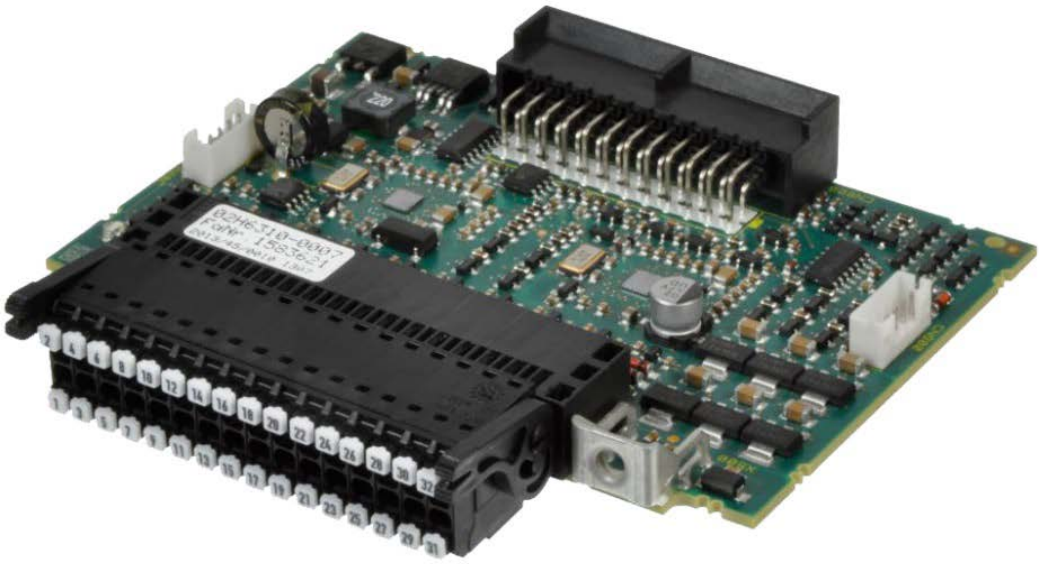


Safety Module Type 3

Supplement | Safety over EtherCAT® **Firmware V3.2.0.1**

Translation of the original manual
Document 20148774 EN 06

1 Preface

The described hardware and software are developments of the KEB Automation KG. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

1.1 Signal words and symbols

Certain operations can cause hazards during the installation, operation or thereafter. There are safety informations in the documentation in front of these operations. Security signs are located on the device or machine. A warning contains signal words which are explained in the following table:

⚠ DANGER	➢ Dangerous situation, which will cause death or serious injury in case of non-observance of this safety instruction.
⚠ WARNING	➢ Dangerous situation, which may cause death or serious injury in case of non-observance of this safety instruction.
⚠ CAUTION	➢ Dangerous situation, which may cause minor injury in case of non-observance of this safety instruction.
ATTENTION	➢ Situation, which can cause damage to property in case of non-observance.

RESTRICTION

Is used when certain conditions must meet the validity of statements or the result is limited to a certain validity range.

i	➢ Is used when the result will be better, more economic or trouble-free by following these procedures.

1.2 More symbols

► This arrow starts an action step.

• / - Enumerations are marked with dots or indents.

=> Cross reference to another chapter or another page.

	Note to further documentation. Search for documents at www.keb.de	

1.3 Laws and guidelines

KEB Automation KG confirms with the CE mark and the EC declaration of conformity, that our device complies with the essential safety requirements.

The CE mark is located on the name plate. The EC declaration of conformity can be downloaded on demand via our website. Further information is provided in chapter "Certification".

1.4 Warranty

The warranty on design, material or workmanship for the acquired device is given in the current terms and conditions.

Here you will find our current terms and conditions.

https://www.keb.de/terms-and-conditions

Further agreements or specifications require a written confirmation.

1.5 Support

Through multiple applications not every imaginable case has been taken into account. If you require further information or if problems occur which are not treated detailed in the documentation, you can request the necessary information via the local agency.

The use of our units in the target products is beyond of our control and therefore exclusively the responsibility of the machine manufacturer, system integrator or customer.

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the application. However, they are considered for information only without responsibility. This also applies to any violation of industrial property rights of a third-party.

Selection of our units in view of their suitability for the intended use must be done generally by the user.

Tests can only be done within the application by the machine manufacturer. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.

1.6 Copyright

The customer may use the instruction manual as well as further documents or parts from it for internal purposes. Copyrights are with KEB Automation KG and remain valid in its entirety.

Other wordmarks or/and logos are trademarks (™) or registered trademarks (®) of their respective owners and are listed in the footnote on the first occurrence.

Content

2 Basic Safety Instructions

The COMBIVERT is designed and constructed in accordance with state-of-the-art technology and the recognised safety rules and regulations. However, the use of such devices may cause functional hazards for life and limb of the user or third parties, or damages to the system and other material property.

The following safety instructions have been created by the manufacturer for the area of electric drive technology. They can be supplemented by local, country- or application-specific safety instructions. This list is not exhaustive. Non-observance will lead to the loss of any liability claims.

ATTENTION

Hazards and risks through ignorance!

- ➢ Read all parts of the instruction manual!
- ➢ Observe the safety and warning instructions !
- ➢ If anything is unclear, please contact KEB !

2.1 Target group

This instruction manual is determined exclusively for safety staff. Safety staff for the purpose of this instruction manual must have the following qualifications:

- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of DIN IEC 60364-5-54.
- Knowledge of national safety regulations (e.g. *DGUV regulation 3*).
- Appropriate knowledge in the field of safety technology
- Fundamentals in handling the Windows® operating system

2.2 Validity of this manual

This supplement of the user manual

- describes the extension of the safety module type by the functionality Safety over EtherCAT® hereinafter FSoE.
- contains only supplementary safety instructions.
- only valid in conjunction with the safety manual of safety module type 3.

2.3 Electrical connection

⚠ DANGER

Voltage at the terminals and in the device !
Danger to life due to electric shock !

- ➢ For any work on the unit switch off the supply voltage and secure it against switching on.
- ➢ Wait until the drive has stopped in order that no regenerative energy can be generated.
- ➢ Await capacitor discharge time (5 minutes) if necessary, measure DC voltage at the terminals.
- ➢ Never bridge upstream protective devices (also not for test purposes).

For a trouble-free and safe operation, please pay attention to the following instructions:

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned according to the design of the machine manufacturer. Specified minimum / maximum values may not be fallen below /exceeded.
- With existing or newly wired circuits the person installing the units or machines must ensure the EN requirements are met.
- For drive converters that are not isolated from the supply circuit (in accordance with *EN 61800-5-1*) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).
- When using components without isolated inputs/outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. by the equipotential line). Disregard can cause destruction of the components by equalizing currents.

2.4 Start-up and operation

The drive converter must not be started until it is determined that the installation complies with the machine directive; Account is to be taken of *EN 60204-1* i.

⚠ WARNING

Software protection and programming!
Hazards caused by unintentional behavior of the drive!!

- ➢ Check especially during initial start-up or replacement of the drive converter if parameterization is compatible to application..
- ➢ Securing a unit solely with software-supported functions is not sufficient. It is imperative to install external protective measures (e.g. limit switch) that are independent of the drive converter.
- ➢ Secure motors against automatic restart.

2.5 Used terms and abbreviations

Term	Description
0V	earth-potential-free common point
1ph	1-phase mains
3ph	3-phase mains
AC	AC current or voltage
COMBIVERT	KEB drive converters
COMBIVIS	KEB KEB start-up and parameterizing software
DC	DC current or voltage
DIN	German Institut for standardization
DS 402	CiA DS 402 - CAN device profile for drives
EMC	Electromagnetic compatibility
EN	European standard
EtherCAT®	Real-time Ethernet bus system; EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. It is marked by the following logo:
Ethernet	Real-time bus system - defines protocols, plugs, types of cables
FSoE	Abbreviated form see Safety over EtherCAT®.
FU	Drive converter
GND	Reference potential, ground
HMI	Human machine interface (touch screen)
IEC	International standard
Modulation	means in drive technology that the power modules are controlled
MTTF	mean service life to failure
NN	above sea level
Emergency switching off	Switching off the voltage supply in emergency case
Emergency stop	Shutdown of a drive in emergency case (not de-energized)
OC	Overcurrent
OH	Overheat
OL	Overload
OSSD	Output switching element; Output Signal Swithching Device - an output signal that is checked in regular intervals on its shutdown. (safety technology)
PA	Potential equalization
PDS	Power drive system incl. motor and measuring probe
Safety over EtherCAT®	Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. It is marked by the following logo:

Table 1: Used terms and abbreviations

3 Fundamentals

3.1 General

The safety module is FSoE Conformance Tested. The drive converter is Ethercat Conformance tested. The description files for the operating tools TwinCAT and COMBIVIS with Codesys Safety are required for the operation as FSoE slave.

3.2 FSoE configuration tools

The procedure used in this manual can be used for TwinCAT 2.11, 3.1 and COMBIVIS studio 6 (CODESYS Safety).

A description of the procedure for TwinCAT 2.11 has been omitted since TwinCAT 2.11 can process only Boolean FSoE data. The dynamic adjustment of integer-based limits for safety functions such as SLS (Safe limited speed) and SSM (Safe stop monitoring), as well as the checking of position and speed data is currently not supported there. The procedure there is nearly similar to the two presented here.

3.2.1 FSoE bus settings in the KEB safety module editor in COMBIVIS

Parameter	Value	Unit
Bus general options		
Bus type	FSoE	
Safety address	10	
Safety bus data length	11	

Figure 1: Safety module address in the configuration (parameter group bus settings)

Parameterisation:

- **Bus type:**
  This is the selection of the safe bus type. The selection parameters are „without bus“ or „FSoE“.
  - Without bus means that no safe bus system is used and the safety module is controlled only via the inputs.
  - FSoE means, that the bus system Safety over EtherCAT® is used.

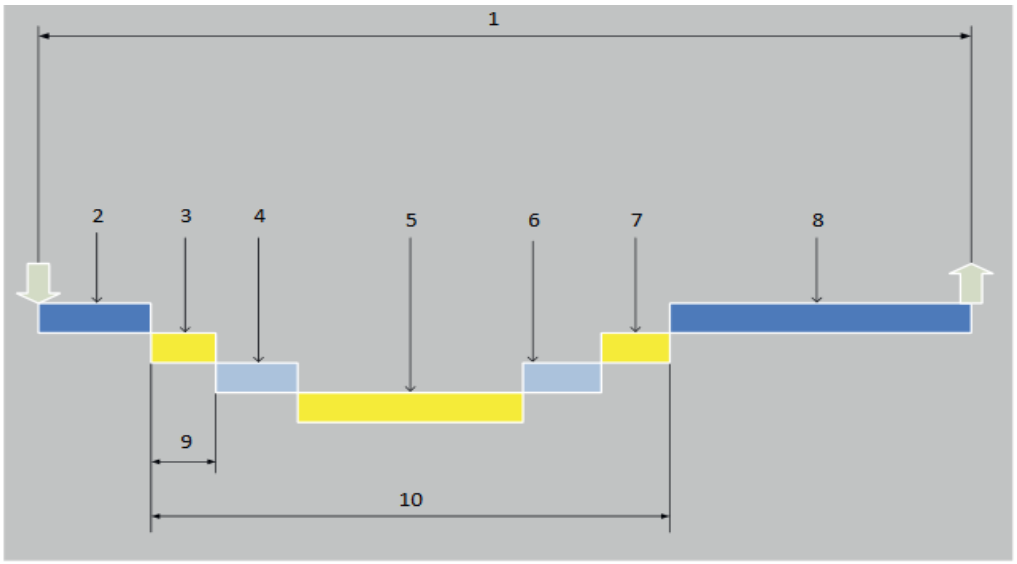
- **Safety module address:**
  The safety module address must agree with the safety module address which is displayed in the tab settings of the safety module. By default, this address is set to 0 (invalid).

- **Data length bus:**
  If a safe bus system has been selected, the length of the safe data can be adjusted here. This length must agree with the configuration in the safe control. For bus type FSoE 6, 7, 11 or 15 bytes are allowed.

4 Response time (FSoE watchdog)

In a safety system, the total response time is produced of the following partial response times:

- Signal processing in the sensor
- Signal processing in the KEB safety module
- Data run time of the input data on the EtherCAT bus between KEB safety module and safe PLC.
- Program run time in the safe PLC
- Data run time of the output data on the EtherCAT bus between Safety PLC and KEB safety module.
- Signal processing in the KEB safety module.
- Signal processing in the actuator



1	total response time	6	transmission of the frame via EtherCAT
2	signal processing by sensor	7	signal processing by safe I/O module
3	signal processing by safe I/O module	8	signal processing by actuator
4	transmission of the frame via EtherCAT	9	safe response time of the module
5	safe PLC program runtime	10	safe response time by system

Figure 2: Response time safety module version 3.

⚠ CAUTION

Observe the run times of the field bus and the cycle time of the Safety PLC for the safe response time!

➢ For designing the safe response time, the run times of the field bus and the cycle time of the Safety PLC must be included in the calculation of the safe response time.

The minimum FSoE watchdog time of the safety module is 1ms.

The actual technically achievable minimum watchdog time is significantly determined by the complete device and is therefore described in the manual of the respective control unit.

5 TwinCAT 3 and KEB Safety Module Type 3

5.1 Installation of the description file for the inverter

The EtherCAT ® description file must be imported in TwinCAT in order that the inverter can be used with the safety module Type 3 in TwinCAT.

The ESI file is delivered with COMBIVIS. On a computer with installed COMBIVIS you will find the files for TwinCAT at:

"C:\<installation directory>\KEB\COMBIVIS_6\KEB\EtherCAT\"

Determine installation directory

- Right click on the COMBIVIS icon.
- Click on Properties.
- The installation directory is displayed in the line "Target".

The following files are required:

KEB_X6_Safety_Type_3.xml

KEB_custommodules.xml

KEB_standardmodules.xml

New or missing description files can be obtained via COMBIVIS or via the KEB homepage.

After the new file is available in the installation directory above, TwinCAT must be closed completely and opened again. The simple "Reload Device Descriptions" in TwinCAT is not sufficient.

5.2 Add a KEB drive converter with safety module type 3

1. Add an EtherCat® master by right-hand click>*Add New Item* under I/O Devices.

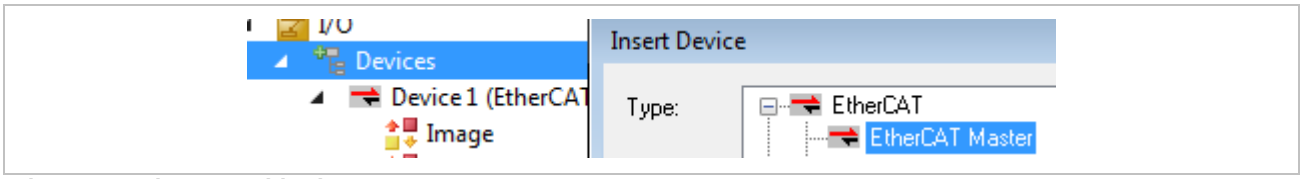


Figure 3: TwinCAT: Add Ethercat master

2. Right-hand click to perform a scan. If the inverter is correctly connected and ready for operation, this scan should be found.

Figure 4: TwinCAT: Scan for Ethercat devices

3. Alternatively, the KEB inverter can also be added by right-hand click on the EtherCat® master and „*Add New Item*“.

5.3 Selection of a FSoE module configuration

KEB offers several module configurations with different FSoE data assignments. These can be selected individually for the respective application.

Please also note chapter 9.3 for the selection of the module description.

Procedure for selecting a module configuration:

1. Double-click on the inverter.
2. Click the "Slots" tab in the new tab.
3. Select the safety module slot.
4. A view with the available modules should be displayed now.

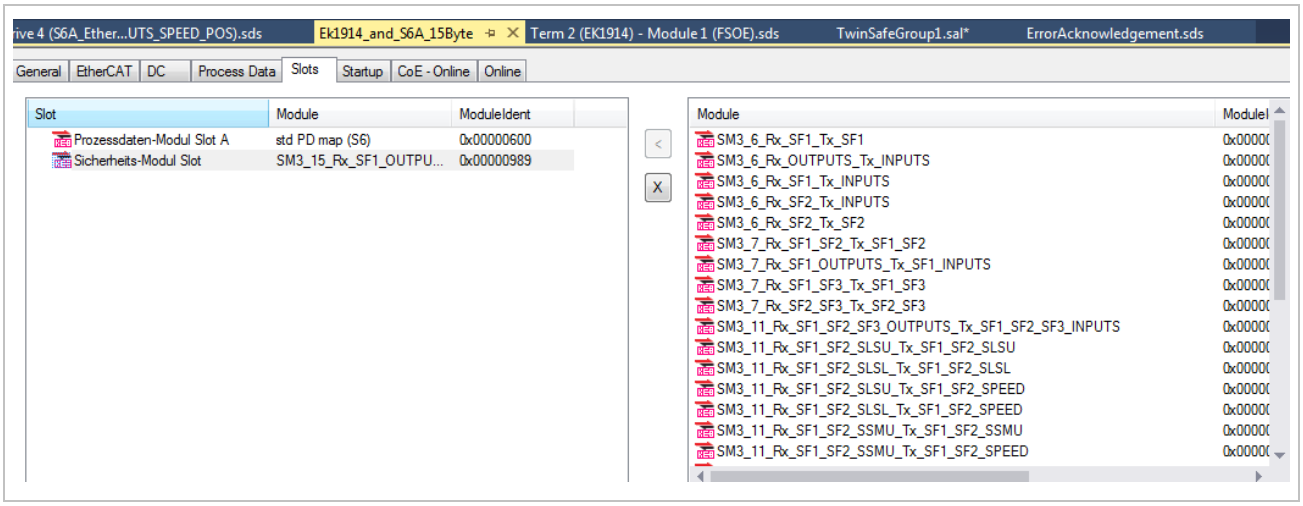


Figure 5: Selection of the module configuration

5. Select a module description and accept with the "<" button.
6. A standard process data description can additionally be mapped in the process data module slot A.
7. Then the overview in TwinCAT should look similar:

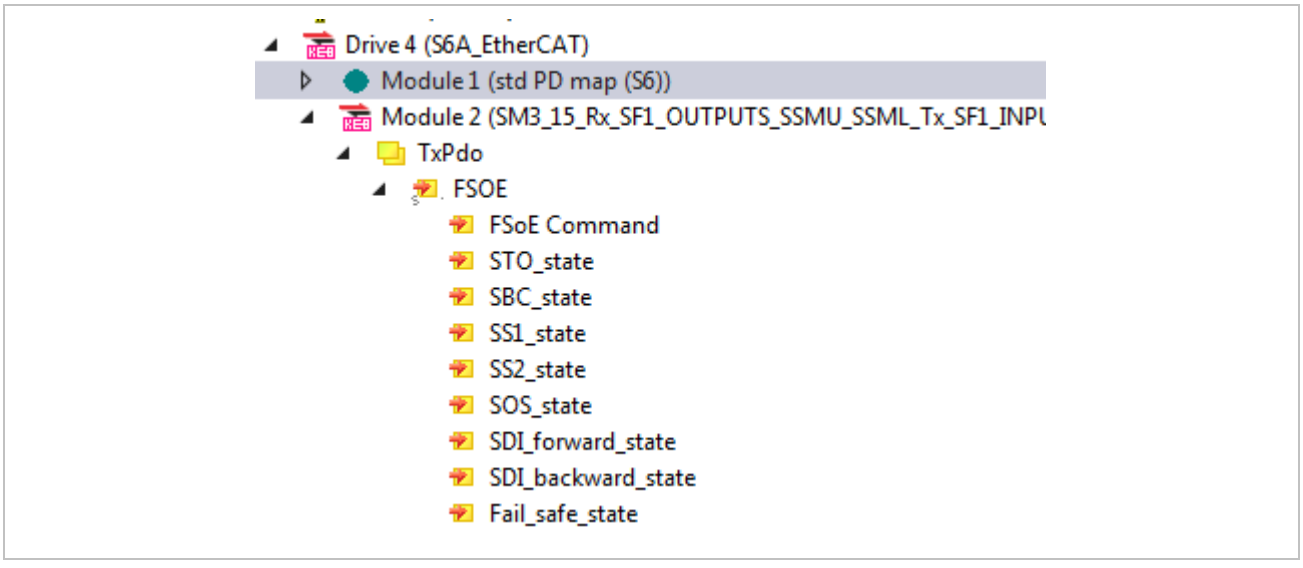


Figure 6: TwinCAT 3, Overview of the configured FSoE process data

5.4 Creating a new safety group

In order that the safety module can be used in the safe control system, a new safety group must be created in TwinCAT.

Procedures:

1. Right-hand click on the "SAFETY" item in the Solution explorer of TwinCAT. Then click on „Add New Item“.
2. Click on „TwinCAT Default Safety Project“ in the following selection dialog.

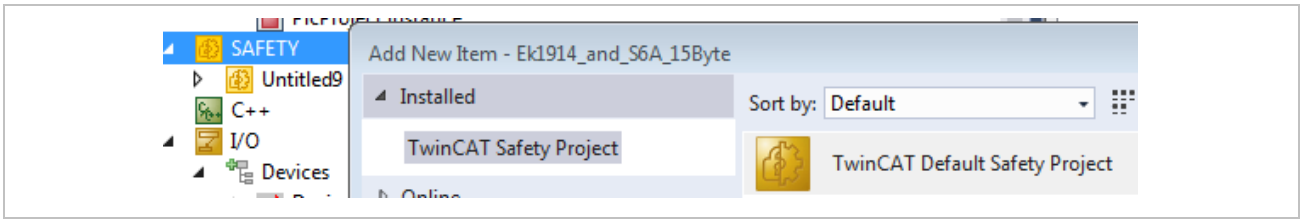
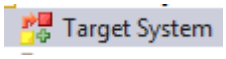


Figure 7: TwinCAT add default safety project

3. Fill in the information in the following menu according to your own specifications.
4. Now a new safety group should be available.
5. Next click on the menu item "Target System".



6. Select the Physical Device:

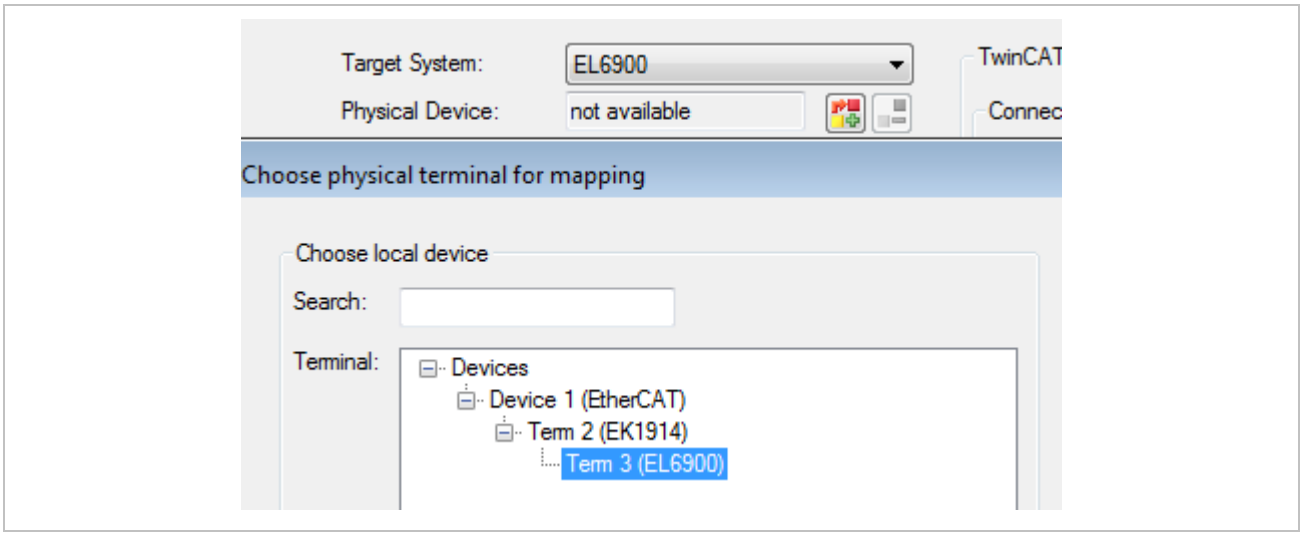


Figure 8: TwinCAT: Select physical device

7. Then right-hand click on Alias Devices and select the menu item "Import Alias Devices".

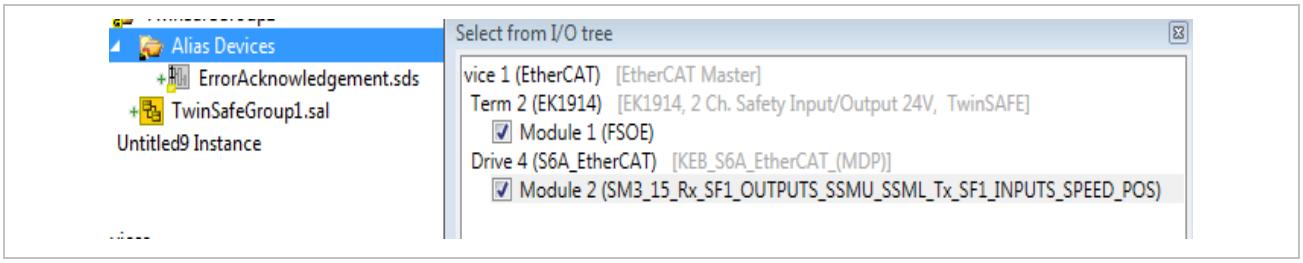


Figure 9: TwinCAT: Import alias devices

Then select the Alias Devices to be imported and click OK.
The KEB inverter with the safety module should be displayed now under Alias Devices.

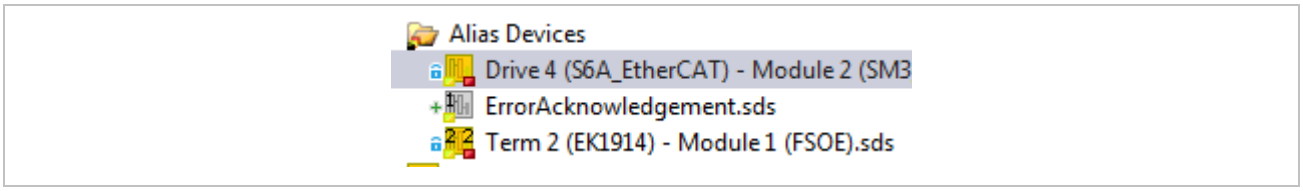


Figure 10: TwinCAT: Alias devices in the Twinsafe group

8. Double-click on the KEB inverter displays the Linking overview page. The correct FSoE address should already be entered here, but for security reasons it should be checked again.

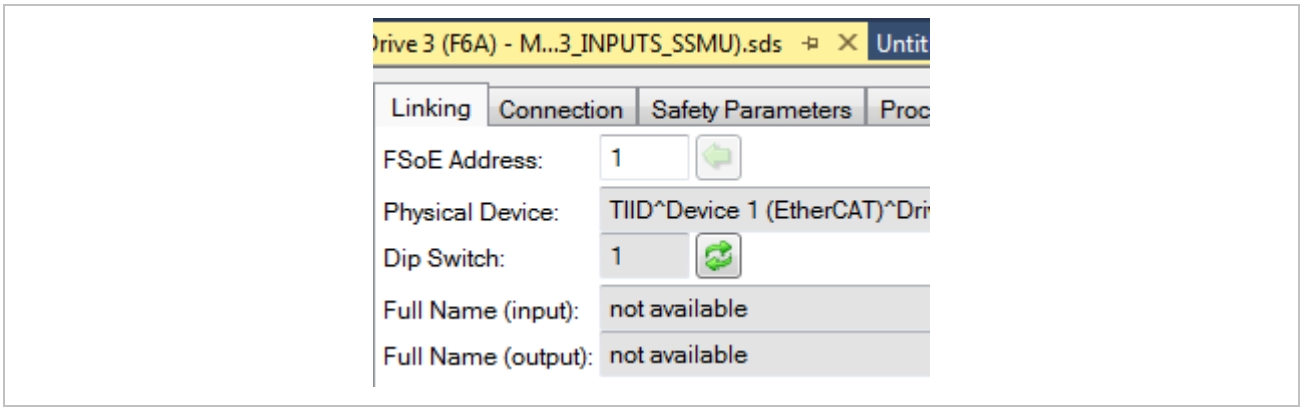


Figure 11: TwinCAT: Changing the FSoE address

9. The settings according to chapter 7 must be done in the safety parameters tab.

6 CODESYS Safety and safety module type 3

6.1 Installation of the description file for the inverter

The required description file can be created in COMBIVIS using the process data assistant. When using the KEB COMBIVIS studio 6, the file can be installed directly into the device repository.

6.2 Add a KEB drive converter with safety module type 3

After a PLC has been added, the EtherCAT Master can be added by right-hand click> Add Device, see Figure 12: CODESYS: Add EtherCAT Master.

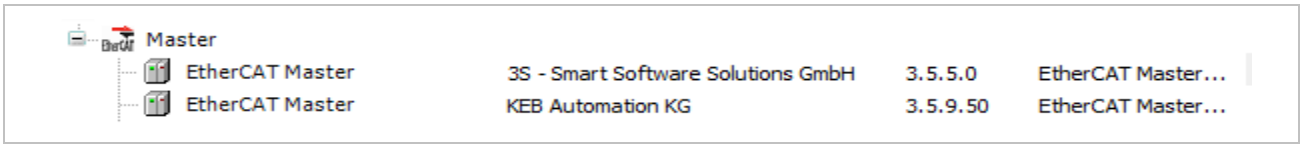


Figure 12: CODESYS: Add EtherCAT Master

After the EtherCAT Master has been added, the connected inverters can be recognized by right-hand click and selecting "Scan for Devices", see Figure .

The scan for devices only works with an ESI file explicitly created for the device revision. Attention, this is not the standard case.

By default, the FSoE module ID is included in the high word of the revision to handle more than one FSoE configuration parallel in the device repository.

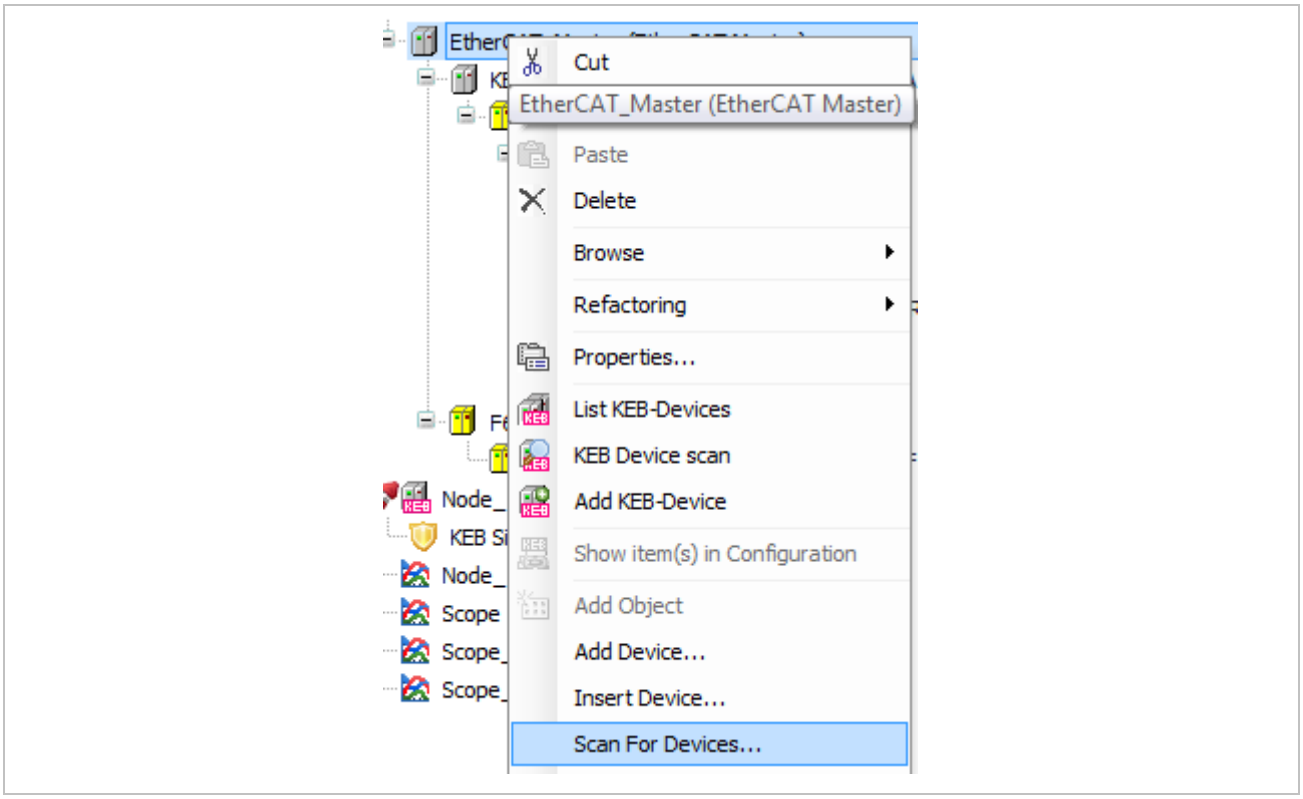


Figure 13: CODESYS: Scan for Devices

Thereby the inverter with the safety module should be found and added. Furthermore, a connected and ready for operation Safety PLC should also have been detected and added.

The view of the KEB inverter with the safety module should then look similar to Figure 14: KEB inverter with safety module in Codesys.

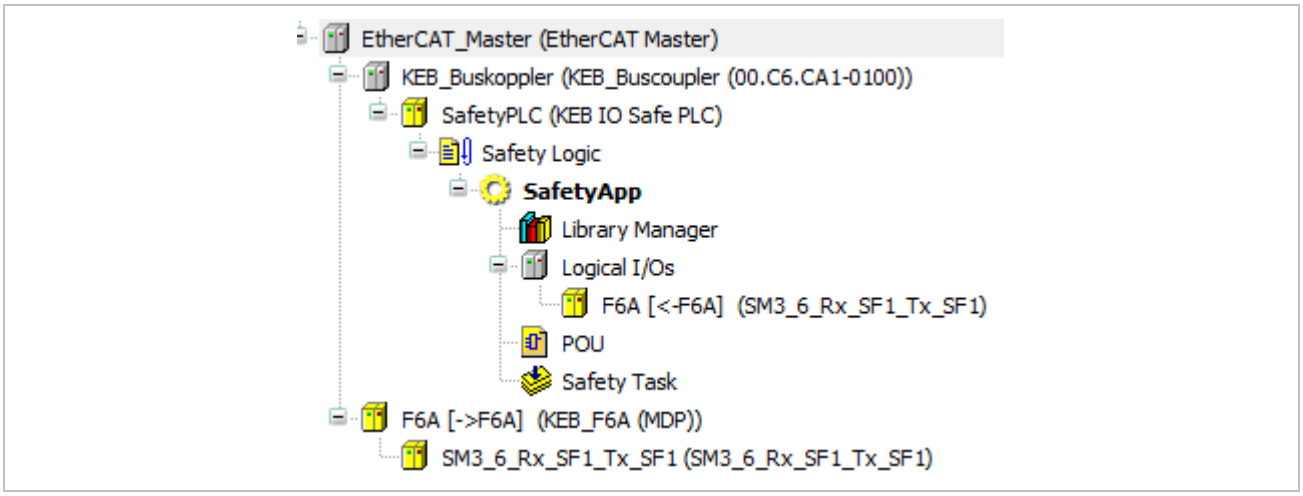


Figure 14: KEB inverter with safety module in Codesys

The safe configuration can be opened by double-click on the inverter under Logical I/Os. The data must be entered according to chapter 7.

7 Setting the safe FSoE configuration data

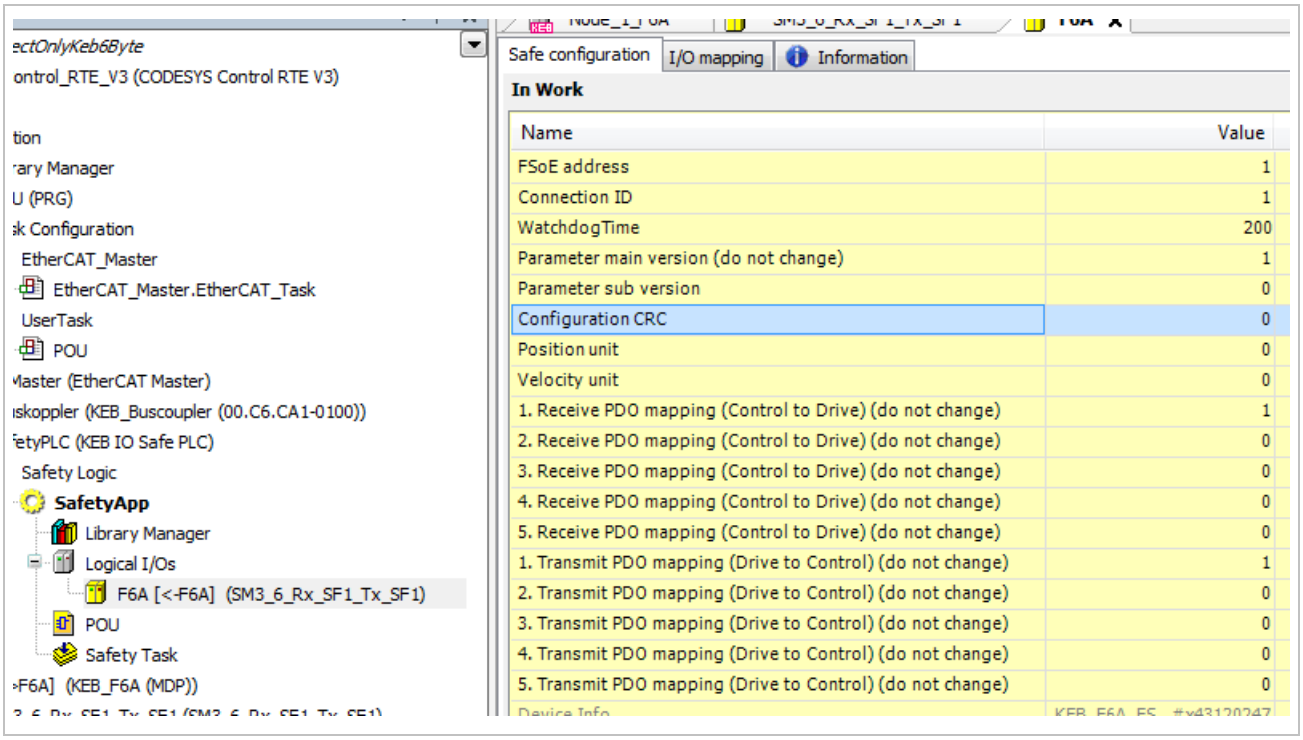


Figure 15: FSoE address, watchdog time and configuration CRC in COMBIVIS (CODESYS safety)

1. **FSoE address:**
   This is the safety module address set in COMBIVIS.
2. **Connection ID:**
   This must be a unique address about all safe slaves. (e.g. equal to the FSoE address)
3. **Parameter main version:**
   This may not be changed.
4. **Parameter sub version:**
   Here the user can enter an own number for personal purposes (e.g. Configuration version). This sub version can be read out after starting FSoE via CoE from the safety module.
5. **Configuration CRC:**
   The configuration CRC, which is displayed in COMBIVIS at Device CRC.

Figure 16 COMBIVIS Device CRC

Alternatively, the CRC can also be read from the SM group in parameter Safety Device Info.

Figure 17: SM Parameter Safety Device Info COMBIVIS CRC

If the CRC does not match when the FSoE communication is started, the boot-up is not carried out by the FSoE slave.

6. **Position Unit:**
   The number of bits for the decimal places of the FSoE process data. The default is 0 bit. This means that the scaling amounts full revolutions.

   For example, if a 4 is configured at the position unit, then the position data are divided into 12 bits full revolutions and 4 bits partial revolutions.

⚠ DANGER

- The position unit affects the FSoE position data.
- If the position unit is changed, the software must be checked and verified in the safe master.

7. **Velocity Unit:**

   The number of bits for the decimal places of the FSoE process data. The default is 0 bit. This means that the scaling amounts full revolutions per minute.

⚠ DANGER

- The velocity unit affects the following FSoE data simultaneously:
  - Speed
  - SLS upper and lower limit
  - SSM upper and lower limit
- If the velocity unit is changed, the mentioned FSoE data must be checked and verified again.

8. **Other settings:**

   Other settings (if displayed) must not be changed.

8 FSoE state machine and check state with COMBIVIS

8.1 FSoE state machine

Figure 18: FSoE state machine in the safety module type 3 shows the state machine of FSoE, which is implemented in the safety module type 3.

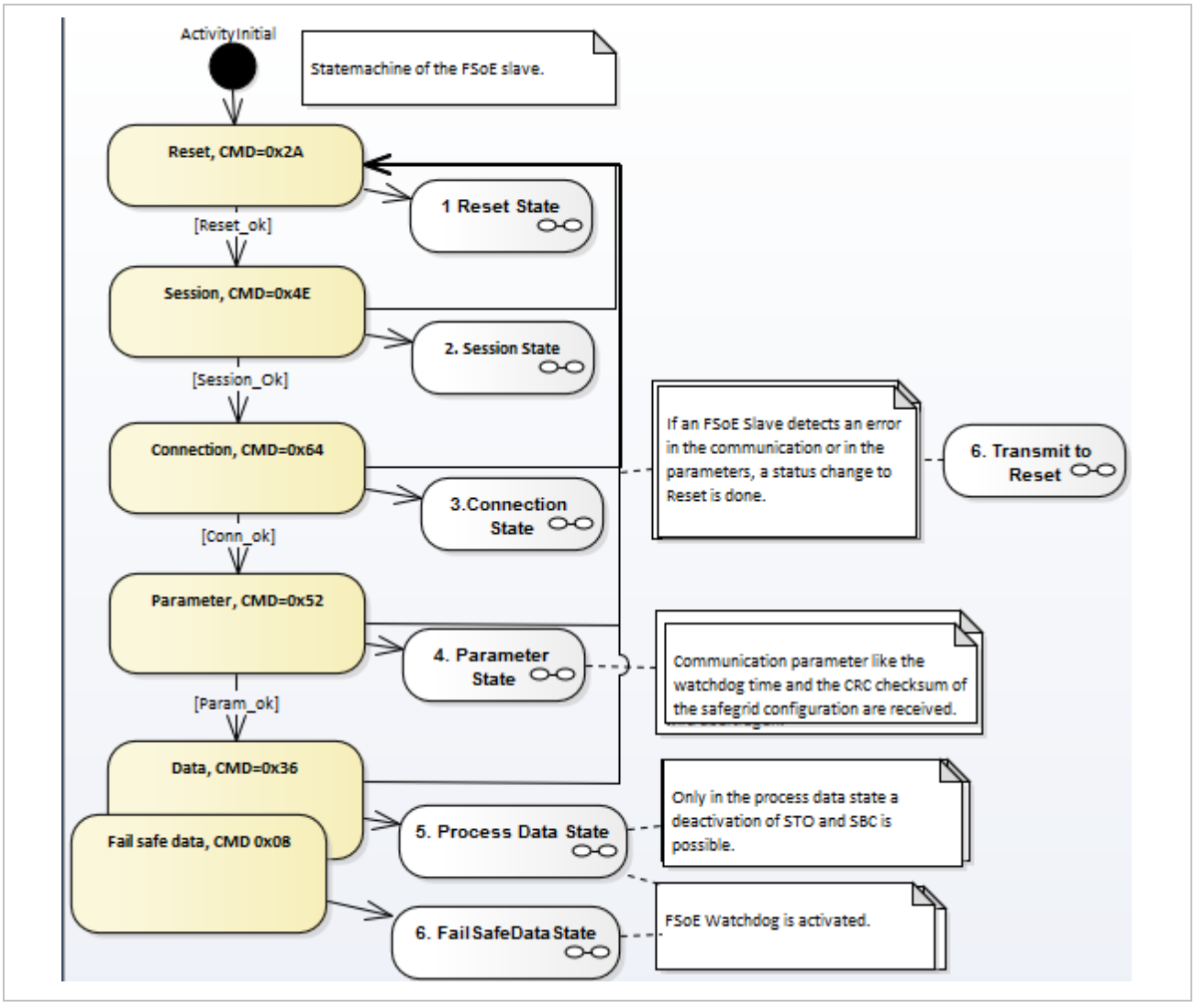


Figure 18: FSoE state machine in the safety module type 3

The data state and fail safe data state can only be achieved if the bus type FSoE is selected in the safety module configuration. Additionally, there must be no error in the safety module. This is checkable with the safety module status page in COMBIVIS. Parameter „error state“ should not display an error.

8.2 Checking the FSoE state

The FsoE state can be seen in COMBIVIS in the safety module on the status page. Also bus errors, discovered by the slave are available there.

8.3 Bus configuration error

There is a separate category for bus configuration errors on the tab protocol in COMBIVIS. Bus configuration errors can occur, if par example a FSoE configuration with encoder data was set, but no encoder has been configured.

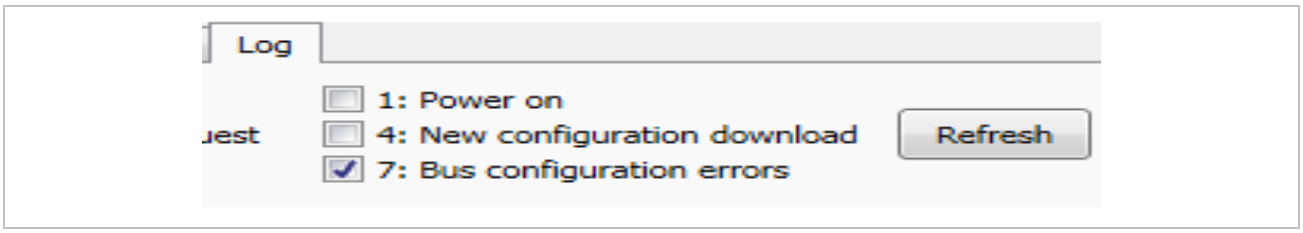


Figure 19 Bus configuration error in the protocol tab

8.4 Bus error

If errors are identified during FSoE operation, these errors will be logged and they can be read out with COMBIVIS in the tab bus errors.

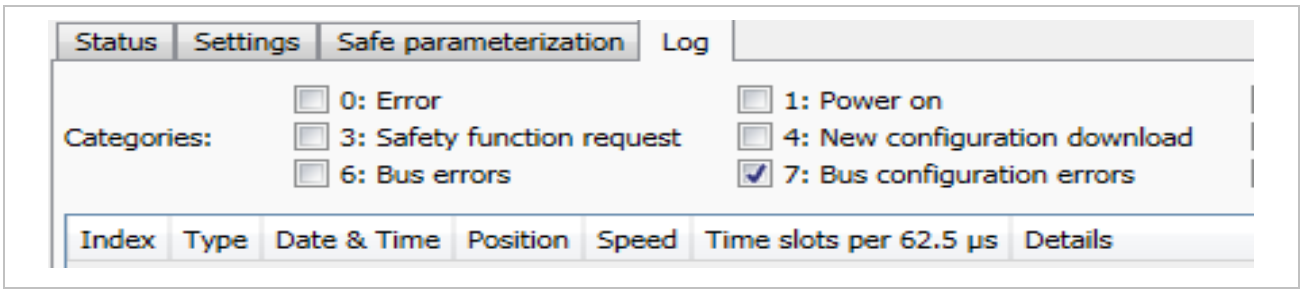


Figure 20 Bus error log in COMBIVIS

9 FSoE process data

If a module configuration is selected, the following must be observed:

1. If there is no SF1 (Safety Functions 1st Byte) in the module configuration, then a safety input with the safety function STO must be configured. Otherwise the safety function STO can not be left.
2. As long as the FSoE communication is not started, the safety module remains in STO status (Safe torque off). Furthermore, the safety function SBC (Safe brake control) is activated. This is independent of whether an STO or SBC input has been configured.
3. If the configuration "monitoring always active" has been selected at SSM, this monitoring is always active, even if the FSoE communication has not started yet. This is important if the configured speed limits are set to 0. In this case, the SSM status can alternate.

9.1 Received process data (Safe master to the safety module)

ATTENTION

- Safe input data always have the ending „_in“.
- The safety functions are 0 active. This means that the safety function is activated when the respective bit has the status 0.
- If not all functions are used in the application, e.g. only SOS should be activated, then all unused safety functions must be set to status 1.
- Parallel to the FSoE process data, the inputs of the safety module can also be configured with safety functions.
- If a safety function is requested via the FSoE process data or via the inputs, then this safety function is carried out.
- The hardware inputs are 1 active. Details see chapter 9.5.1.

9.2 Transmitted process data (Safe master to the safety module)

ATTENTION

- Safe output data always have the ending „_state".
- The status of the safety functions is 1 active. This means, if the safety function is carried out, the respective bit has the status 1.
- The status of the outputs is 1 active. Details see chapter 9.5.2.

9.3 FSoE Modul configuration according to ID

ID	Pd In Mapping					Pd Out Mapping				
	1. In	2. In	3. In	4. In	5. In	1. Out	2. Out	3. Out	4. Out	5. Out
6 Byte										
#x900	SF1	-	-	-	-	SF1	-	-	-	-
#x901	OUTPUT	-	-	-	-	INPUT	-	-	-	-
#x902	SF1	-	-	-	-	INPUT	-	-	-	-
#x903	SF2	-	-	-	-	INPUT	-	-	-	-
#x904	SF2	-	-	-	-	SF2	-	-	-	-
7 Byte										
#x910	SF1	SF2	-	-	-	SF1	SF2	-	-	-
#x911	SF1	OUTPUT	-	-	-	SF1	INPUT	-	-	-
#x912	SF1	SF3	-	-	-	SF1	SF3	-	-	-
#x913	SF2	SF3	-	-	-	SF2	SF3	-	-	-
11 Byte										
#x920	SF1	SF2	SF3	OUTPUT	-	SF1	SF2	SF3	INPUT	-
#x921	SF1	SF2	SLSU	-	-	SF1	SF2	SLSU	-	-
#x922	SF1	SF2	SLSL	-	-	SF1	SF2	SLSL	-	-
#x923	SF1	SF2	SLSU	-	-	SF1	SF2	SPEED	-	-
#x924	SF1	SF2	SLSL	-	-	SF1	SF2	SPEED	-	-
#x925	SF1	SF2	SSMU	-	-	SF1	SF2	SSMU	-	-
#x926	SF1	SF2	SSMU	-	-	SF1	SF2	SPEED	-	-
#x927	SF1	SF2	SSML	-	-	SF1	SF2	SSML	-	-
#x928	SF1	SF2	SSML	-	-	SF1	SF2	SPEED	-	-
15 Byte										
#x980	SF1	SF2	SLSU	SLSL	-	SF1	SF2	SLSU	SLSL	-
#x981	SF1	SF2	SLSU	SLSL	-	SF1	SF2	SPEED	POS	-
#x982	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SPEED
#x983	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SLSU
#x984	SF1	SF2	SLSU	SSMU	-	SF1	SF2	SPEED	POS	-
#x985	SF1	SF2	SLSU	SLSL	-	SF1	INPUT	SPEED	POS	-
#x986	SF1	SF2	SLSU	SSMU	-	SF1	INPUT	SPEED	POS	-
#x987	SF1	SF2	SSMU	SSML	-	SF1	SF2	SSMU	SSML	-
#x988	SF1	SF2	SSMU	SSML	-	SF1	SF2	SPEED	POS	-
#x989	SF1	OUTPUT	SSMU	SSML	-	SF1	INPUT	SPEED	POS	-
#x98A	SF1	SF2	SF3	OUTPUT	SSMU	SF1	SF2	SF3	INPUT	SSMU

For operation without configured safe encoders the Id's 0x0900, 0x0901, 0x0902, 0x0911, 0x0912 are available.

9.4 Safety Functions

9.4.1 SF1 Safety Functions 1st Byte

The following bits are exchanged in this configuration:

Name	Description	Representation	Name
SF1	Safety Functions 1st Byte	Bit 0	STO (Safe Torque off)
		Bit 1	SBC (Safe brake control)
		Bit 2	SS1 (Safe speed 1)
		Bit 3	SS2 (Safe speed 2)
		Bit 4	SOS (Safe operation stop)
		Bit 5	SDI Clockwise (Safe direction)
		Bit 6	SDI Counter Clockwise (Safe direction)
		Bit 7	Fail Safe and Acknowledge

Table 2: Assignment of the safe process data bytes ‚SF1'

Bit7 (Fail Safe and Acknowledge) is activated as soon as a violation of a safety function has been detected. The Fail Safe bit can be reset by briefly setting it to 0 and then back to 1.

ATTENTION

- If no encoder is configured, only the safety functions STO, SBC and SS1 can be activated.
- If another safety function is activated, the safety module changes into the FSoE Reset state.
- It is therefore necessary to set all other bits of the safety functions to status 1 if no encoder is connected.
- At SS1 only SS1C is possible. The selection of the function type for the configuration of the safety module must be set to "only type C".

9.4.2 SF2 Safety Functions 2nd Byte

The following bits are exchanged in this configuration:

Name	Description	Representation	Name
SF2	Safety Functions 2nd Byte	Bit0	SLS (Safe limited speed)
		Bit1	SLA (Safe limited acceleration)
		Bit2	SLP (Safe limited position)
		Bit3	SLP set reference position
		Bit4	SEL (Safe emergency limit)
		Bit5	SLI (Safe limited increment)
		Bit6	SLI Next Step
		BIt7	SSM (Safe speed monitoring)

Table 3: Assignment of the safe process data bytes ‚SF2'

Bit 4 SEL (Safe emergency limit) bit can be activated independently of SLP. As soon as the bit is set to 0, the current position is used as start position for speed monitoring. The speed monitoring of SEL can be taken from the manual of the safety module.

Bit 3 SLP set reference position sets the reference position exactly when the status is changed from TRUE to FALSE. The reference position can be set only once.

9.4.3 SF3 Safety Functions 3rd Byte

The following bits are exchanged in this configuration:

SF3	Safety Functions 3rd Byte	Bit0	SMS (Safe maximum speed)
		Bit1	reserved
		Bit2	reserved
		Bit3	reserved
		Bit4	reserved
		Bit5	Index Bit 1
		Bit6	Index Bit 2
		Bit7	Index Bit 3

Table 4: Assignment of the safe process data bytes ‚SF3‘

Safe maximum speed (SMS) is always active. Additional activation is not required.

The set index of all safety functions can be switched simultaneously by the 3 index bits.

9.5 Input and output state

The input and output state can also be queried by the safety module if a safety function has been configured for the input or output.

9.5.1 Output state

The following bits are exchanged in this configuration:

Output	Output	Bit0	Output 1
		Bit1	Output 2
		Bit3	Ripple output state

Table 5: Assignment of the safe process data bytes ‚Output‘

The outputs of the safety module can be safe switched hereby or the output state of the safety module can be safe detected.

ATTENTION

- The output can only be switched via FSoE, if it is not configured. If the output is configured, it can not be switched via FSoE.
- For the ripple output, the configuration parameter "Ripple Master" must also be set to "on".
- The hardware output outputs 24V when the state of the bit is set to 1.
- The hardware output is reset when the state of the bit is set to 0.

9.5.2 Input State

Input	Input State	Bit0	STO hardware input state
		Bit1	SBC hardware input state
		Bit2	Ripple hardware input state
		Bit3	Function 1 hardware input state
		Bit4	Function 2 hardware input state
		Bit5-7	reserved

Table 6: Assignment of the safe process data bytes ‚Input State‘

Hereby the input state of the safety module can be safe detected.

ATTENTION

- The bit for the respective hardware input state is 0 if the input is not supplied.
- The bit for the respective hardware input state is 1 if the input is supplied with 24V.
- The filter time of the safety inputs in the configuration of the safety module must be considered. A state change is only carried out after the filter time.
- The hardware input configuration of the safe inputs of the safe parameterization of COMBIVIS also apply to the FSoE input state. The tolerance time of the inputs and the state of the inputs can be adjusted hereby. If the input is configured to Equivalent, both input channels must have 24V within the tolerance time in order to set the FSoE state of the input to 1.

9.6 Dynamic speed limits via FSoE

The upper and lower speed limits of SLS and SSM can be changed via FSoE. The following applies:

⚠ DANGER

- The upper speed limit should always be higher than the lower speed limit. If this is not the case, there is no acceptable speed and the safety module would always activate the error function and with SLS always set the SSM state in SSM.
- If only one limit is set via FSoE, check configuration of COMBIVIS whether the above given condition is fulfilled in every operating case.
- The hysteresis must also be considered at SSM.

9.6.1 SLS (Safely limited speed)

The upper and lower speed limits can be adjusted dynamically via FSoE data.

⚠ DANGER

- The SLS bit in SF2 (see chapter 9.4.2) must be set to 0 in order to activate SLS and to activate the transmitted upper and lower speed limit. It is not sufficient if only the limits are written by FSoE.
- The tolerance time and error function must be configured in the safety module.
- If a set changeover is used, the error function and the tolerance time must be checked in each set and configured accordingly.
- The speed limit is a 16 bit value which is dependent on the Velocity Unit parameter (see chapter 7).

9.6.1.1 SLSU (Safely-limited speed: upper speed limit)

The upper speed limit for the safety function SLS can be specified herewith.

⚠ DANGER

- The upper speed limit is continuously transmitted via FSoE if a FSoE configuration with SLSU is selected.
- The setting for the upper speed limit in the configuration of the safety module therefore has no effects anymore.
- Also a set changeover has no effects on the upper speed limit.
- If only FSoE data for the upper speed limit of SLS are exchanged, the lower speed limit is taken from the configuration data.
- The upper speed limit of FSoE also applies for the case that SLS is activated via an input of the safety module.

9.6.1.2 SLSL (Safely-limited speed: lower speed limit)

The lower speed limit for the safety function SLS can be specified herewith.

⚠ DANGER

- The lower speed limit is continuously transmitted via FSoE if a FSoE configuration with SLSL is selected.
- The setting for the lower speed limit in the configuration of the safety module therefore has no effects anymore.
- Also a set changeover has no effects on the lower speed limit.
- If only FSoE data for the lower speed limit of SLS are exchanged, the upper speed limit is taken from the configuration data.
- The lower speed limit of FSoE also applies for the case that SLS is activated via an input of the safety module.

9.6.2 SSM (safe speed monitoring)

The upper and lower speed limits can be adjusted dynamically via FSoE data.

⚠ DANGER

- The SSM bit in SF2 (see chapter 9.4.2) must be set to 0 in order to activate SSM and to activate the transmitted upper and lower speed limit.
- SSM can also be activated by setting the configuration "Monitoring always active" to "on". A possible set changeover must be observed.
- It is therefore not sufficient to write only the limits by FSoE.
- The hysteresis and "Monitoring always active" must be configured in the safety module.
- If a set changeover is used, the hysteresis and the monitoring must be checked actively in each set and configured accordingly.
- The speed limit is a 16 bit value which is dependent on the Velocity Unit parameter (see chapter 7).

9.6.2.1 SSMU (Safe speed monitoring: upper speed limit)

The upper speed limit for the safety function SSM can be specified herewith.

⚠ DANGER

- The upper speed limit is continuously transmitted via FSoE if a FSoE configuration with SSMU is selected.
- The setting for the upper speed limit in the configuration of the safety module therefore has no effects anymore.
- Also a set changeover has no effects on the upper speed limit.
- If only FSoE data for the upper speed limit of SSM are exchanged, the lower speed limit is taken from the configuration data.
- The upper speed limit of FSoE also applies for the case that SSM is activated via an input of the safety module.

9.6.2.2 SSML (Safe speed monitoring: lower speed limit)

The lower speed limit for the safety function SSM can be specified herewith.

⚠ DANGER

- The lower speed limit is continuously transmitted via FSoE if a FSoE configuration with SSML is selected.
- The setting for the lower speed limit in the configuration of the safety module therefore has no effects anymore.
- Also a set changeover has no effects on the lower speed limit.
- If only FSoE data for the lower speed limit of SSM are exchanged, the upper speed limit is taken from the configuration data.
- The lower speed limit of FSoE also applies for the case that SSM is activated via an input of the safety module.

9.7 Speed (Safe speed)

The safe speed as sign-sensitive 16 bit value. The speed is depending on parameter "Velocity Unit" (see chapter 7).

ATTENTION

- The speed scan time and speed PT1 time in the COMBIVIS settings for the speed measurement must be observed.

⚠ DANGER

- If the velocity Unit is selected too high, the speed value can overflow.
- For example, if the velocity unit is set to 0, the FSoE speed is overflow at 32767 rpm and underflow at -32768 rpm.
- Appropriate measures must be taken to intercept this case. For example, a measure which could be taken is to configure the safe maximum speed (SMS) by way that the speed is safely limited.

9.8 Pos (safe position)

The safe position as sign-sensitive 16 bit value. The position is dependent on parameter „Position Unit“ (see chapter 7). The position is specified in revolutions and partial revolutions. If the position unit is configured to 0, 1 corresponds to exactly 1 revolution of the motor.

⚠ DANGER

- The position value can overflow if the position value becomes too high or underflow, if the position value becomes too small.
- For example, if the position unit is set to 0, the FSoE position is overflow at 32767 rpm and underflow at -32768 rpm.
- Appropriate measures must be taken to intercept this case. For example, a measure which could be taken is to activate the safe limited position (SLP) and to limit the position by suitable configuration.

10 FSoE Error identifications

See table 27 and 28 ETG.5001. The following error codes are used by the slave. The exact error cause can be read out in the protocol tab with COMBIVIS.

Error code	Description
0	Reset of the FSoE connection.
1	Invalid command
2	Unknown command
3	Invalid connection ID
4	Invalid CRC error
5	Watchdog expired
6	Error FSoE Slave address (Invalid_ADDRESS)
7	Invalid data
8	Invalid com para length
9	Invalid communication parameter
10	Invalid user parameter length
11	Invalid user parameter

11 Trouble-shooting

11.1 The safety module does not answer FSoE data telegrams

1. The bus type was not set to FSoE in the safe configuration in COMBIVIS. Use the manual of the safety module to check whether the bus type is FSoE.
2. The wrong FSoE data length was configured in the safe configuration in COMBIVIS. Use the manual of the safety module to check whether the data length is correct.

11.2 The safety module does not change into FSoE data state

1. The device CRC from COMBIVIS does not match the checksum transmitted via FSoE. Check the settings according to chapter7.
2. Safety functions have been activated which require an encoder. Check if an encoder is configured.
3. The FSoE address does not agree with the configuration in COMBIVIS. Use the manual of the safety module to check whether the control and status word length are correct.
4. The watchdog time was set too small. Check in chapter 4 whether this time is correct.

11.3 The state of the safety functions in the safety module is always STO

1. Safety functions are 0 active. This means that the safety function will be activated when the respective bit for the safety function is set to 0. Many safety functions release STO. If (e.g.) SOS is activated although this safety function is not configured with COMBIVIS, STO is carried out immediately after activation. Check according to chapter 9.4.1, 9.4.2 if all not required safety functions are set to 1.
2. Check if an input is additionally activated and configured to a safety function.

11.4 Which safety function has been set by the fail safe and acknowledge bit

1. If several safety functions are carried out at the same time, it is difficult to recognize which safety function has set the fail safe and acknowledge bit. Use the following procedure:
   a. Revoke the request for the safety function. The safety functions displayed on the status page in COMBIVIS or via FSoE are now reduced to the safety functions, which have set the fail safe bit or which are always active.
   b. Check the sequence of the safety function and the position and speed in the protocol at safety function execution date. From the position and speed it can usually be concluded which safety function sets the fail safe bit.
   c. If safety functions have been activated by inputs or FSoE, the request for safety functions can be checked via FSoE in category "Bus request for safety functions".

12 Revision history

Date:	Revision:	Note:
12.05.2017	01	Pre-series version
07.06.2017	02	Pre-series version .Codesys description added.
29.06.2017	03	Pre-series version .FSoE process data description added.
11.07.2017	03	Images linked
31.07.2017	04	Comments incorporated
12.12.2017	04	Comments incorporated, Chapter 9.4.2 revised.
26.01.2018	05	Series version of the manual
29.08.2018	06	Table for FSoE modul configuration insert in chapter 9.Text to installation of the description file under 5.1, 6.1 and 6.2 extended.

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