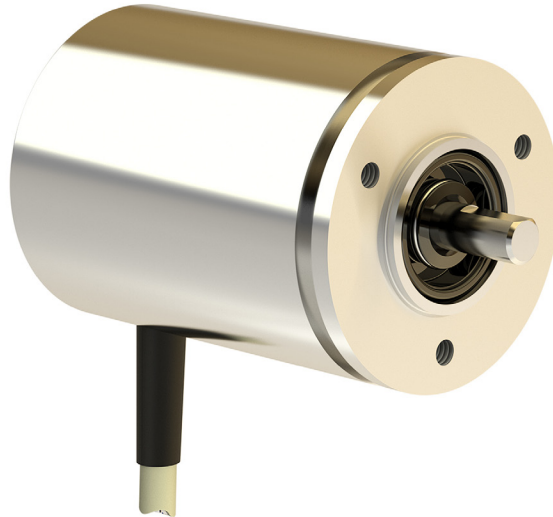


Specification – CANopen Safety (IEC61508) and CANopen for absolute rotary encoder TBN/TRN



Specification rotary encoder TBN/TRN

according to

CANopen Safety - SIL2 acc. IEC 61508
and CANopen Standard

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

General

Scope

This specification is valid exclusively for the following absolute encoders TBN and TRN with CANopen and CANopen Safety (SIL2) interface.

Documentation

The following documents must be observed (depending on device):

- The owner's system-specific operating instructions
- The specification (manual) TXN 15469
- Data sheet TBN/TRN 14271
- The connection assignment enclosed with every device - TYxxxxx
- EDS-File TYxxxxx_xx_xx.eds
- CRC Calculation Program and additional xml-Files for special versions
- TWK_CAN Error description
- Notes on the wiring & assembly of rotary encoder TZY 10206
- Drawings on request

Proper use

The TWK-ELEKTRONIK GmbH absolute encoders are used to register angular positions and make their measured value available in the form of an electrical output signal. As part of a system, they have to be connected to the downstream electronics and must only be used for this purpose.

Commissioning

- The relevant device may only be set up and operated in combination with this and the documentation specified above
- Protect the device against mechanical damage during installation and operation.
- Device commissioning and operation may only be undertaken by a specialist electrician.
- Do not operate the device outside of the limit values specified in the data sheet.
- Check all electrical connections before commissioning the system.

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1 Intended use

The rotary encoder TBN and TRN are intended for use in CANopen and in CANopen safety-relevant systems.

The version TBN is a singleturn and the TRN is a multiturn absolute encoder.

Thanks to its robust design, the encoder can be used in applications with harsh environmental conditions.

Both encoders are designed for connection to a control system (PLC) which evaluates the measured values transmitted via the CAN bus and, in the event of error messages or the absence of process data, reacts according to the relevance of the error and prevents a hazardous state.

2 Design

Position registration is carried out through angle and revolution measurement (TRN). The signals from encoders used to register the position of the shaft and to scan a mechanical transmission for measuring the revolutions covered are combined to form a summarized position value. The position registration system is equipped with a separate controller. Position registration is designed in fully redundant form. The position data are transferred to the evaluation module via two channels.

The evaluation module evaluates the position data supplied by the position registration system. The measured values are filtered, the two redundant channels are compared and the measurement signals are linearized. If the measured values are recognized as safe, the module makes the position data available to the downstream processes.

The absolute encoder module accepts the position data provided by the evaluation module, undertakes calibration depending on the set parameters and transfers the data to the CANopen interface. Depending on setting, the CANopen interface can transfer both secure data via CANopen Safety (internal name S4) and secure data via a normal, insecure CANopen interface to the application.

3 Documents

TWK data sheet	TBN/TRN 14271
Manual (Specification)	TBN/TRN 15469
TÜV Certificate Registration No.	44 799 13 172915 (TWK: TXN15603)
Machinery Directive EC	2006/42/EC
EN 61508: 2011	Functional safety of electronic systems
DIN EN 50325-4:2003	CANopen
DIN EN 50325-5:2016	CANopen Safety
ISO 11898	CAN
EN 61326-1: 2013	Electrical equipment for measurement, control and laboratory use - EMC requirements
EN 61326-3: 2008	Electrical equipment for measurement, control and laboratory use - Immunity requirements - functional safety
CiA DS 301	Application Layer and Communication Profile, Version 4.2.0, 21.02.2011
CiA DSP 305	Layer Setting Service, Version 3.0.0, 08.05.2013
CiA DS 406	Device Profile for Encoders, Version 4.0.2

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

4 Electrical specifications

4.1 Generic informations

Refer to the TBN/TRN 14271 data sheet and the variant specifications for the precise electrical specifications.

Supply voltage	9 V ... 36 VDC
Power consumption	< 2.5 W (inrush current < 500 mA)
Temperature range	-40 °C to +85 °C
Communication profile	Full CAN Part A (11-bit) CANopen CiA 301 V 4.2 Encoder profile CANopen CiA 406 V 4.0.2 CANopen Safety EN 50325-5

4.2 Measuring system

Measuring range	4096 revolutions
Resolution	max. 65536 steps per revolution
Accuracy	TBN: ± 0.05 %, TRN: ± 0.2 %
Reproducibility	± 0.02 %
Temperature drift	± 0.02 °C/K
Sensor unit cycle time	1 ms

4.3 Overall system

Dutycycle (rise time)	
supply voltage	500 ms (10 % to 90 %)
Message density	10,000 messages/s
Memory cycle density	3 s per memory cycle
Set-up time	ca. 1 s

4.4 Velocity signal

The encoder provides a velocity signal. It is transmitted via SRDO2. The relationship between the value v in SRDO2 and the value rotations per minute u is:

$$u \text{ [rev./min]} = \frac{v \text{ [digits]} \times 60000 \times S_D}{B \text{ [digits/rev]} \times T \text{ [ms]} \times S_M}$$

It means:

u = Shaft speed in revolutions per minute

v = Digits read out from SRDO2 (Remark: The velocity signal in SRDO2 is in the format Signed 16 Bits. At increasing position values you can use v directly. At decreasing position values you have to calculate: $FFFF - v$ first, before inserting in the formula. Increasing or decreasing position values depend on the setting of *safety code sequence* - object 6101, sub 01). v_{\max} : 15 Bits due to sign of velocity signal.

B = Basic Resolution for velocity signal - depending on device

T = Safety speed integration time in milliseconds - see object 6101, sub 05

S_D = Safety speed divider - see object 6101, sub 07 (if existing, else = 1)

S_M = Safety speed multiplier - see object 6101, sub 06 (if existing, else = 1)

60000 = Compensation factor milliseconds ↔ minutes

4.5 Connection

Communication profile	Full CAN Part A (11-bit) CANopen 301 V 4.1 Encoder CANopen DS 406 V 4.0.2 CANopen Safety EN 50325-5
-----------------------	---

With galvanic bus separation

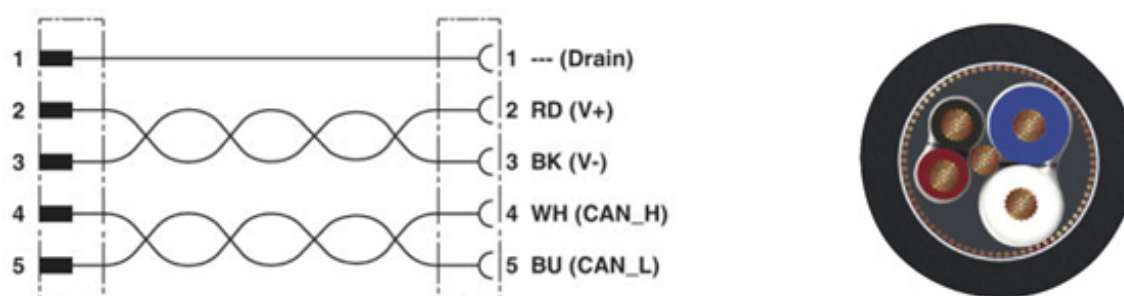
CAN connection assignment: 5-pin M12 male/female, coding A

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4 Electrical specifications

Pin number	Signal designation
1	CAN_GND
2	+Vs/GND
3	-Vs/GND (in case of non galv. separation pin 3 is connected to pin 1 and/or to shield)
4	CAN high
5	CAN low

Recommended type of CANopen/power supply connecting cable:



5 Environmental data

5.1 Dust, moisture

Permissible relative humidity
Protection type

max. 100 % (e.g. Protection grade: IP 69K)
IP 67, optionally IP 69K

5.2 Vibration shock

EN 60068-2-6
EN 60068-2-27
Resistance to shock

Vibration sinus
Mechanical shock
25 g 6 ms each 100x on 3 axes ($1\text{ g} = 9.81\text{ m/s}^2$)
other values on request

Resistance to vibration

Amplitude of excursion 5 mm (peak value)
or 10 g from 5 to 2000 Hz each 1h on 3 axes

5.3 EMC

EN 61000-6-2
EN 61000-6-4

Interference immunity for industrial environments
Interference emission for industrial environments

The reports are available on request.

6 Mechanical system

The mechanical dimensions are specified in data sheet TBN/TRN 14271 or in related drawings due to special mechanical designs.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

7 CANopen functionality

7 CANopen functionality

The CANopen interface enables operation via CANopen Standard and secure operation via CANopen Safety.

The CANopen profile definition for the encoder is executed once according to CiA 301 application layer and according to EN 50325-5 framework for safety-relevant communication.

The sensor system (position registration) is designed in redundant form. The sensor system's measured values are supplied to the self-monitoring controller on separate interfaces (SPI). This compares the position values of both sensors. If the measured values lie within a specified tolerance, the signals are transferred as validated for downstream evaluation. Otherwise, an error message is generated and the controller assumes a secure state (pre-operational).

7.1 Process data objects PDOs

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

Byte 0								Byte 1								Byte 2							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
LSB								Position															

Byte 3								Byte 4								Byte 5															
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47								
MSB								LSB								Speed								MSB							

7.2 Safety-relevant data object SRDO1

The sensor supplies 24 or 25 significant data bits in unsigned long format. Objects 6120/6121 are output.

Byte 0								Byte 1								Byte 2								Byte 3							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	9	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
LSB								Position data																MSB 0 0 0 0							

Byte 0								Byte 1								Byte 2								Byte 3							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	9	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
LSB								Position data inverted																MSB 1 1 1 1							

The position values are transmitted cyclically with the refresh time (object 1301).

7.3 Safety-relevant data object SRDO2

The sensor supplies 16 significant data in unsigned word format for the speed measurement value. Objects 6124/6125 are output on the SRDO2.

Byte 0								Byte 1															
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15								
LSB								Speed								MSB							

Byte 0								Byte 1															
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15								
LSB								Speed inverted								MSB							

The speed values are transmitted cyclically with the refresh time (object 1302).

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8 CANopen profile definition

8.1 CANopen profile overview

Table 1 of all objects contained in the encoder profile

Index	Data type	Designation	Data length	Memory type	m/o
General communication parameter					
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	-	o
1011	ARRAY	restore_default_parameters	LONG	-	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
1029	ARRAY	Error behavior	BYTE	rw	m
SRDO parameter set					
1301	RECORD	SRDO1 communication parameters		rw	m
1381	RECORD	SRDO_1_mapping_parameters			
1302	RECORD	SRDO2 speed parameters		rw	m
1382	RECORD	SRDO_2_mapping_parameters			
13FE	VAR	configuration valid	BYTE	rw	m
13FF	ARRAY	safety configuration checksum		rw	m
PDO parameter set					
1800	RECORD	PDO1_communication_parameters	-	rw	
1A00	RECORD	PDO1_mapping_objects		ro	
1801	RECORD	PDO2_communication_parameters	-	rw	
1A01	RECORD	PDO2_mapping_objects		ro	
General application parameter					
6000	VAR	operating parameters	(WORD)	ro	m
6001	VAR	measuring units per revolution	LONG	ro	m
6002	VAR	total measuring range in measuring units	LONG	ro	m
6003	VAR	preset value	LONG	ro	m
6004	VAR	position value	LONG	ro	m
6030	RECORD	speed_value		ro	o
6031	RECORD	speed_parameters	-	ro	o
6200	VAR	cyclic timer	WORD	rw	

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8 CANopen profile definition

Index	Data type	Designation	Data length	Memory type	m/o
Encoder safety objects					
6100	RECORD	safety_position_configuration_parameters	-	rw	m
6101	RECORD	safety_speed_configuration_parameters	-	rw	m
6120	ARRAY	safety_standard_position_value	BYTE	rw	m
6121	ARRAY	safety_inverted_standard_position_value	BYTE	rw	m
6124	ARRAY	safety_speed_value	BYTE	rw	o
6125	ARRAY	safety_inverted_speed_value	BYTE	rw	o
61FE	VAR	safety_configuration_valid	BYTE	rw	m
61FF	ARRAY	safety_configuration_signature		rw	m
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
- o optional
- m mandatory
- wp Factory programming

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects (SDO)

8.2 Communication service data objects

For every modification of the encoder via SDO communication the device must be set preoperational 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.

8.2.1 Object 1000 device_type

The encoder types are defined as follows:

Coding	Device type designation
1	Singleturn absolute rotary encoder
2	Multiturn absolute rotary encoder
3	Singleturn 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	
TRN	0x96	0x01	0x02	0x00

device_type

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1000	0	Device_type	Long	Long	ro	ROM	0x00020196	-	-

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

8.2.2 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	-	-

8.2.3 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	Custom error code		

See also point 11.1.3.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

8.2.4 Object 1005 COB-ID-SYNC

Identifier of the sync message transmitted by the master.

No range or plausibility check takes place.

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

8.2.5 Object 1008 manufacturer_device_name

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

e.g. "Encoder TRN Safety"

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	See above	-	-

8.2.6 Object 1009 manufacturer_hardware_version

Hardware version of the device. It is stored as a string e.g. "P-0824"

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	See above	-	-

8.2.7 Object 100A manufacturer_software_version

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

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	See above	-	-

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

8.2.8 Object 1010 store_parameters

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

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

1 (saving through command) 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

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 baudrate)	Long	Long	rd/(rw)	ROM	"save" =0x65766173	*	1
	2	save_communication_parameters	Long	Long			"save"	*	1
	3	save_application_parameters	Long	Long			"save"	*	1
	4	save_LMT_parameters (only node ID, baudrate)	Long	Long			"save"	*	1
	5	Save_manufacturer_parameters	Long	Long			"save"	*	1

* Parameters are backed-up in the memory on inputting the correct password (save = 65 76 61 73).

→ Wait for response of the encoder after saving before resetting the device

8.2.9 Object 1011 restore_default_parameters

On inputting "load" (0x64616F6Chex 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 "preoperational" at first.

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.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

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 baudrate)	Long	Long	rd/(rw)	ROM	"load" =0x64616F6C	*	1
	2	load_communication_parameters	Long	Long			"load"	*	1
	3	load_application_parameters	Long	Long			"load"	*	1
	4**	load_LMT_parameters (only node ID, baudrate)	Long	Long			"load"	*	1
	5	load_manufacturer_parameters	Long	Long			"load"	*	1

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

** When loading the default values: For all default node IDs which exceed 32 dez (33) the related COB ID 1 and COB ID 2 have to be entered manually in objects 1301, sub 05/sub 06 and 1302, sub 05/sub 06. Otherwise the SRDOs are disabled (e.g. 0x8000 0141/0x8000 0142). For all node IDs up to 32 dez the COB IDs are adopted by the encoder automatically. (See as well objects 1301, 1302 and 2000)

8.2.10 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.

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.

8.2.11 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

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

8.2.12 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. (GUARD COB-ID = 0x700)

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						

Subscriber status:

0 (0x0): BOOT-UP

4 (0x4): STOPPED

5 (0x5): OPERATIONAL

127 (0x7F): PRE-OPERATIONAL

8.2.13 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 | xxx xxx |

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 xxxx*	-	-
	3	revision_number	Long	Long	ro	ROM	0x0001 0001	-	-
	4	serial_number	Long	Long	ro(rw)	E ² PROM	0	**	-

* depends on device,

** Written in factory programming state (wp).

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.2 Communication service data objects

8.2.14 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
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	-	-
*	4	redundancy_error	Byte	Byte	rw	E ² PROM	0, 1, 2	-	0x01

* Valid for full redundant encoder systems

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.3 CANopen Safety process data objects

8.3 CANopen Safety process data objects

The process data are output via two Safety Relevant Data Objects (SRDOs).

Attention:

The SRDO is only active when the object configuration_valid (object 13FE) is set (written with the datum 0xA5). The configuration_valid object is stored in the E²PROM. The flag is deleted if one of the Safety Relevant Data Objects is changed.

COB ID structure

MSB								LSB		
EN	x	x	x	x	x	x	x	0	COB ID high	COB ID low

The MSB represents the enable bit.

Bit 31 = 0 (EN) SRDO enabled

Bit 31 = 1 (EN) SRDO disabled (=0x80000"FF+2xID" resp. 0x80000"100+2xID")

The plausibility of the other bits is not checked.

Only transmission type 254 is supported (Cyclic output with the defined refresh time, see object 1301/1302).

8.3.1 Object 1301 SRDO1_communication_parameters

The object under this index is only writeable in PRE-OPERATIONAL state.

Modifications will cause 13FE = '0' (must be set '0xA5' after modification). New CRC Checksum 13FF/01 must be calculated and transmitted to the encoder.

The configuration_valid byte is reset after each write access.

SRDO_communication_parameters

Index	Sub	Description	Length		Memory		Range/ value	Action	Default
			COM	MEM	Type	Location			
1301	0	largest_supported_sub-index	-	-	ro	ROM	6	-	-
	1	information_direction	Byte	Byte	ro	ROM	1	-	-
	2	refresh_time (SCT)	Word	Word	rw	E ² PROM	1..65,535 [ms]	-	25
	3	validation_time (SRVT)	Byte	Byte	ro	ROM	20 [ms]	-	-
	4	transmission_type	Byte	Byte	ro	ROM	254	-	-
	5 **	COB-ID_1	Long	Long	rw	E ² PROM	257..384	*	0xFF + (2x node ID)
	6 **	COB-ID_2	Long	Long	rw	E ² PROM	257..384	*	0x100 + (2x node ID)

* Default state evaluation, then addition of the node address. After overwriting, addition is no longer executed. The configuration_valid byte 13FE is reset. No plausibility check is undertaken for the COB IDs.

** For all node IDs which exceed 32 dez (33) the related COB ID 1 and COB ID 2 have to be entered manually in objects 1301, sub 05/sub 06 and 1302, sub 05/sub 06. Otherwise the SRDOs are disabled (e.g. 0x8000 0141 /0x8000 0142, chap. 9.6). For all node IDs up to 32 dez the COB IDs are adopted by the encoder automatically. This has to be considered as well when the default value of the node ID exceeds 32 dez and the default values are loaded by 1011, sub 04. (See as well objects 1302, 1011 and 2000).

Only transmission type 254 is supported (Cyclic output with the defined refresh time, see object 1301, sub 02).

To shut off the SRDO, both COB IDs must be disabled. If only one of the two COB IDs is disabled, setting the configuration_valid flag is not possible.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.3 CANopen Safety process data objects

8.3.2 Object 1302 SRDO2_speed_parameters

The object under this index is only writeable in PRE-OPERATIONAL state. Modifications will cause 13FE = '0' (must be set '0xA5' after modification). New CRC Checksum 13FF/02 must be calculated and transmitted.

The configuration_valid byte is reset after each write access.

SRDO_speed_parameters

Index	Sub	Description	Length		Memory		Range/ value	Action	Default
			COM	MEM	Type	Location			
1302	0	largest_supported_sub-index	-	-	ro	ROM	6	-	-
	1	information_direction	Byte	Byte	ro	ROM	1	-	-
	2	refresh_time (SCT)	Word	Word	rw	E ² PROM	1..65,535	-	25 [ms]
	3	validation_time (SRVT)	Byte	Byte	ro	ROM	20 [ms]	-	-
	4	transmission_type	Byte	Byte	ro	ROM	254	-	-
	5 **	COB-ID_1	Long	Long	rw	E ² PROM	257..384	*	0x13F + (2x node ID)
	6 **	COB-ID_2	Long	Long	rw	E ² PROM	257..384	*	0x140 + (2x node ID)

* Default state evaluation, then addition of the node address. After overwriting, addition is no longer executed. The configuration_valid byte is reset. No plausibility check is undertaken for the COB IDs.

** For all node IDs which exceed 32 dez (33) the related COB ID 1 and COB ID 2 have to be entered manually in objects 1301, sub 05/sub 06 and 1302, sub 05/sub 06. Otherwise the SRDOs are disabled (e.g. 0x8000 0181/0x8000 0182, chap. 9.6). For all node IDs up to 32 dez the COB IDs are adopted by the encoder automatically. This has to be considered as well when the default value of the node ID exceeds 32 dez and the default values are loaded by 1011, sub 04. (See as well objects 1301, 1011 and 2000).

Only transmission type 254 is supported (Cyclic output with the defined refresh time, see 1302, sub 02).

To shut off the SRDO, both COB IDs must be disabled. If only one of the two COB IDs is disabled, setting the configuration_valid flag is not possible.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.4 CANopen process data objects

8.4 CANopen process data objects

8.4.1 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.

Transmit_PDO_1

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

8.4.2 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.

Transmit_PDO_2

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

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.5 Mapping objects

8.5 Mapping objects

8.5.1 Object 1381 SRDO1_mapping_parameters

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.

SRDO_1_mapping_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1381	0	largest_supported_sub_index	-	-	ro	ROM	8	-	-
	1	first_SRDO_mapping_object	Long	Long	ro	ROM	0x6120 0108	-	-
	2	second_SRDO_mapping_object	Long	Long	ro	ROM	0x6121 0108	-	-
	3	third_SRDO_mapping_object	Long	Long	ro	ROM	0x6120 0208	-	-
	4	fourth_SRDO_mapping_object	Long	Long	ro	ROM	0x6121 0208	-	-
	5	fifth_SRDO_mapping_object	Long	Long	ro	ROM	0x6120 0308	-	-
	6	sixth_SRDO_mapping_object	Long	Long	ro	ROM	0x6121 0308	-	-
	7	seventh_SRDO_mapping_object	Long	Long	ro	ROM	0x6120 0408	-	-
	8	eighth_SRDO_mapping_object	Long	Long	ro	ROM	0x6121 0408	-	-

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.5 Mapping objects

8.5.2 Object 1382 SRDO2_mapping_parameters

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.

SRDO_2_mapping_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1382	0	largest_supported_sub_index	-	-	ro	ROM	4	-	-
	1	first_SRDO_mapping_object	Long	Long	ro	ROM	0x6124 0108	-	-
	2	second_SRDO_mapping_object	Long	Long	ro	ROM	0x6125 0108	-	-
	3	third_SRDO_mapping_object	Long	Long	ro	ROM	0x6124 0208	-	-
	4	fourth_SRDO_mapping_object	Long	Long	ro	ROM	0x6125 0208	-	-

8.5.3 Object 1A00 transmit_PDO_1_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.

transmit_PDO_1_mapping

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1A00	0	largest_supported_sub_index	-	-	ro	ROM	2	-	-
	1	PDO1_mapping_object1	Long	Long	ro	ROM	0x6004 0020	-	-
	2	PDO1_mapping_object2	Long	Long	ro	ROM	0x6030 0110	-	-

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.5 Mapping objects

8.5.4 Object 1A01 transmit_PDO_2_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.

transmit_PDO_2_mapping

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
1A01	0	largest_supported_sub_index	-	-	ro	ROM	2	-	-
	1	PDO2_mapping_object1	Long	Long	ro	ROM	0x6004 0020	-	-
	2	PDO2_mapping_object2	Long	Long	ro	ROM	0x6030 0110	-	-

8.6 Safety CAN objects

8.6.1 Object 13FE configuration_valid

This parameter is reset (= 0) each time a "safety relevant parameter" is accessed. Entering 0xA5 switches the configuration to valid. In the case of an invalid value (not 0 or 0xA5) in the configuration_valid flag or incorrect setting of the Safety parameters, write access is rejected and the SRDOs are not transmitted in OPERATIONAL mode.

Attention:

The flag is automatically reset by writing to the safety position data in area 61xx_h.

The flag can only be activated if the data valid flag of the safety position parameter safety_configuration_valid, object 61FE_h, is activated.

The parameter is stored in the E²PROM.

configuration_valid

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
13FE	0	configuration_valid	Byte	Byte	rw	E ² PROM	0 / 0xA5	-	0x0

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.6 Safety CAN objects

8.6.2 Object 13FF safety_configuration_checksum

This parameter contains the checksum crosswise through the safety CAN parameters in objects 1301 and 1302 according to the table below. The checksum is written by the master. The checksum is checked on setting the configuration_valid flag. If no correspondence with the checksum stored in this object is ascertained, setting the flag is blocked (configuration_valid remains ZERO). To calculate the CRC checksum you can use the special TWK program.

Link to the program on www.twk.de: Look at device → “Download” and “Software Safety CRC”.

Or use the following link: www.twk.de/files/CRC-Calculator20.zip

Description file: CRC 14076. Please ask our technicians for xml files for special versions of encoders or look at www.twk.de.

Attention: The parameter can only be written if the data valid flag of the safety position parameter safety_configuration_valid, object 61FE, is activated. See example for parameterization at the end of this document.

safety_configuration_checksum

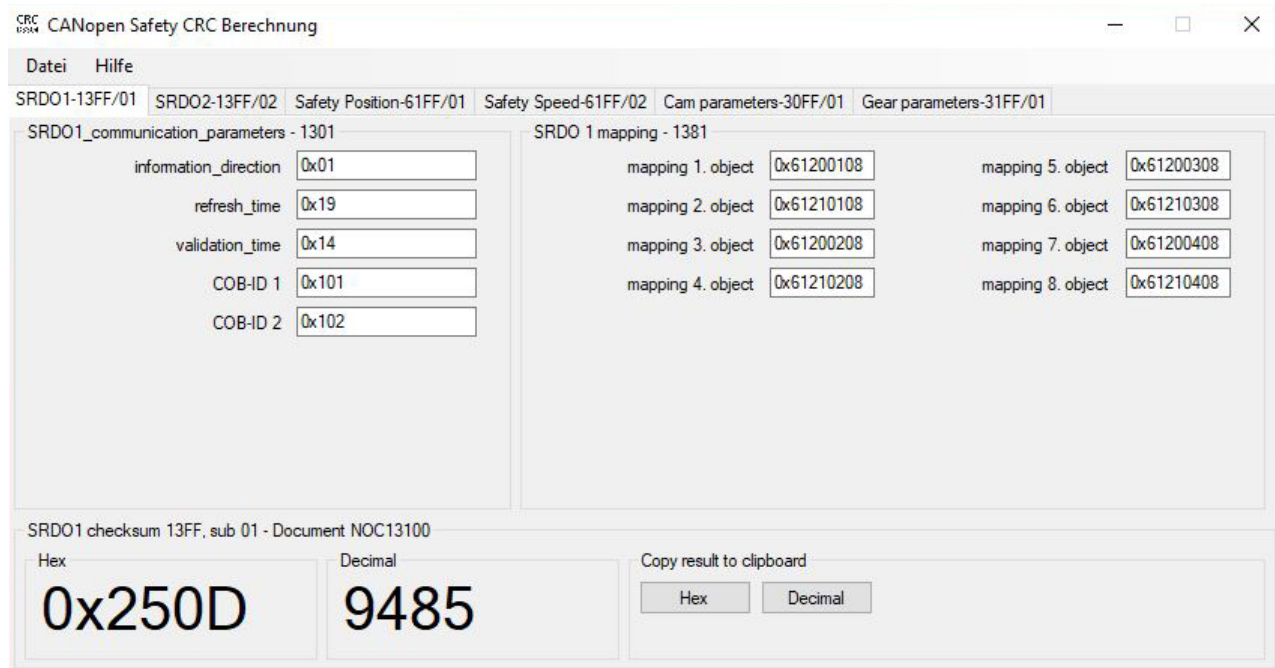
Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
13FF	0	largest_supported_sub-index	Byte	Byte	ro	ROM	4	-	4
	1	SRDO1_checksum (for changes in object 1301)	Word	Word	rw	E ² PROM	0 ... 0xFFFF	-	0x250D
	2	SRDO2_checksum (for changes in object 1302)	Word	Word	rw	E ² PROM	0 ... 0xFFFF	-	0x597B

TWK Program for calculation of the checksum:

Generator polynomial: $2^{16} + 2^{12} + 2^5 + 1 = 0x11021$

Initial value: 0x0000

Final XOR: no



Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.6 Safety CAN objects

CRC
61508
CANopen Safety CRC Berechnung
— □ ×

Datei Hilfe

SRDO1-13FF/01
SRDO2-13FF/02
Safety Position-61FF/01
Safety Speed-61FF/02
Cam parameters-30FF/01
Gear parameters-31FF/01

SRDO2_communication_parameters - 1302

information_direction

refresh_time

validation_time

COB-ID 1

COB-ID 2

SRDO 2 mapping - 1382

mapping 1. object	<input type="text" value="0x61240108"/>	mapping 3. object	<input type="text" value="0x61240208"/>
mapping 2. object	<input type="text" value="0x61250108"/>	mapping 4. object	<input type="text" value="0x61250208"/>

SRDO2 checksum 13FF, sub 02 - Document NOC13100

<p>Hex</p> <div style="border: 1px solid gray; padding: 10px; font-size: 24px; font-weight: bold;">0x597B</div>	<p>Decimal</p> <div style="border: 1px solid gray; padding: 10px; font-size: 24px; font-weight: bold;">22907</div>	<p>Copy result to clipboard</p> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> Hex Decimal </div>
---	--	---

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.7 LMT objects

8.7 LMT objects

8.7.1 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.

For all node IDs which exceed 32 dez (33) the related COB ID 1 and COB ID 2 have to be entered manually in objects 1301, sub 05/sub 06 and 1302, sub 05/sub 06. Otherwise the SRDOs are disabled (i.e. 0x8000 0122 /0x8000 0123, chap. 9.6). For all node IDs up to 32 dez the COB IDs are adopted by the encoder automatically. This has to be considered as well when the default value of the node ID exceeds 32 dez and the default values are loaded by 1011, sub 04. (See as well objects 1301, 1302 and 1011).

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

8.7.2 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 (250 kBaud)

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.8 Objects according to profile definition

8.8 Objects according to profile definition

8.8.1 Object 6000 operating_parameters

Operating mode byte for the sensor.

The parameter is mirrored from the safety area.

The state table:

Bit	m/o	Designation	0	1
0	m	Code direction	CW	CCW
1	o	Set firmly to low		
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	0x0,4

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.8 Objects according to profile definition

8.8.2 Object 6001 measuring_units_per_revolution

Number of steps per revolution.

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	rw	E ² PROM	depending on model and performance e.g.: 4096	-	-

8.8.3 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	rw	ROM	depending on model and performance e.g.: 16777216	-	-

8.8.4 Object 6003 preset_value

Sets the encoder to the value specified in object 6003 or 6100.

The parameter is mirrored from the safety area.

preset_value

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

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.8 Objects according to profile definition

8.8.5 Object 6004 position_value, Object 600C raw_position_Value

Position value. This value is the measured value.

The parameter is provided as a position value by the sensor. This object is updated cyclically. The parameter is taken over from the safety area and contains the secure measured value.

position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6004	0	position_value	Long	Long	ro	RAM	0..(obj 6002) -1	-	-

Remark: Object 600C contains the position raw data with a resolution depending on device. 600C can be used for calculating the speed signal with max. resolution (see object 6101).

8.8.6 Object 600C raw_position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
600C	0	raw_position_value	Long	Long	ro	RAM	0..(obj 6002) -1	-	-

8.8.7 Object 6030 speed_value

Speed value. The dimension is digits per object 6031 sub-index 2 in ms with a resolution of max.12 bits. This object is updated cyclically.

This parameter is equivalent to safety object 6124.

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..(obj 6002) -1	-	-

8.8.8 Object 6031 speed_parameter

The object is mirrored from the safety area (object 6101).

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	rw	ROM	1, 2	-	2*
	2	speed_integration_time	Word	Word	rw	RAM	1 to 1000 [ms]	-	100*
	3	speed_multiplier	Word	Word	rw	RAM	1 to 65535	-	100*
	4	speed_divider	Word	Word	rw	RAM	1 to 65535	-	10*

* Mirrored from object 6101

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.9 Safety objects according to profile definition

8.9 Safety objects according to profile definition

8.9.1 Object 6100 safety_position_configuration_parameters

The object defines the behaviour of the position registration system in the safety area.

Modifications will cause 61FE = '0' (must be set '0xA5' after modification). New CRC Checksum 61FF/01 must be calculated and transmitted to the encoder.

The parameter can only be changed in PRE-OPERATIONAL state.

safety_position_configuration_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6100	0	largest_supported_sub_index	Byte	Byte	ro	ROM	3	-	-
	1	safety_code_sequence	Word	Word	rw	E ² PROM	0 to 1 (0=cw, 1=ccw)	-	0
	2	safety_preset_value	Long	Long	rw	E ² PROM	0..(obj 6002)-1		0
	3	Safety_HR*_preset_value			ro		0x7FFFFFFFFF FFFFFF		

* High resolution

8.9.2 Object 6101 safety_speed_configuration_parameters

The object defines the behaviour of speed measurement in the safety area.

Modifications will cause 61FE = '0' (must be set '0xA5' after modification). New CRC Checksum 61FF/02 must be calculated and transmitted to the encoder.

The parameter can only be changed in PRE-OPERATIONAL state.

If 6100, sub01, sub02 and sub03 is modified, 6101, sub01, sub02 and sub03 is modified automatically and vice versa.

safety_speed_configuration_parameters

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6101	0	largest_supported_sub_index	Byte	Byte	ro	ROM	7	-	-
	1	safety_code_sequence	Word	Word	rw	E ² PROM	0, 1 (0=cw, 1=ccw)	-	0
	2	safety_preset_value	Long	Long	rw	E ² PROM	0..(obj 6002)-1	-	0
	3	safety_preset_HR_value	Long64	Long64	ro	ROM	0x7FFFFFFFFF FFFFFF	-	-
	4	safety_speed_source *	Byte	Byte	rw/ro	ROM	1, 2	-	2
	5	safety_speed_integration_time	Word	Word	rw	E ² PROM	1...1000 [ms]	-	100
	6	safety_speed_multiplier	Word	Word	rw	E ² PROM	1 ... 65535	-	100
	7	safety_speed_divider	Word	Word	rw	E ² PROM	1 ... 65535	-	10

* 1 = scaled position from object 6004. 2 = Raw data of position from object 600C, no scaling factor enabled. The related resolution of setting 1 or 2 for the speed signal depends on the device

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.9 Safety objects according to profile definition

8.9.3 Object 6120 safety_standard_position_value

The object contains the current position. This object is used in the mapping structure for data output within the SRDO. In the event of access to individual objects, it must be noted that the consistency of the measured value is not ensured.

safety_standard_position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6120	0	largest_supported_sub_index	Byte	Byte	ro	ROM	4	-	-
	1	position_value_1	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	2	position_value_2	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	3	position_value_3	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	4	position_value_4	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-

8.9.4 Object 6121 safety_inverted_position_value

The object contains the current bit-inverted position. This object is used in the mapping structure for data output within the SRDO. In the event of access to individual objects, it must be noted that the consistency of the measured value is not ensured.

safety_inverted_standard_position_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6121	0	largest_supported_sub_index	Byte	Byte	ro	ROM	4	-	-
	1	inverted_position_value1	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	2	inverted_position_value2	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	3	inverted_position_value3	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-
	4	inverted_position_value4	Byte	Byte	ro	RAM	0..(obj 6002)-1	-	-

8.9.5 Object 6124 safety_speed_value

The object contains the current measured speed value. This object is used in the mapping structure for data output within the SRDO. In the event of access to individual objects, it must be noted that the consistency of the measured value is not ensured.

safety_speed_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6124	0	largest_supported_sub_index	Byte	Byte	ro	ROM	2	-	-
	1	speed_value1	Byte	Byte	ro	RAM	0..0xFFFF	-	-
	2	speed_value2	Byte	Byte	ro	RAM	0..0xFFFF	-	-

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8.9 Safety objects according to profile definition

8.9.6 Object 6125 safety_inverted_speed_value

The object contains the current bit-inverted measured speed value. This object is used in the mapping structure for data output within the SRDO. In the event of access to individual objects, it must be noted that the consistency of the measured value is not ensured.

safety_inverted_speed_value

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
6125	0	largest_supported_sub_index	Byte	Byte	ro	ROM	2	-	-
	1	inverted_speed_value1	Word	Word	ro	RAM	0 ..0xFFFF	-	-
	2	inverted_speed_value2	Word	Word	ro	RAM	0 ..0xFFFF	-	-

8.9.7 Object 61FE safety_configuration_valid

The object is the confirmation flag stating that the configuration is valid. On setting the flag, the consistency of the CRC checksum and the set parameters is checked.

This parameter can only be changed in PRE-OPERATIONAL state.

When the CRC checksum is not correct (i.e. in case of changes of parameters without changing the CRC checksum or a wrong checksum is transmitted to the encoder) 61FE can't be activated. An error message comes: (e.g. 80 fe 61 00 22 00 00 08).

Attention:

safety_configuration_valid

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
61FE	0	safety_configuration_valid	Byte	Byte	rw	E ² PROM	0/0xA5	-	0xA5

8.9.8 Object 61FF safety_configuration_signature

The object contains the checksum across the safety encoder parameters in objects 6100 and 6101. The checksum must be rewritten in the event of changes by the user. The checksum is checked on setting the configuration_valid flag. If no correspondence with the checksum stored in this object is ascertained, setting the flag is blocked (safety_configuration_signature remains ZERO). To calculate the CRC checksum you can use the special TWK program.

Link to the program on www.twk.de : Look at device → download "Software Safety CRC".

Or use the following link: www.twk.de/files/CRC-Calculator20.zip. Description file: CRC14076

Please ask our technicians for xml files for special versions of encoders or look at www.twk.de.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.9 Safety objects according to profile definition

The parameter can only be changed in PRE-OPERATIONAL state.

safety_configuration_signature

Index	Sub	Description	Length		Memory		Range/value	Action	Default
			COM	MEM	Type	Location			
61FF	0	largest_supported_sub_index	Byte	Byte	ro	ROM	4	-	4
	1	SRDO1_signature (for changes in object 6100)	Word	Word	rw	RAM	0 ..0xFFFF	-	0x...*
	2	SRDO2_signature (for changes in object 6101)	Word	Word	rw	RAM	0 ..0xFFFF	-	0x...*

* Depends on default values in objects 6100 and 6101. Pay attention to the different values which have to be tagged in the TWK program for the CRC checksums for sub 1 and sub 2.

8.10 Objects for achieving compatibility

8.10.1 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 PDO 1. 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

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.11 Diagnosis objects

8.11 Diagnosis objects

8.11.1 Object 6500 operating_status

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

The parameter is provided by the sensor.

operating_status

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

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

8.11.2 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	max. 65536	-	-

8.11.3 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	4096	-	-

8.11.4 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	Not used
5	CRC parameter error
6	Supply out of range
7	Sensor error

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.11 Diagnosis objects

Extended error coding is available for certain errors in this byte in the emergency message and in object 1003 pre_defined_error_field.

- 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 recognizes 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	-

8.11.5 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	0xE8	-	-

8.11.6 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	-	-

8.11.7 Object 6507 profile_and_software_version

The profile and software version of the encoder.

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	0x400100102	-	-

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.11 Diagnosis objects

8.11.8 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	-	-

8.11.9 Object 6509 offset_value

Output offset. In our encoders, this is the zero point cell.

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	-

8.11.10 Object 650A module_identification

The manufacturer offset is used as the zero point parameter for synchronising the two nodes' position data. 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	Long	ro	ROM	0..(obj 6001) -1	-	*

* Written in factory programming state.

8.11.11 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	0...	*	-

* Written in factory programming state.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

8.11 Diagnosis objects

8.11.12 Object 650D absolute_accuracy

Displays the accuracy of the measuring value.

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	10 *

* Depending on device

8.11.13 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
		0b011 to 0b111	Reserved
		rsl: Resolution	3
		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	0x23		-

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

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

9 Object listing

9 Object listing

Name	Index	Sub	Len	Value dez	Value hex	Remark
device_type	1000		4	131478	0x00020196	
error_register	1001		1	0	0x00	
PredefinedErrorField	1003					
NumberOfErrors		0	1	0	0xX	
StandardErrorField_1 to StandardErrorField_13		1 to 0B	4			
COB-ID_SYNC	1005		4	128	0x00000080	
manufacturer_device_name	1008		18	-	-	Encoder TRN Safety
manufacturer_hardware_version	1009		13	-	-	P-0xxx
manufacturer_software_version	100a		15	-	-	Safety Standard
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_EMCY	1014		4	141	0x0000008D	
EMCY_inhibit_time	1015		2	1000	0x03E8	
producer_heartbeat_time	1017		2	0	0x0	
identity_object	1018					
largest_supported_sub-index		0	1	4	0x04	
vendor-ID		1	4	269	0x000010D	
product_code		2	4	25376	0x0000xxxx	
revision_number		3	4	65537	0x00020002	
serial_number		4	4	x	0xxxxxxx	

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9 Object listing

Name	Index	Sub	Len	Value dez	Value hex	Remark
error_behaviour	1029					
NrofErrorClasses		0	1	3	0x03	
CommunicationError		1	1	0	0x00	
InternalDeviceError		2	1	0	0x00	
		3	1	1	0x00	
RedundancyError (only for full redundant encoders)	4	1	1	0x01		
SRDO1_communication_parameter	1301					
largest_supported_sub-index		0	1	6	0x06	
information_direction		1	1	1	0x01	
SRDO_refresh_time		2	2	25	0x0019	
validation_time		3	1	20	0x14	
transmission_type		4	1	254	0xFE	
SRDO_compar_COB_ID_1		5	4	281	0x0000119	0: active 8: inactive
SRDO_compar_COB_ID_2		6	4	282	0x000011A	0: active 8: inactive
SRDO2_communication_parameter	1302					
largest_supported_sub-index		0	1	6	0x06	
information_direction		1	1	1	0x01	
SRDO_refresh_time		2	2	25	0x0019	
validation_time		3	1	20	0x14	
transmission_type		4	1	254	0xFE	
SRDO_compar_COB_ID_1		5	4	345	0x0000159	0: active 8: inactive
SRDO_compar_COB_ID_2	6	4	346	0x000015A	0: active 8: inactive	
SRDO1_mapping_parameter	1381					
largest_supported_sub-index		0	1	8	0x08	
first_SRDO_mapping_object		1	4	1629487368	0x61200108	
second_SRDO_mapping_object		2	4	1629552904	0x61210108	
third_SRDO_mapping_object		3	4	1629487624	0x61200208	
fourth_SRDO_mapping_object		4	4	1629553160	0x61210208	
fifth_SRDO_mapping_object		5	4	1629487880	0x61200308	
sixth_SRDO_mapping_object		6	4	1629553416	0x61210308	
seventh_SRDO_mapping_object		7	4	1629488136	0x61200408	
eighth_SRDO_mapping_object	8	4	1629553672	0x61210408		
SRDO2_mapping_parameter	1382					
largest_supported_sub-index		0	1	4	0x04	
first_SRDO_mapping_object		1	4	1629749512	0x61240108	
second_SRDO_mapping_object		2	4	1629815048	0x61250108	
third_SRDO_mapping_object		3	4	1629749768	0x61240208	
fourth_SRDO_mapping_object	4	4	1629815304	0x61250208		

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9 Object listing

Name	Index	Sub	Len	Value dez	Value hex	Remark	
Configuration_valid	13fe		1	0	0x00		
safety_configuration_checksum							
Safety_checksum_Number_of_entries	13ff	0	1	4	0x04		
SRDO1_checksum		1	2 *	0x.... *		
SRDO2_checksum		2	2 *	0x.... *		
first_transmit_PDO_parameter							
largest_supported_sub-index		0	1	5	0x05		
COB-ID_used_by_PDO	1800	1	4	385	0x8000018D	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							
largest_supported_sub-index		0	1	2	0x02		
COB-ID_used_by_PDO	1801	1	4	641	0x8000028D	0: active 8: inactive	
transmission_type		2	1	1	0x01		
first_transmit_PDO_mapping							
largest_supported_sub-index	1a00	0	1	2	0x02		
PDO_mapping_for_the_first_object		1	4	1610874912	0x60040020		
PDOMappingEntry_2		2	4	1613758736	0x60300110		
second_transmit_PDO_mapping							
largest_supported_sub-index	1a01	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	4096	0x00001000		
total_measuring_range_in_measuring_units	6002		4	16777216	0x01000000		
preset_value	6003		4	0	0x0		
position_value	6004		4	x	0xX		
raw_position_value	600c		4	x	0xX		
Speed value							
NrOfObjects	6030	0	1	1	0x1		
Speed value channel 1		1	2	x	0xX		
speed_parameter							
NrOfObjects	6031	0	1	2	0x04		
speed_source_selector		1	1	2	0x02		
speed_integration_time		2	2	100	0x0064		
speed_multiplier		3	2	100	0x0064		
speed_divider		4	2	10	0x000A		

* Depends on settings ex work.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

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Name	Index	Sub	Len	Value dez	Value hex	Remark
safety_position_configuration_parameters	6100					
NrOfObjects		0	1	3	0x03	
safety_code_sequence		1	2	0	0x0	
safety_preset_value		2	4	0	0x0	
safety_preset_value_high_resolution		3	8			0x7FFFFFFF FFFFFF
safety_speed_configuration_parameters	6101					
NrOfObjects		0	1	5	0x05	
safety_code_sequence		1	2	0	0x0	
safety_preset_value		2	4	0	0x0	
safety_preset_value_high_resolution		3	8	0		0x7FFFFFFF FFFFFF
safety_speed_source_selector		4	1	2	0x02	
safety_speed_integration_time		5	2	100	0x0064	
safety_speed_multiplier		6	2	100	0x0064	
safety_speed_divider	7	2	10	0x00A		
safety_position_value	6120					
NrOfObjects		0	1	4	0x04	
safety_position_value_1		1	1	x	0xX	
safety_position_value_2		2	1	x	0xX	
safety_position_value_3		3	1	x	0xX	
safety_position_value_4	4	1	x	0xX		
safety_inverted_position_value	6121					
NrOfObjects		0	1	4	0x04	
safety_inverted_position_value_1		1	1	x	0xX	
safety_inverted_position_value_2		2	1	x	0xX	
safety_inverted_position_value_3		3	1	x	0xX	
safety_inverted_position_value_4	4	1	x	0xX		
safety_speed_value	6124					
NrOfObjects		0	1	2	0x02	
safety_speed_value_1		1	1	x	0xX	
safety_speed_value_2	2	1	x	0xX		
safety_inverted_speed_value	6125					
NrOfObjects		0	1	2	0x02	
safety_inverted_speed_value_1		1	1	x	0xX	
safety_inverted_speed_value_2	2	1	x	0xX		
safety_application_configuration_valid	61fe		1	165	0xA5	
safety_application_configuration_signature	61ff					
NrOfObjects		0	1	4	0x04	
SRDO1_signature		1	2 *	0x.... *	
SRDO2_signature		2	2 *	0x.... *	
SRDO1_control_signature		3	2 *	0x.... *	
SRDO2_control_signature	4	2 *	0x.... *		

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Name	Index	Sub	Len	Value dez	Value hex	Remark
cyclic_timer	6200		2	0	0x0	
operating_status	6500		2			
singleturn_resolution	6501		4	4096	0x1000	
number_of_distinguishable_revolutions	6502		2	4096	0x1000	
alarms	6503		2	0	0x0	
supported_alarms	6504		2	63488	0xF800	
supported_warnings	6506		2	0	0x0	
profile_and_software_version	6507		4	xxxxxxx	0XXXXXXXXX	
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	10	0xA	
Device_capability	650e		4	35	0x23	
node-ID	2000		1	13	0x0D	
bit_rate	2001		1	2	0x03	

* Depends on settings ex work.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

10 Example of parameterisation of encoder TBN/TRN with CANopen Safety

10 Example of parameterisation of encoder TBN/TRN with CANopen Safety

10.1 Parameter setting Object 2000 safety_node ID: 0x1 -> 0x11 (= 17dez)

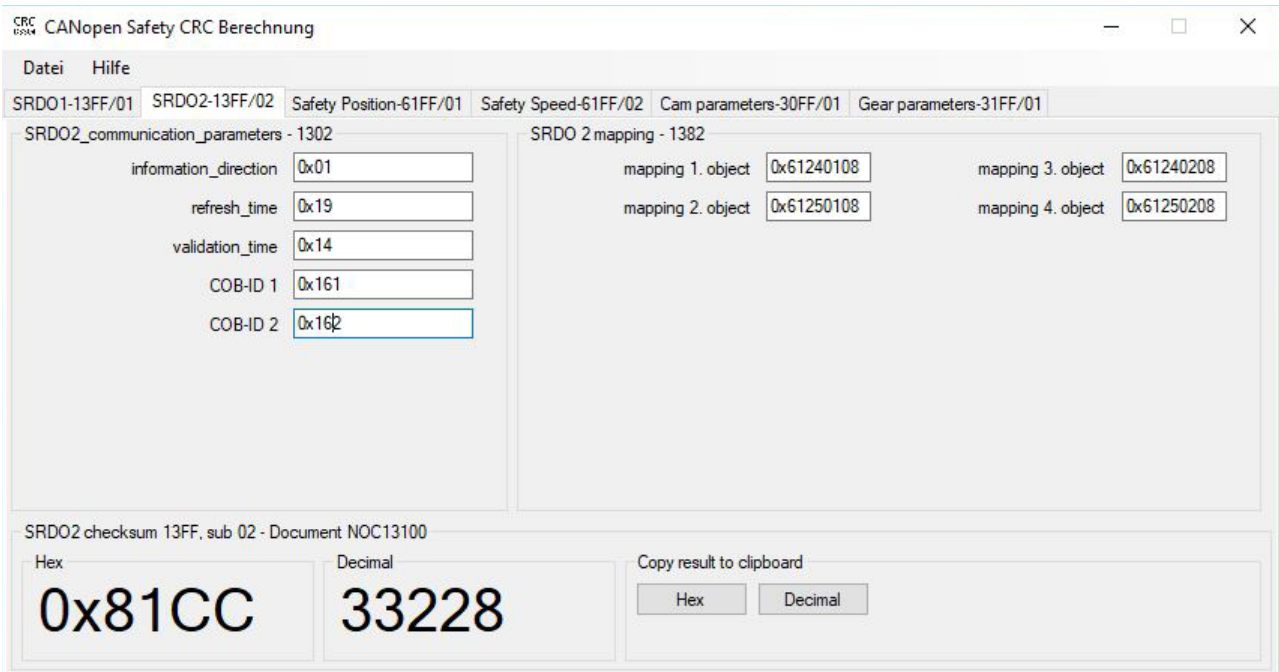
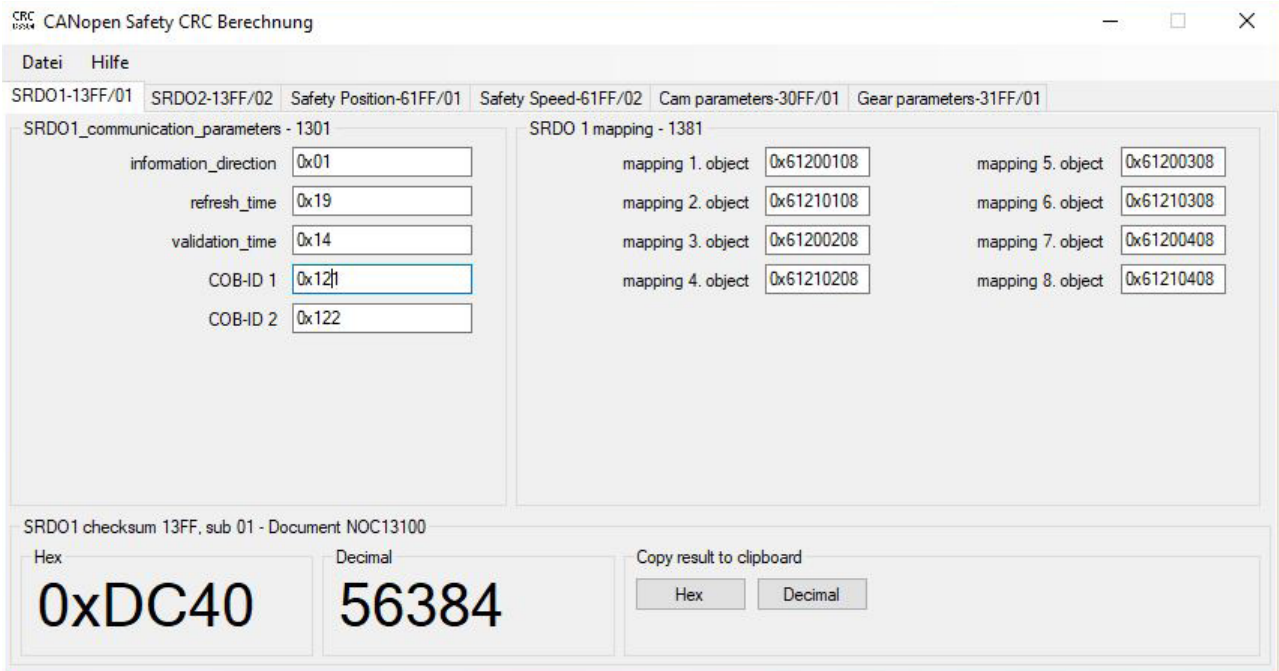
Step	Description	ID	DLC	Byte								Comment
				1	2	3	4	5	6	7	8	
				cs	Index		Sub-Index	Value				
1	Set preoperational	0	2	80	01							
2	Deactivating 13fe/00: configuration_valid	601	8	2f	fe	13	00	00	00	00	00	13fe/00: 00
		581	8	60	fe	13	00	00	00	00	00	
3	Set 2000/00 node ID: 0x11	601	8	2f	00	20	00	11	00	00	00	2000/00: 0x11
		581	8	60	00	20	00	00	00	00	00	
4	Save_LMT_parameters 1010/04	601	8	23	10	10	04	73	61	76	65	1010/04: 0x65766173 (save)
		581	8	60	10	10	04	00	00	00	00	
5	Set 1301/05: COB-ID1	601	8	23	01	13	05	21	01	00	00	1301/05: 121 COB_ID_1 = FF + 2 * Node ID
		581	8	60	01	13	05	00	00	00	00	
6	Set 1301/06: COB-ID2	601	8	23	01	13	06	22	01	00	00	1301/06: 122 COB_ID_2 = 100 + 2 * Node ID
		581	8	60	01	13	06	00	00	00	00	
7	Set 1302/05: COB-ID1	601	8	23	02	13	05	61	01	00	00	1302/05: 161 COB_ID_1 = 13F + 2 * Node ID
		581	8	60	02	13	05	00	00	00	00	
8	Set 1302/06: COB-ID2	601	8	23	02	13	06	62	01	00	00	1302/06: 162 COB_ID_2 = 140 + 2 * Node ID
		581	8	60	02	13	06	00	00	00	00	
9	Calculate CRC checksum (TWK program)											
10	Set 13ff/01: safety_configuration_checksum SRDO1	601	8	2b	ff	13	01	40	DC	00	00	13ff/01: 0xDC40 COB-ID1: 0x121 COB-ID2: 0x122
		581	8	60	ff	13	01	00	00	00	00	
11	Set 13ff/02: safety_configuration_checksum SRDO2	601	8	2b	ff	13	02	CC	81	00	00	13ff/02: 0x81CC COB-ID1: 0x161 COB-ID2: 0x162
		581	8	60	ff	13	02	00	00	00	00	
12	Activating 13fe/00: configuration_valid	601	8	2f	fe	13	00	a5	00	00	00	13fe/00: 0xa5
		581	8	60	fe	13	00	00	00	00	00	
13	Save_all_parameters 1010/01	601	8	23	10	10	01	73	61	76	65	1010/01: 0x65766173 (save) See object 1010 for detailed information concerning sub-indices!
		581	8	60	10	10	01	00	00	00	00	
14	Power off/Power on											
15	Set operational	0	2	11								
16	Position	121	4	12	23	01	00					
17	Position inverted	122	4	ED	DC	FE	FF					
18	Velocity	161	2	23	01							
19	Velocity inverted	162	2	DC	FE							

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

10 Example of parameterisation of encoder TBN/TRN with CANopen Safety

10.2 Screenshots: CRC checksum calculation program

Checksum for 13FF, sub 01 and 02 for Node-ID:.0x11



Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

11 Error behaviour of the encoder

11 Error behaviour of the encoder

11.1 General hints to the error behaviour

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. The data output of the CANopen Safety system is no longer able to work in case a sensor error occurs.

Through the error_behaviour object 1029 the CAN interface can be set up to be operated independently from the status of the sensor.

11.1.1 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 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).

11.1.2 CANopen emergency messages

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:

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

11.1.3 CANopen emergency messages

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
EMC (emergency) error code		Error register	Object 6503 (Alarms)		Specific error code		

EMC (emergency) error codes (Byte 0-1)	
0xFFFF	Customer-specific error; error in the sensor system
0x8120	Passive state error
0x8140	Return from bus off state
0x8110	Overrun error, not all messages can be transmitted by the sensor

Error register (Byte 2): Object 1001		
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 error

Object 6503 (Alarms), (Byte 3-4):	
Bit	Error type
0 - 2	Not used
3	Device error
4	Not used
5	CRC parameter error
6	Supply out of range
7	Sensor error

Specific error code (Byte 5-7):
This part is very differentiated. Examples of typical error messages shown below.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

11.1.3 CANopen emergency messages

Emergency messages (sent on ID 80 + node-ID)								
B0	B1	B2	B3	B4	B5	B6	B7	
FF	FF	81	00	80	01	02	42	
error in the sensor system		generic error, manufacturer-specific error		sensor error		sensor error		error parameter
FF	FF	81	00	20	00	00	00	
				CRC parameter error				
FF	FF	81	00	40	00	00	01	
				supply voltage out of range		supply voltage too high		
FF	FF	81	00	40	00	00	02	
				supply voltage out of range		supply voltage too low or short voltage dips		
FF	FF	81	00	80	03	03	00	
				sensor error		overall	speed overflow	
FF	FF	81	00	80	03	04	00	
						synchronisation fault		
20	81	11	00	00	00	00	00	
passive error state		generic error, communication error						
40	81	11	00	00	00	00	00	
return from bus off state								
Expiry of the inhibit time is followed by the message "correct operation"								
00	00	00	00	00	00	00	00	
Expiry of the inhibit time is followed by the message "correct operation"								

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.

The user of the overall system must assess the errors in the bus system and define the reaction to them.

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

A Appendix

A Appendix

A.1	Command specifier for SDO Messages
A.2	Configuration valid of the safety node (SRDO Parameter set)
A.3	NMT State transitions
A.4	NMT States
A.5	CANopen features of the encoder
A.6	Contact addresses

A.1 Command specifier for SDO Messages

Command specifier describes the type of SDO Message (see examples for SDOs, CiA 301 Work Draft - CANopen application layer and communication profile)		
Command specifier in hex	Type	Function
22	SDO (rx)	Transmit parameter to encoder Initiate download request (data length max. 4 bytes)
23	SDO (rx)	Transmit parameter to encoder Initiate download request (data length max. 4 bytes)
2B	SDO (rx)	Transmit parameter to encoder Initiate download request (data length = 2 bytes)
2F	SDO (rx)	Transmit parameter to encoder Initiate download request (data length = 1 byte)
60	SDO (tx)	Confirmation of take-over to master Initiate download response
40	SDO (rx)	Request parameter from encoder Initiate upload request
43	SDO (rx) Initiate upload response	Parameter to master with data length = 4 bytes Initiate upload response (Unsigned 32)
4B	SDO (rx) Initiate upload response	Parameter to master with data length = 2 bytes Initiate upload response (Unsigned 16)
4F	SDO (rx) Initiate upload response	Parameter to master with data length = 1 byte Initiate upload response (Unsigned 8)
80	SDO (rx)	Encoder reports error code to master Abort domain transfer

A.2 Configuration valid of the safety node (SRDO Parameter set)

Switch the safety node 1 in the state configuration valid										
ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Function
		cs	SDO		Sub-Index	Data				
701	1	7F								Node 1 in preoperational mode
601	8	2F	FE	13	00	A5	00	00	00	configuration valid
581	8	60	FE	13	00	00	00	00	00	answer sensor

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

A Appendix

A.3 NMT State transitions

ID	DLC	Byte 0	Byte 1	Byte 2 - 7	Function
0	2	2	01	00	change to NMT state operational (node-Id = 1)
0	2	80	01	00	change to prepared (stop)
0	2	81	01	00	change to NMT state pre-operational
0	2	81	01	00	reset node
0	2	82	01	00	reset communication

A.4 NMT States

ID	DLC	Byte 0	Function
700 + Node-Id	1	0	Boot up
700 + Node-Id	1	04	Stop
700 + Node-Id	1	05	operational mode
700 + Node-Id	1	7F	pre-operational

A.5 CANopen Features of the encoder

- NMT Master: no
- NMT-Slave: yes
- Maximum Boot up: no
- Minimum Boot up: yes
- COB ID Distribution: Default, SDO
- Node ID Distribution: via Index 2000 or LSS (CiA 305)
- No of PDOs: 2 Tx/Rx
- PDO-Modes: sync, async, cyclic, acyclic, safety specific regarding standard
- Variables PDO-Mapping: no
- Emergency Message: yes
- Heartbeat: yes
- No. of SRDOs: 2 (Position and Velocity - normaly and inverted)
- Device Profile: CiA DS 406 Version 4.0.2 (CANopen or CANopen Safety - SIL2)

Specification CANopen Safety (IEC 61508) and CANopen for absolute encoder TBN/TRN

A Appendix

A.6 Contact addresses

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