

USER MANUAL

Safety over EtherCAT® Slewing Ring

for Absolute Encoder TRK/S3

Manual for the slewing ring feature
Extension of user manual 13349



Safety over
EtherCAT®

SIL2 FUNCTIONAL
IEC 61508 SAFETY
SENSOR

PLd FUNCTIONAL
ISO 13849 SAFETY
SENSOR

1-800-366-5412 | 1-208-263-8541 | [encoder.com](https://www.encoder.com) | sales@encoder.com

©2026 Encoder Products Company. All rights reserved.

Encoder Products Company

464276 Highway 95 South
Sagle, Idaho 83860
USA

Phone: +1 (208) 263-8541

Fax: +1 (208) 263-0541

Email (Sales): sales@encoder.com

Website: encoder.com

Warranty waiver, right of amendment, copyright:

Encoder Products Company accepts no liability or warranty for the correctness of this manual, or for any direct or indirect damage that may arise from it. In the pursuit of constant innovation and cooperation with customers, we reserve the right to amend technical data or content at any time.

This manual is copyrighted, and it may not be modified, added to, reproduced or shared with third parties without prior written consent.

Comments:

Should you have any corrections, notes or requests for changes, please send them to us. Send your comments to: sales@encoder.com

Table of Contents

- 1. SAFETY INSTRUCTIONS4
 - 1.1 Scope. 4
 - 1.2 Documentation 4
 - 1.3 Proper use 4
 - 1.4 Commissioning 4
- 2. GENERAL INFORMATION5
 - 2.1 Overview 5
- 3. MANUFACTURER SPECIFIC OBJECTS6
 - 3.1 Object 3100h safety_gear_configuration 6
 - 3.2 Object 31FEh safety_gear_data_valid. 7
 - 3.3 Object 31FFh safety_gear_CRC_checksum. 7
- 4. INSTRUCTIONS FOR USE8
 - 4.1 Parameterization procedure 8
 - 4.2 Safety notes 8
 - 4.3 SafetyCRC Program 9
 - 4.4 Sample Configurations 10
 - 4.4.1 Example 1: Slewing functionality off – Default values10
 - 4.4.2 Example 2: Single-turn settings10
 - 4.4.3 Example 3: Slewing ring functionality10
 - 4.4.4 Example 4: Slewing ring functionality10

1. SAFETY INSTRUCTIONS

1.1 Scope

This user manual is valid exclusively for encoders of the TRK series with slewing ring functionality. These can be identified by the output code, “**S** – Binary, slewing ring function” according to the order code.

1.2 Documentation

The following documents must be observed:

- The owner’s system-specific operating instructions.
- This user manual **16798**.
- The user manual **13349**.
- Datasheet for the specific device: **TRK42 17023**.
If a customer-specific variant is used, the associated datasheet applies.
- The connection assignment enclosed with the device.
- Assembly instructions **16169**.

1.3 Proper use

The EPC 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 manual 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.

2. GENERAL INFORMATION

2.1 Overview

This manual is intended as a supplement to the manual **13349** and contains additional information on the slewing ring functionality. The manual **13349** remains valid and the instructions must still be followed.

Devices for which the slewing ring functionality is available are identified by the specification “Output code: S” (binary, slewing ring function) in the order code.

The slewing ring function requires advanced software and special hardware. Standard devices “Output code: B” (binary) cannot be upgraded with the slewing ring function afterwards. On the other hand, it is possible to parameterize and use a device with a slewing ring function like a device.

The parameterization of the slewing ring function is carried out, like the other settings, via corresponding CoE (CANopen over EtherCAT) objects. The following new objects are now available for this purpose.

- 3100h safety_gear_configuration
- 31FEh safety_gear_data_valid
- 31FFh safety_gear_CRC_checksum

The object 3100h, which contains the information about the number of teeth of the slew and measure gear and the desired measuring range, is located under the manufacturer specific objects.

As with other safety-relevant settings, object 3100h is protected by a CRC checksum. The correct checksum must be entered in object 31FFh in order to activate the configuration with object 31FEh. These safety features allow a device to be certified up to SIL2 (safety integrity level).

Due to the extended setting options, the procedure for initial configuration changes slightly compared to the standard devices.

This manual provides a complete description of the new objects, explains the setup procedure including the calculation of the checksum and shows configuration examples.

3. MANUFACTURER SPECIFIC OBJECTS

This section introduces each object and provides a description of its function and properties. Here only the new objects are covered, which are additionally necessary for the slewing ring function. The previously existing objects can be found in manual 13349.

3.1 Object 3100h safety_gear_configuration

This object is for setting the safety gear parameters. Only valid for TRK/S3 devices with slewing ring function (Version "S" in order code number between single-turn and multi-turn resolution).

Modifications in object 3100h will cause 31FEh = "0" (must be set "A5" after modification). New CRC Checksum 31FFh/01h must be calculated and transmitted to the device. Because the gear parameters belong to the safety-relevant settings, object 61FEh is also set to 0 when these are changed.

Notes:

$i = \text{slew_gear} / \text{measure_gear}$

Maximum gear ratio $i = 1024$ [decimal], Bigger values are not allowed.

Minimum gear ratio $i = 1$ [decimal], Smaller values are not allowed.

A plausibility check ensures that the valid flag 31FEh cannot be set. Error code 0800 0022 - data not stored to device is transmitted if the plausibility check fails.

Adjustment of gear parameters

Index	Sub	Name	Data type	Access	Range/value	Default
3100h	00h	largest_supported_sub-index	Unsigned8	ro	0x03	
	01h	safety_slew_gear [teeth]	Unsigned32	rw	0x0 - 0x FFFF FFFF	0x0
	02h	safety_measure_gear [teeth]	Unsigned32	rw	0x0 - 0x FFFF FFFF	0x0
	03h	safety_measuring_range	Unsigned32	rw	0x0 - 0x FFFF FFFF*	0x0

3100h/01h safety_slew_gear Number of teeth driving gear (slewing)

3100h/02h safety_measuring_gear Number of teeth of encoder tooth gear

3100h/03h safety_measuring_range Number of steps output for one turn of the slewing ring

* Examples and conditions for object 3100h/03h:

The encoder has a fixed value for the maximum resolution per revolution. A typical value is 65,536 steps per revolution of the encoder shaft. This information is part of the order code. The slewing ring function cannot circumvent this limitation.

Object 3100h/03h describes the number of steps for one revolution of the slewing ring. An upper limit results from the maximum number of steps for one revolution of the encoder shaft multiplied by the transmission ratio i .

$$[3100h/03h] \leq 65,536 \times [3100h/01h] / [3100h/02h] = 65,536 \times i$$

If we have a transmission ratio of $i=8$ for example, one revolution of the slewing ring can be resolved with a maximum of $8 \times 65,536 = 524,288$ steps. This is the maximal available resolution, smaller values are also valid.

3.2 Object 31FEh safety_gear_data_valid

This parameter is reset (= 0x0) 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 safety_gear_data_valid or incorrect setting of the checksum, write access is rejected.

Attention:

The flag is automatically reset by writing to the safety position data in safety_gear_configuration Object 3100h.

Index	Sub	Name	Data type	Access	Range/value	Default
31FEh	00h	safety_gear_data_valid	Unsigned8	rw	0 / 0xA5	0xA5

3.3 Object 31FFh safety_gear_CRC_checksum

This object contains the CRC checksum of the parameters stored in object 3100h.

Activating (writing 0xA5 to) the valid flag in object 31FEh is only possible, if and only if the checksum in object 31FFh is valid for the settings currently stored in object 3100h.

The checksum can be calculated by the external “SafetyCRC” program available for download:

<https://www.encoder.com/hubfs/products/safety/files/CRC-Calculator.zip>

Instructions for this software can be found in the general EtherCAT manual **13349** and additional information in this manual in chapter 4.2.

Index	Sub	Name	Data type	Access	Range/value	Default
31FFh	00h	largest_supported_sub_index	Unsigned8	ro	0x01	0xA1
	01h	safety_gear_CRC_checksum	Unsigned16	rw	0 - 0xFFFF	0x76E9

4. INSTRUCTIONS FOR USE

4.1 Parameterization procedure

For the objects 3100h to be writable, the device must be in the PreOP state.

Modifications to objects 3100h will reset the valid flags 31FEh and 61FEh.

- Set device state to preoperational.
- Fill objects 3100h/01h, 3100h/02h, 3100h/03h with the desired parameters.
- Calculate the CRC checksum for the gear parameters and write it to object 31FFh/01h.
- Activate the valid flag 31FEh by writing 0xA5=165 into this object.
- Activate the valid flag 61FEh by writing 0xA5=165 into this object.
(suitable entry for the checksum in the object 61FFh required)

In order to deactivate the slewing ring function and achieve an encoder behavior exactly as a normal binary encoder, all parameters of 3100h (sub 01h, sub 02h and sub 03h) have to be set to zero.

After modifying the gear parameters it has to be ensured that a “safe all” command via Object 1010h sub 01h is executed. Otherwise after switching the supply power off and back on, the settings are reset to the last saved status.

After modifying any safety gear parameter, the output position is undefined within the code range of the output resolution (object 3100h/03h). By setting a preset value (object 6100h/02h) a defined initial position is set.

This parameter is verified by the checksum of the profile specific parameters.

4.2 Safety notes

The encoder can determine an absolute position of the shaft in the range of 4096 turns. The working range of the slewing ring function is split in two areas, positive and negative relative to its zero position.

The allowed number of encoder shaft-turns r_{safety} in a situation when the encoder is not supplied with power can be calculated according to the following formula:

$$r_{\text{safety}} = 2048 - i$$

r_{safety} is rounded down to “full revolutions”

r_{safety} : allowed safety encoder revolutions in each direction without power supply to the encoder

i : gear ratio ($i = \text{slew gear} / \text{measure gear}$)

Safety Note:

It has to be ensured in the application, that the shaft is never turned x revolutions, where $x > r_{\text{safety}}$ in a state where the encoder is not connected to supply power.

If in a non power state the Encoder shaft is turned for x revolutions, where $x > r_{\text{safety}}$ the output position is not valid, this is not detected by the encoder upon reconnecting it to supply power.

The smallest possible value for r_{safety} is 1024, due to the allowed range of the gear ratio i : $1 \leq i \leq 1024$.

This means the safety area will always be in the range of $2047 \geq r_{\text{safety}} \geq 1024$ revolutions of the encoder shaft-depending on the gear ratio, when the encoder is not connected to power supply.

Note: While the encoder is powered on, there is no restriction on the number of revolutions. The above restrictions only apply when the encoder is powered off.

4.3 SafetyCRC Program

For the calculation of the CRC checksum the program "SafetyCRC" is provided. This program can be used for different devices. Please make sure that the correct settings are loaded. Load the appropriate xml file via the file load function.

By default, some xml files are delivered directly with the program. You can find them in the program path in the subfolder "Data". Otherwise we offer the xml files for download on our homepage www.encoder.com or for special customer variants of the devices on request.

To verify if the SafetyCRC program is configured correctly, please compare it with the following picture. Exactly one tab must be displayed for each of the entries:

- 61FFh/01h: Safety Position CRC
- 61FFh/02h: Safety Speed CRC
- 31FFh/01h: Safety Gear Parameters CRC

The screenshot shows the 'SafetyCRC' application window. It has a menu bar with 'Datei' and 'Hilfe'. Below the menu is a tab bar with three tabs: 'Safety Position CRC - 61FF/01', 'Safety Speed CRC - 61FF/02', and 'Safety Gear Parameters CRC - 31FF/01'. The third tab is selected. The main area is titled 'safety_gear_configuration - 3100' and contains three input fields: 'Objekt 3100/01 slew gear', 'Objekt 3100/02 measure gear', and 'Objekt 3100/03 measuring range', each with a value of '0'. At the bottom, there is a section titled 'Gear parameter's checksum 31FF, sub 01 - Document TRK 16798'. It displays the checksum in two formats: 'Hex' (0x76E9) and 'Decimal' (30441). To the right of these displays are two buttons: 'Hex' and 'Decimal', and a 'Copy result to clipboard' button.

Enter your desired settings in the respective fields. The CRC checksum is automatically calculated and displayed in decimal and hexadecimal notation in the lower part of the screen.

4.4 Sample Configurations

To illustrate the possibilities, some sample configurations are shown here. The free choice of parameters allows to cover different applications with the same device.

4.4.1 Example 1: Slewing functionality off – Default values

In the factory settings, the slewing ring functionality is deactivated. The individual parameters are set to 0.

3100h/01h:	0	Number of teeth driving gear (slewing)
3100h/02h:	0	Number of teeth of encoder tooth gear
3100h/03h:	0	Number of steps output for 1 turn of the slewing ring

In this mode, the device behaves like a device without a slewing ring function, i.e. like a normal multi-turn encoder with resolution and measuring range according to article number.

4.4.2 Example 2: Single-turn settings

By suitable choice of parameters it is possible to obtain the behavior of a single-turn encoder.

3100h/01h:	1
3100h/02h:	1
3100h/03h:	65,536

With these settings a transmission ratio of 1:1 is set and one revolution is sampled with 65,536 steps. With this configuration the encoder behaves like a pure single-turn device.

4.4.3 Example 3: Slewing ring functionality

The main application of the slewing ring function is the automatic conversion between the position of the slewing ring gear and the measuring gear.

3100h/01h:	128
3100h/02h:	16
3100h/03h:	524,288

These parameters describe a transmission ratio of 128:16 or 8:1. The maximum resolution of 524,288 (8 * 65,536) is chosen.

4.4.4 Example 4: Slewing ring functionality

A major advantage of our slewing ring function is that it is not limited to specific gear ratios.

3100h/01h:	451	Number of teeth driving gear (slewing)
3100h/02h:	85	Number of teeth of encoder tooth gear
3100h/03h:	5953	Number of steps output for 1 turn of the slewing ring

The gear ratio is approximately 5.3 (451:85) and is not a problem. The encoder can be adapted very easily to the installation situation and thus enables a flexible and process-safe application. The PLC is freed up and not overloaded with complicated conversions between the position of the encoder and the slewing ring. In the case of non-integer ratios in combination with an endless rotation, the conversion is not trivial.