User Manual

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1. General

The electromagnetic T Series encoders are designed for direct connection to the CAN bus. This is achieved internally via the CAN bus controller T89C51 CC02 SO 28 (Atmel). The following specifications have been implemented:

Device Profile for Encoders
CiA Draft Standard 406, Version 3.0 /1/

CANopen Application Layer and Communication Profile
CiA Draft Standard 301, Version 4.02 /2/

The CANopen specifications can be obtained from the user organisation CiA (www.can-cia.org).

The following T Series encoders with CANopen interface have been taken into consideration:

Model designation	Data sheet	Description
TBN 36	11713	Single-turn encoder
TBN 42	11930	Single-turn encoder
TBN 50	11294	Single-turn encoder
TKN 46	12638	Single- or multi-turn encoder as board
TMN 42	11931	Multi-turn encoder with electronic revolution counter
TMN 50	11451	Multi-turn encoder with electronic revolution counter
TSN 50	11851	Multi-turn encoder with battery powered electronic revolution counter
TRN 42	11916	Multi-turn encoder with magnetic scanned gear
TRN 50	11820	Multi-turn encoder with magnetic scanned gear

2. CANopen features of T Series encoders

- According to device profile DS 406, version 3.0, Device Profile for Encoders /1/
- 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) /4/

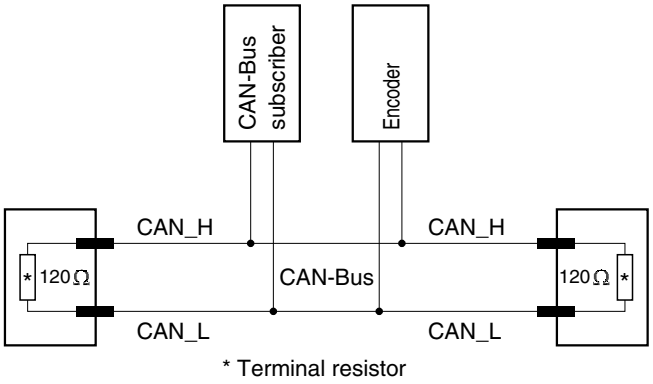
3. Installation instructions

3.1 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 internally. The precise connector assignment is enclosed with each device.

Principle bus structure:



3.2 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

(According to CiA DS 301)

Note: The encoder has no galvanic separation between the supply voltage and bus leads; the total bus length is therefore limited to 200 m.

3.3 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 6000**$_h$	(TWK product number)
Revision number:	**0001 0003**$_h$	(current revision number)
Serial number:	**xxxx xxxx**$_h$	(relevant serial number of the sensor)

See example in Chapter 7.2.

In addition to the option of setting the node address and Baurate via the LSS, the parameters can also be changed via objects 2000$_h$ and 2001$_h$ (see manufacturer-specific object range, Chapter 6.5).

The default values are: Baud rate: **20 kBaud**
Node address: **1**

3.4 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. 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.

4.1 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. (See Chapter 6.2)

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	Reser				
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).

4.2 Data format

The definition of the output data (mapping) and their depiction is identical for both PDOs. The position value is output in steps and, in the case of the variant with speed signal, the speed value is output in steps per 100 ms. The position and speed value can also be called up in the object directory under indices 6004_h - Position value and 2010_h - Speed value. The position and speed values are depicted in Intel format.

The following tables show encoders with 13 bits single turn resolution. For encoders with 12 bit resolution the positi-onvalue is one bit shorter in each case.

Single-turn encoder TBN / TKN without speed signal - 2 data bytes:

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

Single-turn encoder TBN / TKN with speed signal - 4 data bytes:

Byte 0								Byte 1								Byte 2								Byte 3							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
13 Bit Position data													0	0	0	16 Bit Speed															

Multi-turn encoder TMN and TSN without speed signal - 4 data bytes:

Byte 0								Byte 1								Byte 2								Byte 3							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
28 Bit Position data																												0	0	0	0

Multi-turn encoder TRN without speed signal - 4 data bytes:

Byte 0								Byte 1								Byte 2								Byte 3							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
25 Bit Position data																								0	0	0	0	0	0	0	

Single-turn and multi-turn encoders with speed signal - 6 data bytes:

Byte 0								Byte 1								Byte 2								Byte 3								Byte 4								Byte 5							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
25 Bit Position data																								0	0	0	0	0	0	0	Speed																

5. Emergency messages

Each time the internal error status register (Index 1001_h) changes, the encoder transmits an emergency message with the identifier: 80_h + node ID (even if an error which has occurred has been rectified).

An emergency message is comprised of 8 data bytes and is structured as follows:

Byte	0	1	2	3…7
Content	Error code		Error register (Index 1001_h)	Manufacturer-specific

See CANopen Specifications /2/ for error code.

The bits in the error register, index 1001_h, (see Chapter 6.1), have the following meaning:

Bit	Meaning
0	General error
1-6	Not used
7	Manufacturer-specific error

In the case of an error, the error register always contains 81_h. The cause of the error is then contained in index 6503_h.

Bytes 3 and 4 of the emergency message reflect the content of the index 6503_h (see Chapter 6.4.4) and may assume the following values:

Bit	Meaning	Error rectification
0-11	Not used	
12	EEPROM error	Re-programming an arbitrary parameter and saving with „save“, index 1010_h /01
13	EEPROM CRC error	Re-programming an arbitrary parameter and saving with „save“, index 1010_h /01
14	Not used	
15	Sensor error	Encoder voltage supply off/on

6. Programming and diagnosis (object directory)

In the case of CANopen, all parameters and diagnostic information are contained in the object directory. There, they may be changed and/or read with the SDO (Service Data Object) message, specifying their index and sub-index. The object directory is sub-divided into the following areas:

Communication parameters	Index 1000_h - $1FFF_h$
Manufacturer-specific parameters	Index 2000_h - $5FFF_h$
Standardised device parameters	Index 6000_h - $9FFF_h$

Those parameters marked with “rw” in this chapter can be set by the user. To store the parameters in a failsafe manner in the encoder’s EEPROM, the “save” command must then be executed under the object 1010_h. Refer to the following Table for a description of the individual parameters and the diagnostic information.

6.1 Overview of the object directory

Index	Object	Name	Data type	Access
Communication Profile Area				
1000_h	VAR	Device type	Unsigned32	ro
1001_h	VAR	Error register	Unsigned8	ro
1005_h	VAR	COB-ID-SYNC	Unsigned32	rw
1008_h	VAR	Manufacturer device name	String	ro
1009_h	VAR	Manufacturer hardware version	String	ro
$100A_h$	VAR	Manufacturer software version	String	ro
1010_h	RECORD	Store parameters		rw
1011_h	RECORD	Restore default parameters		rw
1014_h	VAR	COB-ID-EMCY	Unsigned32	rw
1015_h	VAR	Inhibit time EMCY	Unsigned16	rw
1017_h	VAR	Producer heartbeat time	Unsigned16	rw
1018_h	RECORD	Identity object		ro
1800_h	RECORD	1. Transmit PDO		rw
1801_h	RECORD	2. Transmit PDO		rw
$1A00_h$	RECORD	PDO 1 Mapping		ro
$1A01_h$	RECORD	PDO 2 Mapping		ro
Standardised Device Profile Area				
6000_h	VAR	Operating parameters	Unsigned16	rw
6001_h	VAR	Measuring units per revolution	Unsigned32	ro
6002_h	VAR	Total measuring range in measuring units	Unsigned32	ro/rw*
6003_h	VAR	Preset value	Unsigned32	rw
6004_h	VAR	Position value	Unsigned32	ro
6030_h	VAR	Speed value (from rev. 0x10100 on)	Unsigned16	ro
6200_h	VAR	Cyclic timer	Unsigned16	rw
6500_h	VAR	Operating status	Unsigned16	ro
6501_h	VAR	Single turn resolution	Unsigned32	ro
6502_h	VAR	Number of distinguishable revolutions	Unsigned16	ro
6503_h	VAR	Alarms	Unsigned16	ro
6504_h	VAR	Supported alarms	Unsigned16	ro
6506_h	VAR	Supported warnings	Unsigned16	ro
6507_h	VAR	Profile and software version	Unsigned32	ro
6508_h	VAR	Operating time	Unsigned32	ro
6509_h	VAR	Offset value	Unsigned32	ro
$650A_h$	RECORD	Module identification		ro
$650B_h$	VAR	Serial number	Unsigned32	ro
Manufacturer Specific Profile Area				
2000_h	VAR	Node ID	Unsigned8	rw
2001_h	VAR	Bit timing	Unsigned8	rw
2010_h	VAR	Speed value (optional)	Unsigned16	ro
2011_h	VAR	Speed gate time (from rev. 0x10100 on)	Unsigned16	rw

* dependend on type, see object description

6.2 Communication parameters

6.2.1 Object 1000_h - Device type

Index	Sub	Name	Data type	Access	Range/Value	Default
1000_h	00	Device type	Unsigned32	ro		0x10196 (TBN) 0x30196 (TMN, TRN, TSN)

6.2.2 Object 1001_h - Error register

Index	Sub	Name	Data type	Access	Range/Value	Default
1001_h	00	Error register	Unsigned8	ro		

Bit	Meaning
0	General error
1-6	Not used
7	Manufacturer-specific error

The error register is the higher-level error register. Bit 0 and bit 7 are always set in the event of an error (81_h). The cause of the error is then contained in index 6503_h.

6.2.3 Object 1005_h - COB-ID SYNC

Index	Sub	Name	Data type	Access	Range/Value	Default
1005_h	00	COB-ID SYNC	Unsigned32	rw	0 ... 0x7FF	0x80

Object 1005_h defines the COB ID (11-bit identifier) for the Sync message.

6.2.4 Object 1008_h - Manufacturer device name

Index	Sub	Name	Data type	Access	Range/Value	Default
1008_h	00	Manufacturer device name	String	ro		

Contains the manufacturer device name, e.g.: „Encoder TBN“

6.2.5 Object 1009_h - Manufacturer hardware version

Index	Sub	Name	Data type	Access	Range/Value	Default
1009_h	00	Manufacturer hardware version	String	ro		

Contains the manufacturer hardware version e.g.: "P-0462"

6.2.6 Object $100A_h$ - Manufacturer software version

Index	Sub	Name	Data type	Access	Range/Value	Default
$100A_h$	00	Manufacturer software version	String	ro		

Contains the manufacturer software version, e.g.: „TBN Std“

6.2.7 Object 1010_h - Store parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1010_h	00	Largest supported subindex	Unsigned8	ro	1	
	01	Password	Unsigned32	rw	„save“	0

Writing „save“ (in hex: 73 61 76 65) in sub-index 01 saves the current parameters in the encoder‘s EEPROM, where they are protected against zero-voltage.

6.2.8 Object 1011_h - Restore default parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1011_h	00	Largest supported subindex	Unsigned8	ro	1	
	01	Password	Unsigned32	rw	“load”	0

Writing „load“ (in hex: 6C 6F 61 64) in sub-index 01 loads the parameter‘s default values and saves them in the encoder‘s EEPROM, where they are protected against zero-voltage.

6.2.9 Object 1014_h - COB-ID EMCY

Index	Sub	Name	Data type	Access	Range/Value	Default
1014_h	00	COB-ID EMCY	Unsigned32	rw	0 ... 0x7FF	0x80 + Node-ID

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

In default status, this has the value 0x80 + node address. If the object is written, the node address is no longer added. The default status can be restored via „load default“ (object 1011_h).

6.2.10 Objekt 1015_h - Inhibit time EMCY

Index	Sub	Name	Data type	Access	Range/Value	Default
1015_h	00	Inhibit time EMCY	Unsigned16	rw	0 ... 65535	1000

Defines the minimal time between two emergency messages. The inhibit time is given in multiples of 100 µs.

6.2.11 Object 1017_h - Producer heartbeat time

Index	Sub	Name	Data type	Access	Range/Value	Default
1017_h	00	Producer heartbeat time	Unsigned16	rw	0 ... 65535	0

If the value is > 0, the heartbeat message is transmitted on the identifier guard COB ID + node ID in the heartbeat time interval in ms.

6.2.12 Object 1018_h - Identity Object

Index	Sub	Name	Data type	Access	Range/Value	Default
1018_h	00	Largest supported subindex	Unsigned8	ro	4	
	01	Manufacturer ID	Unsigned32	ro	0x10D	
	02	Product ID	Unsigned32	ro	0x6000	
	03	Revision No.	Unsigned32	ro	0x1 0003	
	04	Serial No.	Unsigned32	ro	0xXXXX XXXX	

The information in object 1018_h (also see Chapter 3.3) is required to use the Layer Setting Service (LSS, /5/).

6.2.13 Object 1800_h - First transmit PDO

Index	Sub	Name	Data type	Access	Range/Value	Default
1800_h	00	Largest supported subindex	Unsigned8	ro	3	
	01	COB-ID	Unsigned32	rw	0 ... 0x7FF	0x180 + Node-ID
	02	Transmission type	Unsigned8	rw	252,253,254	253
	03	Inhibit time	Unsigned16	rw	0 ... 65535	0

Object 1800_h defines the first PDO‘s communication data. Only transmission types 252,253,254 are supported.

Sub-index 01 (COB ID) contains the identifier for PDO1.

In default status, this has the value 0x180 + node address. If the object is written, the node address is no longer added. The default status can be restored via „load default“ (object 1011_h).

The inhibit time (ms) is the time before the PDO is permitted to be transmitted again.

(See operating modes in Chapter 4.1)

6.2.14 Object 1801_h - Second transmit PDO

Index	Sub	Name	Data type	Access	Range/Value	Default
1801_h	00	Largest supported subindex	Unsigned8	ro	2	
	01	COB-ID	Unsigned32	rw	0 ... 0x7FF	0x280 + Node-ID
	02	Transmission type	Unsigned8	rw	0 ... 240	1

Object 1801_h defines the second PDO‘s communication data. Only transmission types 0... 240 are supported.

Sub-index 01 (COB ID) contains the identifier for PDO2.

In default status, this has the value 0x280 + node address. If the object is written, the node address is no longer added. The default status can be restored via „load default“ (object 1011_h).

(See operating modes in Chapter 4.1)

6.2.15 Object $1A00_h$ - First transmit PDO mapping

Single-turn encoder without speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A00_h$	00	Largest supported subindex	Unsigned8	ro	1	
	01	First mapping object	Unsigned32	ro	0x6004 0010	

Multi-turn encoder without speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A00_h$	00	Largest supported subindex	Unsigned8	ro	1	
	01	First mapping object	Unsigned32	ro	0x6004 0020	

Mono- and Multitour-encoder with speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A00_h$	00	Largest supported subindex	Unsigned8	ro	2	
	01	First mapping object	Unsigned32	ro	0x6004 0020	
	02	Second mapping object	Unsigned32	ro	0x2010 0010	

(see Chapter 4.2)

6.2.16 Object $1A01_h$ - Second transmit PDO mapping

Single-turn encoder without speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A01_h$	00	Largest supported subindex	Unsigned8	ro	1	
	01	First mapping object	Unsigned32	ro	0x6004 0010	

Multi-turn encoder without speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A01_h$	00	Largest supported subindex	Unsigned8	ro	1	
	01	First mapping object	Unsigned32	ro	0x6004 0020	

Single-turn and multi-turn encoders with speed signal:

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A01_h$	00	Largest supported subindex	Unsigned8	ro	2	
	01	First mapping object	Unsigned32	ro	0x6004 0020	
	02	Second mapping object	Unsigned32	ro	0x2010 0010	

(see Chapter 4.2)

6.3 Standardised device parameters

6.3.1 Object 6000_h - Operating parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
6000_h	00	Operating parameters	Unsigned16	rw		0

The following Table contains an overview of operating parameters for the encoder. Before scaling the encoder via objects 6001_h, 6002_h or 6003_h, the „Scaling function control“ bit must be set to „1“.

Safing of the parameters in a failsafe manner is done via object 1010_h

Bit	Name	0	1	Remarks
0	Code sense	CW	CCW	
1	Not used			
2	Scaling function control	disabled	enabled	
3 - 13	Not used			
14	Speed value	off	on	from revision 0x10100 on
15	Not used			

6.3.2 Object 6001_h - Measuring units per revolution

Index	Sub	Name	Data type	Access	Range/Value	Default
6001_h	00	Measuring units per revolution	Unsigned32	rw	2 … 4096 (8192)	4096 (8192)

The „Scaling function control“ bit (object 6000_h) must be enabled in order to change the parameter. Values in brackets represent an encoder with 13 bit single turn resolution.

6.3.3 Object 6002_h - Total measuring range

Single-turn encoder TBN / TKN

Index	Sub	Name	Data type	Access	Range/Value	Default
6002_h	00	Total measuring range	Unsigned32	ro	4096 (8192)	

Multi-turn encoder TMN and TSN

Index	Sub	Name	Data type	Access	Range/Value	Default
6002_h	00	Total measuring range	Unsigned32	rw	1...134217728 (268435456)	134217728 (268435456)

The values 134217728 or 268435456 depict the maximum, total number of steps of a multi-turn sensor with a resolution of 4096 or 8192 steps per revolution and max. 32768 revolutions.

Multi-turn encoder TKN / TRN

Index	Sub	Name	Data type	Access	Range/Value	Default
6002_h	00	Total measuring range	Unsigned32	rw	1...16777216 (33554432)	16777216 (33554432)

Values in brackets represent an encoder with 13 bit single turn resolution.

The „Scaling function control“ bit (object 6000_h) must be enabled in order to change the parameter.

Note: For parametration of **TRN** it must be noted that the calculation of the number of revolutions is carried out in 2^n powers internally within the encoder. Regardless of this requirement, the user may programme the desired total measuring range in units and the desired single turn resolution in accordance with the application. During calculation, the encoder accesses the next highest 2^n power if required. In this case, the values are designated as the actual single turn resolution or as the actual total measuring range in units, and are displayed as the output value.

Example:

desired total measuring range in units	:	20480
desired single turn resolution	:	4096
desired number of revolutions	:	5
next 2^n number of revolution	:	8
resulting to:		
total measuring range in units	:	32768
single turn resolution	:	4096

6.3.4 Object 6003_h - Preset value

Index	Sub	Name	Data type	Access	Range/Value	Default
6003_h	00	Preset value	Unsigned32	rw	0 … Total measuring range -1	0

The preset value is displayed as the position value if object 6003_h is written and the „Scaling function control“ bit (object 6000_h) is enabled.

6.3.5 Object 6004_h - Position value

Index	Sub	Name	Data type	Access	Range/Value	Default
6004_h	00	Position value	Unsigned32	ro	0 ... Total measuring range -1	

This value is the position value, and is output via the PDOs (see Chapter 4).

6.3.6 Objekt 6030_h - Speed value (from revision 0x10100 on)

Index	Sub	Name	Data type	Access	Range/Value	Default
6030_h	00	Speed value	Signed16	ro	-35535 ... 35535	

From revision 0x10100 the speed value can be find here. It will be mapped via Index 6000_h into the PDOs. The dimension of the speed value is steps/gate time. The gate time can be adjusted via Index 2011_h . The resolution of the speed value is independent on the resolutioin of the position value (Index 6001_h). The speed value is always based on a resolution of 4096 steps/turn.

The dimension steps/gate time can be calculated into rpm with the following formula:

$$n = \frac{v / (t \times ms^{-1}) \times 60000}{4096 \text{ steps}}$$

n = in rpm, v = speed value in steps/gate time, t = gate time in ms

6.3.7 Object 6200_h - Cyclic timer

Index	Sub	Name	Data type	Access	Range/Value	Default
6200_h	00	Cyclic timer	Unsigned16	rw	0 … 65535	0

In the case of values of > 0 ms for the cyclic timer, the position value (or position and speed value) is transmitted cyclically with PDO 1 (see Chapter 4).

6.4 Standardised device diagnosis

6.4.1 Object 6500_h - Operating status

Index	Sub	Name	Data type	Access	Range/Value	Default
6500_h	00	Operating status	Unsigned16	ro		

Object 6500_h represents the encoder‘s operating status (also see object 6000_h).

6.4.2 Object 6501_h - Singleturn resolution

Index	Sub	Name	Data type	Access	Range/Value	Default
6501_h	00	Singleturn resolution	Unsigned32	ro	4096 (8192)	

The maximum setable resolution. Values in brackets represent an encoder with 13 bit single turn resolution.

6.4.3 Object 6502_h - Number of distinguishable revolutions

Single-turn encoder

Index	Sub	Name	Data type	Access	Range/Value	Default
6502_h	00	Number of distinguishable revolutions	Unsigned16	ro	1	

Multi-turn encoder

Index	Sub	Name	Data type	Access	Range/Value	Default
6502_h	00	Number of distinguishable revolutions	Unsigned16	ro	4096 (TRN) or 32768 (TMN, TSN)	

6.4.4 Object 6503_h - Alarms

Index	Sub	Name	Data type	Access	Range/Value	Default
6503_h	00	Alarms	Unsigned16	ro		

On occurrence of an error, an emergency message is transmitted, and the encoder switches to pre-operational status (see Chapter 5). The following Table shows the possible errors:

Bit	Meaning	Error rectification
0-11	Not used	
12	EEPROM error	Re-programming an arbitrary parameter and saving with „save“, index 1010_h /01
13	EEPROM CRC error	Re-programming an arbitrary parameter and saving with „save“, index 1010_h /01
14	Not used	
15	Sensor error	Encoder voltage supply off/on

6.4.5 Object 6504_h - Supported alarms

Index	Sub	Name	Data type	Access	Range/Value	Default
6504_h	00	Supported alarms	Unsigned16	ro	0xB000	

Only the alarms listed under object 6503_h are supported.

6.4.6 Object 6506_h - Supported Warnings

Index	Sub	Name	Data type	Access	Range/Value	Default
6506_h	00	Supported warnings	Unsigned16	ro	0	

No warnings are supported.

6.4.7 Object 6507_h - Profile and software version

Index	Sub	Name	Data type	Access	Range/Value	Default
6507_h	00	Profile and software version	Unsigned32	ro		

Version of the encoder profile which is implemented and encoder software version. The version numbers are each BCD-encoded byte-by-byte.

Profile Version		Software Version	
Byte 0	Byte 1	Byte 2	Byte 3
Bit 7 - 0	Bit 15 - 8	Bit 7 - 0	Bit 15 - 8

6.4.8 Object 6508_h - Operating time

Index	Sub	Name	Data type	Access	Range/Value	Default
6508_h	00	Operating time	Unsigned32	ro	0xFFFF FFFF	

Not supported at present.

6.4.9 Object 6509_h - Offset value

Index	Sub	Name	Data type	Access	Range/Value	Default
6509_h	00	Offset value	Unsigned32	ro		

Internal calculation value.

6.4.10 Object $650A_h$ - Modul identification

Index	Sub	Name	Data type	Access	Range/Value	Default
$650A_h$	00	Largest supported subindex	Unsigned8	ro	1	
	01	Offset value	Unsigned32	ro	0	

Not supported at present.

6.4.11 Object $650B_h$ - Serial number

Index	Sub	Name	Data type	Access	Range/Value	Default
$650B_h$	00	Serial number	Unsigned32	ro		

The object contains the device‘s serial number.

6.5 Manufacturer-specific parameters

6.5.1 Object 2000_h - Node ID

Index	Sub	Name	Data type	Access	Range/Value	Default
2000_h	00	Node-ID	Unsigned8	rw	1 … 127	1

The sensor‘s node address. After setting the node address via index 2000_h, this must be permanently saved in the EEPROM via index 1010_h. It only comes into effect following power off/on or a reset.

This object can also be changed via the Layer Setting Service (see Chapter 3.3).

6.5.2 Object 2001_h - Bit timing

Index	Sub	Name	Data type	Access	Range/Value	Default
2001_h	00	Bit timing	Unsigned8	rw	0 … 7	7

The sensor‘s Baud rate can be set via this index. After setting the Baud rate via index 2001_h, this must be permanently saved in the EEPROM via index 1010_h. It only comes into effect following power off/on or a reset.

This object can also be changed via the Layer Setting Service (see Chapter 3.3).

The Baud rate is set according to the following Table:

Baud rate [kBit/s]	Bit timing value
1000	00_h
800	01_h
500	02_h
250	03_h
125	04_h
125	05_h
50	06_h
20	07_h

6.5.3 Object 2010_h - Speed value (encoder with speed signal only, up to rev. 0x10100)

Index	Sub	Name	Data type	Access	Range/Value	Default
2010_h	00	Speed value	Unsigned16	ro		

The speed value, which is transmitted together with the position value in the PDO.

In the case of T Series encoders, the following key data apply for speed measuring:

Time basis: 100 ms
Speed specification: Steps / 100 ms
Basic resolution per revolution: 12-bit (4096 steps)
Speed signal resolution: 16-bit

6.5.4 Objekt 2011_h - Speed gate time (from revision 0x10100 on)

Index	Sub	Name	Data type	Access	Range/Value	Default
2011_h	00	Speed gate time	Unsigned16	rw	0 ... 65535	100

Gate time for speed measurement in ms. The updating time of the speed signal is equal to the gate time.

7. Examples

Message traffic between a master and the TBN encoder (single-turn encoder without speed signal) during boot-up and when setting the slave address with LSS is shown in the following. The identifier (ID), the transmission direction (Rx/Tx), the Data Length Code (DLC) and the data bytes are shown in tabular form.

The following applies:
- The encoder has the address 1 (default) and is the only slave
- Encoder with default parameter values
- Tx: Master transmits data to the encoder
- Rx: Encoder transmits data

7.1 Boot-up

The following Table shows encoder boot-up, from switching on the supply voltage to initial transmission of the position value. The position value is subsequently polled via a Sync command.

Action	Id	Rx/Tx	DLC	Databytes								Remark
				00	01	02	03	04	05	06	07	
Bus active, encoder in the bus with node address 1												
Voltage off -> on	701	Rx	1	00								Boot up node 1
Start all nodes	0	Tx	2	1	0							Operational for all nodes
	181	Rx	2	xx LSB	xx MSB							Response from TBN (PDO1)
Master (user) transmits a Sync												
Sync from the master	80	Tx	0									
	281	Rx	2	xx LSB	xx MSB							Response from TBN (PDO2)

All values in hex!

7.2 Change parameter

Here the changing of the code sense by the parameter "Operating parameters" Index 6000_h is shown. Afterwards the parameters are saved in the encoders EEPROM.

Action	Id	Rx/Tx	DLC	Databytes								Remark
				00	01	02	03	04	05	06	07	
Write 0x01	601	Tx	8	2b	00	60	00	01	00	00	00	
	581	Rx	8	60	00	60	00	00	00	00	00	Response from TBN
Save parameters	601	Tx	8	23	10	10	01	73	61	76	65	"save"
	581	Rx	8	60	10	10	01	00	00	00	00	Response from TBN

All values in hex!

7.3 Setting the node address via LSS

In the case of the LSS /4/, either all CANopen subscribers are addressed via a global command or an individual subscriber is addressed via its LSS address, which is comprised of the manufacturer name, the product name, the revision number and the serial number (see Chapter 3.3).

In the following example, the sensor is addressed via its LSS address (i.e. is switched from LSS-Operation-Mode to LSS-Configuration-Mode), node address 2 is programmed and saved. LSS-Operation-Mode is subsequently reset. The sensor then reboots and logs on (without voltage off/on) with its boot-up protocol. It is now ready to operate with its new address.

To do this, a switch first has to be made to stop status and the heartbeat timer has to be deactivated, i.e. heartbeat time=0 (default status).

Attention: During LSS-programming the Heartbeat-Time (Index 1017_h) has to be zero (default status).

Aktion	Id	Rx/Tx	DLC	Databytes								Comment
				00	01	02	03	04	05	06	07	
Stop Node	0	Tx	2	02	00							Stop node for all nodes
LSS-Switch Mode Selective	7E5	Tx	8	40	0D	01	00	00	00	00	00	1. Transmission of the manufacturer name
LSS-Switch Mode Selective	7E5	Tx	8	41	00	60	00	00	00	00	00	2. Transmission of the product number
LSS-Switch Mode Selective	7E5	Tx	8	42	03	00	01	00	00	00	00	3. Transmission of the revision number
LSS-Switch Mode Selective	7E5	Tx	8	43	66	BE	02	00	00	00	00	4. Transmission of the serial number (in this case: 179814)
	7E4	Rx	8	44	00	00	00	00	00	00	00	Success message from the sensor, which is now in LSS Configuration-Mode
LSS-Configure Modul ID	7E5	Tx	8	11	02	00	00	00	00	00	00	Node address 2 programming
	7E4	Rx	8	11	00	00	00	00	00	00	00	Success message from the sensor
LSS-Store Configuration	7E5	Tx	8	17	00	00	00	00	00	00	00	Zero-voltage-protected saving
	7E4	Rx	8	17	00	00	00	00	00	00	00	Success message from the sensor
LSS-Switch Mode Global: Operation Mode	7E5	Tx	8	04	00	00	00	00	00	00	00	Sensor is reset to LSS-Operation-Mode
	702	Rx	1	00								Boot-up node with new node address

All values in hex!

8. Literature

/1/ CiA Draft Standard 406, Version 3.0, Device Profile for Encoders

/2/ CiA Draft Standard 301, Version 4.02, CANopen Application Layer and Communication Profile

/3/ CiA Draft Recommendation Proposal 303-1, Version 1.1.1 CANopen Cabling and Connector Pin Assignment

/4/ CiA Draft Standard Proposal 305, Version 1.1.1, CANopen Layer Setting Services and Protocol (LSS)