Supplement

Safety Module Type 3
PROFIsafe Firmware 3.3.0.2

Table of Contents

List of Figures

List of Tables

1   Introduction

The described devices, accessories, hardware and/or software are products of KEB Automation KG. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

1.1   Markings

1.1.1   Warnings

Certain operations can cause hazards during the installation, operation or thereafter. There are safety informations in the documentation in front of these operations.

Warnings contain signal words for the severity of the hazard, the type and/or source of the hazard, the consequence of non-compliance and the measures to avoid or reduce the hazard.

⚠ DANGER	**Type and/or source of the hazard.**
⚠	**Leads to death or serious bodily injury if not observed.** a) Measures to avoid the hazard. b) Can be supplemented by an additional danger sign or pictogram.

⚠ WARNING	**Type and/or source of the hazard.**
⚠	**May cause death or serious injury if not observed.** a) Measures to avoid the hazard. b) Can be supplemented by an additional danger sign or pictogram.

⚠ CAUTION	**Type and/or source of the hazard.**
⚠	**May cause bodily injury if not observed.** a) Measures to avoid the hazard. b) Can be supplemented by an additional danger sign or pictogram.

NOTICE	**Type and/or source of the hazard.**
❗	**Can cause damage to property if not observed.** a) Measures to avoid the hazard. b) Can be supplemented by an additional danger sign or pictogram.

1.1.2   Information notes

ℹ	Indicates to the user a special condition, prerequisite, scope or simplification.
📖	This is a reference to further documentation with barcode for smartphones and link for online users. https://www.keb.co.uk/nc/search

Notes on conformity for use in the North American or Canadian market.

1.1.3   Symbols and markers

✓ Condition

a) Action step

⇨ Result or intermediate result

=> Cross-reference to a chapter, page or picture

Hyperlink

`<Steuercode>`

Lexicon entry

1.2   Laws and guidelines

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

The EU declaration of conformity can be downloaded on demand via our website.

1.3   Warranty and liability

The warranty and liability on design, material or workmanship for the acquired device is given in the general conditions of sale.

Here you will find our general sales conditions.

https://www.keb.co.uk/terms-and-conditions

Further agreements or specifications require a written confirmation.

1.4   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 KEB Automation KG agency.

The use of our units in the target products is beyond of our control and therefore exclusively the responsibility of the 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 intended use. However, they are considered for information only without responsibility and changes are expressly reserved, in particular due to technical changes. 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 carried out within the scope of the intended end use of the product (Application**) by the** Customer**. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.**

1.5   Copyright

The customer may use the instructions for use 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 and/or logos are trademarks (™) or registered trademarks (®) of their respective owners.

1.6 Validity of this manual

This safety manual supplements the instructions for use accompanying the unit with the implemented safety functions. The safety manual

- is only valid in conjunction with the instructions for use (control- and/or power part).
- supplements the instructions for use with the safety functions.
- contains safety-related supplements and requirements for operation in safety-related applications.
- contains only supplementary safety instructions.
- supplements existing standards. The basic and application standards must still be observed.

1.7 Target group

The safety manual is intended exclusively for qualified electrical personnel with special training or instruction in the field of safety technology. Electrical personnel for the purpose of this instruction manual must have the following qualifications:

- Further training or instruction in the field of safety engineering.
- 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 IEC 60364.
- Knowledge of national safety regulations (e. g. DGUV Regulation.

2   General Safety Instructions

The products are developed and built according to the state of the art and recognized safety rules. Nevertheless, their use may create dangers to life and limb of the user or third parties or damage to the machine 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 of the safety instructions by the customer, user or other third party leads to the loss of all resulting claims against the manufacturer.

NOTICE	**Hazards and risks through ignorance!**

a) Read the instructions for use.

b) Observe the safety and warning instructions.

c) Ask if something is unclear.

2.1   Installation

⚠ **DANGER**	**Electrical voltage at terminals and in the device!**

Danger to life due to electric shock !

✓ For any work on the device

a) Switch off the supply voltage.

b) Secure it against switching on.

c) Wait until all drives has been stopped in order that no regenerative energy can be generated.

d) Await capacitor discharge time (min. 5 minutes). Measure DC voltage at the terminals.

e) Never bridge upstream protective devices. Also not for test purposes.

⚠ **DANGER**	**Improper installation of safety technology!**

Death and serious bodily injuries.

a) Therefore the safety functions may only be installed and put into operation by qualified personnel which are trained in safety technology.

b) Check the safety functions and error responses and generate an acceptance report after installation.

⚠ **CAUTION**	**Movement of the axis due to load**

Crushing due to automatic movement with suspended loads or asymmetrical weight distribution.

a) Secure load against mechanical movement (e.g. by brake).

NOTICE	**Automatic restart when STO is no longer triggered.**

Unpredictable consequences for personnel and machine.

✓ In order to comply with EN 60204-1, observe the following:

a) Ensured by external measures that the drive restarts only after confirmation.

NOTICE ❗	**Malfunction due to wrong dimensioning of the current source.** a) Consider all input currents of the used safety functions. b) If several safety modules are connected, the safety switchgear must supply the required total current.

2.2 Start-up and operation

The start-up (i.e. the starting of normal operation) is prohibited until the machinery has been proved to conform to the provisions Directive 2006/42/EG and Directive 2014/30/EU; EN 60204-1 must be observed.

⚠ **DANGER** ⚡	**Continue mains voltage with active STO function!** **Electric Shock** a) Always switch off the power supply before working on the device. b) Await discharge time.

Without mechanical brake the drive leads to coast. Motor is free-wheeling. Additional protective devices must be installed (e.g.locking systems) if damage to persons or property can occur.

⚠ **DANGER** ⚠	**Motor coast in the event of a fault** **Danger to persons** ✓ If there is a danger to persons after the motor control has been switched off by STO: a) Block access to the hazardous area. b) Wait until the drive stops.

The start-up can be prevented with interruption of the STO signals. STO may not be released in case of danger according to EN 60204-1. Also note the instructions to the external safety switch devices.

2.3 Maintenance

⚠ **WARNING** 🚷	**Failure of safety functions** **No protection** ✓ To ensure the safety permanently: a) The safety functions must be checked in regular intervals. b) The intervals result from the risk analysis. c) The useful life is limited to 20 years. After this time the unit must be replaced.

3   Product description

3.1   General

PROFIsafe is a technology for safe communication between different F-Devices.

The safety module is PROFIsafe conformance tested. For the operating tool "TiA-Portal", a GSD file is required for the operation as PROFIsafe device. This is available on the KEB homepage.

The safety module supports PROFIsafe version 2.6.1 and additionally provides a compatibility mode for PROFIsafe version 2.4.

3.2   Validity of these instructions

This supplement to the instructions for use

- describes the extension of the safety module type 3 by the functionality PROFIsafe.
- only contains supplementary safety instructions.
- is only valid in conjunction with the safety manual of the safety module type 3.
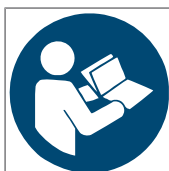
	Safety manual type 3 https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safety-typ3-20148769_en.pdf	

4   Fundamentals

PROFIsafe bus settings in the KEB COMBIVIS Editor safety module:

The procedure used in this manual can be used for bus configuration of the Siemens TiA-Portal in combination with COMBIVIS.

Parameter	Value
Bus general options	
Bus type	PROFIsafe
Safety address	65534
Safety bus data length	11
Safety bus telegram selection	0x98Ah

Fig. 1: Safety module bus configuration (parameter group bus settings)

Parameterization

Bus type

Selection of the safe bus type:

- **no bus**
  No safe bus system is used. The safety module is only controlled via the hardware inputs.
- **FSoE**
  The bus system uses Safety over EtherCAT®.
  The use of FSoE is explained in the corresponding supplement.
- **PROFIsafe**
  The bus system uses PROFIsafe.

Safety module address

Value range: 0; 1…65534

- By default, the address is set to the invalid value 0.
- The safety module address must agree with the safety module address displayed in the tab "Settings" at the safety module.
- In addition, this address must be set as "F-Destination" address in the F-parameter configuration of the plugged submodule in the TiA Portal.

The PROFIsafe address type is "Address type 1". The clarity of the F device is ensured for this address type exclusively by the F destination address. The F source address is irrelevant.

Safe bus data length

If a safe bus system has been selected, the length of the safe output data can be set here.

Value range: 5…11 byte

- This bus data length must agree with the configuration in the safe control.
- It includes the entire PROFIsafe telegram (I/O data + control word + CRC).
- For bus type PROFIsafe the data length must be set according to the selected telegram and the PROFIsafe version.

Safe bus data telegram selection

The selected telegram must agree with the selected submodule in the TiA Portal. By default this address is set to value 0x920. A list of the selectable telegrams as well as their contents is presented further on in this manual.

Devices CRC

A CRC is generated via the parameter data set. The CRC of the displayed data set is displayed in the field device CRC and is taken over by the safety module when it is loaded.

- The CRC of the currently valid configuration in the safety module is displayed in the field "CRC (online)" (=> Setting the safe PROFIsafe parameters (F parameters) [▶ 22]).
- Enter CRC when configuring the safety module as F-Device in the TiA Portal in the field "F_iPar_CRC".
- "F_iPar_CRC" with value 0 is invalid.

Fig. 2: Safety module bus configuration (parameter group bus units)

Scaling of the position via safe bus data

⚠ **DANGER**

Undefined position when changing the scaling.

The scaling of the position affects the PROFIsafe position values.

a) When changing the scaling, the software in the F-Host must be checked and verified.

Setting the decimal places of the position in bits, which is transmitted via PROFIsafe process data. A total of 16 bits are available for the position. The number of bits for complete revolutions is reduced by the bits set here for partial revolutions.

0 bit (default) means no decimal places. The scaling is in "complete revolutions".

If, for example, a "4" is configured here, the position values are divided into 12 bits of complete revolutions and 4 bits of partial revolutions..

Scaling of the speed via safe bus data

⚠ **DANGER**	**Undefined speed when changing the scaling.**
⚠	**The scaling of the speed affects the following PROFIsafe data:** • **Speed** • **SLS upper and lower limit** • **SSM upper and lower limit** a) The following values must be checked and verified when changing the scaling.

Setting the decimal places of the speed in bits, which is transmitted via PROFIsafe process data.

0 bit (default) means no decimal places. Scaling occurs in "whole" revolutions per minute.

5   Response times & PFH value

In a PROFIsafe based safety system, the total reaction time is made up of the following partial reaction times:

- Device Acknowledgement Time (DAT)
  Time period from the processing of a received data telegram in the safety module to the supply of the safe status word. The device-specific DAT of the safety module is specified as ≤ 75 ms.

- Bus
  data runtime of the safety message on the PROFIsafe bus between safety module and safe PLC.

- Host Acknowledgement Time (HAT)
  Time span from the processing of the safety telegram in the safe PLC to the supply of the new control word.

The maximum tolerated time of the total response time is configured as F-Watchdog time (=„F_WD_Time") within the F-parameters.

F_WD_TIME (minimum)

| DAT | BUS | HAT | BUS |

Fig. 3: Response time safety module type 3 with PROFIsafe

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a) The runtimes of the fieldbus and the cycle time of the safe control must be observed for the dimension and calculation of the F_WD_Time.

b) For the best availability, it is recommended to set a cycle time on the Safety PLC in the range of 0.3 x of the selected F_WD_Time. Cycle times below 15 ms should be avoided for performance reasons.

The actual, technically minimum F_WD_Time is mainly determined by the complete device. The minimum configurable safe watchdog time of the safety module is 100 ms for PROFIsafe.

Furthermore, the Worst Case Delay Time (WCDT) must be named. This time specifies the theoretical maximum time between the incoming of a safety telegram at the safety module until the reaction of a linked output. The WCDT of the safety module in operation with PROFIsafe is ≤ 60 ms plus the output delay of the used safety function and the delay of the input signal, e.g. due to filter times. These can be found in the generic safety manual of the safety module type 3.

Except the PROFIsafe communication itself, all error components have already been considered in the PFH calculation of the safety module type 3. The resulting value will be specified in the generic safety manual. This value includes all errors that can occur in the device itself. Not included are all errors of the PROFIsafe communication itself, which should be a maximum of 1% of the available PFH for the entire safety function. This was ensured during the development of PROFIsafe, because of this a supplementary PFH value of the PROFIsafe communication channel is mentioned here.

PFH < $1 * 10^{-9}$ /h

If the PROFIsafe functionality is used in version 2.4, the PFH value applies under the assumption that a maximum of 100 F peripherals are involved in a safety function. If more than 100 F peripherals are used, $4.00*10^{-12}$ /h per F peripheral must be additionally added for this safety function.

See also "Classification of safety functions according to IEC 61508" in the following instructions:

	Safety manual type 3	
	https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safety-typ3-20148769_en.pdf	

6   TiA portal and KEB safety module type 3

6.1   Installing the description file for the drive controller

The required GSDML can be installed with the device description management in the TIA Portal. The official GSDML is available at www.keb.de.

6.2   Adding a KEB drive controller with safety module type 3

At the beginning, a S6A or F6A F-Device, which can be identified by "FS Module" must be added to the net view of the TiA Portal. Select the correct GSDML for F6 or S6.

Fig. 4: Add F-Device

After the F-Device has been added, the IO-Controller must be assigned and you have to assign a name.

Fig. 5: F-Device network view

6.3   Selection of a PROFIsafe module configuration

The safety module offers several module configurations with different data assignments in connection with PROFIsafe. These can be selected individually for the respective application. In the context of this also the chapter PROFIsafe module configuration according to ID [▶ 26] must be observed for the selection of the module description.

In the device view, a PROFIsafe module and the associated submodule must be assigned to the F-Device (default telegram: 0920h). Attention must be paid to the correct PROFIsafe version. Then the address ranges can be assigned.

	Module	...	Rack	Slot	I address	Q address	Type
	▼ kebs6-0		0	0			KEB X6A PNS IR...
	▶ PN-IO		0	0 Inte...			kebs6-1
	32 Byte Input_1		0	1	1...32		32 Byte Input
	32 Byte Output_1		0	2		1...32	32 Byte Output
			0	3			
	▼ PROFIsafe-Module_1	☐	0	4	570...578	570...578	PROFIsafe-Mod...
	PROFIsafe-SubMod 0920h	☐	0	4 1	570...578	570...578	PROFIsafe-Sub...

Catalog

<Search>

☑ Filter   Profile: <All>

- ▼ 📁 Head module
  - KEB X6A PNS IRT FS Module V1.0
- ▼ 📁 Module
  - ▼ 📁 InOutputModule
    - PROFIsafe-Module
    - PROFIsafe-Module V2.4 comp.
  - ▶ 📁 InputModule
  - ▶ 📁 OutputModule
  - ProfiDrive_PAP
- ▼ 📁 Submodules
  - PROFIdrive Safety Tel30
  - PROFIdrive Safety Tel31
  - PROFIsafe-SubMod 0900h
  - PROFIsafe-SubMod 0901h
  - PROFIsafe-SubMod 0902h
  - PROFIsafe-SubMod 0903h
  - PROFIsafe-SubMod 0904h
  - PROFIsafe-SubMod 0910h
  - PROFIsafe-SubMod 0911h
  - PROFIsafe-SubMod 0912h
  - PROFIsafe-SubMod 0913h
  - PROFIsafe-SubMod 0920h
  - PROFIsafe-SubMod 0921h
  - PROFIsafe-SubMod 0922h
  - PROFIsafe-SubMod 0923h

Fig. 6: Add PROFIsafe module

The configuration of the F-parameters is described in the chapter Setting the safe PROFIsafe parameters (F parameters) [▶ 21] .

6.4   Creating an F program

A safety-oriented program ("F program") must be created in the safety part of the TiA portal by way that the safety module can be used in the safe control. If a controller with activated F capability is added, an empty Main_Safety_RTG1 ("F program") is already present.
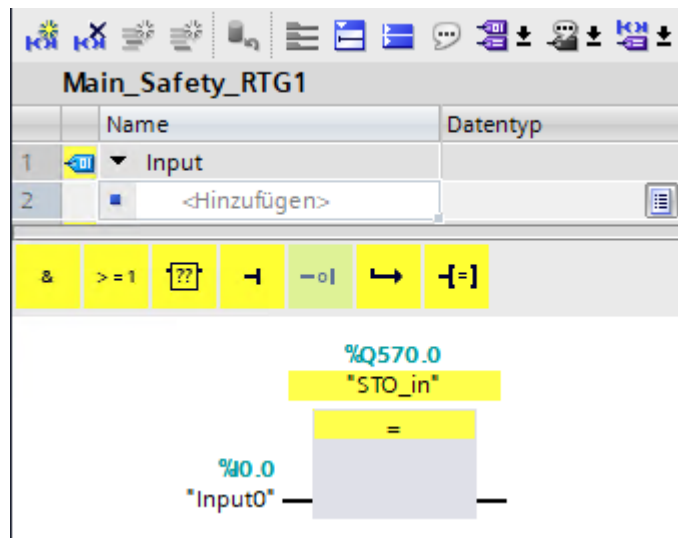
Fig. 7: Main_Safety_RTG1 (F program)

NOTICE	**Safety functions are 0 active.**
	a) Unused safety functions must be set to TRUE.

7 Setting the safe PROFIsafe parameters (F parameters)

PROFIsafe is configured in the safe control via F parameters.

Fig. 8: F parameters for PROFIsafe in TiA Portal

F_SIL
This field describes the SIL of the application to be configured. The maximum adjustable SIL is SIL 3.

F_CRC_Length
The CRC length is depending on the selected PROFIsafe version and cannot be changed.

F_Block_ID
Can not be changed.

F_Par_Version
Can not be changed.

F_Source_Add
Source address of the safety-oriented information. This corresponds to the address of the control, which however is not used for identification due by the safety modul supported address type (address type 1). The valid address range is 1 to 65534.

F_Dest_Add
Destination address of the safety-oriented information. This corresponds to the address of the safety module and must agree with the configuration in COMBIVIS (=> Fundament-als [▸ 13]). The valid address range is 1 to 65534.

F_WD_Time
The F monitoring time can be set here (=> Response times & PFH value [▸ 16]).

F_iPar CRC
The F_iPar_CRC in PROFIsafe corresponds to the CRC of the individual configuration of the safety module. This is also visible as "CRC (Online)" in COMBIVIS (=> Setting the safe PROFIsafe parameters (F parameters) [▸ 22]).

If the F_iPar_CRC does not agree with the device-CRC when PROFIsafe communication ist started, the PROFIsafe slave will not ramp-up and a corresponding alarm will be sent.

Fig. 9: Overview of the device-CRC of the safety module

8   PROFIsafe state machine and checking the state

8.1   The PROFIsafe state machine

The following PROFIsafe state machine is implemented in the safety module type 3.
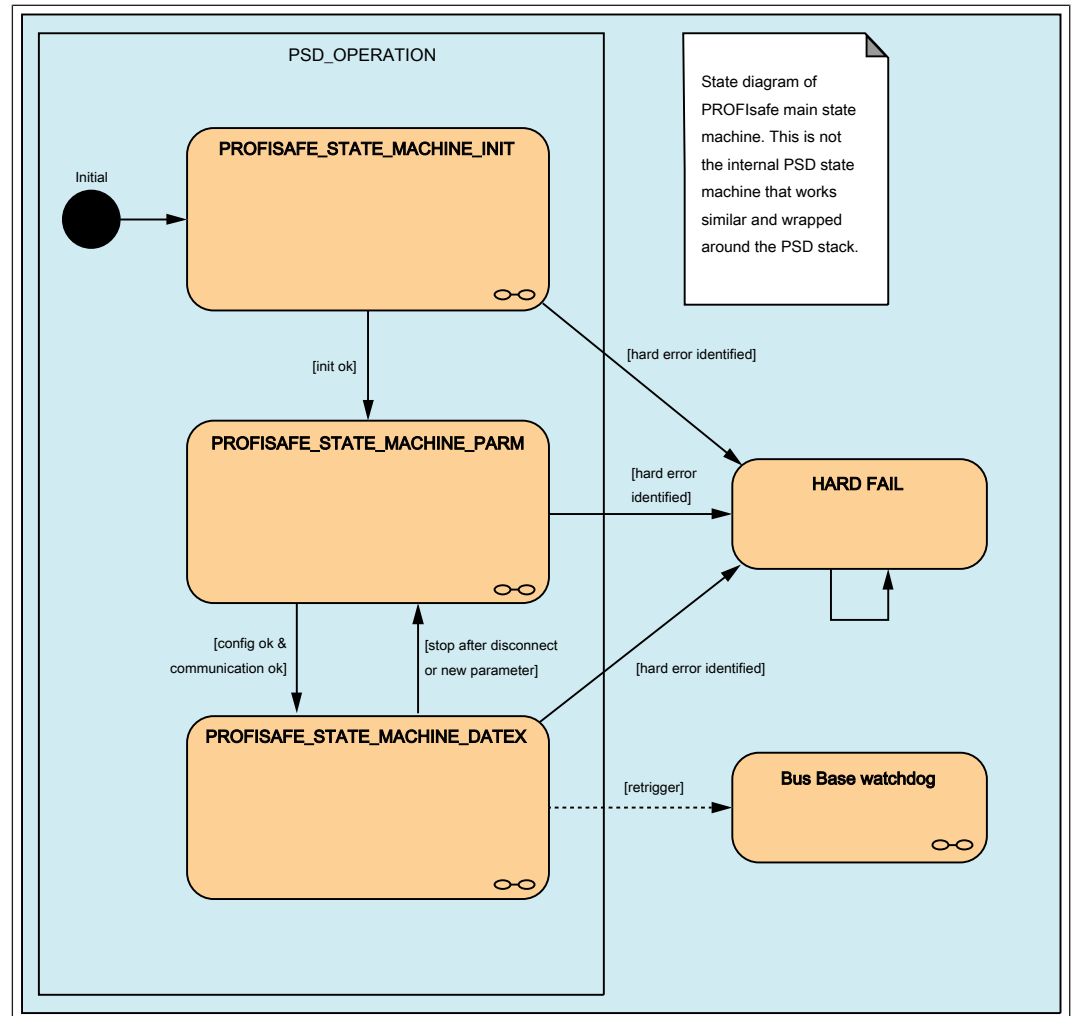
Fig. 10: Profisafe status machine in safety module type 3

Safe data exchange and leaving STO is only possible in the state `PROFISAFE_STATE_MACHINE_DATEX`. For this, there must be no error in the F parameters. Configuration errors in the F parameters are displayed as alarms in the TiA Portal diagnostics. The PROFIsafe state remains in the state `PROFISAFE_STATE_MACHINE_PARAM` until valid F parameters have been transferred to the safety module. Additionally, configuration or bus errors may be present in the COMBIVIS protocol (=> PROFIsafe module configuration according to ID [▶ 26] and Safety functions [▶ 28]).

8.2   Checking the PROFIsafe state

The PROFIsafe state can be read out in the state overview of the safety module in COMBIVIS in the area of the bus state (=> Checking the PROFIsafe state [▶ 24]). In the case of the "PROFISAFE_STATE_MACHINE_DATEX" state, either "Error data" or "Data" is displayed here. The display "Error data" means that the data exchange basically works, but fail-safe substitute data are exchanged.

In the "PROFISAFE_STATE_MACHINE_PARAM" state, "Reset" is displayed in the area of the bus state.
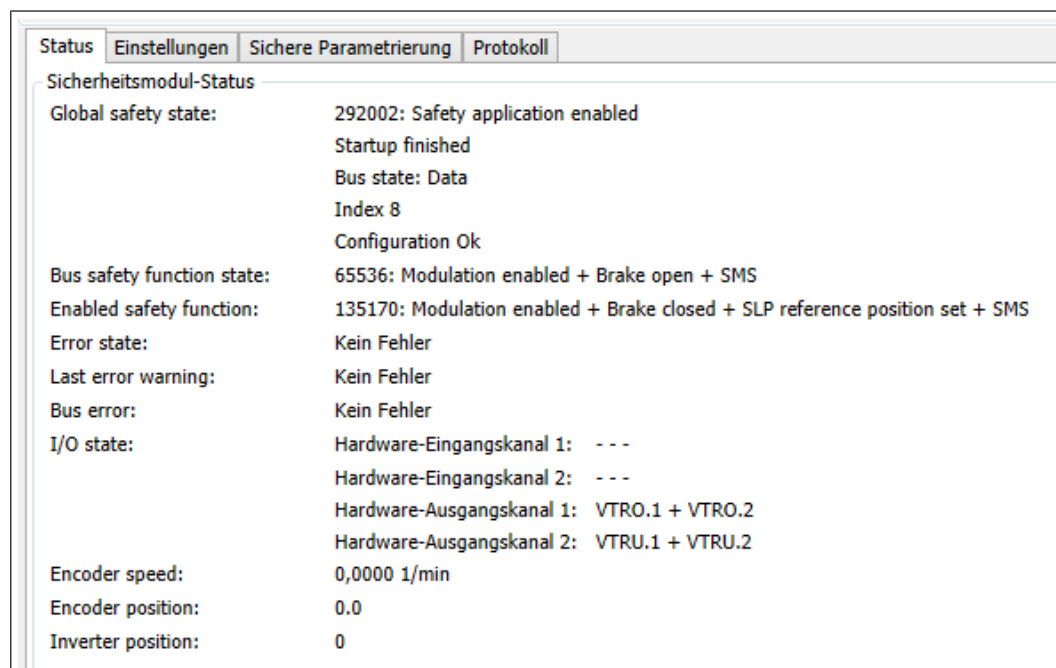
Fig. 11: State overview in the COMBIVIS safety editor

In addition, further information which can be used for diagnostic purposes if there is a problem are displayed in the area of the pa group in COMBIVIS (PROFIsafe parameters; address range 0x3D..; => Checking the PROFIsafe state [▶ 24]). This information is not subject to any safety-related consideration and may differ from the information available on the safety module depending on the situation. Further information on this parameter group is provided in the Drive Controller manual.

Fig. 12: State overview in the non-safe part of COMBIVIS

8.3   Bus configuration error

There is a separate category for bus configuration errors in the "Protocol" tab in COMBIVIS. Bus configuration errors can occur if, for example, a PROFIsafe configuration with encoder data has been set, but no encoder is configured.
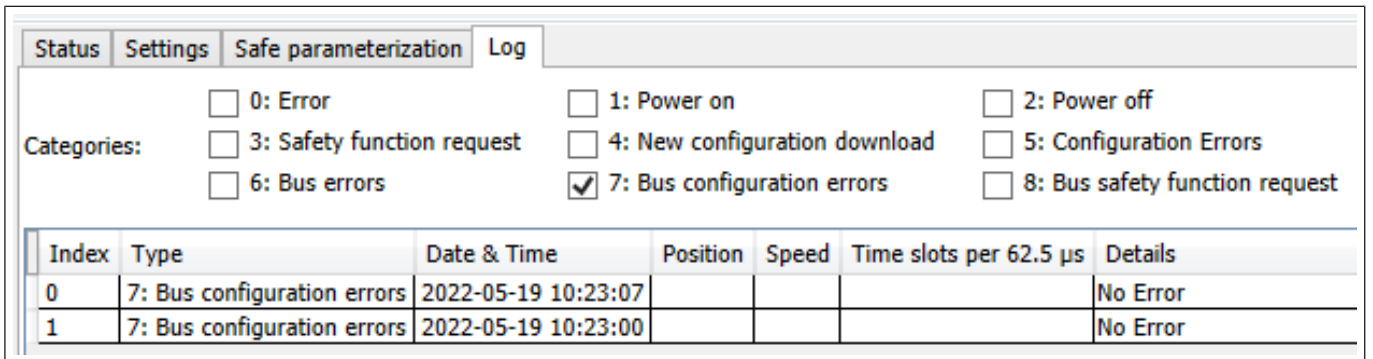
Fig. 13: Bus configuration error in the Protocol tab

8.4 Bus error

If errors are detected in PROFIsafe operation, these errors are logged. They can be read out via COMBIVIS in the Protocol tab as bus error.
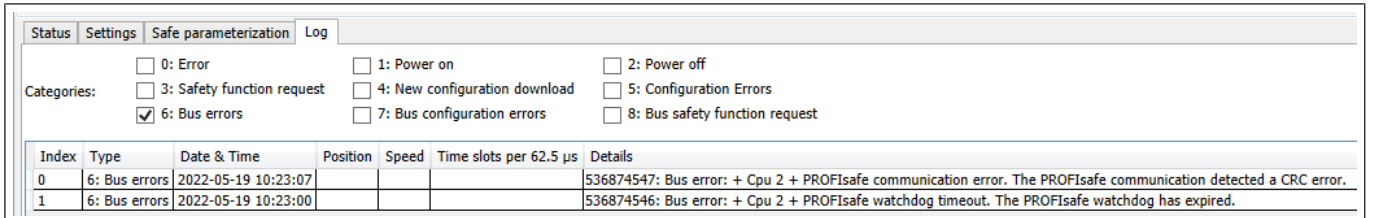
Fig. 14: Bus error Log in COMBIVIS

9 PROFIsafe process data

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

- If there is no SF1 (Safety Functions 1st Byte) in the module configuration, then a safety input must be configured with the safety function STO. Otherwise, the STO safety function cannot be exited.

- As long as the PROFIsafe communication has not started, the safety module remains in STO status.Furthermore, the safety function SBC is activated. This is independent of whether an STO or SBC input has been configured.

- If the configuration "Monitoring always active" has been selected for the SSM function, this is always active, even if PROFIsafe communication has not yet been started. This is relevant if the configured speed limits are set to 0. In this case, the SSM status can alternate.

- If a process data with speed or position function is selected, a safe encoder must also be used.

9.1 Received process data (F-CPU from safety module)

NOTICE

Received process data (F-CPU from safety module).

Additional notes of Pd Out Mapping.

a) Safe output data at the safety module always have "_state" as ending.

b) The status of the safety functions is 1 active. This means, when the safety function is executed, the respective bit has the status 1.

c) The hardware inputs are 1 active (=> Input State [▶ 32]).

see also

▤ Output Control [▶ 32]

9.2 Sent process data (F-CPU to the safety module)

NOTICE

Sent process data (F-CPU to the safety module).

Additional notes of Pd In mapping

a) Safe input data always have "_in" as ending..

b) The safety functions are 0 active. This means, the safety function is activated when the respective bit has the status 0.

c) If not all functions are used in the application, e.g. only SOS shall be activated, all unused safety functions must be set to status 1.

d) Parallel to the PROFIsafe process data, the inputs of the safety module can also be configured with safety functions.

e) If a safety function is requested via the PROFIsafe process data or via the inputs, then this safety function is executed.

f) The status of the outputs is 1 active (=> Output Control [▶ 32]).

see also

▤ Input State [▶ 32]

9.3 PROFIsafe module configuration according to ID

The following module configurations, also referred to as telegrams or ID's, can be set in the safety module.

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
Data length 6 byte (V2.4: 5 Byte)										
0x900	SF1	-	-	-	-	SF1	-	-	-	-
0x901	OUTPUT	-	-	-	-	INPUT	-	-	-	-
0x902	SF1	-	-	-	-	INPUT	-	-	-	-
0x903	SF2	-	-	-	-	INPUT	-	-	-	-
0x904	SF2	-	-	-	-	SF2	-	-	-	-
Data length 7 byte (V2.4: 6 Byte)										
0x910	SF1	SF2	-	-	-	SF1	SF2	-	-	-
0x911	SF1	OUTPUT	-	-	-	SF1	INPUT	-	-	-
0x912	SF1	SF3	-	-	-	SF1	SF3	-	-	-
0x913	SF2	SF3	-	-	-	SF2	SF3	-	-	-
Data length 9 byte (V2.4: 8 Byte)										
0x920	SF1	SF2	SF3	OUTPUT	-	SF1	SF2	SF3	INPUT	-
0x921	SF1	SF2	SLSU	-	-	SF1	SF2	SLSU	-	-
0x922	SF1	SF2	SLSL	-	-	SF1	SF2	SLSL	-	-
0x923	SF1	SF2	SLSU	-	-	SF1	SF2	SPEED	-	-
0x924	SF1	SF2	SLSL	-	-	SF1	SF2	SPEED	-	-
0x925	SF1	SF2	SSMU	-	-	SF1	SF2	SSMU	-	-
0x926	SF1	SF2	SSMU	-	-	SF1	SF2	SPEED	-	-
0x927	SF1	SF2	SSML	-	-	SF1	SF2	SSML	-	-
0x928	SF1	SF2	SSML	-	-	SF1	SF2	SPEED	-	-
Data length 11 byte (V2.4: 10 Byte)										
0x980	SF1	SF2	SLSU	SLSL	-	SF1	SF2	SLSU	SLSL	-
0x981	SF1	SF2	SLSU	SLSL	-	SF1	SF2	SPEED	POS	-
0x982	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SPEED
0x983	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SLSU
0x984	SF1	SF2	SLSU	SSMU	-	SF1	SF2	SPEED	POS	-
0x985	SF1	SF2	SLSU	SLSL	-	SF1	INPUT	SPEED	POS	-
0x986	SF1	SF2	SLSU	SSMU	-	SF1	INPUT	SPEED	POS	-
0x987	SF1	SF2	SSMU	SSML	-	SF1	SF2	SSMU	SSML	-
0x988	SF1	SF2	SSMU	SSML	-	SF1	SF2	SPEED	POS	-
0x989	SF1	OUTPUT	SSMU	SSML	-	SF1	INPUT	SPEED	POS	-
0x98A	SF1	SF2	SF3	OUTPUT	SSMU	SF1	SF2	SF3	INPUT	SSMU

Tab. 1: Module configuration according to ID

Id's 0x0900, 0x0901, 0x0902, 0x0911, 0x0912 are available for operation without a configured safe encoder.

Supported standard telegrams from the "PROFIdrive over PROFIsafe" amendment of the PROFIdrive profile:

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
Data length 7 byte (V2.4: 6 Byte)										
Tel.30	S_STW1	-	-	-	-	S_ZSW1	-	-	-	-
Data length 9 byte (V2.4: 8 Byte)										

| **Tel.31** | S_STW2 | - | - | - | S_ZSW2 | - | - | - |

Tab. 2: Supported standard telegrams

9.4 Safety functions

9.4.1 SF1 Safety Functions 1st Byte

With this configuration, the following bits are exchanged:

Name	Description	Bit	Function
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 counterclockwise (Safe Direction)
		Bit 7	Fail Safe and Acknowledge

Tab. 3: Assignment of the safe process data byte 'SF1'

Bit 7 (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 setting it to 0 for a short time and then back to 1.

> ℹ️ If the encoderless mode is switched off, only STO, SBC and SS1-t can be activated in the module configurations "Safety Functions 1st Byte".
>
> • If another safety function is activated, the safety module will enter the FSoE reset state.
>
> • It is necessary to set all other bits of the safety functions to status 1 if the encoderless mode is not configured.
>
> • For SS1, only SS1-t is possible. The selection of the function type when configuring the safety module must be set to "Type t only".

9.4.2 SF2 Safety Functions 2nd Byte

With this configuration, the following bits are exchanged:

Name	Description	Bit	Function
SF2	Safety Functions 2nd Byte	Bit 0	SLS (Safe Limited Speed)
		Bit 1	SLA (Safe Limited Acceleration)
		Bit 2	SLP (Safe Limited Position)
		Bit 3	SLP set reference position
		Bit 4	SEL (Safe Emergency Limit)
		Bit 5	SLI (Safe Limited Increment)
		Bit 6	SLI next step
		Bit 7	SSM (Safe Speed Monitoring)

Tab. 4: Assignment of the safe process data byte 'SF2'

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

Bit 3 SLP set reference position exactly when a status change from TRUE to FALSE is performed. The reference position can only be set once.

9.4.3 SF3 Safety Functions 3rd Byte

With this configuration, the following bits are exchanged:

Name	Description	Bit	Function
SF3	Safety Functions 3rd Byte	Bit 0	SMS (Safe Maximum Speed)
		Bit 1	reserved
		Bit 2	reserved
		Bit 3	reserved
		Bit 4	reserved
		Bit 5	Index Bit 1
		Bit 6	Index Bit 2
		Bit 7	Index Bit 3

Tab. 5: Assignment of the safe process data byte 'SF3'

The Safe Maximum Speed function (SMS) is always active. Additional activation is not required.

The three index bits can be used to switch the set index of all safety functions simultaneously.

9.4.4 S_STW1 - safety control word 1

This configuration corresponds to S_STW1 from the "PROFIdrive on PROFIsafe" amendment. The following bits are exchanged:

Bit0	Safe torque off (STO)
Bit1	Safe stop 1 (SS1)
Bit2	Safe stop 2 (SS2)
Bit3	Safe operational stop (SOS)
Bit4	Safe limited speed (SLS)
Bit5	Safe limited torque (SLT) - not supported
Bit6	Safe limited position (SLP)
Bit7	Fail safe and acknowledge
Bit8	Index bit 1
Bit9	Index bit 2
Bit10	Index bit 3
Bit11	Safe brake control (SBC)
Bit12	Safe direction positive (SDI clockwise)
Bit13	Safe direction negative (SDI counterclockwise)
Bit14	SLP set reference position
Bit15	Safe speed monitoring (SSM)

Tab. 6: S_STW1 - safe control word 1

9.4.5 S_STW2 – safety control word 2

This configuration corresponds to S_STW2 from the "PROFIdrive on PROFIsafe" amendment. The following bits are exchanged:

Bit0	Safe torque off (STO)
Bit1	Safe stop 1 (SS1)
Bit2	Safe stop 2 (SS2)

Bit3	Safe operational stop (SOS)
Bit4	Safe limited speed (SLS)
Bit5	Safe limited torque (SLT) - not supported
Bit6	Safe limited position (SLP)
Bit7	Fail safe and acknowledge
Bit8	Safe limited acceleration (SLA)
Bit9	Bit 0 for selection of SLS - not supported
Bit10	Bit 1 for selection of SLS - not supported
Bit11	reserved
Bit12	Safe direction positive (SDI clockwise)
Bit13	Safe direction negative (SDI counterclockwise)
Bit14	Bit 0 for selection of SLA - not supported
Bit15	Safe speed monitoring (SSM)
Bit16	Bit 0 for selection of SLT - not supported
Bit17	Bit 0 for selection of SLT - not supported
Bit18	reserved
Bit19	Bit 0 for selection of SLP - not supported
Bit20	Bit 0 for selection of SLP - not supported
Bit21	reserved
Bit22	reserved
Bit23	Safe cam (SCA) - not supported
Bit24	Safe brake control (SBC)
Bit25	SLP set reference position
Bit26	Safe emergency limit (SEL)
Bit27	Safe limited increment (SLI)
Bit28	SLI next step
Bit29	Index bit 1
Bit30	Index bit 2
Bit31	Index bit 3

Tab. 7: S_STW2 – safety control word 2

9.4.6   S_ZSW1 – safety status word 1

This configuration corresponds to S_ZSW1 from the "PROFIdrive on PROFIsafe" amendment. The following bits are exchanged:

Bit0	Safe torque off (STO)
Bit1	Safe stop 1 (SS1)
Bit2	Safe stop 2 (SS2)
Bit3	Safe operational stop (SOS)
Bit4	Safe limited speed (SLS)
Bit5	Safe limited torque (SLT) - not supported
Bit6	Safe limited position (SLP)
Bit7	Fail safe and acknowledge
Bit8	Index bit 1
Bit9	Index bit 2
Bit10	Index bit 3
Bit11	Safe brake control (SBC)

Bit12	Safe direction positive (SDI clockwise)
Bit13	Safe direction negative (SDI counterclockwise)
Bit14	SLP set reference position
Bit15	Safe speed monitoring (SSM)

Tab. 8: S_ZSW1 – safety status word 1

9.4.7   S_ZSW2 – safety status word 2

This configuration corresponds to S_ZSW2 from the "PROFIdrive on PROFIsafe" amendment. The following bits are exchanged:

Bit0	Safe torque off (STO)
Bit1	Safe stop 1 (SS1)
Bit2	Safe stop 2 (SS2)
Bit3	Safe operational stop (SOS)
Bit4	Safe limited speed (SLS)
Bit5	Safe simited torque (SLT) - not supported
Bit6	Safe limited position (SLP)
Bit7	Fail safe and acknowledge
Bit8	Safe limited acceleration (SLA)
Bit9	Bit 0 for selection of SLS - not supported
Bit10	Bit 1 for selection of SLS - not supported
Bit11	reserved
Bit12	Safe direction positive (SDI clockwise)
Bit13	Safe direction negative (SDI counterclockwise)
Bit14	Bit 0 for selection of SLA - not supported
Bit15	Safe speed monitoring (SSM)
Bit16	Bit 0 for selection of SLT - not supported
Bit17	Bit 0 for selection of SLT - not supported
Bit18	reserved
Bit19	Bit 0 for selection of SLP - not supported
Bit20	Bit 0 for selection of SLP - not supported
Bit21	reserved
Bit22	SP_VALID - not supported
Bit23	SP_REF - not supported
Bit24	Safe brake control (SBC)
Bit25	SLP set reference position
Bit26	Safe emergency limit (SEL)
Bit27	Safe limited increment (SLI)
Bit28	SLI next step
Bit29	Index bit 1
Bit30	Index bit 2
Bit31	Index bit 3

Tab. 9: S_ZSW2 – safety status word 2

9.5   Input and output status

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

9.5.1 Output Control

With this configuration, the following bits are exchanged:

Name	Description	Bit	Function
OUTPUT	Output control byte	Bit0	Output 1
		Bit1	Output 2
		Bit2	Ripple output

Tab. 10: Assignment of the safe process data byte 'Output'

Hereby, the outputs of the safety module can be switched safely in the data direction to the safety module (output data sent by the safe master).

> **Switching the outputs with PROFIsafe.**
> • The output can only be switched via PROFIsafe if this is not configured.
> • For the ripple output, the configuration parameter "Ripple Master" must also be set to "on".
> • The hardware output outputs 24V when the status of the bit is set to 1.
> • The hardware output is reset when the status of the bit is set to 0.

9.5.2 Input State

Name	Description	Bit	Function
INPUT	Input State Byte	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

Tab. 11: Assignment of the safe process data byte 'Input State'

The input status of the safety module can be detected safely herewith.

NOTICE! Evaluation of the inputs

• The bit for the respective hardware input status is 0 if the input is not supplied.
• The bit for the respective hardware input status 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 observed. A status change is only carried out after the filter time.
• The hardware input configuration of the safe inputs of the safe parameterization of COMBIVIS also applies to the PROFIsafe input status. The tolerance time of the inputs and the status of the inputs can be adjusted herewith. If the input is configured to "equivalent", both input channels must have 24V within the tolerance time so that the PROFIsafe status of the input is set to "1".

9.6 Dynamic speed limits via PROFIsafe

The upper and lower speed limits of SLS and SSM can be changed via PROFIsafe.

⚠ **DANGER**	**Speed limits of SLS and SSM!**
⚠ (warning triangle)	a) The upper speed limit must always be greater 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.
	b) The upper speed limit must always be greater than 0.
	c) The lower speed limit must always be less than 0.
	d) If only one limit is set via PROFIsafe, check configuration of COMBIVIS whether the above given condition is fulfilled in every operating case.
	e) With SSM, the hysteresis must also be taken into account.

9.6.1 SLS (Safely Limited Speed)

The upper and lower speed limit can be adjusted dynamically via PROFIsafe data.

ℹ (info icon)	**Observe the following notes during parameterization**
	The SLS bit in SF2 (=> SF2 Safety Functions 2nd Byte [▶ 28]) must be set to "0" to activate SLS and the transmitted upper and lower speed limit. It is not sufficient if only the limits are written via PROFIsafe.
	The tolerance time and error function must be configured in the safety module.
	If index switching is used, the error function and the tolerance time must be checked and configured accordingly in each set index.
	The speed limit is a 16 bit value which is depending on the configuration of parameter "Scaling of the speed via safe bus data" (=> Fundamentals [▶ 13]).

see also

9.6.1.1 SLSU (Safely Limited Speed: Upper speed limit)

This can be used to specify the upper speed limit for the SLS safety function.

⚠ **DANGER**	**Speed limits of SLSU!**
⚠ (warning triangle)	a) If a PROFIsafe configuration with SLSU has been selected, the upper speed limit is continuously transmitted via PROFIsafe.
	b) Thus the setting for the upper speed limit in the configuration of the safety module has no longer any effect.
	c) A set changeover also has no effect on the upper speed limit.
	d) If only PROFIsafe data for the upper speed limit of SLS is exchanged, the lower speed limit is still taken from the configuration data.
	e) The upper speed limit of PROFIsafe also applies in the case that SLS is activated via an input of the safety module.

9.6.1.2 SLSL (Safely Limited Speed: Lower speed limit)

This can be used to specify the lower speed limit for the SLS safety function SLS.

⚠ **DANGER**

Speed limits of SLSL!

a) If a PROFIsafe configuration with SLSL has been selected, the lower speed limit is continuously transmitted via PROFIsafe.

b) Thus the setting for the lower speed limit in the configuration of the safety module has no longer any effect.

c) A set changeover also has no effect on the lower speed limit.

d) If only PROFIsafe data for the lower speed limit of SLS is exchanged, the upper speed limit is still taken from the configuration data.

e) The lower speed limit of PROFIsafe also applies in the case that SLS is activated via an input of the safety module.

9.6.2   SSM (Safe Speed Monitor)

The upper and lower speed limit can be adjusted dynamically via PROFIsafe data.

⚠ **DANGER**

Speed limits of SSM!

a) The SSM Bit in SF2 (=> SF2 Safety Functions 2nd Byte [▶ 28]) must be set to 0 to activate SSM and the transmitted upper and lower speed limit.

b) SSM can also be activated by setting "Monitoring always active" to "on" in the configuration. In this case, any set changeover must be observed.

c) It is not sufficient to write the limits via PROFIsafe only.

d) The hysteresis and "monitoring always active" must be configured in the safety module.

e) If a set changeover is used, the hysteresis and monitoring must always be actively checked in each set and configured accordingly.

f) The speed limit is a 16 bit value which is dependent on the parameter Fundamentals [▶ 14]".

see also

▤ SF2 Safety Functions 2nd Byte [▶ 28]

▤ Fundamentals [▶ 13]

9.6.2.1   SSMU (Safe Speed Monitor: Upper speed limit)

This can be used to specify the upper speed limit for the SSM safety function.

⚠ **DANGER**

Speed limits of SSMU!

a) If a PROFIsafe configuration with SSMU has been selected, the upper speed limit is continuously transmitted via PROFIsafe.

b) Thus the setting for the upper speed limit in the configuration of the safety module has no longer any effect.

c) A set changeover also has no effect on the upper speed limit.

d) If only PROFIsafe data for the upper speed limit of SSM is exchanged, the lower speed limit is still taken from the configuration data.

e) The upper speed limit of PROFIsafe also applies in the case that SSM is activated via an input of the safety module.

9.6.2.2   SSML (Safe Speed Monitor: Lower speed limit)

This can be used to specify the lower speed limit for the safety function SSM.

⚠ DANGER	**Speed limits of SSML!**
	a) If a PROFIsafe configuration with SSML has been selected, the lower speed limit is continuously transmitted via PROFIsafe.
	b) Thus the setting for the lower speed limit in the configuration of the safety module has no longer any effect.
	c) A set changeover also has no effect on the lower speed limit.
	d) If only PROFIsafe data for the lower speed limit of SSM is exchanged, the upper speed limit is still taken from the configuration data.
	e) The lower speed limit of PROFIsafe also applies in the case that SSM is activated via an input of the safety module.

9.7 Speed (Safe speed)

The safe speed as signed 16 bit value. The speed depends on parameter Fundamentals [▶ 14]").

NOTICE	**Speed scan time and speed PT1-time!**
	a) The speed scan time and speed PT1 time in the settings of the Safety Editor of COMBIVIS on the "Safe parameterization" tab for speed measurement must be observed.

⚠ DANGER	**Overflow speed value!**
	a) If the "Scaling of the speed via safe bus data" is selected too high, the speed value may overflow.
	b) If e.g. the "Scaling of the speed via safe bus data" is set to 0, the PROFIsafe speed will overflow at 32767 rpm and underflow at -32768 rpm.
	c) Appropriate measures must be taken to intercept this case. Such a measure would be, for example, to configure the safe maximum speed (SMS) by way that the speed is safely limited.

9.8 Pos (Safe position)

The safe position as signed 16 bit value. The position depends on the parameter "Fundamentals [▶ 14]". The position is standardized in revolutions and partial revolutions. If the parameter is configured to "0", then "1" corresponds exactly to one revolution of the motor.

⚠ DANGER	**Overflow position value!**
	a) The position value can overflow if the position value becomes too high or underflow if the position value becomes too small.
	b) If, for example, the "Scaling of the position via safe bus data" is set to "0", the PROFIsafe position is overflow at 32767 rpm and underflow at -32768 rpm.
	c) 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   PROFIsafe alarms and error detections

The in table PROFIsafe alarms and error detections [▶ 36] displayed error codes are used by the F-device. The exact error cause can be read out in the protocol tab with COMBIVIS. These error codes are listed in Table 4 of the PROFIsafe specification (PROFIsafe - Profile for Safety Technology on PROFIBUS and PROFINET V2.6MU1 2018) too.

Hex	Dec	Diagnosis information
0x0040	64	Mismatch of safety destination address (F_Dest_Add)
0x0041	65	Safety destination address not valid (F_Dest_Add)
0x0042	66	Safety source address not valid or mismatch (F_Source_Add)
0x0043	67	Safety watchdog time value is 0 ms (F_WD_Time, F_WD_Time_2)
0x0044	68	Parameter "F_SIL" exceeds SIL from specific device application
0x0045	69	Parameter "F_CRC_Length" does not match the generated values
0x0046	70	Version of F-Parameter set incorrect
0x0047	71	Data inconsistent in received F-Parameter block (CRC1 error)
0x0048	72	Device specific or unspecified diagnosis information,
0x0049	73	Save iParameter watchdog time exceeded (alarm is not supported)
0x004A	74	Restore iParameter watchdog time exceeded (alarm is not supported)
0x004B	75	Inconsistent iParameters (iParCRC error)
0x004C	76	F_Block_ID not supported
0x004D	77	Transmission error: data inconsistent (CRC2 error)
0x004E	78	Transmission error: timeout (F_WD_Time or F_WD_Time_2 elapsed)
0x004F	79	Acknowledge required to enable the channel(s) - as channel error(s) is/are remedied. (Alarm is not supported)

Tab. 12: Error codes that can be sent from the F-Device as alarms

11   Trouble-shooting

11.1   The safety module does not answer any PROFIsafe data telegrams

- The bus type was not set to PROFIsafe in the safe configuration in COMBIVIS. Check with the help of the manual of the safety module if the bus type is PROFIsafe.
- A wrong PROFIsafe data length was configured in the safe configuration in COMBIVIS. Check with the help of the manual of the safety module if the data length is correct.

11.2   The safety module does not change into the PROFIsafe State "Data"

- The device CRC from COMBIVIS does not agree with the checksum transmitted via PROFIsafe. Check the settings according to chapter Setting the safe PROFIsafe parameters (F parameters) [▶ 21].
- Safety functions have been activated which require an encoder. Check if an encoder is configured.
- The safety module address or the telegram configuration in the controller does not match the configuration in COMBIVIS. Use the manual of the safety module to check whether the address and the length of the control and status word are correct.
- The watchdog time has been selected too small. Check according to chapter Response times & PFH value [▶ 16] if this is correct.

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

- Safety functions are 0 active. This means, if the respective bit for the safety function is set to 0, this function is activated. Many of the safety functions end in STO. For example, if SOS is activated although this safety function is not configured with COMBIVIS, STO is executed immediately after activation.
- Check according to chapter SF1 Safety Functions 1st Byte [▶ 28] and SF2 Safety Functions 2nd Byte [▶ 28], if all safety functions that are not required are set to 1.
- Check if an input is additionally activated and configured with a safety function.

11.4   Which safety function has set the Fail Safe and Acknowledge Bit

If several safety functions are executed simultaneously, it is difficult to identify which safety function has set the Fail Safe and Acknowledge Bit. You can use the following procedure:

- Revoke the request for the safety function.
  - The safety functions displayed on the status page in COMBIVIS or via PROFIsafe are now reduced to the safety functions, which have set the fail safe bit or which are always active.
- Check the sequence of the safety functions, the position and the speed in the log of the "safety function execution time".
  - From the position and speed it can usually be concluded which safety function sets the fail safe bit.
- If safety functions have been activated both via inputs and via PROFIsafe, the request for safety functions via PROFIsafe can be checked in the "Bus request for safety functions" category.

11.5   All safety functions are active after the start-up of the F-CPU and the module is in the error state

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.

- Check according to chapter Safety functions [▶ 28], if all safety functions that are not required are set to 1.

- Check if a safety function is additionally configured with an input.

12   Revision History

Edition	Revision	Note
2022-03	00	Pre-series version.
2022-10	01	Series version.

Tab. 13: Revision history

13 Glossary

Application

The application is the intended use of the KEB product.

COMBIVERT

Proper name for a KEB Drive Controller

Customer

The customer has purchased a product from KEB and integrates the KEB product into his product (customer product) or resells the KEB product (reseller).

DGUV Regulation

Electrical installations and equipment

Directive 2006/42/EC

Machinery Directive

Directive 2014/30/EU

Electromagnetic Compatibility (EMC) Directive

Drive Controller

Designation for a frequency inverter or servo controller

EN 60204-1

Safety of machinery - Electrical equipment of machines - Part 1: General requirements (VDE 0113-1, IEC 44/709/CDV).

F-Device

Device with integrated safety (host, remote, sensor or drive)

IEC 60364

Electrical low-voltage installation (DIN VDE 0100)

IEC 61508

Functional safety of electrical/electronic/programmable electronic safety-related systems.

PROFIsafe®

PROFIsafe is a safety profile for the transmission of safety-related data via PROFINet or PROFIBUS.

Safety over EtherCAT®

Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

SBC

Safe brake control

SDI

Safe direction

SEL

Safe Emergency Limit

SIL

The security integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7).

SLA

Safely limited acceleration

SLI

Safely limited increment

SLP

Safely limited position

SLS

Safely limited speed

SLT

Safely limited torque

SMS

Safe maximum speed

SOS

Safe operating stop

SS1

Safe stop 1emergency stop according to IEC 60204-1 Stop category 1

SS2

Safe stop 2; emergency stop according to IEC 60204-1 Stop category 2

SSM

Safe speed monitor

STO

Safe torque off

TiA-Portal

TiA stands for "Totally integrated Automation". The portal is operated by the company Siemens at https://new.siemens.com.

14 Index

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