifications for NBN66-D

7 Object listing

Name	Index	Sub	Len	Value dez	Value hex	Remark
producer_heartbeat_time	1017		2	0	0x0	
identity_object	1018					
largest_supported_sub-index		0	1	4	0x04	
vendor-ID		1	4	269	0x0000010D	
product_code		2	4	24577	0x00006001	
revision_number		3	4	65537	0x00010001	
serial_number		4	4	x	0xX	
error_behaviour	1029					
NrofErrorClasses		0	1	2	0x02	
CommunicationError		1	1	0	0x00	
InternalDeviceError		2	1	0	0x00	
first_transmit_PDO_parameter	1800					
largest_supported_sub-index		0	1	5	0x05	
COB-ID_used_by_PDO		1	4		0x80000180 + node ID	0: active 8: inactive
transmission_type		2	1	253	0xFD	
inhibit_time		3	2	0	0x0	
reserved		-	-	-	-	
EventTimer		5	2	0	0x0	
second_transmit_PDO_parameter	1801					
largest_supported_sub-index		0	1	2	0x02	
COB-ID_used_by_PDO		1	4		0x80000280 + node ID	0: active 8: inactive
transmission_type		2	1	1	0x01	
first_transmit_PDO_mapping	1a00					
largest_supported_sub-index		0	1	2	0x02	
PDO_mapping_for_the_first_object		1	4	1610874912	0x60040020	
PDOMappingEntry_2		2	4	1613758736	0x60300110	
second_transmit_PDO_mapping	1a01					
largest_supported_sub-index		0	1	2	0x02	
PDO_mapping_for_the_first_object		1	4	1610874912	0x60040020	
PDOMappingEntry_2		2	4	1613758736	0x60300110	
operating_parameters	6000		2	4	0x04	
measuring_units_per_revolution	6001		4	32768	0x00008000	
total_measuring_range_in_measuring_units	6002		4	32768	0x00008000	
preset_value	6003		4	0	0x0	
position_value	6004		4	x	0xX	
raw_position_value	600c		4	x	0xX	

Specifications for NBN66-D

7 Object listing

Speed value						
NrOfObjects	6030	0	1	1	0x1	
Speed value channel 1		1	2	x	0xX	
speed_parameter						
NrOfObjects	6031	0	1	4	0x04	
speed_source_selector		1	1	1	0x01	
speed_integration_time		2	2	1000	0x03E8	
speed_multiplier		3	2	36000	0x8CA0	
speed_divider		4	2	32768	0x8000	
cyclic_timer	6200		2	0	0x0	
operating_status	6500		2	04	0x04	
singleturn_resolution	6501		4	32768	0x00008000	
number_of_distinguishable_revolutions	6502		2	1	0x1	
alarms	6503		2	0	0x0	
supported_alarms	6504		2	63488	0xF800	
supported_warnings	6506		2	0	0x0	
profile_and_software_version	6507		4	16859138	0x01014002	
operating_time	6508		4	-1	0xFFFFFFFF	
offset_value	6509		4	0	0x0	
module_identification						
largest_supported_sub-index	650a	0	1	1	0x01	
manufacturer_offset_value		1	4	0	0x0	
serial_number	650b		4	x	0xX	
absolute_accuracy	650d		1	0	0x0	
Device_capability	650e		4	3	0x00000003	
node-ID	2000		1	1	0x01	
bit_rate	2001		1	3	0x03	

Specifications for NBN66-D

8 Recommendation for parameterization

Recommended steps for parameterization of NBN-D

(See trace sequences for further details, chapter 10)

8.1 Set preset value (code direction is and remains CW)

- set NBN pre-operational *
- set object 6000, sub00 to active by writing 0x4 (= state: CW and active). 6000 might be already active.
- set object 6003, sub00 (preset value) to the desired value (e.g. 0)
- set object 6000, sub00 to inactive by writing 0x0 (= state: CW and inactive), if required
- save setting with 1010, sub01 by writing "save" = 0x65766173
- reset NBN with NMT reset or power OFF/ON
- set NBN operational

8.2 Set code sense from CW to CCW

- set NBN pre-operational *
- set object 6000, sub00 to CCW by writing 0x1 (= state: CCW and inactive) or 0x05 (CCW and active)
- save setting with 1010, sub01 by writing "save" = 0x65766173
- reset NBN with NMT reset or power OFF/ON *
- set NBN operational

Specifications for NBN66-D

9 Examples for parameterization

9.1 Set object 6003 preset value: 0°

Step	Description	ID	DLC	Byte								Comment
				1(0)	2(1)	3(2)	4(3)	5(4)	6(5)	7(6)	8(7)	
				cs	Index	Index	Sub-Index	Value	Value	Value	Value	
1	Set pre-operational	0	2	80	0d							
2	Set object 6000 to 0x4	601	8	2b	00	60	00	00	04	00	00	6000/00: 0x4 (CW and active)
		581	8	60	00	60	00	00	00	00	00	
3	Set object 6003 to 0x0	601	8	23	03	60	00	00	00	00	00	6003/00: 0x0
		581	8	60	03	60	00	00	00	00	00	
4	Set object 6000 to 0x0 *	601	8	2b	00	60	00	00	00	00	00	6000/00: 0x0 (CW and inactive)
		581	8	60	00	60	00	00	00	00	00	
5	Save_all_parameters 1010/01	601	8	23	10	10	01	73	61	76	65	1010/01: 0x65766173 (save) See object for details
		581	8	60	10	10	01	00	00	00	00	
6	NMT reset or power OFF/ON *	0	2	81	00							
7	Set operational	0	2	01	00							

9.2 Set object 6000 code sense from CW to CCW

Step	Description	ID	DL C	Byte								Comment
				1(0)	2(1)	3(2)	4(3)	5(4)	6(5)	7(6)	8(7)	
				cs	Index	Index	Sub-Index	Value	Value	Value	Value	
1	Set pre-operational	0	2	80	0d							
2	Set object 6000 to 0x1	601	8	2b	00	60	00	00	01	00	00	6000/00: 0x1 (CCW and inactive)
		581	8	60	00	60	00	00	00	00	00	
3	Save_all_parameters 1010/01	601	8	23	10	10	01	73	61	76	65	1010/01: 0x65766173 (save) See object for details
		581	8	60	10	10	01	00	00	00	00	
4	NMT reset or power OFF/ON *	0	2	81	00							
5	Set operational	0	2	01	00							

Legend:

cs	Command specifier
2f	Byte
2b	Word
23	Long
DLC	Data length code

Specifications for NBN66-D

9 Examples for parameterization

9.3 LMT objects: Set 2001/00 bit rate: 0x2 (=500 kbps)

Step	Description	ID	DLC	Byte								Comment
				1(0)	2(1)	3(2)	4(3)	5(4)	6(5)	7(6)	8(7)	
				cs	Index	Index	Sub-Index	Value	Value	Value	Value	
1	Set preoperational	0	2	80	0d							
2	Set bit_rate 2001/00	601	8	2f	01	20	00	02	00	00	00	2001/00: 0x2 (500 kbps)
		581	8	60	01	20	00	00	00	00	00	
3	Save_LMT_parameters 1010/04	601	8	23	10	10	04	73	61	76	65	1010/04: 0x65766173 (save) See object for details
		581	8	60	10	10	04	00	00	00	00	
4	NMT reset or power OFF/ON	0	2	81	00							
5	Set operational	0	2	01	00							

9.4 LMT objects: Set 2000/00 node ID: 0xA

Step	Description	ID	DLC	Byte								Comment
				1(0)	2(1)	3(2)	4(3)	5(4)	6(5)	7(6)	8(7)	
				cs	Index	Index	Sub-Index	Value	Value	Value	Value	
1	Set preoperational	0	2	80	0d							
2	Set bit_rate 2000/00	601	8	2f	00	20	00	0A	00	00	00	2000/00: 0xA
		581	8	60	00	20	00	00	00	00	00	
3	Save_LMT_parameters 1010/04	601	8	23	10	10	04	73	61	76	65	1010/04: 0x65766173 (save) See object for details
		581	8	60	10	10	04	00	00	00	00	
4	NMT reset or power OFF/ON	0	2	81	00							
5	Set operational	0	2	01	00							

Legend:

cs	Command specifier
2f	Byte
2b	Word
23	Long
DLC	Data length code

Specifications for NBN66-D

10 Recognition aid for error / emergency messages

This chapter is taken from the NOCN manual [13100](#). The error messages of NBN-D are of the same structure as the NOCN's, since the NBN-D uses a rotary encoder profile.

Appearance of error / emergency messages in a trace and in object 1003 resp.

(In this chapter other SIL2 safety components are mentioned as well - inclinometer NBN and vibration sensor NVA115)

If the encoder sends an error message it has 8 Bytes in the trace and looks as follows:

FF FF 81 00 10 02 0D 0F → Example for a certain message (in this case a "cam error" at NOCN. See below).

The emergency message is sent on identifier **80 + node ID**.

To identify this error message and to read its content you have to look at the different bytes. The first two bytes (B0 and B1, B's counted from '0') in the error message make the following distinguishing: "Error in sensor" (FF FF) or "Error in CAN communication" (81 10 or 81 20 or 81 40) due to bus problems etc.. In most cases the content in byte 2 (B2) correlates to byte 0 and 1:

FF FF → **81 in byte 2, 81 = Manufacturer specific error**

81 . . → **11 in byte 2, 11 = CAN communication error**

Byte 3 (B3) and byte 4 (B4) display the content of object 6503 which shows the error category (alarm specification). B3 displays the low byte of 6503 and it is always 00. B4 displays the high byte of 6503. The possible categories describe malfunctions of the device and no CAN communication errors.

The next three bytes (B5, B6, B7) display detailed information which error has occurred depending on the error category B4 (= content of 6503). These errors are only errors which are caused by

- device internal CRC parameter error (internal check of parameter set)
- failure in the power supply
- encoder malfunctions

The bytes B4, B5, B6 and B7 are shown in object 1003: "pre_defined_error_field" as well. In this object all by the sensor recognised errors are stored (20 errors at maximum - then errors will be overwritten). With 1003 the customer can look if an error has occurred in the sensor and he can see this error at a later date. In 1003 you can see malfunctions of the device but no CAN communication errors. The error history object 1003 is not implemented in every device.

The sequence of B4 to B7 is reverse in 1003 in comparison to the emergency message:

Trace: FF FF 81 00 **10 02 0D 0F** → object 1003: **0 x 0F 0D 02 10**

B4 (= 10 in the above trace example) displays the error category. B5 to B7 show more details which can be read in the tables and remarks on the following pages and in further documents for different encoders which are available on request for some devices.

The definition of B4 to B7 depends on the device (e.g. NOCN, NVA, NBN, HBN and so on) due to the fact that different devices have different possibilities of errors (e.g. NOCN with cams can have a cam-malfunction but NBN not).

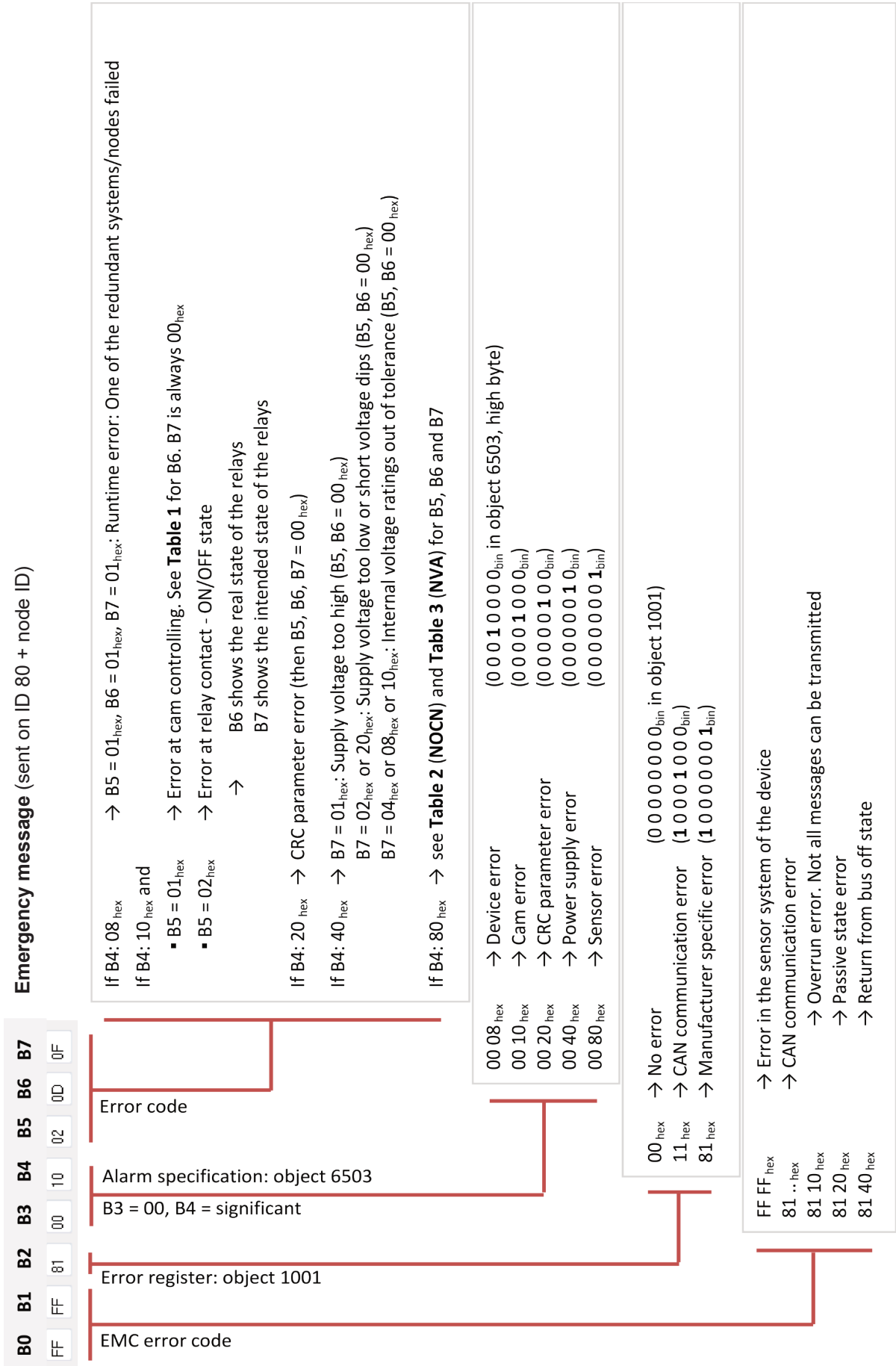
The example on the next page shows an overview and an aid for the recognition of an error message at device NOCN with 2 switching contacts (cams):

B0 & B1: FF FF	Error in the sensor system (device)
B2: 81	Manufacturer specific error
B3 & B4: 00 10	Cam error
B5: 02	Error at output contact ON/OFF
B6: 0D	Real state of the relays (→ R4 R3 R2 R1 = 1 1 0 1bin = Dhex)
B7: 0F	Intended state of the relays (1 1 1 1bin = Fhex)

Means: → Only 3 of the required 4 relays are closed (i.e. 1 + 3 + 4). One relay failed (i.e. 2)

→ Error of the related relay / electronic

→ Safety switching contact S1 doesn't close because S1 consists of R1 + R2 connected in series



Specifications for NBN66-D

taken from NOC13100 handbook

Table 1 (NOCN with cams and NVA115 → cam error - error at cam controlling, B4 = 10, B5 = 01, B7 = 00)

Byte B6:

General error	0x00
No error	0x01
No start flag found	0x02
No end flag found	0x03
Error frame	0x04
CRC error when checked	0x05
Timeout	0x06
Error data length	0x07
Unknown address	0x08
Error message number	0x09

(SLV)

General error	0x80
No error	0x81
No start flag found	0x82
No end flag found	0x83
Error frame	0x84
CRC error when checked	0x85
Timeout	0x86
Error data length	0x87
Unknown address	0x88
Error message number	0x89

Table 2 (NOCN → sensor error, B4 = 80)

Byte B5 (channel number):

No error	0x00
Error channel 1	0x01
Error channel 2	0x02
Error: No channel	0x03
Error inverse calculation	0x04 (only slewing ring code 'S', when 31FE is not set A5 again)

Byte B6 (error type):

No error	0x00
Error communication	0x01
Error sensor	0x02
Error speed overflow	0x03
Error synchronisation	0x04

Byte B7 (error code):

(Error in communication)

No error	0x00
Error time out	0x01
Error CRC	0x02
Error MSG_NBR	0x03
Error position	0x04

(Error of sensor)

CRC error code range	0x06
Chip error of detection ICs	0x0A
Error in gear detection	0x12
Error of parameter	0x42
Error of calibration parameters	0x82

Specifications for NBN66-D

taken from NOC13100 handbook

Table 3 (NVA115 → sensor error, B4 = 80)

Byte B5 → always 00

Byte B6 → always 00

Byte B7	No error	0x00
	Time out error of filter	0x01
	Position monitoring	0x04
	Zero position	0x05
	Communication sampling	0x06
	No valid configuration (32FE)	0x07
	Error calibration data	0x08
	Error sensor static value	0x09
	Error sensor ID 1	0x10
	Error sensor ID 2	0x11

Modell	B0	B1	B2	B3	B4	B5	B6	B7	Objekt 1003 (B4-B7)
NOCN	FF	FF	81	00	80	02	02	12	0x12020280
	Error in the Sensor system of the device		Manufactur specific error		Sensor error		Error Ch 2		
							Error Sensor		
							Error in gear detection		
NOCN	FF	FF	81	00	40	00	00	02	0x02000040
	Error in the Sensor system of the device		Manufactur specific error		Power supply error		always 00		
							always 00		
							too less voltage		
NOCN cam switch	FF	FF	81	00	10	02	0d	0F	0x0F0D0210
	Error in the Sensor system of the device		Manufactur specific error		Cam error		Error at relay contact- ON/OFF state		
							"is" =0d=1101		
							"should"=0F=1111		
NOCN cam switch	FF	FF	81	00	10	01	00	86	0x86000110
	Error in the Sensor system of the device		Manufactur specific error		Cam error		Error cam controlling		
							General error		
							Time out		

Specifications for NBN66-D

taken from NOC13100 handbook

The pre_defined_error_field object 1003 in which several errors are stored during lifetime contains 4 bytes:
B7 B6 B5 B4. E.g.: Read out value of 1003: 0 x 02 00 00 40

→

B7 = 02 → supply voltage too low

B6 = 00

B5 = 00

B4 = 0x40 → power supply error

Subject to completion.