SUPREME SENSORING

TWK

Absolute encoder
Model TRK/S3
Interface: Safety over EtherCAT®

Document no.:
TRK 13349 ME
06.05.2025

USER MANUAL

Safety over EtherCAT®

SIL2 IEC 61508 FUNCTIONAL SAFETY SENSOR

PLd ISO 13849 FUNCTIONAL SAFETY SENSOR

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SAFETY INSTRUCTIONS

1. SAFETY INSTRUCTIONS

1.1 Scope

This user manual is valid exclusively for the following inclination sensor with EtherCAT interface:

- TRKxx-xxxxxxx RS3xKxx (Singleturn)
- TRKxx-xxxxxxx x4096S3xKxx (Multiturn)

1.2 Documentation

The following documents must be observed:

- The owner's system-specific operating instructions
- This user manual
- Data sheet number TRK58: 13348, TRK42: 17023, TRK38: 15532
- The connection assignment enclosed with the device
- Assembly instructions AN16169 enclosed with the device

1.3 Proper use

The TWK-ELEKTRONIK GmbH absolute encoders and linear transducers are used to register angular or linear 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.

1.4 Commissioning

- The relevant device may only be set up and operated in combination with this and the documentation specified under point 1.2.
- 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.

GENERAL INFORMATION

2. GENERAL INFORMATION

The TRK/S3 model is an absolute electromagnetic rotary encoder with Failsafe over EtherCAT (FSoE) interface. Thanks to his redundant sensor system and additional internal monitoring measures, it is suitable for use in safety-related applications up to SIL2 or PLd.

In addition to a safe position signal, the TRK/S3 also supplies a safe vehicle speed signal. Use of the CANopen over EtherCAT message (CoE) enables parameter and diagnostic data handling as familiar from CANopen.

The EtherCAT interface according to IEC 61158-2 to 6 and the encoder profile CiA DSP406 plus the FSoE protocol as per Safety over EtherCAT Specification ETG.5100 Version 1.2.0 are implemented.

The EtherCAT specifications must be obtained from the EtherCAT Technology Group ETG (www.ethercat.org).

INSTALLATION

3. INSTALLATION

3.1 General information

The physical characteristics of the interface are based on the 100BASE-TX Ethernet standard in accordance with ISO/ I EC 8802-3. As a result of this:

- The EtherCAT cable must at least meet the requirements according to CAT5.
- The max. cable length between two subscribers may be 100 m.
- Setting the baud rate is not possible/necessary.

In the case of EtherCAT, the network topology normally has a linear structure. However, tree structures or branch-off lines may also be implemented by means of bus modules with an integrated switch port.

In contrast to the EDP networks which are usual today, hubs are not permissible, and a standard switch is only permitted directly to the rear of the master (the first subscriber must then possess a MAC address).

For wiring purposes, we recommend pre-assembled data cables with M12 connectors moulded on at both ends. These can be ordered from us in various lengths (see data sheet TRK13348 or TRK17023 (TRK42)). Terminating resistors are not necessary.

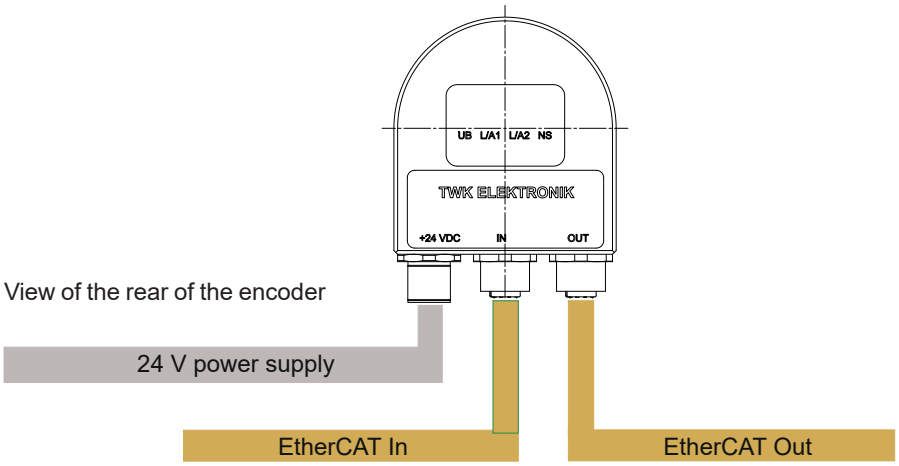
3.2 Electrical connection

The „...M01“ type absolute encoders have separate connectors, encoders with cable output type "...KxK01" have separate connection cables for the supply and the EtherCAT system…

Connection	Name	Connector type
EtherCAT	IN	M12x4 D-coded socket or M8x4 A-coded socket (TRK42)
EtherCAT	Out	M12x4 D-coded socket or M8x4 A-coded socket (TRK42)
Power supply	24 VDC	M12x4 A-coded pins or or M8x4 A-coded pins (TRK42)

See data sheet TRK13348 or TRK17023 (TRK42) for connector assignment.

Fig.: 1



3.3 Addressing

Manually setting the subscriber address is not necessary. It is assigned automatically by the EtherCAT master in accordance with the physical sequence in the bus.

INSTALLATION

3.4 Status LEDs

Four LEDs are housed in the absolute encoder's connecting cap. These have the following meaning:

UB	Link/Activity (L/A)	Status (ST)		Description
green	**green**	**green**	**red**	
on				Operating voltage available
	on			Network connection established
	flashing			Network active
		off		Initialisation
		1x flashing		Safe-Operational
		flashing		Pre-Operational
		on		Operational
			off	Normal operating mode
			flickering	Boot error
			flashing	General configuration error
			1x flashing	Change of EtherCAT state due to internal error
			2x flashing	EtherCAT watchdog expired
			on	Critical communication controller error

3.5 XML file

An XML file (ESI file) to integrate the absolute encoder into a project planning tool is available for download on our website www.twk.de (under documentation). This describes the features of the EtherCAT subscriber in the standardised XML format.

After integrating the XML file into the project planning tool (e.g. TwinCAT System Manager from Beckhoff), the absolute encoder can be integrated off-line into the bus.

4. PROCESS DATA EXCHANGE

4.1 Overview

Input data: Controller ← Encoder

Octet																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Com-mand	position low		CRC_0		position high		CRC_1		Speed		CRC_2		Status		CRC_3		Connection ID		

Output data: Controller → Encoder

Octet						
1	2	3	4	5	6	7
Command	Control		CRC_0		Connection ID	

4.2 Input data

4.2.1 Position data format

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

* At 12 bit resolution. With higher resolution correspondingly longer.

The position value is output as a 32-bit signed integer value in Intel format (Little-Endian).The absolute encoder's counting direction and the preset value can be changed via the CoE-Parameter 6100_h "Safety position configuration parameters". (see chapter 5.4.1).

4.2.2 Velocity data format

The velocity value is determined via the cyclically read-in of the position data. The dimension is steps per gating time. The gating time (time interval for determining the change of position) is adjustable in the range of 10 - 1000 ms (see chapter 5.4.2). The default value is 10 ms. A multiplier and a divider for scaling the speed value are also available here.

Octet 11								Octet 10							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16 bit velocity															

The speed value is output as a 16-bit signed integer value in Intel format (Little-Big Endian). The following applies to the prefix:

- positive for increasing position
- negative for decreasing position

The refresh rate of the velocity signal is independent from the selected gating time always 1 ms. The speed measurement resolution is independent of the resolution of the encoder. It is always based on the maximum resolution of 65536 steps.

PROCESS DATA EXCHANGE

The steps/gating time unit can be converted to rpm as follows:

$$u = \frac{v \times 60000 / t}{65536} \times \frac{d}{m}$$

v = encoder output for speed value
t = gate time in ms (default 10 ms)
u = speed in rpm
d = divider (default 1)
m = multiplier (default 1)

With the default values mentioned above, there is a value range for speed of -3000 ... +3000 rpm at position resolution of 16 bit.

4.2.3 Status data format

In the status word, the rotary encoder supplies error and status information.

Octet 15								Octet 14							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16 bit status															

The meaning of the individual bits is:

Bit	Meaning	Remark/remedy
0	Preset_Set	Preset value has been set
1	Preset_Enabled	Preset process is enabled
2	Not used	
3	Not used	
4	Preset error	Error on preset setting: The preset value must lie between 0 and the total number of steps -1. Execute preset setting only when the shaft is stationary.
5	Reserved	
6	Reserved	
7	Speed mearsu-ring range excee-ded	Reduce the speed or the value for the gate time
8	Position error	The position monitoring detected a not permissible deviation. The encoder has to be checked by the manufacturer.
9-14	Not used	
15	Reserved	

An entry in the status word is displayed through 0x81 in the error register.

PROCESS DATA EXCHANGE

4.3 Output data

4.3.1 Control word data format

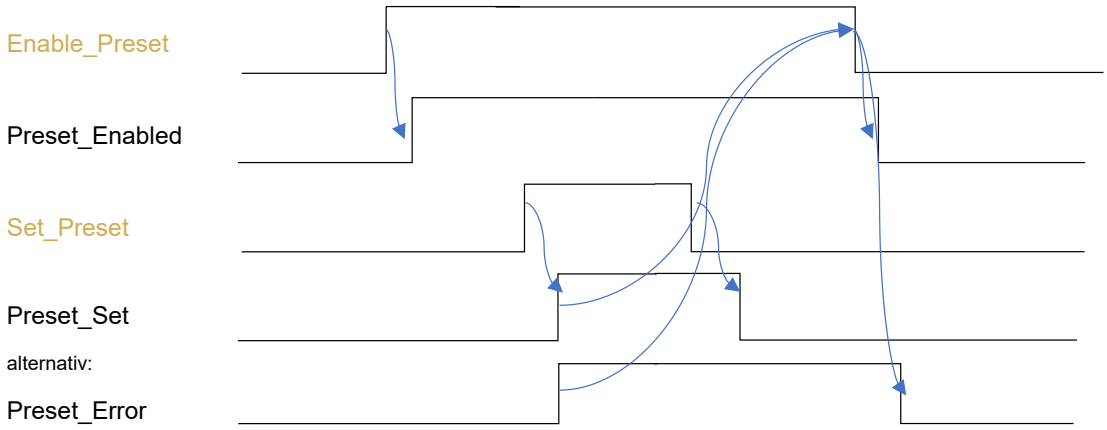
Octet 3								Octet 2							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16 bit control															

Bit	Meaning	Remark/remedy
0	Set Preset	The preset value is activated on the rising edge.
1	Enable Preset	Must be set to 1 before setting the preset value.
2-15	Not used	

To adapt the position of the encoder to the machine position, the encoder can be preset by the user to any value (preset value) within the measuring range. The preset value can be specified via object 0x6100 (see chapter 5.4.1) or by transferring the preset value in the output bytes. The default value is zero. The preset value in the encoder is set when writing object 0x6100, or by setting bit 0 in the control word. The preset value can only be set when the encoder shaft is stationary!

To set a new actual position, use the timing diagram as shown in the figure below. Here you can see that a handshake exists for both the set command and the enable bit. The preset can only be triggered after the enable bit has been acknowledged. In this preset release cycle, a new preset value can only be triggered/set once. In case of a preset error the cycle must be started again from the beginning. See example in chapter 7.8.

Timing Diagram Preset-Function



Signals of the PLC

Signals of the encoder

PROGRAMMING AND DIAGNOSIS

5. PROGRAMMING AND DIAGNOSIS (CANOPEN OVER ETHERCAT)

In the case of CANopen over EtherCAT, all parameters and diagnostic information are located in what is called the object directory. By specifying their index and sub-index, they can be modified or read there with the SDO (Service Data Object) message. 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 - $9FFF_h$
- FSoE Communication parameters — Index $E000_h$- $EFFF_h$
- FSoE Device parameters — Index $F000_h$- $FFFF_h$

Refer to the following tables for a description of the individual parameters and diagnostic information.

5.1 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
1008_h	VAR	Device name	String	ro
1009_h	VAR	Hardware version	String	ro
$100A_h$	VAR	Software version	String	ro
1010_h	RECORD	Store parameters		rw
1011_h	RECORD	Restore Default Parameters		rw
1018_h	RECORD	Identity		ro
1600_h	RECORD	FSoE RxPDO Mapping		ro
$1A00_h$	RECORD	FSoE TxPDO Mapping		ro
$1C00_h$	RECORD	Sync manager type		ro
$1C12_h$	RECORD	RxPDO assign		ro
$1C13_h$	RECORD	TxPDO assign		ro
Device specific area				
2100_h	RECORD	Encoder FSoE Address Setting		rw
Encoder Profile for Safety Encoders according to CiA 406				
6100_h	RECORD	Safety position configuration parameters		rw
6101_h	RECORD	Safety speed configuration parameters		rw
$61FE_h$	VAR	Safety application configuration valid	Unsigned8	rw
$61FF_h$	ARRAY	Safety application configuration signature	Unsigned16	rw

PROGRAMMING AND DIAGNOSIS

Index	Object	Name	Data type	Access
FSoE Connection Specific Area				
$E600_h$	RECORD	FSoE Slave Frame Elements		ro
$E601_h$	RECORD	FSoE Inputs		ro
$E700_h$	RECORD	FSoE Master Frame Elements		ro
$E701_h$	RECORD	FSoE Outputs		ro
$E900_h$	RECORD	FSoE Slave Modul Information		ro
$E901_h$	RECORD	FSoE Communication Parameter		ro
$EA00_h$	RECORD	FSoE Connection Diagnosis		ro
FSoE Device Area				
$F980_h$	RECORD	Safe Address		ro

5.2 Communication parameters

5.2.1 Object 1000_h - Device type

Index	Sub	Name	Data type	Access	Range/Value	Default
1000_h	00	Device type	Unsigned32	ro	0x20196	

5.2.2 Object 1001_h - Error register

Index	Sub	Name	Data type	Access	Range/Value	Default
1001_h	00	Error register	Unsigned8	ro	0 / 0x81	0

Value	Case of error
0	No error
0x05	Over- or undervoltage
0x81	Sensor or synchronisation error

5.2.3 Object 1008_h - Manufacturer device name

Index	Sub	Name	Data type	Access	Range/Value	Default
1008_h	00	Device name	String	ro	TRK/S3	

5.2.4 Object 1009_h - Manufacturer hardware version

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

Contains the current manufacturer hardware version e.g.: „P-820-3“

PROGRAMMING AND DIAGNOSIS

5.2.5 Object $100A_h$ - Manufacturer software version

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

Contains the current manufacturer software version e.g.: „TRK_A0001_R15“

5.2.6 Object 1010_h - Store parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1010_h	00	Highest sub-index supported	Unsigned8	ro	1	
	01	Save_all_para-meters	Unsigned32	rw	0	

Writing “save” (hex: 0x65766173) in sub-index 1 leads to the failsafe saving of the parameters in the EEPROM. The read access to subindex 1 always returns the value 0. This indicates that saving is supported.

5.2.7 Object 1011_h - Restore Default Parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1011_h	00	Highest sub-index supported	Unsigned8	ro	1	
	01	Save_all_para-meters	Unsigned32	rw	1	

By writing “load” (hex: 0x64616F6C) in sub-index 1, the parameters’ default values are loaded into the EEPROM and become active after power off/on. The read access to subindex 1 always returns the value 1. This indicates that the restore command is supported.

5.2.8 Object 1018_h - Identity Object

Index	Sub	Name	Data type	Access	Range/Value	Default
1018_h	00	Highest sub-index supported	Unsigned8	ro	4	
	01	Vendor ID	Unsigned32	ro	0x10D	
	02	Product code	Unsigned32	ro	0x6305	
	03	Revision	Unsigned32	ro	0x00030001	
	04	Serial number	Unsigned32	ro	XXXX XXXX	

PROGRAMMING AND DIAGNOSIS

5.2.9 Object 1600_h - Receive PDO Mapping

Index	Sub	Name	Data type	Access	Range/Value	Default
1600_h	00	Highest sub-index supported	Unsigned8	ro	6	
	01	Receive mapping object	Unsigned32	ro	0xE700:01:08	Command
	02	Receive mapping object	Unsigned32	ro	0xE701:01:01	Set_Preset
	03	Receive mapping object	Unsigned32	ro	0xE701:02:01	Enable_Preset
	04	Receive mapping object	Unsigned32	ro	0x0000:00:0E	Padding
	05	Receive mapping object	Unsigned32	ro	0xE700:03:10	CRC_0
	06	Receive mapping object	Unsigned32	ro	0xE700:02:10	Connection ID

5.2.10 Object $1A00_h$ - Transmit PDO Mapping

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A00_h$	00	Highest sub-index supported	Unsigned8	ro	17	
	01	Transmit mapping object	Unsigned32	ro	0xE600:01:08	Command
	02	Transmit mapping object	Unsigned32	ro	0xE601:01:10	Position low
	03	Transmit mapping object	Unsigned32	ro	0xE600:03:10	CRC_0
	04	Transmit mapping object	Unsigned32	ro	0x0000:00:10	Position high
	05	Transmit mapping object	Unsigned32	ro	0xE600:04:10	CRC_1
	06	Transmit mapping object	Unsigned32	ro	0xE601:02:10	Speed
	07	Transmit mapping object	Unsigned32	ro	0xE600:05:10	CRC_2
	08	Transmit mapping object	Unsigned32	ro	0xE601:03:01	Preset_Set
	09	Transmit mapping object	Unsigned32	ro	0xE601:04:01	Preset_Enabled
	10	Transmit mapping object	Unsigned32	ro	0x0000:00:02	Padding1
	11	Transmit mapping object	Unsigned32	ro	0xE601:05:01	Preset_Error
	12	Transmit mapping object	Unsigned32	ro	0x0000:00:02	Padding2

PROGRAMMING AND DIAGNOSIS

Index	Sub	Name	Data type	Access	Range/Value	Default
$1A00_h$	13	Transmit mapping object	Unsigned32	ro	0xE601:06:01	Speed_Limit_ Exceeded
	14	Transmit mapping object	Unsigned32	ro	0xE601:07:01	Position Error
	15	Transmit mapping object	Unsigned32	ro	0x0000:00:07	Padding3
	16	Transmit mapping object	Unsigned32	ro	0xE600:06:10	CRC_3
	17	Transmit mapping object	Unsigned32	ro	0xE600:02:10	Connection ID

5.2.11 Object $1C00_h$ - Sync Manager Communication Type

Index	Sub	Name	Data type	Access	Range/Value	Default
$1C00_h$	00	Number of used sync manager channels	Unsigned8	ro	4	
	01	Communication type sync manager 1	Unsigned8	ro	1	
	02	Communication type sync manager 2	Unsigned8	ro	2	
	03	Communication type sync manager 3	Unsigned8	ro	3	
	04	Communication type sync manager 4	Unsigned8	ro	4	

5.2.12 Object $1C12_h$ - Sync Manager Channel 2 (Process Data Output)

Index	Sub	Name	Data type	Access	Range/Value	Default
$1C12_h$	00	Number of RxPDOs	Unsigned8	ro	1	
	01	Receive assign object	Unsigned16	ro	0x1600	

5.2.13 Object $1C13_h$ - Sync Manager Channel 3 (Process Data Input)

Index	Sub	Name	Data type	Access	Range/Value	Default
$1C13_h$	00	Number of TxPDOs	Unsigned8	ro	1	
	01	Transmit assign object	Unsigned16	ro	0x1A00	

PROGRAMMING AND DIAGNOSIS

5.3 Manufacturer specific parameters

5.3.1 Object 2100_h - Encoder FSoE Address Setting

Index	Sub	Name	Data type	Access	Range/Value	Default
2100_h	00	Highest sub-index supported	Unsigned8	ro	2	
	01	Encoder FSoE Address	Unsigned16	rw	1…65535	1234
	02	Encoder Serial Number	Unsigned32	rw		0

The object 2100_h is used to set the FSoE address of the TRK/S3. After entering the FSoE address under sub-index 01, the serial number of the device concerned must be entered under sub-index 02. If the serial number specified here matches the device's serial number, the set FSoE address is taken over and displayed in objects $E901_h$ and $F980_h$. The modification of the parameters is only possible in the pre-operational status.

5.4 Standardised device parameters

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 (see chapter 5.2.6).The modification of the parameters is only possible in the pre-operational status.

5.4.1 Object 6100_h - Safety position configuration parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
6100_h	00	Highest sub-index supported	Unsigned8	ro	2	2
	01	Safety code sequence	Unsigned16	rw	See below	0
	02	Safety preset value	Unsigned32	rw	0 - total steps* -1	0

Value definition for safety code sequence

Bit	Value	Remarks/remedy
0	0	Ascending position value on clockwise rotation of the shaft, viewed in the direction of the shaft
	1	Ascending position value on counter-clockwise rotation of the shaft, viewed in the direction of the shaft
1 - 15	0	Not used

Note:

The "Safety preset value" parameter can be used to set the rotary encoder's position value to any desired value within its total number of steps. The values entered here are only output as a new position value after the calculation and transfer of both CRC checksums in object $61FF_h$ and setting the configuration valid flag under object $61FE_h$. To save the position so that it is voltage-failsafe, the command Store Parameters must then be executed via object 1010_h.

* The total number of steps is depending on the encoder type.

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5.4.2 Object 6101_h - Safety speed configuration parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
6101_h	00	Highest sub-index supported	Unsigned8	ro	6	
	01	Safety code sequence	Unsigned16	rw	See 5.4.1	0
	02	Safety preset value	Unsigned32	rw	0 - total steps* -1	0
	03	Safety speed source selector	Unsigned8	ro	2	2
	04	Safety speed integration time	Unsigned16	rw	10…1000	10
	05	Safety speed multiplier	Unsigned16	rw	1 - 65535	1
	06	Safety speed divider	Unsigned16	rw	1 - 65535	1

Observe the note in chapter 5.4.1.

5.4.3 Object $61FE_h$ - Safety application configuration valid

Index	Sub	Name	Data type	Access	Range/Value	Default
$61FE_h$	00	Safety application configuration valid	Unsigned8	rw	0 / $A5_h$	

After changing a safety parameter and writing the new checksum (object $61FF_h$), the parameterisation must be enabled here by writing hex. A5. After each write access to a safety parameter, the object is set to zero. It can only be written in PRE-OPERATIONAL status. If the checksum is not correct, writing the object is not possible and an error message is displayed.

5.4.4 Object $61FF_h$ - Safety application configuration signature

Index	Sub	Name	Data type	Access	Range/Value	Default
$61FF_h$	00	Highest sub-index supported	Unsigned8	ro	2	
	01	SRDO1 signature	Unsigned16	rw	0…0xFFFF	0xC537
	02	SRDO2 signature	Unsigned16	rw	0…0xFFFF	0xEE03

This object contains the checksum for the safety rotary encoder parameters. In this case, the "SRDO1 signature" contains the checksum for the position parameters (object 6100_h) and the "SRDO2 signature" contains the checksum for the speed parameters (object 6101_h).

After changing a parameter, the checksum must be recalculated and stored here. After receiving the parameters, the rotary encoder in turn calculates a checksum and compares the checksum entered here with the checksum it has calculated itself. The checksum can only be written in PRE-OPERATIONAL status.

A programme for calculating the checksum is available for download at www.twk.de (see Appendix).

* The total number of steps is depending on the encoder type.

PROGRAMMUNG AND DIAGNOSIS

5.5 FSoE Communication Parameters

The object indices of the FSoE parameters are oriented towards the Modular Device Profile (MDP) Safety Modules Specification No. ETG.5001.4 Version 0.1.1. for drives (FSoE Safety Drive Profile).

5.5.1 Object $E600_h$ - FSoE Slave Frame Elements

Index	Sub	Name	Data type	Access	Description / Value
$E600_h$	00	Highest sub-index supported	Unsigned8	ro	6
	01	FSoE Slave Command	Unsigned8	ro	0
	02	FSoE Slave Connection ID	Unsigned16	ro	0
	03	FSoE Slave CRC_0	Unsigned16	ro	0
	04	FSoE Slave CRC_1	Unsigned16	ro	0
	05	FSoE Slave CRC_2	Unsigned16	ro	0
	06	FSoE Slave CRC_3	Unsigned16	ro	0

5.5.2 Object $E601_h$ - FSoE Input Data

Index	Sub	Name	Data type	Access	Description / Value
$E601_h$	00	Highest sub-index supported	Unsigned8	ro	7
	01	Save position value	Unsigned32	ro	Actual position value
	02	Save speed value	Unsigned16	ro	Actual speed value
	03	Preset set	Bool	ro	See chapter 4.2.3
	04	Preset enabled	Bool	ro	See chapter 4.2.3
	05	Preset error	Bool	ro	See chapter 4.2.3
	06	Speed limit exceeded	Bool	ro	See chapter 4.2.3
	07	Position error	Bool	ro	See chapter 4.2.3

Please refer to chapter 4.2 for a detailed view on the input data.

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5.5.3 Object $E700_h$ - FSoE Frame Elements

Index	Sub	Name	Data type	Access	Description / Value
$E700_h$	00	Highest sub-index supported	Unsigned8	ro	3
	01	FSoE Master Command	Unsigned8	ro	0
	02	FSoE Master Connection ID	Unsigned16	ro	0
	03	FSoE Master CRC_0	Unsigned16	ro	0

5.5.4 Object $E701_h$ - FSoE Output Data

Index	Sub	Name	Data type	Access	Description / Value
$E701_h$	00	Highest sub-index supported	Unsigned8	ro	2
	01	Set preset	Bool	ro	See chapter 4.3.1
	02	Enable preset	Bool	ro	See chapter 4.3.1

Please refer to chapter 4.3 for a detailed view on the output data.

5.5.5 Object $E900_h$ - FSoE Slave Modul Information

Index	Sub	Name	Data type	Access	Description / Value
$E900_h$	00	Highest sub-index supported	Unsigned8	ro	8
	01	FSoE Connection ID	Unsigned16	ro	Actual connection ID
	02	Type	String[16]	ro	FSoE
	03	Name	String[16]	ro	Same as 0x1008
	04	Device type	Unsigned32	ro	Same as 0x1000
	05	Vendor ID	Unsigned32	ro	Same as 0x1018:01
	06	Product Code	Unsigned32	ro	Same as 0x1018:02
	07	Revision Number	Unsigned32	ro	Same as 0x1018:03
	08	Serial Number	Unsigned32	ro	Serial number of the device

PROGRAMMING AND DIAGNOSIS

5.5.6 Object $E901_h$ - FSoE Connection Communication Parameter

Index	Sub	Name	Data type	Access	Description / Value
$E901_h$	00	Highest sub-index supported	Unsigned8	ro	8
	01	Version	String(2)	ro	1
	02	Safety Address	Unsigned16	ro	FSoE Address of the slave
	03	Connection ID	Unsigned16	ro	Same as 0xE900:01
	04	Watchdog Time	Unsigned16	ro	100…10000 ms*
	05	Unique Device ID	String(6)	ro	000000
	06	Connection Type	Enum	ro	1 = Slave Connection
	07	Com Parameter Length	Unsigned16	ro	2
	08	Appl Parameter Length	Unsigned16	ro	0

*The watchdog time is assigned by the FSoE Master

5.5.7 Object $EA00_h$ - FSoE Connection Diagnosis

Index	Sub	Name	Data type	Access	Description / Value
$EA00_h$	00	Highest sub-index supported	Unsigned8	ro	2
	01	Connection State	Enum	ro	State of the FSoE Connection 0 = Reset 1 = Session 2 = Connection 3 = Parameter 4 = Data 5 = Failsafe
	02	Connection Diagnosis	Unsigned16	ro	Diagnosis bits of the FSoE connection Bit 0 = Null message received (e.g. interruption of fieldbus) Bit 1 = Reserved Bit 2 = Watchdog expired Bit 3 = CRC error Bit 4 = Sequence No. error Bit 5 = Slave error Bit 6 = Communication parameter are transmitted Bit 7 = Failsafe values are transmitted Bit 8…15 = Reserved

PROGRAMMING AND DIAGNOSIS

5.6 FSoE Device Parameter

5.6.1 Object $F980_h$ - Safety Addres

Index	Sub	Name	Data type	Access	Description / Value
$F980_h$	00	Highest sub-index supported	Unsigned8	ro	2
	01	FSoE Address	Unsigned16	ro	Same as 0xE901:02
	02	Serial Number	Unsigned32	ro	Same as 0x1018:04

DIAGNOSIS OVERVIEW

6. DIAGNOSIS OVERVIEW

Error	Cause/Remedy	Reaction
Position error	The position monitoring detected a not permissible deviation. The encoder has to be checked by the manufacturer.	Data state = Fail safe data
Application errors		
Speed masuring range exceeded	Reduce the speed or the value for the gate time.	Status word = Speed measuring excee-ded (Bit 7)
Preset error	Preset value too high or setting when not in stationary.	Status word = Preset error (Bit 4)
Internal errors		
F stack error	The F stack has detected an error	Hard error*
CRC error	CRC error in the ROM detected	Hard error*
RAM/XRAM error	Error when checking the memory	Hard error*
Program se-quence error	Error in the program sequence	Hard error*
Power con-sumption to high	Power supply outside the allowed range or current to high	Hard error*
FSoE errors		
Watchdog error	Communication problem	FSoE status = Reset FSoE connection diagnosis (Object 0xEA00, Subindex 2) = Watchdog error
CRC error	Communication problem	FSoE status = Reset FSoE connection diagnosis (Object 0xEA00, Subindex 2) = CRC error

* In the "Hard Error" status the communication with the EtherCAT master is stopped. The internal program is stopped. The Hard Error status can only be reset via a power off/on.

7. TWINCAT SYSTEM MANAGER

The documentation is based on TwinCAT version 3.1.4022 and the TwinSAFE terminal EL6910 from Beckhoff as the FSoE master.

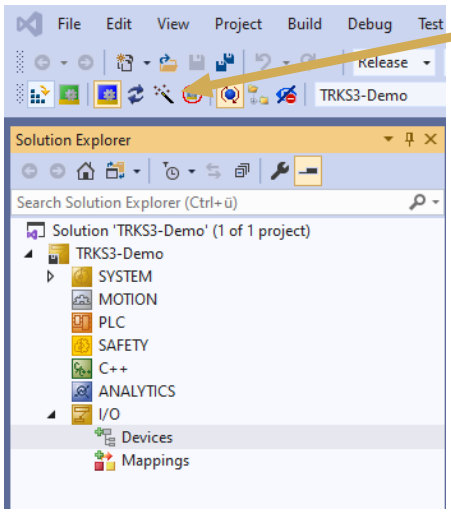
When creating the safety project, also observe the documentation from Beckhoff at infosys.beckhoff.com in the area TwinCAT3 → TE1000 XAE → Safety.

7.1 installation of the XML file

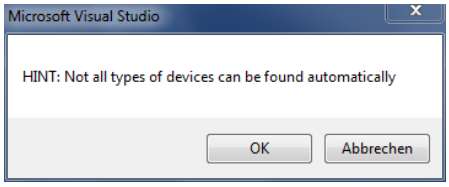
- Copy the XML file "TWK_Encoder_TRKS3_xxxxxxxx" to the directory ..\Twincat\3.1\Config\Io\Ethercat
- Start the TwinCAT System Manager

7.2 Reading-in the EtherCAT bus structure

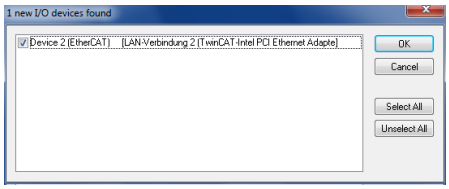
If a wired, operable system is available, it is easiest to read the bus structure in online. The procedure is described here.



Create a new project, mark "Devices" and click onto the "wand"

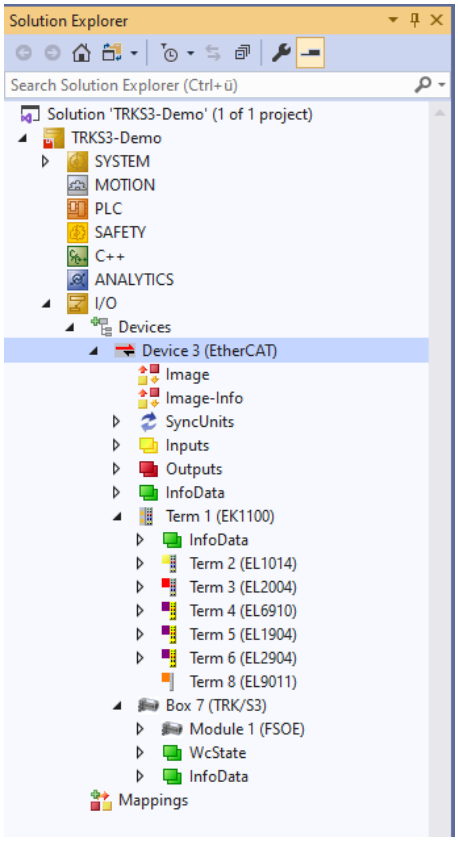


Confirm the following prompt with OK.

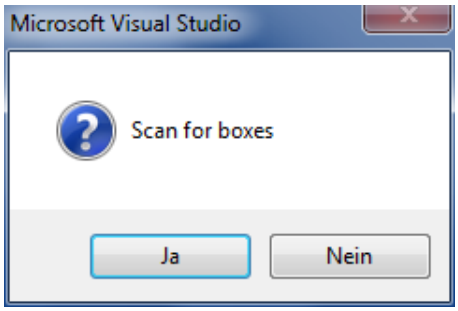


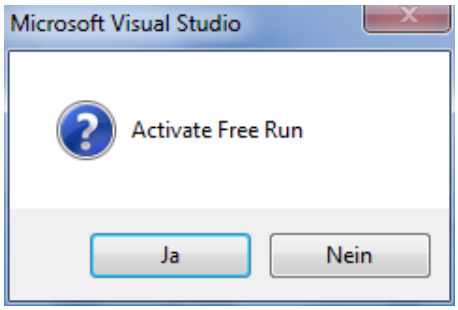
TwinCAT should then find your network card.
Confirm this with OK.

TWINCAT SYSTEM MANAGER



After confirming the following dialogue with "Yes", all connected devices should be found. In this case, the EtherCAT master, a Beckhoff bus terminal EK1100 with standard I/O modules, an EL6910 as a TwinSAFE logic terminal with TwinSAFE I/O modules and the TWK-FSoE rotary encoder TRK/S3.





If the so-called free run is now activated, the I/O data are cyclically exchanged and can be monitored in the TwinCAT. However, the TwinSAFE devices and the rotary encoder are still in reset status (0x2A).

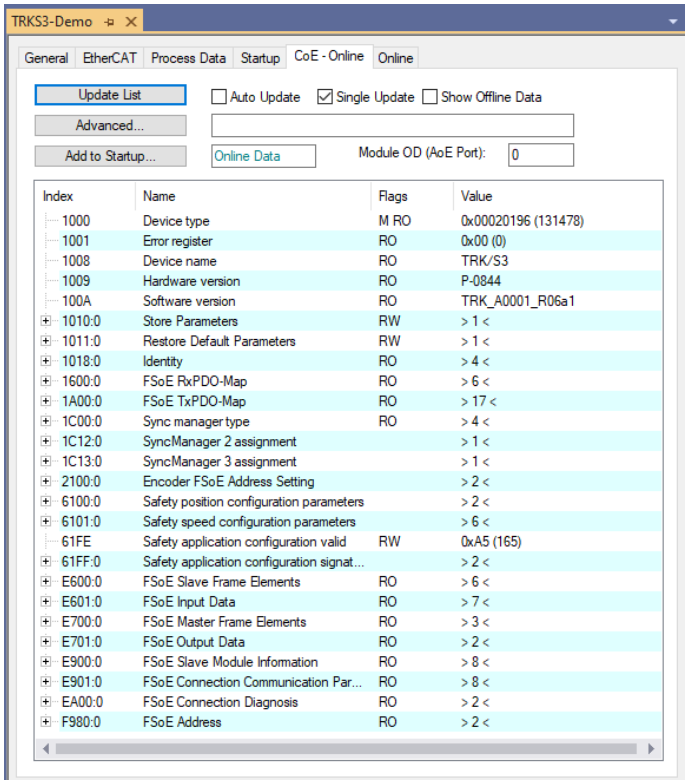
7.3 Assigning the FSoE address

After activating the free run, the rotary encoder's diagnostic information and parameters (CoE objects) can now be accessed (see illustration on the following page).

The desired FSoE address of the encoder, which is unique throughout the network, can now be set under object 2100_h. To do this, enter the FSoE address under sub-index 1 and then enter the serial number read off from the model plate under sub-index 2. If the serial number specified here matches the device's serial number, the set FSoE address is taken over and displayed in objects $E901_h$ and $F980_h$.

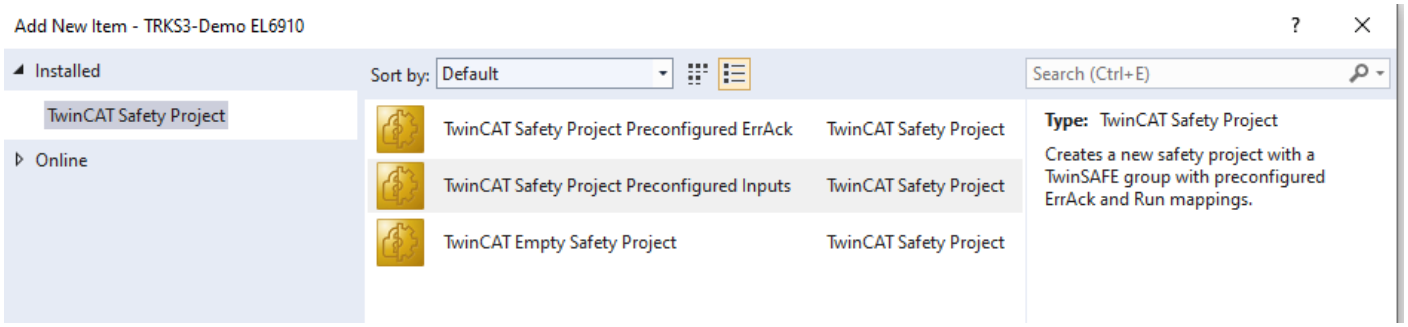
The modification of the parameters is only possible in the pre-operational status.The new FSoE address is only taken over after restarting the device (power off/on).

TWINCAT SYSTEM MANAGER

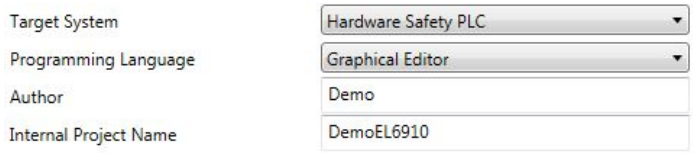


7.4 Creating a TwinSAFE project

To commission the FSoE rotary encoder TRK/S3 and the TwinSAFE devices, a SAFETY project must now be created. In the Solution Explorer, select the "Add New Item..." entry via the SAFETY folder's context menu. Mark "TwinCAT Safety Project Preconfigured Inputs" and enter a name for the safety project.

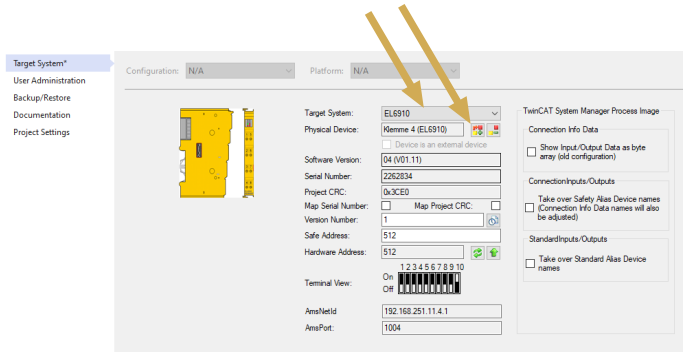


In the following dialogue, confirm the default settings with OK.

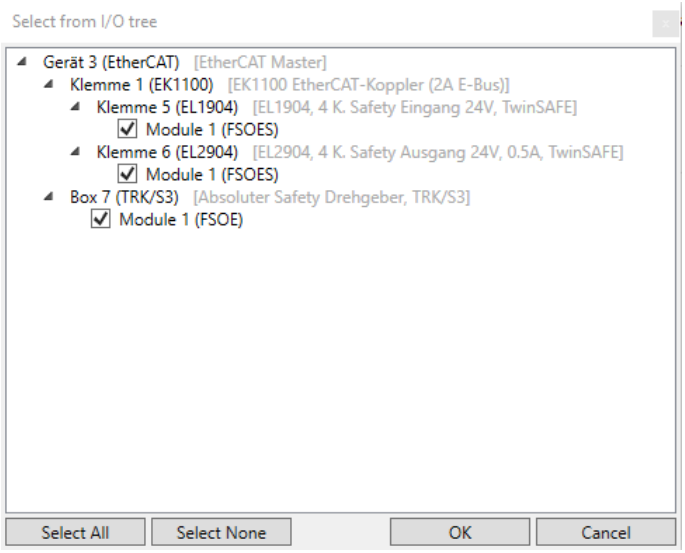


TWINCAT SYSTEM MANAGER

In your safety project call the settings dialog of the FSoE master system with a double click on "Target System" and set your TwinSAFE-Master (here EL6910) under "Target System". Afterwards connect the projected Master with the "Physical Device" and enter its FSoE address under "Safe Address" or take it over with the green flash. Save your settings.

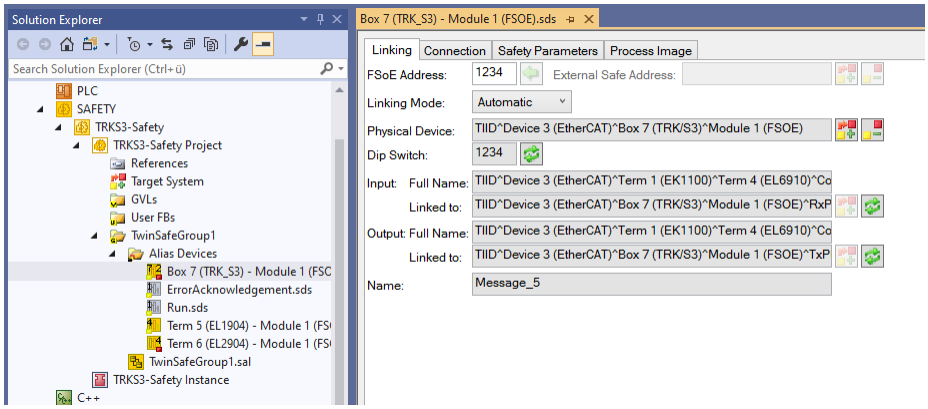


Then open the branch "TwinSafeGroup1" and enter the rotary encoder and other TwinSafe components which are already in the EtherCAT network via "Alias Devices" → "Import Alias-Device(s)".



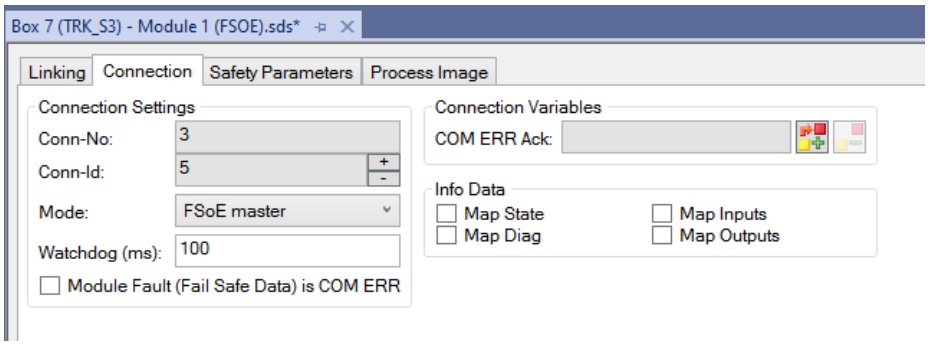
7.5 FSoE setting of the encoder

The TRK/S3 is now available in the Safety Project. With a double click on the encoder you can open the FSoE properties. In the "Linking" tab choose the "Physical Device" if not yet present and enter the FSoE address set in chapter 7.3.



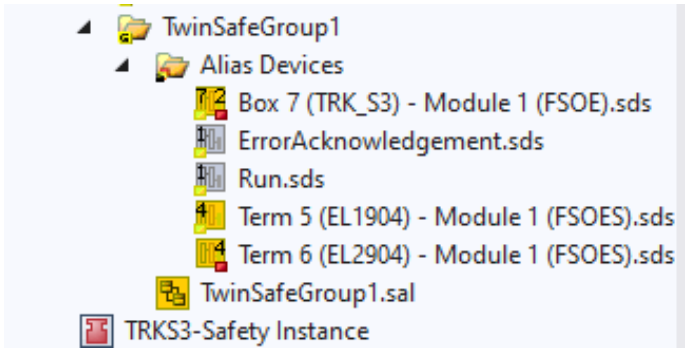
TWINCAT SYSTEM MANAGER

In the "Connection" tab the watchdog time has to be set. It should be selected so that message delays are tolerated by the communication system but that the error reaction is executed quickly enough in the event of an error (e.g. communication connection interruption). The minimum watchdog time is 100 ms.

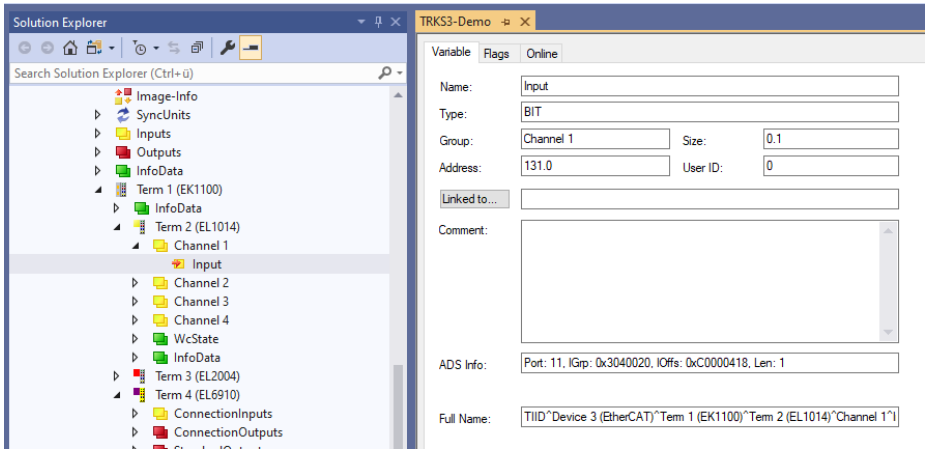


7.6 Connect ErrAcknowledge and RUN variables

To run the safety program we now connect the alais inputs ErrAcknowledgement and Run with real inputs from the standard EtherCAT branch (see next page). The Run signal has to stay on during operation. The signal ErrAcknowledgement serves to acknowledge safety errors and to restart the FSoE communication and the safety program.

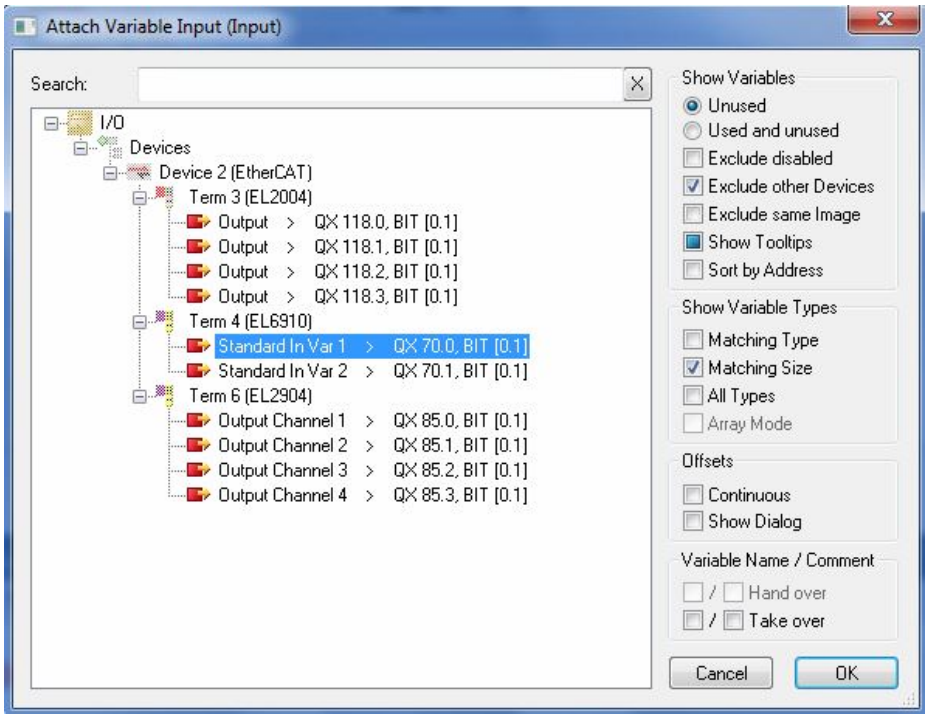


Open the tree under your standard input modul. A doubleclick on "Input" opens the associated dialog (picture below).



TWINCAT SYSTEM MANAGER

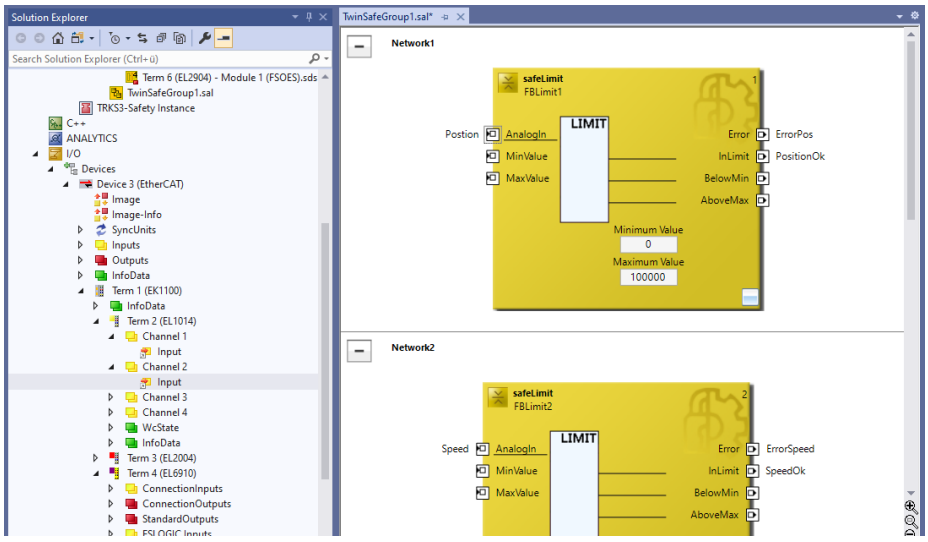
In After a click on "Linked to..." the following window appears but empty. Remove the check mark "Exclude same Image" to have access to the "Pre-Configured Inputs". Please choose here "StandardInVar1" for the ErrAcknowledgement signal and "StandardIn-Var2" for the Run-Signal.



Save your configuration and translate it with "Build Solution"

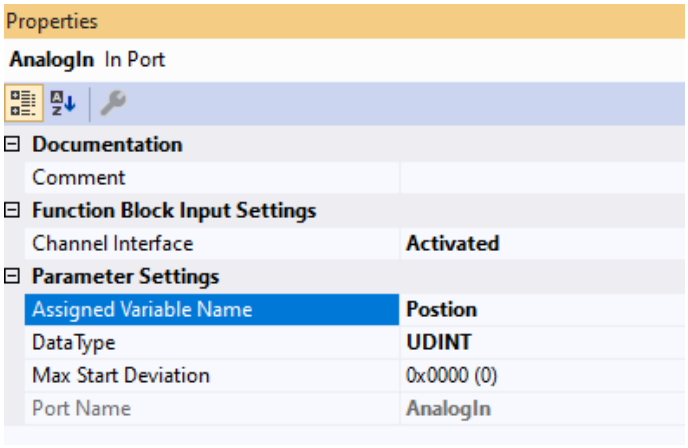
7.7 Safety programme

As shown in the example below, you can now access the rotary encoder's data in the automatically inserted "TwinSafeGroup1" safety programme.

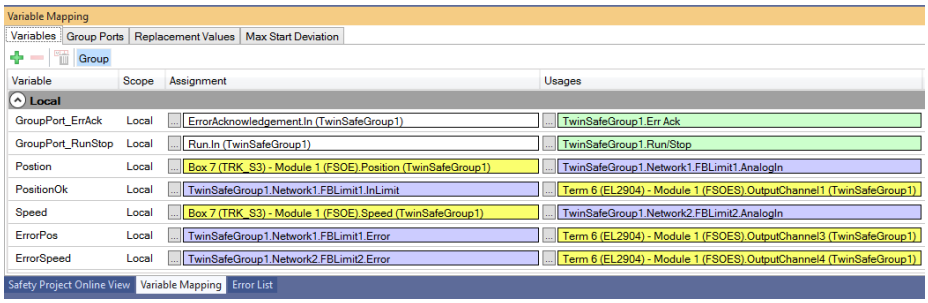


TWINCAT SYSTEM MANAGER

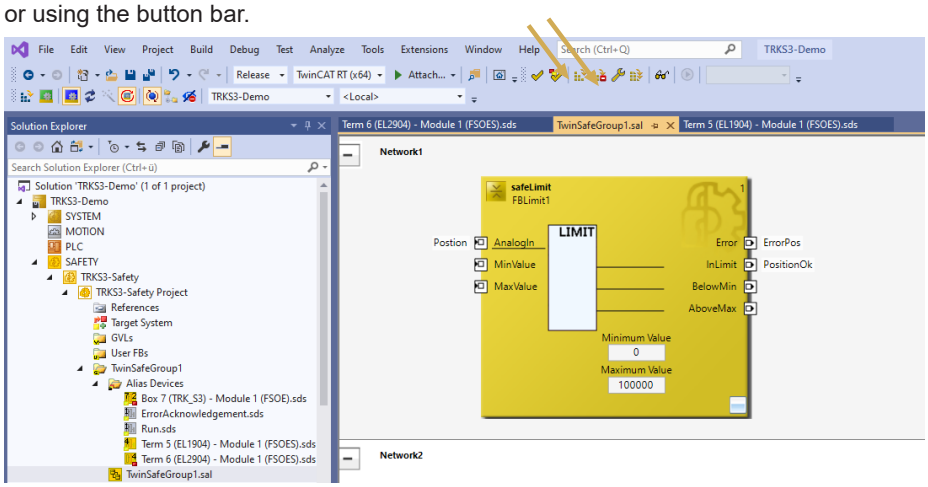
When accessing the 32-bit position value, the default datatype of the input AnalogIn has be changed from UINT to UDINT. When using the speed value the data type has to be changed to INT.



In the window "Variable Mapping" connect the variables with the real In-/Outputs of the existing safety hardware.



Your finished safety programme can subsequently be translated and transferred to the EL6910 via the main menu point "TwinSAFE" or using the button bar.



If you have not already done so, activate your TwinCAT configuration. Then change to the Config Mode and aktivate the Free Run. (Without a executable PLC application operating the encoder is only possible in the Free Run of the Config Mode). Now set your RUN input to one. The online data of the TRK should "run" now and show the following picture (the checksums change permanently).

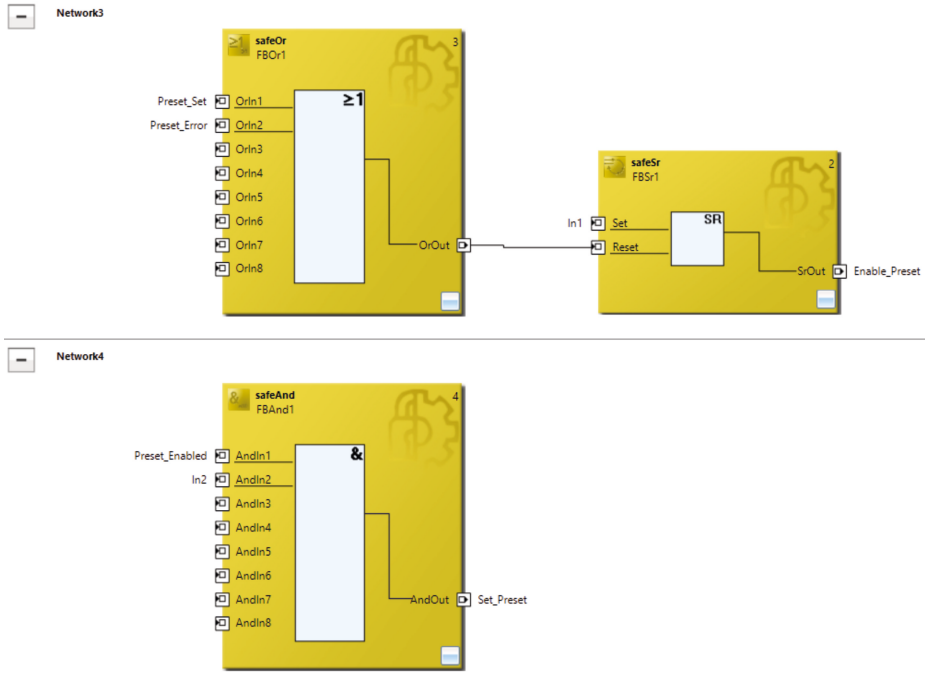
TWINCAT SYSTEM MANAGER

The TRK is in status "ProcessData" (0x36, first line) while the EL6910 is in "FailSafeData" state (0x08, last line). Following an Error-Acknowledge this should change to 0x36 as well. Only in this state your safety application is in run and the outputs are set.

Name		Online
FSOE	X	36 C5 11 0B 38 01 00 8F 01 00 00 29 8D 00 00 CA 80 06 00
WcState		0
InputToggle		1
State		8
AdsAddr		192.168.251.11.4.1:1007
FSOE	X	36 00 00 7A 71 06 00

7.8 Setting a preset value

The preset value entered in index 0x6100 and 0x6101 (default value = 0) can be set via the I/O data in the safety programme. The timing diagram from chapter 4.3.1 must be observed here. An example of the implementation can be found below.



The enable signal is set here via the digital input In1 and the preset is triggered via the digital input In2.

REVISION HISTORY

8. REVISION HISTORY

Version		Date		Change
TRK 13349 ME		06.05.2025		- New design - Added revision history - Fixed some minor typos

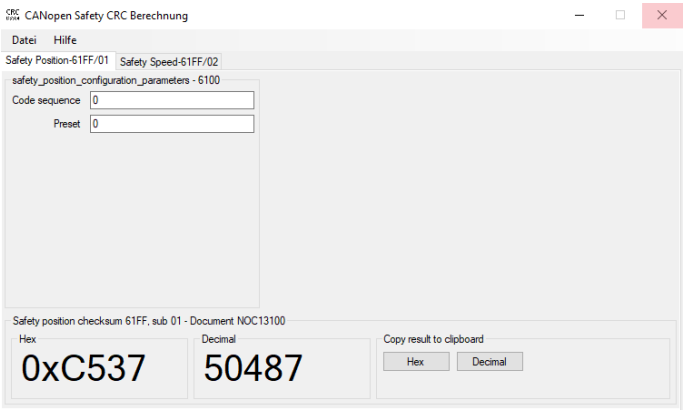
Bismarckstraße 108 · 40210 Düsseldorf · Germany
Tel. +49 211 96117-0 · info@twk.de · www.twk.de

APPENDIX

APPENDIX

Program SafetyCRC for calculation of the checksums SRDO1 and SRDO2

The SafetyCRC program is a universal CRC calculation program for different types of devices. To set it up for the TRK/S3 encoder, load the XML file "TRKS3" under "File->Load file". You will then see the following figure:



The register "Safety Position 61FF/01" is used to calculate the checksum SRDO1. Register "Safety Speed 61FF/02" is used to calculate the checksum SRDO2.