COMBICONTROL **C6**

INSTRUCTIONS FOR USE | **KEB-I/O ETHERCAT SAFE-IN4 / SAFE-OUT2**

Translation of the original manual
Document 20141617 EN 02

Preface

The hardware and software described in this document are products of KEB. The information contained in this document is valid at the time of publishing. KEB reserves the right to update this document in response to misprints, mistakes or technical changes.

Signal words and symbols

Certain procedures within this document can cause safety hazards during the installation or operation of the device. Refer to the safety warnings in this document when performing these procedures. Safety signs are also located on the device where applicable. A safety warning is marked by one of the following warning signs:

⚠ DANGER	Dangerous situation, which will cause death or serious injury iif this safety warning is ignored.
⚠ WARNING	Dangerous situation, which may cause death or serious injury if this safety warning is ignored.
⚠ CAUTION	Dangerous situation, which may cause minor injury if this safety warning is ignored.
NOTICE	Situation, which can cause damage to property if this safety warning is ignored.

RESTRICTION

Used when the following statements depend on certain conditions or are only valid for certain ranges of values.

Used for informational messages or recommended procedures.

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.
www.keb.de/service/downloads

Laws and guidelines

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

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

Warranty and liability

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

Here you will find our general sales conditions.
www.keb.de/terms-and-conditions

Further agreements or specifications require a written confirmation.

Support

Although multiple applications are referenced, not every case has been taking into account. If you require further information or if problems occur which are not referenced in the documentation, you can request the necessary information via the local KEB agency.

The use of our units in the target products is outside of our control and therefore lies exclusively in the area of 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 regarded as being only informal 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 done within 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.

Copyright

Table of Contents

Preface **3**
Signal words and symbols 3
More symbols 3
Laws and guidelines 4
Warranty and liability 4
Support 4
Copyright 4
Table of Contents **5**
List of Figures **10**
List of Tables **11**
Glossary **12**
Standards for control & automation **13**

1 Basic Safety Instructions 15
1.1 Target Group **15**
1.2 Transport, storage and proper use **16**
1.3 Installation **16**
1.4 Electrical connection **17**
1.5 Start-up and operation **17**
1.6 Maintenance **17**
1.7 Repair **18**
1.8 Disposal **18**

2 System description 20
2.1 KEB-I/O EtherCAT **20**
2.1.1 KEB-I/O EtherCAT Safety System 21
2.1.2 Safety over EtherCAT² (FSoE) 21
2.1.3 KEB-I/O EtherCAT Safety PLC 21
2.1.4 KEB-I/O EtherCAT Safe I/O Module 22
2.1.5 COMBIVIS studio 6 22
2.1.6 SafetyPLCopen Library in COMBIVIS studio 6 22

3 Product description 24
3.1 General description **24**
3.2 Range of application **25**
3.2.1 Specified Application 25
3.2.2 Qualified staff 25
3.2.3 Suspension of liability 25
3.3 Safe states **26**
3.3.1 Functional safe state 26
3.3.2 Fail-safe state – external error 26
3.3.3 Fail-safe state – internal error 26

3.3.4 Traceability 26
3.4 Service life 27

4 Technical data 28

4.1 General specifications 28
4.1.1 General specifications 28
4.1.2 Safe digital inputs 29
4.1.3 Safe digital test pulse outputs 30
4.1.4 Safe digital outputs 30
4.2 Safety-related input ratings 31
4.2.1 Safety-related ratings of a single-channel application 31
4.2.2 Safety-related ratings of a two-channel application 32
4.3 Safety-related output ratings 33
4.3.1 Safety-related ratings of a single-channel application 33
4.3.2 Safety-related ratings of a two-channel application 34
4.3.3 Response time 35
4.4 Dimensions 36
4.5 *ransport und Lagerung 37

5 Construction and functionality 38

5.1 Labelling and identification 38
5.1.1 Imprinted texts and symbols 38
5.1.2 Serial number 38
5.2 Contents of package 39
5.3 Connector overview 39
5.3.1 E-bus and module lock 39
5.3.2 Spring-assisted combi plug X1 40
5.3.3 Wiring example 42
5.3.4 I/O supply 43

6 Displays and controls 44

6.1 LED "EtherCAT Run“ 44
6.2 LED "Safe State“ 44
6.3 LED "Power“ 45
6.4 LEDs "Channel“ 46
6.4.1 Safe digital inputs SI 0 .. SI 3 using test pulse outputs 46
6.4.2 Safe digital outputs SO 0 … SO 1 47
6.5 Operating software 47

7 Installation and operation 48

7.1 Mechanical installation 48
7.1.1 Mounting position 49
7.1.2 To snap on a single module 50

7.1.3 To interconnect two modules 50
7.1.4 To disconnect two modules 50
7.1.5 To take down a single module 51
7.2 Electrical installation 52
7.2.1 Earthing 52
7.2.2 Module interconnection 53
7.2.3 System power supply 53
7.2.4 I/O Supply 54
7.2.4.1 I/O power supply fusing 54
7.2.5 Sensor and actuator power supply 55
7.2.6 Voltage supply wiring example 56
7.2.7 Sensor connection 56
7.2.8 Actuator connection 61
7.2.9 Multiple socket connector (MSC) 64
7.3 Configuration 66
7.3.1 Address setting 66
7.3.2 FSoE Parameters 68
7.3.3 Input Parameters 75
7.3.4 Output Parameters 75
7.4 Initial start-up 77
7.5 Diagnosis 78
7.5.1 Self-test 78
7.5.2 KEB-I/O EtherCAT Safety I/O module faults 78
7.5.3 Wrong wiring 79
7.5.4 Wrong supply voltage 79
7.5.5 Table of faults 79
7.5.6 Error Codes 80
7.5.7 EtherCAT Link Lost 82
7.5.8 Wrong FSoE address 82
7.5.9 Damage to KEB-I/O EtherCAT Safety I/O System 82
7.6 Reset / Acknowledge Error 82
7.7 Maintenance / Servicing 83
7.7.1 General 83
7.7.2 Servicing 83
7.7.3 Maintenance 84
7.8 Replacing a KEB-I/O EtherCAT Safe I/O module 84
7.8.1 Procedure 85
7.8.2 Restart 85
7.9 Lifetime 85
7.9.1 Reparaturen / Kundendienst 85
7.9.2 Gewährleistung 86
7.9.3 Außerbetriebnahme 86
7.9.4 Entsorgung 86

8 Connecting examples 90

8.1 Safety function with single-channel input 91
8.1.1 Safety ratings of single-channel sensors 92
8.2 Safety function with two-channel input 93
8.2.1 Safety ratings of two-channel sensors 94
8.3 Two-hand actuation 95
8.3.1 Safety ratings of two-channel sensors 96
8.4 Mode selector, rotary table 97
8.5 Safety Mats, connecting blocks and bumpers 98
8.5.1 Safety ratings of two-channel sensors 99
8.6 Connecting two actuators with internal GND reference 100
8.6.1 Safety ratings of two-channel actuator 100
8.7 Connecting two parallel actuators to one safe output 102

9 Annex 105

9.1 Object Dictionary 105
9.1.1 Device Type 105
9.1.2 Error Register 105
9.1.3 Manufacturer Device Name 106
9.1.4 Manufacturer Hardware Version 106
9.1.5 Manufacturer Software Version 106
9.1.6 Identity Object 107
9.1.6.1 Highest sub index supported 107
9.1.6.2 Vendor ID 107
9.1.6.3 Product Code 107
9.1.6.4 Revision Number 107
9.1.6.5 Serial Number 108
9.1.7 Supply24Voltage 108
9.1.8 Out1Current 108
9.1.9 Ext Temperature 109
9.1.10 Err.code 109
9.1.11 Err.line CPU 1/2 116
9.1.12 Err.module CPU 1/2 116
9.1.13 Err.class CPU 1/2 118
9.1.14 System uptime [s] (implizit MRAM test) 118
9.1.15 Temperature warning 118

10 Certification 120

10.1 Standards complied with 120
10.1.1 Product standard applied 120
10.1.2 Safety-oriented standards and guidelines 120

10.1.3 EMC standards 120
10.2 Conformity marking 121
10.2.1 Annex to the conformity marking 122
10.3 TÜV certificate 124
10.4 Approvals 125

11 Revision history 126

Notice 127

List of Figures

Figure 1: Module layout 22
Figure 2: Module printing 36
Figure 3: Five-digit number of the unit built on that day / serial number 36
Figure 4: Single-row spring-assisted connector with releasing lever 39
Figure 5: Example of how to wire the inputs and outputs 40
Figure 6: Multi-channel contact-type sensors 56
Figure 7: Electronic sensors, OSSD sensor 57
Figure 8: Safety function with single-channel input 84
Figure 9: Safety function with two-channel input 86
Figure 10: Two-hand actuation 88
Figure 11: Safety Mats, connecting blocks and bumpers 91

List of Tables

Table 1: General specifications 27
Table 2: Safe digital inputs 27
Table 3: Safe digital test pulse outputs 28
Table 4: Safe digital outputs 28
Table 5: Safety-related ratings of a single-channel application 29
Table 6: Safety-related ratings of the outputs of a single-channel application 31
Table 7: Safety-related ratings of the outputs of a two-channel application 32
Table 8: Plug X1 38
Table 9: LED „EtherCAT Run“ 42
Table 10: LED „Safe Status“ 42
Table 11: „Power“ LED 43
Table 12: Safe digital inputs SI 0 .. SI 3 44
Table 13: Safe digital outputs SO 0 and SO 1 45
Table 14: Aluminium profile 50
Table 15: Voltage supply wiring example 54
Table 16: Allocation of safe inputs for the mode selector function 56
Table 17: Allocation of safe inputs for the bumper function 58
Table 18: Multiple socket connector 63
Table 19: Connection socket connector 63
Table 20: Examples for FSoE addresses 66
Table 21: Table of faults 76
Table 22: Error codes (object dictionary 0x2007 or 0x2017 - Err.code) 77
Table 23: Error classes 78

Glossary

0V	Earth-potential-free common point
1ph	1-phase mains
3ph	3-phase mains
AC	AC current or voltage
Application	The application is the intended use of the KEB product.
ASCL	Asynchronous sensorless closed loop
AWG	American wire gauge
B2B	Business-to-business
CAN	Fieldbus system
CODESYS	Operating system of the standard control and programming environment
CODESYS Safety-PS	Safety programming system
COMBIVERT	KEB drive converters
COMBIVIS	KEB start-up and parameterizing software
Customer	The customer has purchased a KEB product from KEB and integrates the KEB product into his product (customer product) or resells the KEB product (dealer)
DC	DC current or voltage
DIN	German Institut for standardization
EMC	Electromagnetic compatibility
Emergency stop	Shutdown of a drive in emergency case (not de-energized)
Emergency switching off	Switching off the voltage supply in emergency case
EN	European standard
End customer	The end customer is the user of the customer product.
EtherCAT	Real-time Ethernet bus system of the company Beckhoff
Ethernet	Real-time bus system - defines protocols, plugs, types of cables
FE	Functional earth
FSoE	Functional Safety over Ethernet
GND	Reference potential, ground
Head module	Description for the bus coupler or small control in the KEB-I/O EtherCat system
HMI	Human machine interface (touch screen)
IEC	International standard
IP xx	Degree of protection (xx for level)
KEB product	The KEB product is subject of this manual.
KEB-I/O EtherCAT SPS	Small control system from the KEB-I/O system
KEB-I/O EtherCAT System	I/O module family
Manufacturer	The manufacturer is KEB, unless otherwise specified (e.g. as manufacturer of machines, engines, vehicles or adhesives).
MCM	American unit for large wire cross sections
MTTF	Mean service life to failure
NN	Sea level
PE	Protective earth
PELV	Protective Extra Low Voltage
PFD	Term used in the safety technology (EN 61508-1...7) for the size of error probability
PFH	Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour
PLC	Programmable logic controller
POU	Program Organization Unit
RJ45	Modular connector with 8 lines
Safety Package	Plug in for COMBIVIS studio 6 with safety functionally
Safety PLC	Safety programmable logic controller
Safety PLCopen	Library of the certified basic level safety blocks
SELV	Safety Extra Low Voltage (< 60 V)
SIL	The security integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7)
USB	Universal serial bus

Standards for control & automation

DGUV regulation 3	Electrical installations and equipment
DIN 46228-1	Wire-end ferrules; Tube without plastic sleeve
DIN 46228-4	Wire-end ferrules; Tube with plastic sleeve
DIN IEC 60364-5-54	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, protective conductors and protective bonding conductors (IEC 64/1610/CD)
DIN VDE 0100-729	Low-voltage electrical installations - Part 7-729: Requirements for special installations or locations - Operating or maintenance gangways (IEC 60364-7-729); German implementation HD 60364-7-729
EN 1037	Safety of machinery - Prevention of unexpected start-up; German version EN 1037
EN 55011	Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement (IEC/CISPR 11); German version EN 55011
EN 55021	Interference to mobile radiocommunications in the presence of impulse noise - Methods of judging degradation and measures to improve performance (IEC/CISPR/D/230/FDIS); German version prEN 55021
EN 60204-1	Safety of machinery - electrical equipment of machines Part 1: General requirements (VDE 0113-1, IEC 44/709/CDV)
EN 60439-1	Low-voltage switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1); German version EN 60439-1
EN 60529	Degrees of protection provided by enclosures (IP Code) (IEC 60529)
EN 60664-1	Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests (IEC 60664-1)
EN 60721-3-1	Classification of environmental conditions - Part 3-1: Classification of groups of environmental parameters and their severities - Section 1: Storage (IEC 104/648/CD)
EN 60721-3-2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation and handling (IEC 104/670/CD)
EN 60721-3-3	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities; section 3: Stationary use at weatherprotected locations; Amendment A2 (IEC 60721-3-3); German version EN 60721-3-3
EN 61000-2-1	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems
EN 61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment; Compatibility levels in industrial plants for low-frequency conducted disturbances (IEC 61000-2-4); German version EN 61000-2-4
EN 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (IEC 61000-4-2); German version EN 61000-4-2
EN 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3); German version EN 61000-4-3
EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test (IEC 61000-4-4); German version EN 61000-4-4
EN 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement

	techniques - Surge immunity test (IEC 61000-4-5); German version EN 61000-4-5
EN 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6); German version EN 61000-4-6
EN 61000-4-34	Electromagnetic compatibility (EMC) - Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase (IEC 61000-4-34); German version EN 61000-4-34
EN 61131-2	Programmable controllers - Part 2: Equipment requirements and tests (IEC 61131-2)
EN 61373	Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373)
EN 61439-1	Low-voltage switchgear and controlgear assemblies - Part 1: General rules (IEC 121B/40/CDV); German version FprEN 61439-1
EN 61508-1...7	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1...7 (VDE 0803-1…7, IEC 61508-1…7)
EN 61800-2	Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable frequency a.c. power drive systems (VDE 0160-102, IEC 61800-2)
EN 61800-3	Speed-adjustable electrical drives. Part 3: EMC requirements and specific test methods (VDE 0160-103, IEC 61800-3)
EN 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy (IEC 61800-5-1); German version EN 61800-5-1
EN 61800-5-2	Adjustable speed electrical power drive systems - Part 5-2: Safety Requirements - Functional (IEC 22G/264/CD)
EN 62061	Safety of machinery - functional safety of electrical, electronic and programmable electronic safety-related systems (VDE 0113-50, IEC 62061)
EN ISO 13849-1	Safety of machinery - safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1); German version EN ISO 13849-1
UL 61800-5-1	American version of the EN 61800-5-1 with „National Deviations“

1 Basic Safety Instructions

The COMBICONTROL 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 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.

- ► Read the instructions for use !
- ► Observe the safety and warning instructions !
- ► If anything is unclear, please contact KEB Automation KG !

1.1 Target Group

This manual is written for design, project planning, servicing and commissioning experts. Qualified personnel for the purpose of this instruction manual must have the following qualifications:

- Knowledge and understanding of the safety instructions.
- Knowledge of automation technology.
- Knowledge of functional safety.
- Skills for installation and assembly of electrical equipment.
- Detection of hazards and risks of the electrical drive technology.
- Understanding of the function in the used machine.
- Knowledge of the operation of the Windows operating system.
- Knowledge of *DIN IEC 60364-5-54*.
- Knowledge of *EN 60204-1*
- Knowledge of national safety regulations (e.g. *DGUV regulation 3*).

1.2 Transport, storage and proper use

The transport is carried out by qualified persons in accordance with the environmental conditions specified in this manual. The devices shall be protected against excessive strains.

Electronic devices contain electrostatic sensitive components.

► Avoid contact.

► Wear ESD-protective clothing.

Do not store the devices

- in the environment of aggressive and/or conductive liquids or gases.
- with direct sunlight.
- outside the specified environmental conditions.

1.3 Installation

⚠ DANGER

Do not operate in an explosive environment!

► The device is not intended for the use in potentially explosive environment.

To prevent damages to the device:

- Make sure that no components are bent and/or isolation distances are changed.
- The device must not be put into operation in case of mechanical defects. Non-compliance with the applicable standards.
- Do not allow moisture or mist to penetrate the unit.
- Avoid dust permeating the device. Allow for sufficient heat dissipation if installed in a dust-proof housing.
- Note installation position and minimum distances to surrounding elements. Do not cover the ventilation openings.
- Mounting according to the specified degree of protection.
- Make sure that no small parts fall into the device during assembly and wiring (drilling chips, screws etc.). This also applies to mechanical components, which can lose small parts during operation.
- Check the reliable fit of the device connections in order to avoid contact resistances and sparking.
- The safety instructions are to be kept!

1.4 Electrical connection

ATTENTION

In order to prevent malfunctions or unpredictable conditions, observe the following instructions:

- ► For any work on the device switch off the supply voltage.
- ► Never bridge upstream protective devices (also not for test purposes).
- ► Install all required covers and protective devices for operation.
- ► 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.
- ► 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.

1.5 Start-up and operation

When the device is installed in machines, start-up (i.e. commencement of the intended operation) is prohibited until it is determined that the machine complies with the machine directive; Account is to be taken of *EN 60204-1*.

- During operation, all covers and doors shall be kept closed.
- Use only approved accessories for this device.
- Never touch terminals, busbars or cable ends.

1.6 Maintenance

The following maintenance work has to be carried out when required, but at least once per year by authorized and trained personnel.Check unit for loose screws and plugs and tighten if necessary.

- ► Check unit for loose screws and plugs and tighten if necessary.
- ► Clean the device from dirt and dust deposits. Depending on the device, pay particular attention to ventilation slots or cooling fins.
- ► Examine and clean extracted air filter and cooling air filter of the control cabinet.

1.7 Repair

In case of malfunction, unusual noises or smells inform a person in charge!

⚠ DANGER

Unauthorized exchange, repair and modifications!

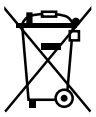
Unpredictable malfunctions!

- ► The function of electronic devices can be influenced by the setting and parameterization. Never replace without knowledge of the application.
- ► Modification or repair is permitted only by KEB Automation KG authorized personnel.
- ► Only use original manufacturer parts.
- ► Infringement will annul the liability for resulting consequences.

1.8 Disposal

Electronic devices of the KEB Automation KG are exclusively professional devices for further industrial processing (so-called B2B devices).

Manufacturers of B2B devices are obliged to take back and recycle devices manufactured after 14.08.2018. These devices may not be disposed at the collection centres of public sector disposal organisations.



If no deviating agreement has been made between the customer and KEB or no deviating mandatory legal regulation exists, KEB products marked in this way can be returned. Company and keyword to the return point can be taken from the list below. Shipping costs are paid by the customer. Thereupon the devices will be professionally recycled and disposed.

The entry numbers are listed country-specific in the following table. The corresponding KEB return addresses can be found on our website.

Withdrawal by	WEEE-Reg.-No.		Keyword
Austria			
KEB Automation GmbH	ERA:	51976	Stichwort „Rücknahme WEEE“
France			
RÉCYLUM - Recycle point	ADEME:	FR021806	Mots clés „KEB DEEE“
Germany			
KEB Automation KG	EAR:	DE12653519	Stichwort „Rücknahme WEEE“
Italy			
COBAT	AEE: (IT)	19030000011216	Parola chiave „Ritiro RAEE“
Spain			
KEB Automation KG	RII-AEE	7427	Palabra clave „Retirada RAEE“
Česko			
KEB Automation KG	RETELA	09281/20 ECZ	Klíčové slovo: Zpětný odběr OEEZ
Slowakei			
KEB Automation KG	ASEKOL:	RV22EEZ0000421	Kľúčové slovo: ”Spätný odber OEEZ”

The packaging must be feed to paper and cardboard recycling.

2 System description

EtherCAT®[1] is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT® puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT® is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale.

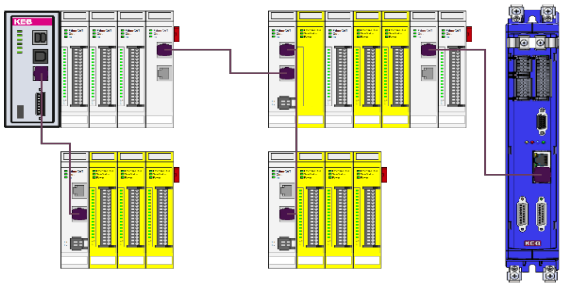
Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT controllers thus nearly act like centralised control systems, overcoming the issue of the bus transfer times that conventional fieldbus systems are burdened with.

2.1 KEB-I/O EtherCAT

KEB-I/O EtherCAT is a system of I/O modules for interconnecting the process signals in an EtherCAT network.

The KEB-I/O EtherCAT system consists of the EtherCAT bus coupler (if necessary already integrated in the control head) and different Ether-CAT I/O modules.

The EtherCAT I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the EtherCAT I/O modules for the process signals connect to the other. This is how the EtherCAT protocol is retained right through to the last I/O module.



[1] *EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany*

2.1.1 KEB-I/O EtherCAT Safety System

The KEB-I/O EtherCAT Safety system allows users to add EtherCAT I/O modules with safe signals to the EtherCAT control unit. making the separate wiring of safety circuits a thing of the past. The safe signals are transmitted together with the standard signals in the EtherCAT protocol to the KEB-I/O EtherCAT Safety PLC. This integrated transfer process is based on FSoE (Fail Safe over EtherCAT), the safety protocol certified by TÜV, the German Technical Testing & Inspection Association.

2.1.2 Safety over EtherCAT[2] (FSoE)

Along with EtherCAT, a safety protocol was developed and made available for EtherCAT as "Safety over EtherCAT" (FSoE = Fail Safe over EtherCAT). It is the backbone of providing functional safety over EtherCAT. TÜV has certified both the protocol and its implementation to comply with Safety Integrity Level 3 to IEC 61508. In 2010,IEC 61784-3-12 was published as the international reference standard for Safety over EtherCAT.

Since EtherCAT is used as single-channel medium of communication, Safety over EtherCAT does not impose any constraints regarding the transfer rate and cycle time. The transport medium is considered a "black channel" which is left out of the safety assessment.

2.1.3 KEB-I/O EtherCAT Safety PLC

The KEB-I/O EtherCAT Safety PLC (Mat.No. 00C6CE1-0200) links up the inputs and outputs of EtherCAT I/O Safety and other FSoE devices. At the basic level, certified function blocks are graphically "wired up" to establish the system's safety program. In case a project demands more than the technology of the certified function blocks can provide, the extra instructions available at the extended level can be used to expand the safety programs.

The KEB-I/O EtherCAT Safety PLC has been designed as an add-on to a normal COMBIVIS studio 6 control unit. This is a two-channel system which uses the normal control unit to communicate with the COMBIVIS studio 6 Development System and all non-safe I/Os. Programming is based on a certified plug-in that is fully integrated in the COMBIVIS studio 6 Development System.

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[2] Safety over EtherCAT®

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

2.1.4 KEB-I/O EtherCAT Safe I/O Module

The KEB-I/O EtherCAT Safe I/O module "Safe-In4 / Safe-Out2“ provides connections for standard security appliances. The module can be installed at any place of the EtherCAT I/O block, preferably close to the bus coupler. The signals are transferred by the EtherCAT bus of EtherCAT I/O Safety PLC and processed in a safe manner. The module outputs safely switch actuators such as contactors, signal lamps or servo converters.

2.1.5 COMBIVIS studio 6

Programming of EtherCAT I/O Safety PLC is based on a certified plug-in that is fully integrated in the COMBIVIS studio 6 Development System.

The EtherCAT I/O Safety PLC is a sub-node of the standard control and provides an application, task, lists of global variables, POUs and logical I/Os.

The integrated function diagram FUP safety editor (to IEC 61131-3, certified for use with IEC 61508 SIL3 applications) is used for basic or extended-level programming by means of certified function blocks (IEC 61131-3 standard or according to PLCopen Safety) as specified in the user manual. Further software functions are available for safeguarding the safety functions by change tracking, safe flow of signals, safe version control (pinning), separating safe operation, debugging mode, etc.

2.1.6 SafetyPLCopen Library in COMBIVIS studio 6

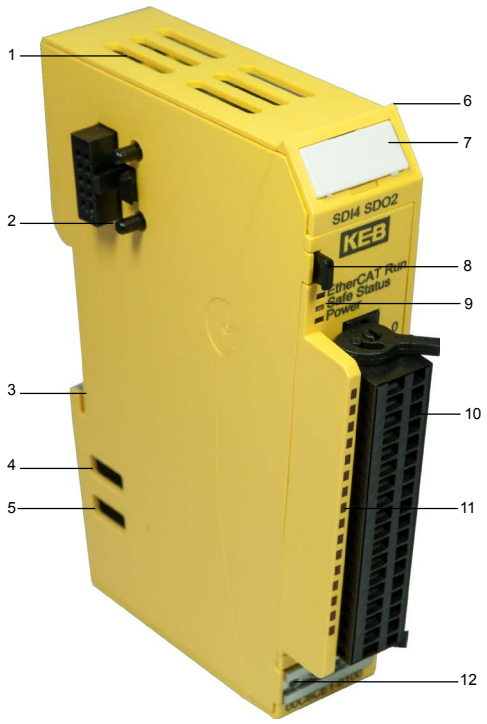
The PLCopen components have been defined by the PLCopen organisation, its members and external organisations specialising in all safety-related aspects. Since these are certified components, they reduce the time and costs involved in developing, verifying and testing a safety application for acceptance. They interlink by logical operations which behave like logical wiring and therefore minimise the time and programming efforts needed to create major parts of safety applications.

3 Product description

3.1 General description

KEB-I/O EtherCAT Safety (Mat.-No. 00C6CE1-0100)

The KEB-I/O EtherCAT Safety is a decentralised terminal with 4 safe inputs and 2 safe outputs.



1	Convection slots
2	Module lock and E-bus
3	Carrier rail mount and functional earth
4	FSoE address Bit 8 - 15
5	FSoE address Bit 0 - 7
6	Grip
7	Marking clip
8	Release lever
9	Status LEDs
10	Spring-assisted combi plug X1
11	Signal state LEDs
12	Shield connection on the housing mount

Figure 1: Module design

The housing mount consists of an aluminum profile with an integrated clamp used to snap the module to a 35mm DIN mounting rail. The housing trough including the optical fibres for the status indicators, the side face and the front is made of plastic and contains the module. The optical fibre of the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

3.2 Range of application

3.2.1 Specified Application

KEB-I/O EtherCAT is a system of I/O modules for interconnecting the process signals in an EtherCAT network. It consists of the bus coupler and various I/O modules.

KEB-I/O EtherCAT Safety System with KEB-I/O EtherCAT Safety PLC, KEB-I/O EtherCAT Safety I/O module and the COMBIVIS studio 6 extends the KEB-I/O EtherCAT system with functions that allow it to be used in the area of functional safety of machines.

The intended areas of application of the KEB-I/O EtherCAT Safety system are safety functions on machines and the directly related tasks in industrial automation. In this context, the system may only be used for applications with a defined fail-safe state. The defined fail-safe state of the KEB-I/O EtherCAT Safety System is the powerless state.

When using all safety-related control components, the safety measures applicable to the industrial controls (protection by means of protective devices such as emergency stop, etc.) must be observed in accordance with the applicable national or international regulations. This also applies to all other connected devices such as drives or light grids. The safety instructions, the information on the connection conditions (nameplate and documentation) and the limit values specified in the technical data in this user manual must be read carefully before installation and start-up and must be observed without fail.

The KEB-I/O EtherCAT Safety system is not suitable for use which involves fatal risks or hazards which, unless exceptionally high safety measures are taken, could result in death or injury to many persons or serious damage to the environment. Such are in particular the use in the monitoring of nuclear reactions in nuclear power plants, flight control systems, air traffic control, in the control of mass transport, in medical life support systems and control of weapon systems.

3.2.2 Qualified staff

The use of the safety-related products is limited to the following persons only:

- Qualified personnel who are familiar with the relevant safety concepts for functional safety and the applicable standards and regulations.
- Qualified personnel who plan, develop, install and commission safety equipment for machinery and plants.

Qualified personnel in the sense of the safety instructions of this manual are persons who, due to their training, experience and instruction as well as their knowledge of relevant standards, regulations, accident prevention rules and operating conditions, are authorised to carry out the respective required activities and are able to recognise and avoid possible dangers. In this sense, sufficient language skills are required to understand this manual.

3.2.3 Suspension of liability

The user must coordinate and comply with the use of the safety-related control components on his own responsibility with the authority responsible for him.

The manufacturer accepts no liability or warranty for damage caused by:

- Improper use
- Non-observance with standards and guidelines
- Unauthorised changes to devices, connections and settings
- The use of unapproved or unsuitable devices or device groups

- Non-observance of the safety instructions given in this manual

3.3 Safe states

Two different safe states are distinguished.

The first safe state is set functionally and depends on the respective application, operation and software of the machine. It is the required **functional safe state**. The system works without errors.

The second safe state is the **fail-safe state** and is set in error case in the monitored components.

3.3.1 Functional safe state

The functional safe state is reached when the inputs are displayed as "zero" in the safe process image and when the outputs are set to the "zero" state means voltage-free at the output. This is also symbolised in the data telegram by "zero" in the process image.

3.3.2 Fail-safe state – external error

In case of an external error (short circuits, cross-faults, etc.), all outputs are switched to the de-energised state (output: "zero") and the inputs send a zero to the safe control. FSoE communication will not be stopped.

The fail-safe state is the energy-free state.

- This state can be reset via the safety PLC.

3.3.3 Fail-safe state – internal error

In case of an internal module error, all outputs are switched to the de-energised state (output: "zero"). The FSoE communication is discontinued, thus the input information are also no longer transmitted.

The fail-safe state is the energy-free state.

This state can only be left after a reset by switching off the supply voltage. A complete self-test, as part of the initialisation phase, is thus carried out.

⚠ CAUTION

Uncontrolled movements e.g. with suspended loads!

Injuries caused by moving or unbraked machine parts

► For applications in which the safe state is reached by actively switched on an actuator, additional, external safety measures must be provided (e.g. mechanical brakes with suspended load).

3.3.4 Traceability

Traceability means that it can be determined at any time when, where and by whom a product or merchandise was manufactured, processed, stored, transported, consumed or disposed of. KEB Automation KG can take over this requirement for the manufacture, processing, storage and transport; the customer is responsible for the further whereabouts of the product.

The product is clearly identifiable and thus traceable by the serial number glued to the underside and stored in the object directory => 5.1 Kennzeichnung und Identifikation. The customer must note this number together with the machine, installation site and end customer to ensure traceability.

The customer must ensure the traceability of the devices via the serial number.

3.4 Service life

The KEB-I/O EtherCAT Safe I/O module has a maximum service life of 20 years.

This means that the KEB-I/O EtherCAT Safe I/O module must be taken out of operation at the latest one week before expiry of these 20 years (calculated from the date of manufacture).

The production date can be read from the serial number of the module => 5.1.2 Seriennummer.

4 Technical data

4.1 General specifications

4.1.1 General specifications

Produktbezeichnung	KEB-I/O EtherCAT Safe-In4 / Safe-Out2 (Mat.-Nr. 00C6CE1-0100)
Feldbus	EtherCAT 100Mbit/s
Controller	ASIC ET1200
Baudrate	100 Mbit/s
Anschluss E-Bus	10-poliger Systemstecker in Seitenwand
Potenzialtrennung	Alle Module sind untereinander und gegen den Bus potenzialgetrennt
Diagnose	LED: Status Bus, Status Modul, Drahtbruch/Überstrom => 7.5 Diagnose
Anschluss I/O/Power	Stecker 18-polig (nicht Bestandteil des Moduls KEB Art. Nr. 00C6CD1-0200) Federzugsammelstecker mit mechanischem Auswerfer, 18-polig
E-Bus-Last	maximal 300 mA (Systemversorgung)
Endmodul	nicht notwendig
Versorgung (I/O Versorgung / Systemversorgung)	
Versorgungsspannung	24 V DC -15% / +20% (SELV/PELV)
Überspannungskategorie	Kategorie II nach EN 61131-2
Stromaufnahme Modulversorgung	Ca. 7 mA + Laststrom
Verpolungsschutz	Ja
Nennisolationsspannung	500 V_{eff} zwischen I/O-Versorgung und E-Bus
Störfestigkeit	Zone B nach EN 61131-2 Einbau auf geerdeter Hutschiene im geerdeten Schaltschrank
Lager- und Transportbedingungen	
Temperatur	-25°C … + 70°C
Rel. Luftfeuchte	5% … 95% ohne Betauung
Luftdruck	70 kPa bis 108 kPa / 0 bis 3000 m ü. NN
Schwingungen	5 bis 8,4 Hz: +/- 3,5 mm Amplitude, 8,4 bis 150 Hz: 10 m/ s2 (1g), nach IEC 60068-2-6, Prüfung Fc
Schock	150 m/s2 (15g), 11 ms Sinus-Halbwelle, nach IEC 60068-2-27
Einsatzbedingungen	
Einbaulage	waagerecht, anreihbar
Verschmutzungsgrad	Verschmutzungsgrad II der IEC 60664-3
Zulässige Betriebsumgebung	Betrieb nur zulässig in einer Umgebung, die mindestens der Schutzart IP54 nach IEC 60529 entspricht (z.B. geeigneter Schaltschrank)
Betriebstemperatur	0°C ... + 55°C
Rel. Luftfeuchte	5% … 95% ohne Betauung
Luftdruck	80 kPa bis 108 kPa / 0 bis 2000 m ü. NN

weiter auf nächster Seite

Schwingungen	5 bis 8,4 Hz: +/- 3,5 mm Amplitude, 8,4 bis 150 Hz: 10 m/ s2 (1g), nach IEC 60068-2-6, Prüfung Fc
Schock	150 m/s² (15g), 11 ms Sinus-Halbwelle, nach IEC 60068-2-27
Mechanische Eigenschaften	
Montage	35 mm DIN-Schiene (Hutschiene)
Abmessungen	25 mm x 120 mm x 90 mm (B x H x T)
Schutzart	IP20
Gehäuseträger	Aluminium
Schirmanschluss	direkt am Modulgehäuse
Table 1: Allgemeine Gerätedaten	

4.1.2 Safe digital inputs

Anzahl und Typ	4 x einkanalig oder 2 x zweikanalig, EN 61131-2, Typ3)
Diagnose	Querschluss, Fremdeinspeisung
Max. erreichbare Sicherheitsklassen (je nach Konfiguration)	Einkanalige Verwendung: Kat. 2/PL d nach EN ISO 13849-1 SIL2 nach EN 62061 / IEC 61508 Zweikanalige Verwendung: Kat. 3/PL e nach EN ISO 13849-1 SIL3 nach EN 62061 / IEC 61508
Eingangsverzögerung	300 µs ... 1500 µs (parametrierbar)
Sensortyp	Einsatz von Sensoren mit OSSD-Ausgängen nach EN 61496, Kontaktbehaftete Sensoren
Potentialtrennung	Kanal / Kanal: nein Kanal / EBus: 500 Veff
Signalpegel	Aus : -3 V … 5 V Ein: 11 V … 30 V
Maximale Spannung	33 V (Auch im Fehlerfall darf nicht mehr an den Eingang angelegt werden.)
Signalanzeige	LED, der Klemmstelle örtlich zugeordnet, parallel zum Eingang geschaltet
Testpulslänge	300 µs ... 1500 µs (parametrierbar), phasenversetzt auf den einzelnen Kanälen
Sichere Reaktionszeit	< 5 ms; siehe auch Kapitel „4.3.3 Reaktionszeit“
Eingangsstrom	typisch 3,3 mA
Eingangswiderstand	typisch 7,3 kΩ
Eingangskapazität	typisch 100 nF
Maximale Leitungslänge	100 m (Zwischen den Anschlussklemmen Sensor / Modul)
Table 2: Sichere Digitale Eingänge	

4.1.3 Safe digital test pulse outputs

Anzahl und Typ	4
Ausgangsnennstrom	50 mA, kurzschlussfest
Signalanzeige	LED, der Klemmstelle örtlich zugeordnet
Schaltspannung	24 V DC -15% / +20%
Spannungsfestigkeit	33 V (Auch im Fehlerfall darf nicht mehr an den Ausgang angelegt werden)
Testpulslänge	300 µs ... 1500 µs, phasenversetzt auf den einzelnen Kanälen
Maximale Leitungslänge	100 m (Zwischen den Anschlussklemmen Modul / Sensor)
Table 3: Sichere Digitale Testpulsausgänge	

4.1.4 Safe digital outputs

Anzahl und Typ	2 x Halbleiter, 24 V DC, Toleranzen nach EN 61131-2
Erreichbare Sicherheitsklassen	2 x Kat. 3/PL e nach EN ISO 13849-1 2 x SIL3 nach EN 62061 2 x SIL3 nach EN 61508-1...7
Diagnose	Querschluss, Fremdeinspeisung
Signalanzeige	LED, der Klemmstelle örtlich zugeordnet, von der CPU gesteuert
Minimaler Ausgangsstrom	2 mA, Details unter => 7.2.8 Aktoranschluss
Maximaler Ausgangsstrom	2,0 A, kurzschlussfest, Summenstrom und Derating beachten Details unter => 7.2.8 - Derating des Summenstroms
Kapazitive Last	Ja, Details unter => 7.2.8 Aktoranschluss Schalten von kapazitiven Lasten
Bremsspannung beim Abschalten induktiver Lasten	Typ. 40 V DC
Induktive Last	Ja, Details unter => 7.2.8 Aktoranschluss Schalten von induktiven Lasten
Maximale Leitungslänge	100 m (Zwischen den Anschlussklemmen Modul / Aktor)
Ansprechschwelle Ausgangsschutz Überlast	Min. 2,5 A Typ. 3,5 A Max. 5,5 A
Maximaler Ausgangsstrom	4 A, Summenstrom und Derating beachten Details unter => 7.2.8 Aktoranschluss - Derating des Summenstroms
Lastwiderstandsbereich (Bei Nennspannung)	12 Ω ... 12 kΩ
Potentialtrennung	Kanal / Kanal: nein Kanal / EBus: 500 Veff
Zugelassene Aktuatoren	Für DC13 nach EN 60947-5-1 Für DC1 nach EN 60947-4
Testpulslänge	Parametrierbar: 500 µs ... 1500 µs (parametrierbar)
Versorgungsspannung	24 V DC -15% / +20%
Spannungsfestigkeit	33 V (Auch im Fehlerfall darf nicht mehr an den Ausgang angelegt werden)
Table 4: Sichere Digitale Ausgänge	

4.2 Safety-related input ratings

4.2.1 Safety-related ratings of a single-channel application

The table below lists the safety-related ratings of a single-channel safety function that uses one input of the safe I/O module. All components involved in the safety function must be taken into account in order to access whether the desired safety level is achieved.

Maximaler Safety Integrity Level gem. EN 62061:2010	SIL2	
Maximaler Safety Integrity Level gem. IEC 61508:2010	SIL2	
Maximaler Performance Level gem. EN ISO 13849-1:2015	Kat. 2/PL d	
Hardwarefehlertoleranz HFT bei einkanaliger Anwendung (IEC 61508:2010/EN ISO 13849-1:2015)	0 (ein Fehler in der Anwendung kann zu einem Ausfall der Sicherheitseinrichtung führen)	
Sicherheitstechnische Kennwerte	**Umgebungstemperatur 25°C**	**Umgebungstemperatur 55°C**
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für einen Eingang (bis Feldbus)	$5{,}40 * 10^{-6}$ (0,06 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)	$2{,}23 * 10^{-5}$ (0,23 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für einen Eingang (bis Feldbus)	$1{,}24 * 10^{-10}$ 1/h (0,02 % der gesamten PFH von 10^{-6} bei SIL2)	$5{,}27 * 10^{-10}$ 1/h (0,06 % der gesamten PFH von 10^{-6} bei SIL2)
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für einen Eingang (bis Feldbus)	$1{,}10* 10^{-5}$ (0,11 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)	$4{,}77 * 10^{-5}$ (0,48 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für einen Eingang (bis Feldbus)	$1{,}28 * 10^{-10}$ 1/h (0,02 % der gesamten PFH von 10^{-6} bei SIL2)	$5{,}79 * 10^{-10}$ 1/h (0,06 % der gesamten PFH von 10^{-6} bei SIL2)
DC (Diagnosedeckungsgrad) gem. EN ISO 13849-1:2015	98,32 %	95,89 %
Anteil sicherer Fehler an der Gesamtfehleranzahl SFF	99,27 %	98,51 %
$MTTF_d$ - gem. EN ISO 13849-1:2015 (Mean Time To Failure dangerous)	100 Jahre (errechnet: 283 Jahre)	100 Jahre (errechnet: 185 Jahre)

Table 5: Sicherheitstechnische Kennwerte der Eingänge bei einkanaliger Anwendung

4.2.2 Safety-related ratings of a two-channel application

The table below lists the safety-related ratings of a two-channel safety function that uses two inputs of the safe I/O module. All components involved in the safety function must be taken into account in order to access whether the desired safety level is achieved.

Maximaler Safety Integrity Level gem. EN 62061:2010	SIL3	
Maximaler Safety Integrity Level gem. IEC 61508:2010	SIL3	
Maximaler Performance Level gem. EN ISO 13849-1:2015	Kat. 3/PL e	
Hardwarefehlertoleranz HFT bei zweikanaliger Anwendung (IEC 61508:2010/EN ISO 13849-1:2015)	1 (ein Fehler in der Anwendung kann noch nicht zu einem Ausfall der Sicherheitseinrichtung führen)	
Sicherheitstechnische Kennwerte	**Umgebungstemperatur 25°C**	**Umgebungstemperatur 55°C**
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für zwei Eingänge (bis Feldbus)	$5{,}21 * 10^{-6}$ ($0{,}51$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)	$2{,}16 * 10^{-5}$ ($2{,}16$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für zwei Eingänge (bis Feldbus)	$1{,}20 * 10^{-10}$ 1/h ($0{,}12$ % der gesamten PFH von 10^{-7} bei SIL3)	$5{,}11 * 10^{-10}$ 1/h ($0{,}51$ % der gesamten PFH von 10^{-7} bei SIL3)
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für zwei Eingänge (bis Feldbus)	$1{,}06 * 10^{-5}$ ($1{,}06$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)	$4{,}62 * 10^{-5}$ $4{,}62$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für zwei Eingänge (bis Feldbus)	$1{,}24 * 10^{-10}$ 1/h ($0{,}12$ % der gesamten PFH von 10^{-7} bei SIL3)	$5{,}62 * 10^{-10}$ 1/h ($0{,}56$ % der gesamten PFH von 10^{-7} bei SIL3)
DC (Diagnosedeckungsgrad) gem. EN ISO 13849-1:2015	98,32 %	95,93 %
Anteil sicherer Fehler an der Gesamtfehleranzahl SFF	99,28 %	98,59 %
$MTTF_d$ - gem. EN ISO 13849-1:2015 (Mean Time To Failure dangerous)	100 Jahre (errechnet: 283 Jahre)	100 Jahre (errechnet: 185 Jahre)
Sicherheitstechnische Kennwerte der Eingänge bei zweikanaliger Anwendung		

4.3 Safety-related output ratings

4.3.1 Safety-related ratings of a single-channel application

The table below lists the safety-related ratings of a single-channel safety function that uses one output of the safe I/O module. All components involved in the safety function must be taken into account in order to access whether the desired safety level is achieved.

Maximaler Safety Integrity Level gem. EN 62061:2010	SIL2	
Maximaler Safety Integrity Level gem. IEC 61508:2010	SIL2	
Maximaler Performance Level gem. EN ISO 13849-1:2015	Kat. 2/PL d	
Hardwarefehlertoleranz HFT bei einkanaliger Anwendung (IEC 61508:2010/EN ISO 13849-1:2015)	0 (ein Fehler in der Anwendung kann zu einem Ausfall der Sicherheitseinrichtung führen)	
Sicherheitstechnische Kennwerte	**Umgebungstemperatur 25°C**	**Umgebungstemperatur 55°C**
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für einen Ausgang (bis Feldbus)	$5{,}36 * 10^{-6}$ (0,06 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)	$2{,}24 * 10^{-5}$ (0,23 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für einen Ausgang (bis Feldbus)	$1{,}24 * 10^{-10}$ 1/h (0,02 % der gesamten PFH von 10^{-6} bei SIL2)	$5{,}31 * 10^{-10}$ 1/h (0,06 % der gesamten PFH von 10^{-6} bei SIL2)
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für einen Ausgang (bis Feldbus)	$1{,}10 * 10^{-5}$ (0,11 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)	$4{,}82 * 10^{-5}$ (0,48 % der gesamten PFD_{avg} von 10^{-2} bei SIL2)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für einen Ausgang (bis Feldbus)	$1{,}28 * 10^{-10}$ 1/h (0,02 % der gesamten PFH von 10^{-6} bei SIL2)	$5{,}89 * 10^{-10}$ 1/h (0,06 % der gesamten PFH von 10^{-6} bei SIL2)
DC (Diagnosedeckungsgrad) gem. EN ISO 13849-1:2015	98,40 %	96,56 %
Anteil sicherer Fehler an der Gesamtfehleranzahl SFF	99,34 %	98,81 %
$MTTF_d$ - gem. EN ISO 13849-1:2015 (Mean Time To Failure dangerous)	100 Jahre (errechnet: 264 Jahre)	100 Jahre (errechnet: 152 Jahre)

Table 6: Sicherheitstechnische Kennwerte der Ausgänge bei einkanaliger Anwendung

4.3.2 Safety-related ratings of a two-channel application

The table below lists the safety-related ratings of a two-channel safety function that uses two outputs of the safe I/O module. All components involved in the safety function must be taken into account in order to access whether the desired safety level is achieved.

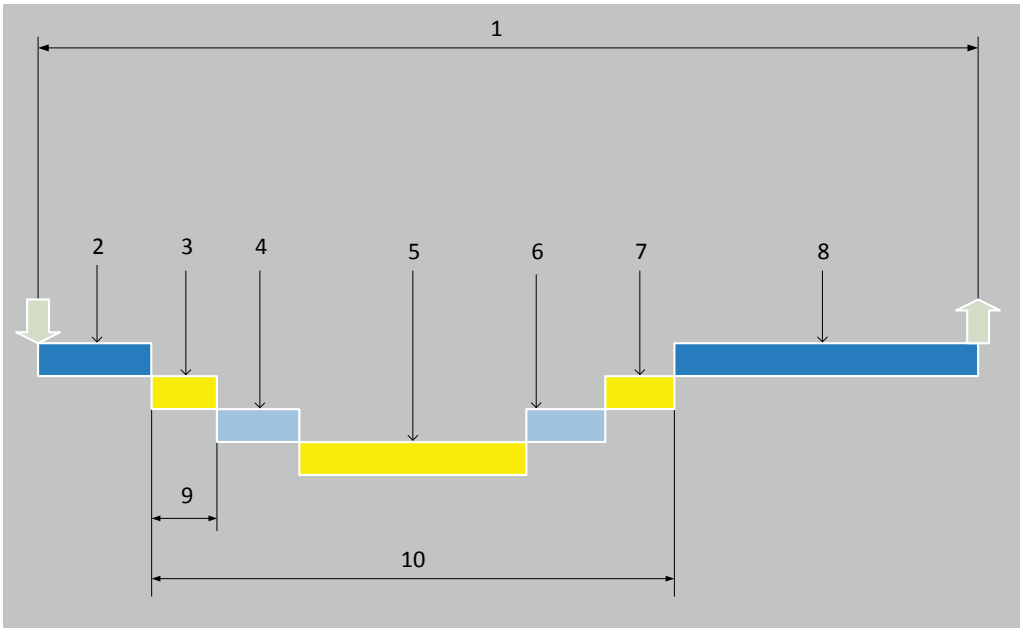
Maximaler Safety Integrity Level gem. EN 62061:2010	SIL3	
Maximaler Safety Integrity Level gem. IEC 61508:2010	SIL3	
Maximaler Performance Level gem. EN ISO 13849-1:2015	Kat. 3/PL e	
Hardwarefehlertoleranz HFT bei zweikanaliger Anwendung (IEC 61508:2010/EN ISO 13849-1:2015)	1 (ein Fehler in der Anwendung kann noch nicht zu einem Ausfall der Sicherheitseinrichtung führen)	
Sicherheitstechnische Kennwerte	**Umgebungstemperatur 25°C**	**Umgebungstemperatur 55°C**
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für zwei Ausgänge (bis Feldbus)	$5{,}52 * 10^{-6}$ ($0{,}55$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)	$2{,}33 * 10^{-5}$ ($2{,}33$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 10 Jahre, (IEC 61508:2010) für zwei Ausgänge (bis Feldbus)	$1{,}28 * 10^{-10}$ 1/h ($0{,}13$ % der gesamten PFH von 10^{-7} bei SIL3)	$5{,}53 * 10^{-10}$ 1/h ($0{,}56$ % der gesamten PFH von 10^{-7} bei SIL3)
Ausfallwahrscheinlichkeit PFD_{avg}, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für zwei Ausgänge (bis Feldbus)	$1{,}13 * 10^{-5}$ ($1{,}13$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)	$5{,}03 * 10^{-5}$ ($5{,}03$ % der gesamten PFD_{avg} von 10^{-3} bei SIL3)
Ausfallwahrscheinlichkeit PFH, Prooftest-Intervall 20 Jahre, (IEC 61508:2010) für zwei Ausgänge (bis Feldbus)	$1{,}32 * 10^{-10}$ 1/h ($0{,}13$ % der gesamten PFH von 10^{-7} bei SIL3)	$6{,}18 * 10^{-10}$ 1/h ($0{,}62$ % der gesamten PFH von 10^{-7} bei SIL3)
DC (Diagnosedeckungsgrad) gem. EN ISO 13849-1:2015	98,42 %	96,78 %
Anteil sicherer Fehler an der Gesamtfehleranzahl SFF	99,36 %	98,90 %
$MTTF_d$ - gem. EN ISO 13849-1:2015 (Mean Time To Failure dangerous)	100 Jahre (errechnet: 254 Jahre)	100 Jahre (errechnet: 140 Jahre)

Table 7: Sicherheitstechnische Kennwerte der Ausgänge bei zweikanaliger Anwendung

4.3.3 Response time

In a safety system, the total response time is made up of the following separate times:

- Signal processing by sensor
- Signal processing by KEB-I/O EtherCAT Safety module
- Time of input data transfer across the EtherCAT bus between KEB-I/O EtherCAT Safe I/O module and the safe PLC
- Safe PLC program runtime
- Time of output data transfer across the EtherCAT bus between KEB-I/O EtherCAT Safety PLC and KEB-I/O EtherCAT Safe I/O module
- Signal processing by KEB-I/O EtherCAT Safe I/O module
- Signal processing by actuator



1	Gesamt Reaktionszeit	6	Übertragung des Frames über EtherCAT
2	Signalverarbeitung im Sensor	7	Signalverarbeitung im sicheren I/O Modul
3	Signalverarbeitung im sicheren I/O Modul	8	Signalverarbeitung im Aktor
4	Übertragung des Frames über EtherCAT	9	Sichere Reaktionszeit des Moduls
5	Programmlaufzeit in der sicheren SPS	10	Sichere Reaktionszeit im System

⚠ VORSICHT

Für die Sicherheitsreaktionszeit die Laufzeiten des Feldbusses und Zykluszeit der Safety PLC berücksichtigen!

Personen- und Sachschäden vermeiden!

► Für die Auslegung der Sicherheitsreaktionszeit müssen die Laufzeiten des Feldbusses und die Zykluszeit der Safety PLC in die Berechnung der Sicherheitsreaktionszeit einfließen.

As a general rule, a safe response time of **5 ms** may be assumed for the safe I/O module. This time ensures that the input and output signals will change and a safe state will be achieved. The configurable input filters (adjustable between 0.3 ms and 1.5 ms) have an influence on the maximum response time of the IO module.

The safe response time of digital inputs defines as the maximum time it takes before the FSoE frame is available on the EtherCAT bus after the signal of an input changes.

The safe response time of digital outputs defines as the maximum time it takes until the signal of a digital output changes after the EtherCAT module has received a FSoE frame.

Even if a fault occurs will the module be in a safe state before the safe response time is over. The following failure sources will provoke a change to the safe state:

- Fault detected at the module inputs
- Fault detected at the module outputs
- Internal module fault (self-diagnosis)

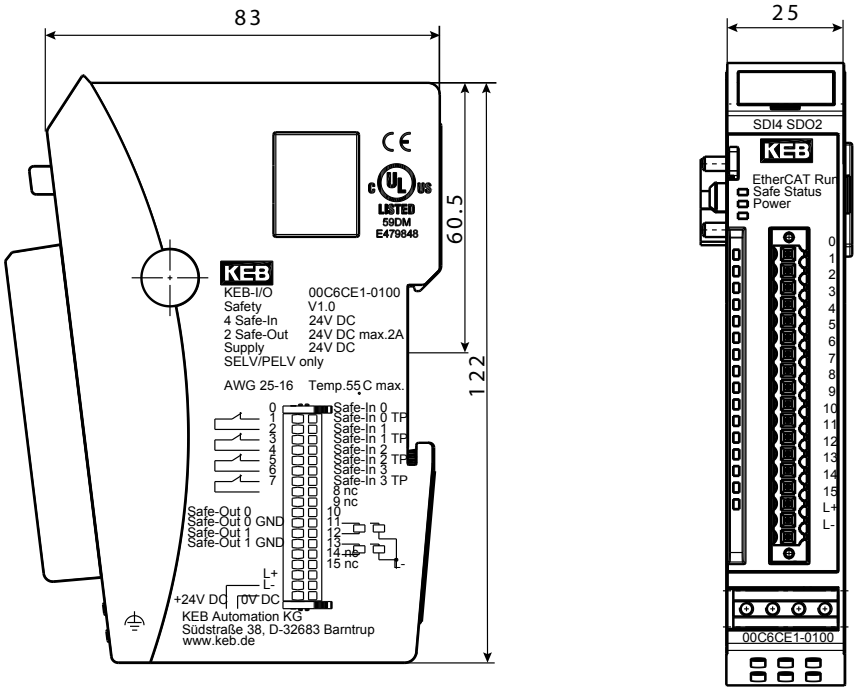
⚠ VORSICHT

Für die Sicherheitsfunktion Schaltmatte ist eine Reaktionszeit von 50ms zu berücksichtigen!

Personen- und Sachschäden vermeiden!

► Mit der Funktion Schaltmatte wird eine feste Reaktionszeit, von der Zustandsänderung der Schaltmatte bis zur Bereitstellung der Information auf dem EtherCAT-Bus, von 50ms erreicht.

4.4 Dimensions



4.5 *ransport und Lagerung

Bei Transport und Lagerung muss das KEB-I/O EtherCAT Safe-In4 / Safe-Out2 vor unzulässigen Beanspruchungen wie mechanische Belastungen, Temperatur, Feuchtigkeit und aggressiver Atmosphäre geschützt werden. Das KEB-I/O EtherCAT Safe-In4 / Safe-Out2 ist möglichst in der Originalverpackung zu transportieren und zu lagern.

Bei Kommissionierung oder Umverpackung dürfen die Kontakte nicht verschmutzt oder beschädigt werden. Das KEB-I/O EtherCAT Safe-In4 / Safe-Out2 muss unter Beachtung der ESD-Hinweise in geeigneten Behältern/Verpackungen gelagert und transportiert werden. Die Geräte enthalten elektrostatisch gefährdete Bauelemente, die durch unsachgemäße Behandlung beschädigt werden können. Verwenden Sie daher für den Transport offener Baugruppen elektrostatisch geschirmte Transporttaschen mit Metallbeschichtung, bei denen eine Verunreinigung mit Aminen, Amiden und Silikonen ausgeschlossen ist. Treffen Sie außerdem bei der Inbetriebnahme und Wartung des KEB-I/O EtherCAT Safe-In4 / Safe-Out2 die erforderlichen Schutzmaßnahmen gegen elektrostatische Entladungen (ESD).

⚠ VORSICHT

Elektrostatische Entladungen!

Zerstörung oder Schädigung des Gerätes!

- ► Verwenden Sie zum Transport und zur Lagerung des KEB-I/O EtherCAT Safe-In4 / Safe-Out2 die originale Verpackung.
- ► Stellen Sie sicher, dass die Geräte nur bei den spezifizierten Umgebungsbedingungen transportiert und gelagert werden.
- ► Achten Sie beim Umgang mit dem KEB-I/O EtherCAT Safe-In4 / Safe-Out2 auf gute Erdung der Umgebung (Personen, Arbeitsplatz und Verpackung).
- ► Berühren Sie keine elektrisch leitenden Bauteile, z. B. Datenkontakte. Die Geräte sind mit elektronischen Bauelementen bestückt, die bei elektrostatischer Entladung zerstört werden können.

5 Construction and functionality

5.1 Labelling and identification

5.1.1 Imprinted texts and symbols

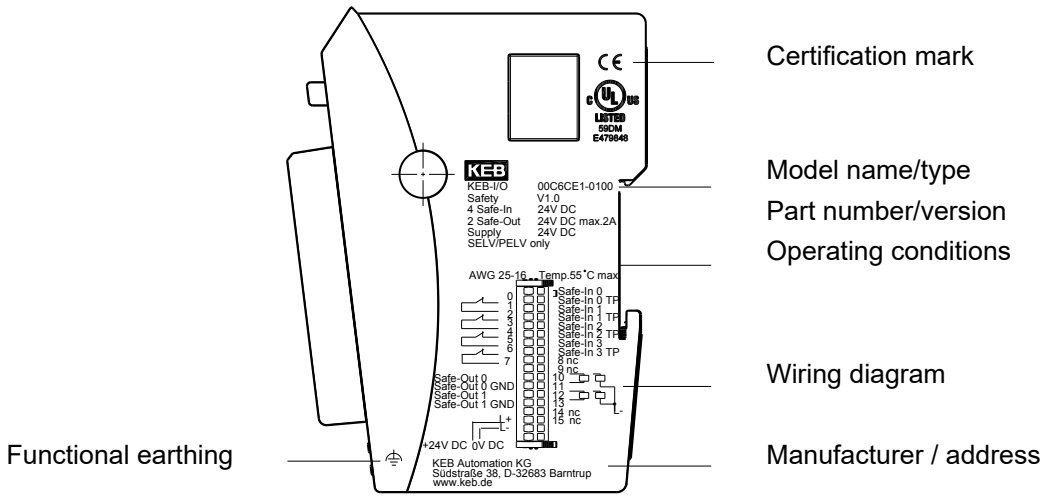


Figure 2: Module printing

5.1.2 Serial number

A label showing the serial number is affixed to the aluminium mount on the back of the module.

The numerical code incorporates the production date and a serial number. KEB Automation KG can use the numerical code to distinctly identify the model, software and hardware release date.

Figure 3: Five-digit number of the device built on that day / serial number

5.1.2.1 Structure of the serial number:

YY MM DD NNNNN

Example:
The device shown in the picture was manufactured on June 5th, 2015 with the serial number 00039.

15 06 05 00039

Production date in the format: Year Month Day

The serial number is also stored in object 1018 sub-index 4 and can be retrieved by SDO transfer.

5.2 Contents of package

The KEB-I/O EtherCAT Safety I/Os package contains:

- KEB-I/O EtherCAT Safety I/O
- Module bus cover
- Connector

5.3 Connector overview

5.3.1 E-bus and module lock

The system plugs and the module lock are located on the sides of the Safety I/O. These contact pins interconnect the modules. They supply power to the module's electronic circuitry and transfer the EtherCAT signals. Verify that the end cap from the package is in place to protect the module bus connector on the last module at the right-hand side of a terminal unit against dirt.

The integrated module lock prevents the modules from coming apart under mechanical load or vibration.

⚠ CAUTION

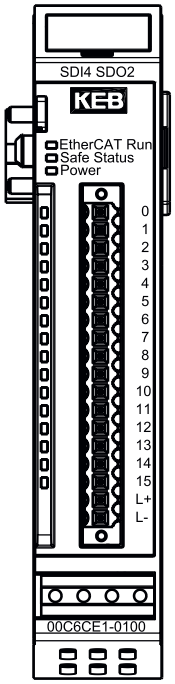
Interconnecting units of different design!

Damage to the device mechanics!

► Use approved modules in a KEB-I/O EtherCAT network only.

5.3.2 Spring-assisted combi plug X1

The spring-assisted combi plug is located at the front of KEB-I/O Ether CAT Safety. The sensors and actuators and the module's power supply all attach to this connector.



Pin	Function	Signal
0	Safe-In 0	SI0
1	Safe-In 0 TP	SI0 TP
2	Safe-In 1	SI1
3	Safe-In 1 TP	SI1 TP
4	Safe-In 2	SI2
5	Safe-In 2 TP	SI2 TP
6	Safe-In 3	SI3
7	Safe-In 3 TP	SI3 TP
8	- Do not connect -	GND
9	- Do not connect -	GND
10	Safe-Out 0	SO0 +
11	Safe-Out 0 GND	SO0 -
12	Safe-Out 1	SO1 +
13	Safe-Out 1 GND	SO1 -
14	- Do not connect -	GND
15	- Do not connect -	GND
16	24 V supply to power unit (outputs)	L+
17	GND	L-

Table 8: Plug X1

Figure 4: Single-row spring-assisted connector with releasing lever

For connection to the Safe I/O module, only the suitable spring-assisted connector available from KEB may be used. For information on connecting sensors and actuators, see chapter „7.2 Elektrische Installation“.

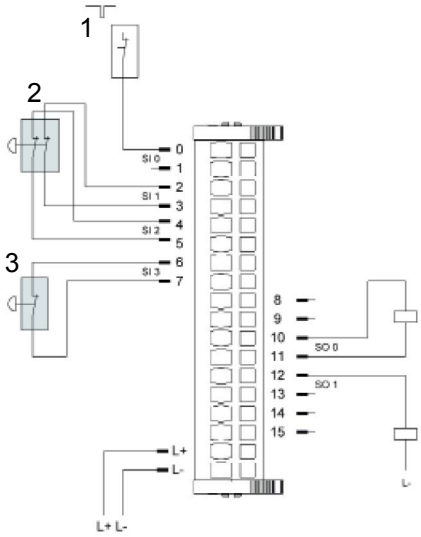
⚠ CAUTION

Loss of safe function due to cross-circuits!

Improper installation may cause malfunctions due to cross-circuits at the contacts

► The spring-assisted connector is designed by way that there are no cross-circuits of the contacts, if correctly installed. Pay attention to a correct and proper installation, since cross-circuits or short-circuits can affect the safe function of the module.

5.3.3 Wiring example



1 Sensor with OSSD output signals

2 EM STOP button
Two-channel connection

3 EM STOP button

Figure 5: Example of how to wire the inputs and outputs

The Safe I/O module is intended to provide functional safety to industrial automation and to protect humans and machines in conformity with Machine Directive 2006/42/EC.

It therefore supports the connection of many different safety-related sensors.

Examples:

- Single-channel and two-channel contact-type sensors such as EMERGENCY STOP switches
- Sensors with single and two-channel OSSD signals such as light grids
- Selector switches, safety mats and connecting blocks

Provided that the admissible maximum installed loads are not exceeded, resistive and inductive loads can be operated at the outputs → „4.1.4 Sichere Digitale Ausgänge“.

Refer to section „8 Anschlussbeispiele“ for examples of how to connect various sensors and actuators.

⚠ CAUTION

Safe function jeopardised by cross-faults!

Improper installation may cause malfunctions due to cross-faults at the contacts!

► When test pulses are enabled, the Safe I/O module will detect cross-faults between the inputs / outputs and other signal lines of the same module. Note that you must prevent cross-faults with the security functions of other modules. You should therefore protect the signal lines and/or lay them separately.

5.3.4 I/O supply

The I/O supply of the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is rated at 24 VDC. It is monitored.

The cord must have external protection against short cicuit and overload triggering at max. 10 A.

Power to Safe I/O module may be supplied by PELV/SELV-ready 24V DC power supply units according to EN50178 / EN60950-1. This applies to both the system power supply → „7.2.3 Systemversorgung“, and the I/O supply → „7.2.4 I/O Versorgung“.

⚠ CAUTION

Risk of fire by overload or overvoltage!

Damage to the device!

- ► Power to Safe I/O module may be supplied by PELV/SELV-ready 24V DC power supply units according to EN50178 / EN60950-1.
- ► The maximum voltage supplied must not exceed 33 V even in case of an error.
- ► The cord must have external protection against short cicuit and overload triggering at max. 10 A.

⚠ CAUTION

Module defect by reversing the polarity of the voltage supply!

Although the Safe I/O module is reverse polarity-proof, reversing the polarity will still put considerable stress on the electronic circuitry and may cause module defects!

- ► Avoid a reversal of polarity.

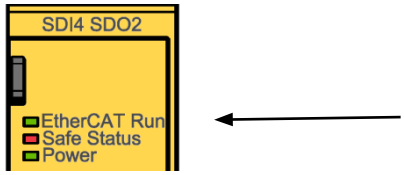
In case the voltage supply is interrupted, drops or increases beyond the rated limits, the module will change to the safe state and output the appropriate error code to the service block → „7.5.6 Fehlercodes“.

Refer to section „7.5 Diagnose“ for further details on how the module responds to a non-conforming voltage supply.

6 Displays and controls

6.1 LED "EtherCAT Run“

LED "EtherCAT Run" indicates the state of EtherCAT communication.

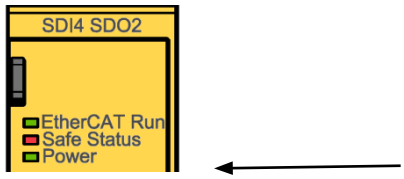


LED	State	Explanation / state
Off	Init	Initialisation no data exchange
Off/green, 1:1	Pre-Op	Pre-operational, no data exchange
Off/green, 5:1	Safe-Op	Safe operation, inputs readable
Green, on	Op	Operational, unrestricted data exchange

Table 9: LED "EtherCAT Run“

6.2 LED "Safe State“

Duo LED "Safe State" indicates the state of the module regarding its safety function.

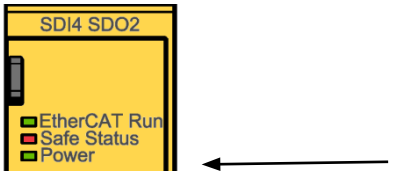


LED	State	Meaning
Green, on	OK	Safety I/O provides safe functionality
Red, on	Error	Safety I/O in fail-safe state

Table 10: LED "Safe State“

6.3 LED "Power“

LED "Power" indicates the state of the power supply to the Safe I/O module.



LED	State	Meaning
Off		No power supplied to the module.
Green on	OK	Operating voltage supplied to the module.

Table 11: LED "Power“

The Safe I/O module feature a voltage watchdog for the 24 VDC supply voltage. It enables the module's safe state when a voltage is out of the specified range.

6.4 LEDs "Channel“

The "Channel“ LEDs are allocated to the module's terminals. Every group of 2 LEDs displays the state of the associated functional unit of output and/or input.

6.4.1 Safe digital inputs SI 0 .. SI 3 using test pulse outputs

LED Position	Channel	Function	LED	Meaning
0	Input SI 0	SI0 state	Off	No valid input signal on channel 0, logical "0"
			Green	DC 24 V supplied to channel 0, logical "1"
1		SI0 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
2	Input SI 1	SI1 state	Off	No valid input signal on channel 1, logical "0"
			Green	DC 24 V supplied to channel 1, logical "1"
3		SI1 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
4	Input SI 2	SI2 state	Off	No valid input signal on channel 2, logical "0"
			Green	DC 24 V supplied to channel 2, logical "1"
5		SI2 diagnosis	Off	Normal operation
			Red	External power supply or cross-circuit
6	Input SI 3	SI3 state	Off	No valid input signal on channel 3, logical "0"
			Green	DC 24 V supplied to channel 3, logical "1"
7		SI3 diagnosis	Off	Normal operation
			Red	External power supply or cross-circuit

Table 12: Safe digital inputs SI 0 .. SI 3

The red "diagnosis" LEDs are disabled if the safe digital inputs are used without the safe digital test pulse outputs.
The green "state" LEDs of the inputs will indicate the presence of a 24 VDC signal at an input even if that input has not been set up in the configuration.

6.4.2 Safe digital outputs SO 0 … SO 1

LED Position	Channel	Function	LED	Meaning
10	Output SO 0	State	Off	No output signal at output 0, logical "0"
			Green	Output signal output 0 active, logical "1"
11		Diagnosis	Off	Normal operation
			Red	External power supply or cross-circuit
12	Output SO 1	Status	Off	No output signal at output 1, logical "0"
			Green	Output signal output 1 active, logical "1"
13		Diagnosis	Off	Normal operation
			Red	External power supply or cross-circuit

Table 13: Safe digital outputs SO 0 and SO 1

6.5 Operating software

The FSoE master's configuration tool is used for operation and configuration. Refer to the FSoE master user guide for further information and details (in case of the KEB-I/O EtherCAT Safety PLC the operating tool COMBIVIS studio 6).

7 Installation and operation

Before installing the Safe I/O module, verify that it has been transported and stored at the ambient conditions specified in sections *„1.2 Transport, Lagerung und sachgemäße Handhabung“*and chapter *„4 Technische Daten“*.

Module operation is subject to the service conditions specified in section *„7.1.1 Einbaulage“*and *„4 Technische Daten“*.

⚠ CAUTION

Inappropriate operation!

Malfunction to KEB-I/O EtherCAT Safe I/O module!

- ► Only persons qualified for dealing with safety matters are allowed to add, replace and put Safe I/O modules into operation!
- ► Before installing, servicing or putting the Safe I/O module into service, please read the safety instructions in the preface of this document.
- ► Before putting the device into service, verify that all safety functions work as specified!

7.1 Mechanical installation

Environment of installation

Protect KEB-I/O EtherCAT against inadmissible contamination. Do not allow the units to contaminate more than specified for degree II in IEC 60664-3.

Whereas an enclosure providing IP 54 protection (e.g. an appropriate control cabinet) ensures that degree of contamination II is complied with, please consider that operation under condensing humidity is NOT allowed.

⚠ WARNING

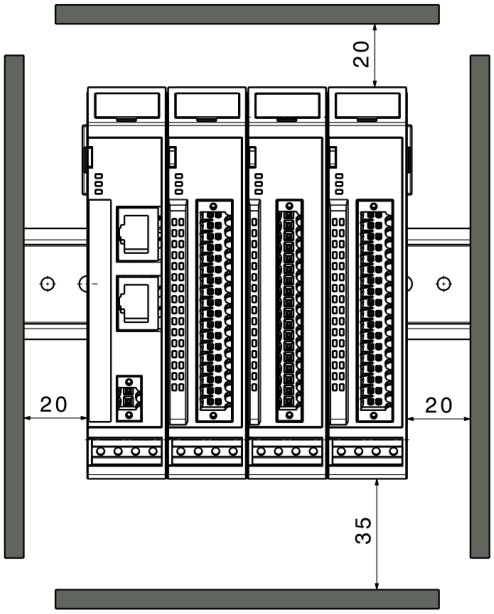
Potentially hazardous failures due to contamination!

Contaminations more severe than those described for degree of contamination II of IEC 60664-3 may cause potentially hazardous failures!

- ► Do ensure that the operating environment complies with at least IP54, e.g. by installing the unit in a suitable control cabinet.

7.1.1 Mounting position

The KEB-I/O EtherCAT are designed for mounting on mounting rails (according to DIN EN 50022, 35 x 7.5 mm). The mounting rail is mounted horizontally, with the socket connectors of the modules facing forwards. To ensure that enough air gets in through the ventilation slots, leave at least 20 mm to the top and 35 mm to the bottom of a module and any adjacent devices or cabinet surfaces. The lateral distance to third-party devices and control cabinet surfaces must not be less than 20 mm.



7.1.1.1 Order of modules in multi KEB-I/O EtherCAT systems

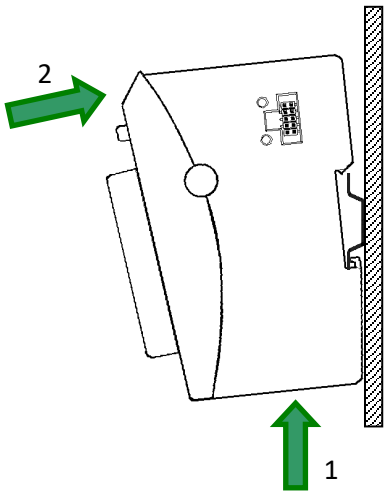
Order of modules in multi KEB I/O EtherCAT systems

In order to ensure that the entire KEB-I/O EtherCAT system works properly, arrange the KEB-I/O EtherCAT Safe I/O module by their specific E-bus load, placing the modules with the highest E-bus load immediately next to the head module (bus coupler or controller). Please note the maximum bus load of the head module.

If possible, place the Safe I/O module immediately next to the head module.

7.1.2 To snap on a single module

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- Push the top of the module against the mounting wall until it snaps in.



7.1.3 To interconnect two modules

- After snapping on the first module to the rail, snap on the second module about 1 cm away towards the right of the first module.
- Push the second module along the mounting rail towards the first module until you hear the locking device snap in.Correctly mounting the modules is the only way of ensuring that the system works properly.
- To prevent inadmissible contamination, mount the cover of the module bus connector on the rightmost module of the EtherCAT I/O system.

⚠ CAUTION

Short circuit fault of module bus contacts!

A short circuit of the module bus contacts may cause the communication with the safe module to fail!

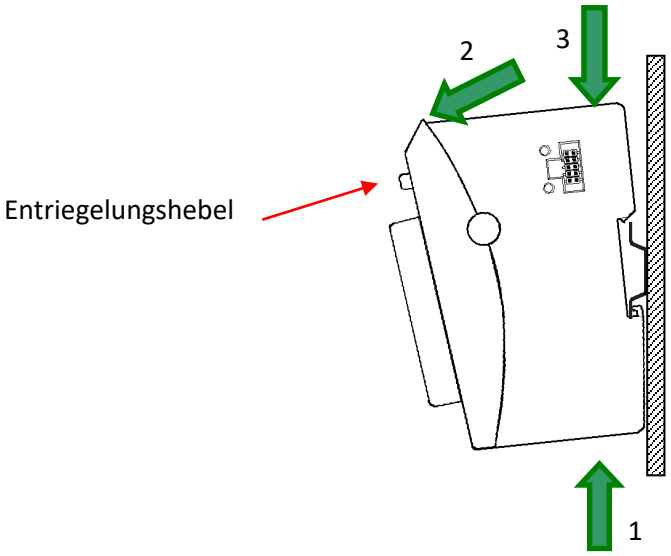
► Verify that the cover of the module bus connector is mounted on the rightmost module of the KEB-I/O system.

7.1.4 To disconnect two modules

- Push down the unlock button (see figure 4) of the module that you wish to disconnect from the module to the left of it.
- Push both modules away from one another until they are about 1 cm apart.

7.1.5 To take down a single module

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the mounting rail as shown in the illustration.
- Pull the module down and out of the mounting rail.



7.2 Electrical installation

7.2.1 Earthing

The KEB-I/O EtherCAT Safe I/O modules must be grounded by attaching the metal housing to functional earth. Since the functional earth connector dissipates HF currents, it is of utmost importance for the module's interference immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector.You would normally ensure that the connection between the module housing and the DIN rail as well as the connection between the DIN rail and the control cabinet conducts well and that the control cabinet is properly connected to earth.

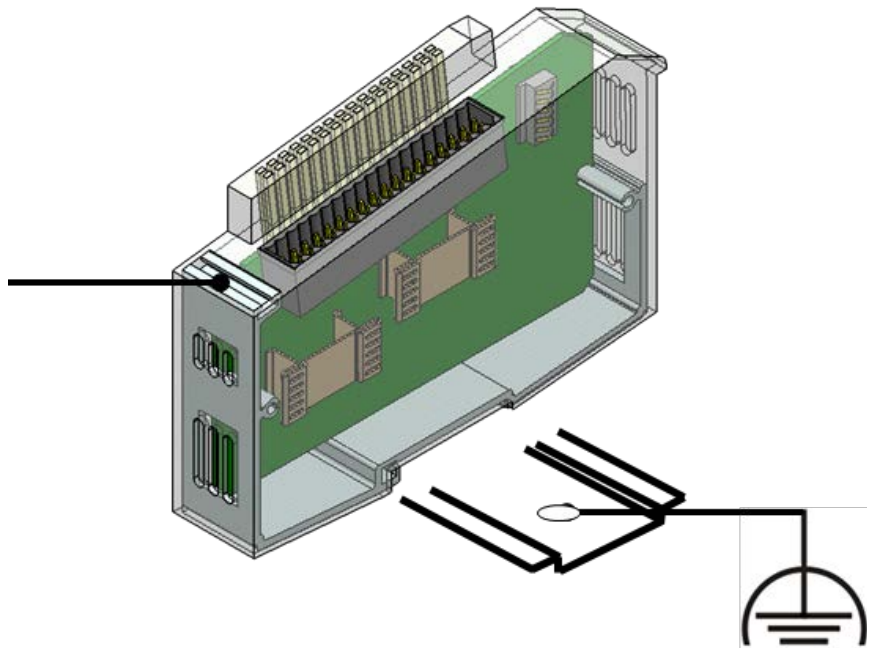


Table 14: Aluminiumprofil

Erdungsleitungen sollen kurz sein und eine große Oberfläche haben (Kupfergeflecht). Hinweise finden Sie z.B. unter http://de.wikipedia.org/wiki/Masse_(Elektronik).

Bei der Errichtung von Anlagen ist eine Erdungsmessung gemäß den Richtlinien (Erdungsprüfung nach VDE 0100) an der DIN-Hutschiene durchzuführen. Mittels Erdungsmessung müssen Schutzerdungen und Betriebserdungen auf die Einhaltung der durch die Normen geforderten Werte überprüft werden. Beachten Sie auch die sich aus der Gefährdungsbeurteilung ergebende Frequenz für die Wiederholungsprüfung.

7.2.2 Module interconnection

The KEB-I/O EtherCAT modules electrically connect by completely pushing the modules together. This automatically connects the modules to both the EtherCAT bus system and the system power supply. If possible, place the KEB-I/O EtherCAT Safety I/O module immediately next to the head module. Refer to section => 7.1 Mechanische Installation for details about how to interconnect two modules.

Please note that the maximum current supplied by the bus coupler limits the number of EtherCAT I/O modules you may connect to a single block.

7.2.3 System power supply

A system connector supplies the KEB-I/O EtherCAT Safety I/O system with system power from an upstream bus coupler or a compact controller. This system power supply is used for the analysis circuitry and for bus communication only.

Bitte beachten Sie die Informationen zur Systemversorgung in den Bedienungsanleitungen der vorgeschalteten Buskoppler oder Kleinsteuerungen sowie die zusätzlichen Anweisungen zur Systemversorgung in diesem Anwenderhandbuch.

⚠ WARNUNG

Gefahrbringende Ausfälle durch die Stromversorgung!

Durch eine falsche Spannungsversorgung kann das Gerät beschädigt oder zerstört werden und es kann zu gefahrbringenden Ausfällen kommen!

- ► Für die 24V DC-Versorgung von Buskopplern oder Kleinsteuerungen mit angeschlossenen KEB-I/O EtherCAT Safe I/O Modulen dürfen Sie nur PELV/SELV-fähige Netzteile gemäß EN 50178 bzw. EN 60950-1 verwenden.
- ► Sofern die Spannungsversorgung geerdet wird (PELV System), ist ausschließlich eine Erdverbindung mit GND zulässig. Erdungsvarianten, in denen die Erde mit +24V verbunden werden, sind nicht erlaubt.
- ► Weiterhin müssen Sie beachten, dass auf diese Baugruppen auch im Fehlerfall nur eine maximale Spannung U max. < 33 V einwirken darf.
- ► Um einen störungsfreien Betrieb zu gewährleisten, müssen die Versorgungsleitungen eines KEB-I/O EtherCAT Modulblocks sternförmig mit möglichst kurzen Leitungen von einem zentralen Versorgungsanschluss verlegt werden.

7.2.4 I/O Supply

The power supplied to the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is rated at 24 VDC. It is monitored. In case of overvoltage (> +20%) and low voltage (> -15%) alike, the module changes to its safe state.

⚠ WARNUNG

Gefahrbringende Ausfälle durch die Stromversorgung!

Durch eine falsche Spannungsversorgung kann das Gerät beschädigt oder zerstört werden und es kann zu gefahrbringenden Ausfällen kommen!

- ► Für die 24 V DC I/O Versorgung am EtherCAT I/O Safety dürfen Sie nur PELV/SELV-fähige Netzteile gemäß EN50178 bzw. EN60950-1 verwenden.
- ► Die I/O Versorgung des EtherCAT I/O Safety muss mit einer Sicherung mit maximal 10 A abgesichert werden.
- ► Sofern die Spannungsversorgung geerdet wird (PELV System), ist ausschließlich eine Erdverbindung mit GND zulässig. Erdungsvarianten, in denen die Erde mit +24V verbunden werden, sind nicht erlaubt.
- ► Weiterhin müssen Sie beachten, dass auf diese Baugruppen auch im Fehlerfall nur eine maximale Spannung U max. < 33 V einwirken darf.
- ► Sollte das Gerät mit einer Spannung > 33 V betrieben worden sein, ist das Gerät auszutauschen, da es nicht wieder verwendet werden darf.
- ► Um einen störungsfreien Betrieb zu gewährleisten, müssen die Versorgungsleitungen eines EtherCAT I/O Modulblocks sternförmig mit möglichst kurzen Leitungen von einem zentralen Versorgungsanschluss verlegt werden.

7.2.4.1 I/O power supply fusing

The cord must have external protection against short cicuit and overload triggering at max. 10 A, min. 60V.

⚠ WARNUNG

Brandgefahr durch Kurzschluss!

Ein Kurzschluss im Modul oder der Versorgungsleitungen kann ein Überhitzen oder einen Brand verursachen!

- ► Sehen Sie eine Sicherung mit einem maximalen Auslösestrom von 10A vor!

7.2.5 Sensor and actuator power supply

All sensors and actuators of the EtherCAT Safety I/O system supplied with power from an external source must still run on safe low operating voltage (SELV/PELV). This power may also be fed to the I/Os of the EtherCAT I/O Safety I/O module.

⚠ WARNUNG

Gefahrbringende Ausfälle durch falsche Stromversorgung der Sensoren und Aktoren!

Durch eine falsche Spannungsversorgung kann das Gerät beschädigt oder zerstört werden und es kann zu gefahrbringenden Ausfällen kommen!

- ► Für die 24V DC I/O Versorgung am EtherCAT I/O Safety dürfen Sie nur PELV/SELV-fähige Netzteile gemäß EN50178 bzw. EN60950-1 verwenden.
- ► Sofern die Spannungsversorgung geerdet wird (PELV System), ist ausschließlich eine Erdverbindung mit GND zulässig. Erdungsvarianten, in denen die Erde mit +24V verbunden werden, sind nicht erlaubt.
- ► Weiterhin müssen Sie beachten, dass auf diese Baugruppen auch im Fehlerfall nur eine maximale Spannung U max. < 33 V einwirken darf.
- ► Sollte das Gerät mit einer Spannung > 33 V betrieben worden sein, ist das Gerät auszutauschen, da es nicht wieder verwendet werden darf.
- ► Um Spannungsverschleppung zu verhindern, müssen die Masseanschlüsse der Spannungsversorgung der Sensoren und Aktoren und der 24V-DC I/O Versorgung am KEB-I/O EtherCAT Safe I/O Modul niederohmig miteinander verbunden sein.

7.2.6 Voltage supply wiring example

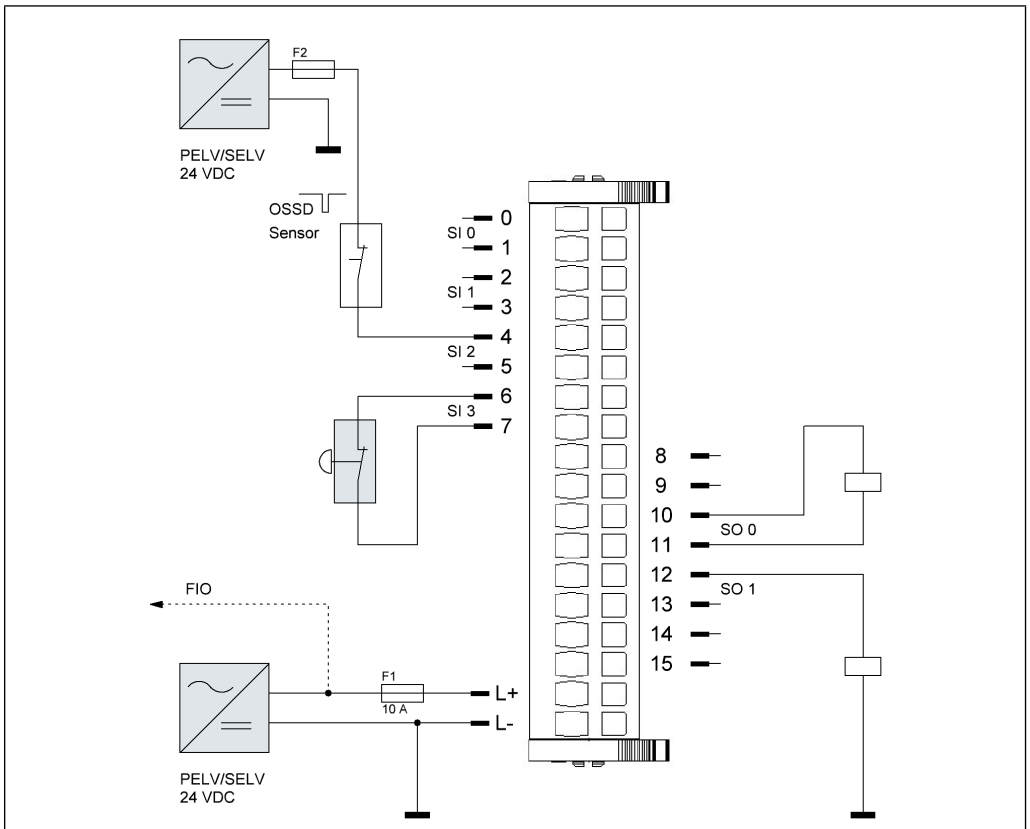
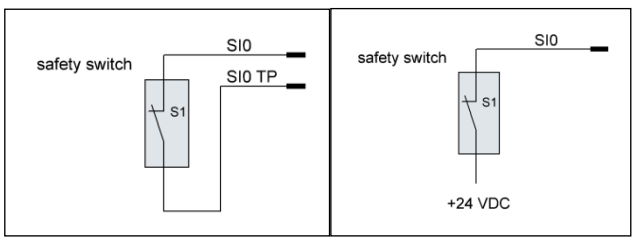


Table 15: Anschlussbeispiel Spannungsversorgung

7.2.7 Sensor connection

Single-channel contact-type sensor

The inputs of single-channel contact-type sensors work entirely separate from one another. Wiring should take account of the fact that every input signal is allocated to the test pulse output. Use the configuration to separately enable each of the inputs => 7.3.3 Parameter für Eingänge.



Analysis of states

The module checks the states of the inputs and transfers the result to the safe control unit.

The process data image of a safe input transfers

- eine „0“ übertragen, wenn am Eingang ein „0“-Signal anliegt **oder** ein Fehler erkannt wurde.
- eine „1“ übertragen, wenn am Eingang ein „1“-Signal anliegt **und** kein Fehler erkannt wurde.

To disable the clock signals

If the appropriate parameter disables the clock signals, you may supply 24VDC to the sensor from an external power source. If so, please remember that disabled test pulse outputs prevent the detection of faults in the external wiring.

⚠ WARNUNG

Nichtaufdecken einer fehlerhaften äußeren Beschaltung bei deaktivierten Testpulsausgängen!

Unsicherer Zustand der Maschine, Gefährung der Sicherheit!

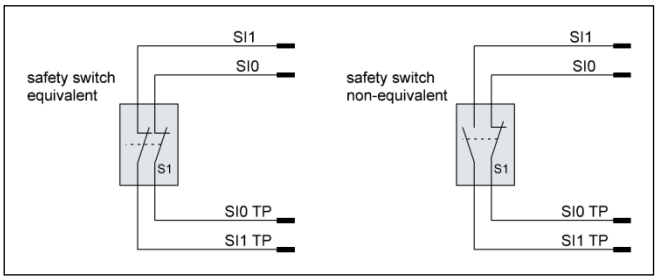
► Nutzen Sie immer den entsprechenden aktivierten Testpulsausgang für die Versorgung von kontaktbehafteten Sensoren!

Refer to section „8.1 Sicherheitsfunktion mit einkanaligem Eingang“ for connection examples.

Two-channel contact-type sensor

Two-channel contact-type sensors allow different inputs to be connected to the test pulse output of a two-channel sensor. A software module of the safe control unit provides the required analysis of the input signals.

The software can be used to interconnect any of the safe inputs. Wiring should take account of the fact that every input signal is allocated to the test pulse output. You must use the configuration to enable the safe inputs you use, see chapter „7.3.3 Parameter für Eingänge“.



The process data image of a safe input transfers

- eine „0“ übertragen, wenn am Eingang ein „0“-Signal anliegt **oder** ein Fehler erkannt wurde.
- eine „1“ übertragen, wenn am Eingang ein „1“-Signal anliegt **und** kein Fehler erkannt wurde.

Refer to section „8.2 Sicherheitsfunktion mit zweikanaligem Eingang“ for connection examples.

Multi-channel contact-type sensor

Multi-channel switches such as mode selectors or "toggle“ type switchgear connect to several safe inputs only using test pulse output SI0 TP to provide the correct function. You must use the configuration to enable the safe inputs you use and parameter "External Inputs" to choose the mode selector function.

Switches with 2, 3 or 4 channels can be analysed.

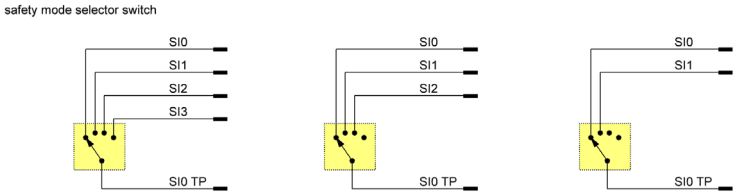


Figure 6: Mehrkanalige kontaktbehaftete Sensoren

Kanalanzahl	Verwendete sichere Eingänge	Taktsignal
4	SI0, SI1, SI2, SI3	SI0 TP
3	SI0, SI1, SI2	SI0 TP
2	SI0, SI1	SI0 TP

Table 16: Zuordnung der sicheren Eingänge bei der Funktion Wahlschalter

Safe inputs you do not use are available for other functions.

PLCopen module "Mode Selector“ or a similar module of the safe control unit is used for multi-channel analysis. The achievable category to EN ISO 13849 depends on the switching device's error model (e.g. mode selector) and must needs be analysed in conjunction with the PLCopen module's error detection.

Testpulsaugang

Der Testpulsausgang TP0 lässt sich im Wahlschalterbetrieb auf „0“ parametrieren. Dies hat aber keine Auswirkung auf den Testpuls, da dieser im Wahlschalterbetrieb automatisch mit maximaler Frequenz aktiviert ist.

Diskrepanz-Zeit im Wahlschalter/Rundtisch Betrieb

Es ist eine feste Diskrepanz-Zeit von 100ms für fehlende Signale an den Eingängen beim Wechsel des Wahlschalterzustands implementiert.

Electronic sensors, OSSD sensor

The OSSD sensor provides the fault detection function when connecting an OSSD sensors. Depending on the sensor's functionality, the retrieval of signals is able to detect cross-faults between the 24 V power supply and earth as well as cross-faults between the sensor signals.

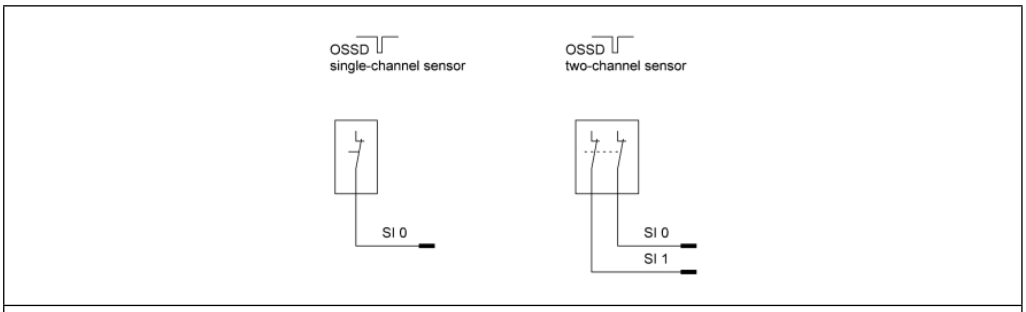


Figure 7: Elektronische Sensoren, OSSD Sensor

Wiring of sensors providing OSSD signals

Two-channel sensors delivering OSSD signals can be connected to any safe input of the KEB-I/O EtherCAT Safety I/O module. A software module of the safe control unit provides the required allocation and analysis of the input signals.

Sensors with OSSD signals do not support the module's test pulses. You must therefore set the input channels to "Test pulse duration =0" => 7.3.3 Parameter für Eingänge.

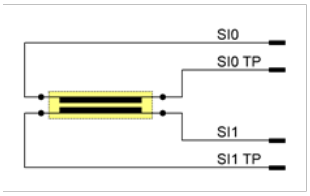
To prevent voltages from being carried over, provide a low-impedance connection between the chassis ground of both the sensor and the KEB-I/O EtherCAT Safety I/O module.

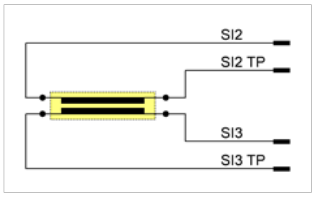
Pressure-sensitive mat, bumper

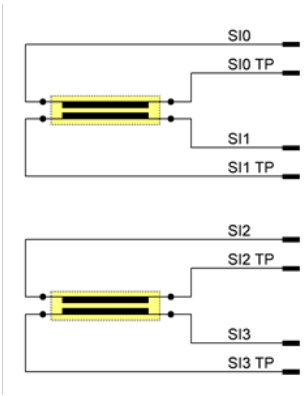
Pressure-sensitive mats and bumpers are used to safeguard the floor around a machine. The mats are placed in the danger zone and make the control unit change to its safe functional state whenever pressure is exerted on them. In this case, a high signal is sent from both inputs. The KEB-I/O Ether CAT Safety I/O module supports four-wire mats. Two safe digital inputs and the associated test pulse outputs are used for one mat / bumper.

You must use the configuration to enable the safe inputs you use and parameter "External Inputs" to choose the bumper function => 7.3.3 Parameter für Eingänge.

You may use up to two mat channels.







Parameter "External Inputs"		Verwendete sichere Eingänge	Verwendete sichere Eingänge
Bit 7	Bit 6		
0	0	Keine Bumper Funktion angewählt	keine
0	1	SI0, SI1	SI0 TP, SI1 TP
1	0	SI2, SI3	SI2 TP, SI3 TP
1	1	SI0, SI1, SI2, SI3	SI0 TP, SI1 TP, SI2 TP, SI3 TP

Table 17: Zuordnung der sicheren Eingänge bei der Funktion Bumper

Safe inputs you do not use are available for other functions.

PLCopen module "SF_ESPE" or a similar module of the safe control unit is used for mat / bumper analysis. The achievable category to EN ISO 13849 depends on the switching device's error model and must needs be analysed in conjunction with the PLCopen module's error detection.

Die Zuleitungen der Schaltmatten und Bumper müssen zusammen verlegt werden.

Pro Schaltmatte oder Bumper müssen die verwendeten vier Leiter (z.B. SI0, SI0 TP, SI1, SI1 TP) zusammen verlegt werden, um Einflüsse und Fehlerfunktionen durch EMV Einwirkungen zu vermeiden.

⚠ VORSICHT

Fehlerfall „Kurzschluss der Schaltmatte“ kann nicht erkannt werden!

Ein Kurzschluss der Schaltmatten-Kontakte kann durch das sichere I/O-Modul nicht erkannt werden. Dies wird als betätigte Schaltmatte interpretiert. Achten Sie auch auf eine fehlerfreie Verdrahtung der Sicherheitseinrichtung.

► Die Funktion der Schaltmatte ist regelmäßig zu überprüfen.

⚠ VORSICHT

Für die Sicherheitsfunktion Schaltmatte ist eine Reaktionszeit von 50 ms zu berücksichtigen!

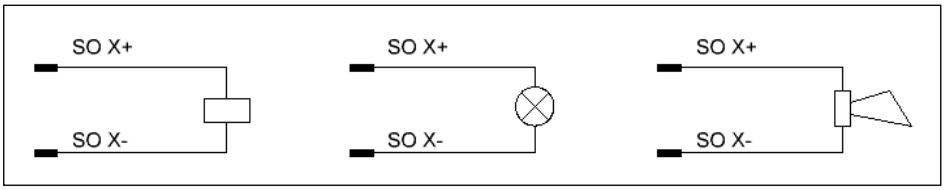
Personen- und Sachschäden vermeiden!

► Mit der Funktion Schaltmatte wird eine Reaktionszeit, von der Zustandsänderung der Schaltmatte bis zur Bereitstellung der Information auf dem EtherCAT-Bus, von 50ms erreicht.

7.2.8 Actuator connection

Fehler an den Ausgängen führen in den sicheren Zustand.
Die Ausgänge verfügen über einen Überlast- und Kurzschlussschutz.
Bei auftretenden Überlast- und Kurzschlussfällen geht das Modul in den sicheren Zustand über. In gleicher Weise reagiert das Modul auf detektierte Fremdeinspeisungen und Querschlüsse an den Ausgängen.

Resistive loads, inductive loads and resistive loads with some capacitive fractions can be connected to the digital power outputs of the KEB-I/O EtherCAT Safety I/O module. They also support signal lamps dissipating resistive power of up to 10W.

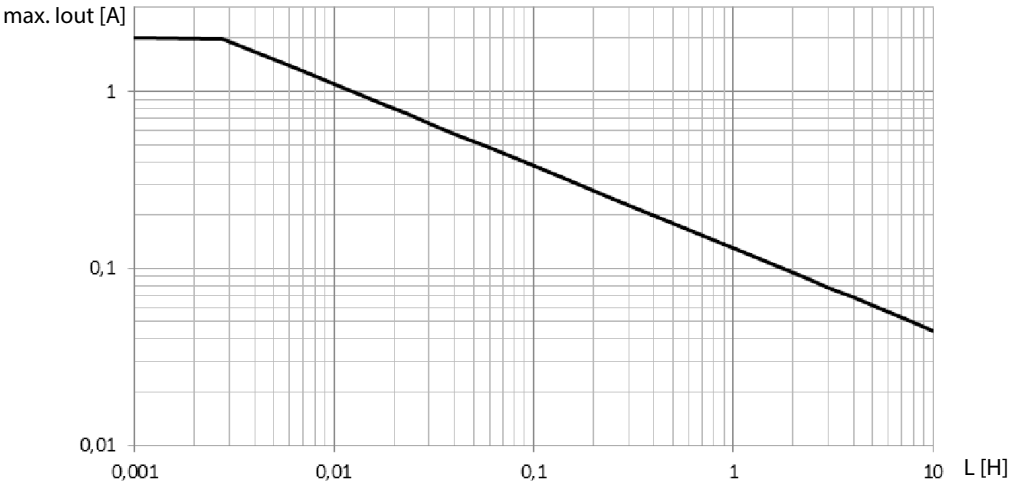


Actuators with external GND reference

Provided that the configuration is taken account of, actuators with external GND reference can be connected to the KEB-I/O EtherCAT Safety I/O module.

Switching of inductive loads

If the internal free wheel circuit is enabled, the digital power outputs of the KEB-I/O EtherCAT Safety I/O module can be used to operate inductive loads. The graph below illustrates the maximum inductance of the load vs. the load current.



Maximaler Ausgangsstrom pro Kanal [A]	Induktivität [H]

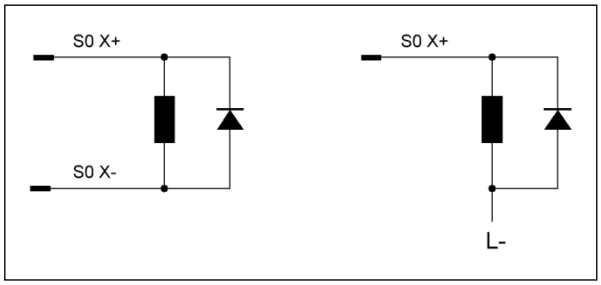
Defekt durch thermische Überhitzung bei zu hoher Induktivität!
Wenn die Induktivität und der Laststrom höher als angegeben gewählt werden, kann dies zur thermischen Zerstörung des digitalen Leistungsausgangs führen. Die Zerstörung des digitalen Leistungsausgangs kann zu einem Ausfall der Sicherheitsfunktion führen.

Use an external free wheel circuit if the external load exceeds the specified inductance limits.

External free wheel circuit

Rückwirkung der externen Freilaufschaltung beachten!
Abhängig von der Sicherheitsfunktion hat die externe Freilaufschaltung einen Einfluss auf die Sicherheitsfunktion und muss in der Sicherheitsbewertung mit betrachtet werden.

An external free wheel circuit will transduce the magnetic energy when turning off the inductive load.



Verify that the external free wheel circuit is designed to withstand the ensuing dissipation heat.

When connecting the inductive load to the outputs, be sure to limit the negative voltage of the external free wheel element you choose to anything smaller than -30 V because the digital output will otherwise transduce the magnetic energy to heat.

Verlustwärme des externen Freilaufgliedes beachten!
Wenn Sie ein geeignetes externes Freilaufglied verwenden, dann wird die magnetische Energie beim Abschalten der induktiven Last nicht im sicheren I/O Modul umgesetzt, sondern am externen Freilaufglied.
Das externe Freilaufglied muss für die entstehende Verlustwärme ausgelegt sein.

Switching of digital inputs

Digital inputs of I/O modules can be switched by the module's SO X+ outputs. Verify that you have enabled parameter "extGroundOutput" of the output you use. Output test pulse configuration must consider the input capacitance of the input to be actuated. See the section on the switching of capacitive loads below.

To ensure that the test pulses of the digital power outputs are filtered properly when the safe digital inputs of the Safety IO module are used, the inputs' configurable filters should be set to the same test pulse duration (parameter "Test pulse duration") as the digital power output.

Switching of capacity loads

Switching of capacitive loads must take account of the limits below described with reference to the output current and the test pulse length.

Test pulses cyclically test the module's digital outputs. If you connect a capacitive load to the digital power output, you may have to modify the test pulse duration. A test pulse length not adapted to the load may cause the module to change to its safe state.

The outputs support loads connected to SOX+ and SOX- as well as to SOX+ and an external GND potential. Different maximum capacitive loads apply to both configurations because they are built around a different internal composition of the outputs. Every output supports a maximum capacitive load of 2.2 µF.

Ausgangskapazität bei Anschluss von Aktoren mit externen GND-Bezug oder digitalen Eingängen an SOX+		
Testpulslänge	Ausgangsstrom 2mA	Ausgangsstrom 20mA
500 µs	50 nF	300 nF
1000 µs	110 nF	600 nF
1500 µs	175 nF	1000 nF

Ausgangskapazität bei Anschluss von Aktoren mit geschalteten GND-Bezug zwischen SOX+ und SOX-		
Testpulslänge	Ausgangsstrom 2mA	Ausgangsstrom 20mA
500 µs	17 nF	310 nF
1000 µs	48 nF	620 nF
1500 µs	77 nF	950 nF

Total current derating

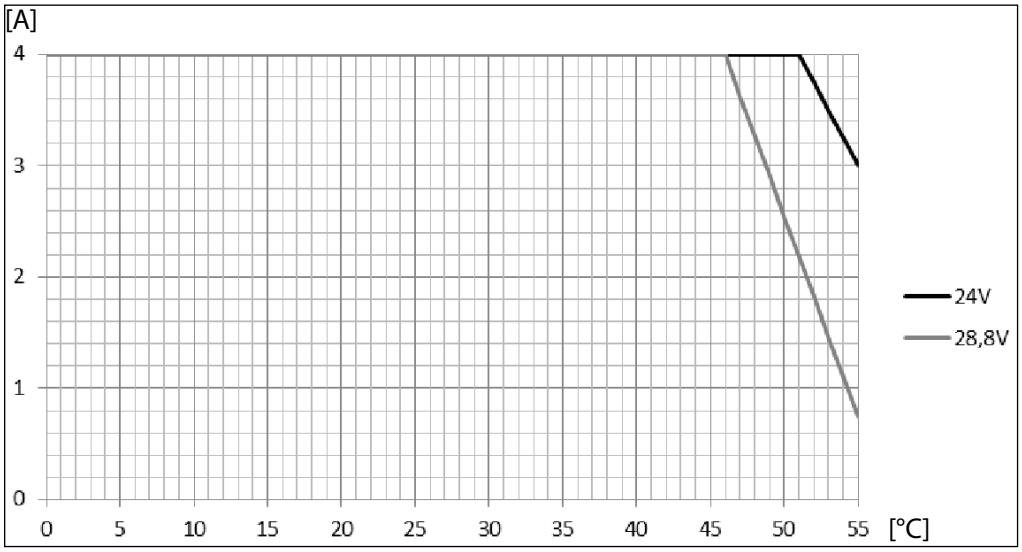
⚠ VORSICHT

Betrieb des EtherCAT I/O Safe I/O Moduls außerhalb des spezifizierten Bereichs unzulässig!

Fehler durch Überlastung von Bauteilen!

► Das Modul darf nur entsprechend den in den technischen Daten spezifizierten Umgebungsbedingungen betrieben werden unter gleichzeitiger Berücksichtigung des Deratings der Ausgänge.

The maximum rated total current of the output module varies with the I/O module's ambient temperature. Refer to the diagram below for the resulting total current.



Summenstrom [A] Umgebungstemperatur [°C]

The output current derating shown on the graph was measured under free convection in a typical installation (I/O modules on the left and right, 50% duty cycle, identical supply voltage).

7.2.9 Multiple socket connector (MSC)

The multiple socket connector features tension springs which make wiring quick and easy. Use the unlock button to easily disconnect the wires where there is little space. Only use the MSC from the package to connect to the KEB-I/O EtherCAT module.

Typ der Buchsenleiste	Weidmüller, OMNIMATE Signal – Serie BL/SL 3.50 (KEB Mat. Nr. 00C6CD1-0200)
Werkzeug:	Schraubendreherklinge 0,4 x 2,5 x 75 (DIN 5264-A)
Klemmbereich, Bemessungsanschluss:	min. 0,14 mm² … max. 1,5 mm²
Leiteranschlussquerschnitt AWG:	min. AWG 26 … max. AWG 14
Außendurchmesser der Isolation:	max. 2,9 mm
Leiteranschlussquerschnitt eindrähtig:	min. H05(07) V-U 0,2 mm² … max. H05(07) V-U 1,5 mm²
Leiteranschlussquerschnitt feindrähtig:	min. H05(07) V-K 0,2 mm² … max. H05(07) V-K 1,5 mm²
Leiteranschlussquerschnitt:	
mit Aderendhülse nach DIN 46 228/1, min. 0,2 mm² … max. 1,5 mm²	
Leiteranschlussquerschnitt	
mit Aderendhülse mit Kragen DIN 46 228/4, min. 0,2 mm² … max. 1,5 mm²	
Abisolierlänge 10mm,	
Nennstrom:	10 A (CSA) / 10 A (UL)

Table 18: Anschluss an der Buchsenleiste

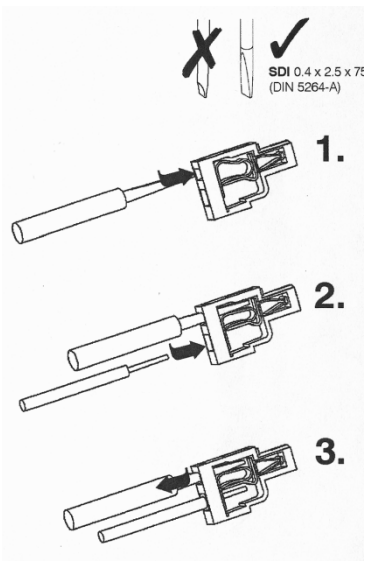


Table 19: Anschluss der Buchsenleiste

⚠ WARNUNG

Gefahrbringende Ausfälle durch unsachgemäße Verdrahtung!

Durch Kurzschlüsse zwischen benachbarten Klemmen kann das Gerät beschädigt werden und es kann zu gefährbringenden Ausfällen kommen!

► Maßnahmen zur Vermeidung. Achten Sie auf eine sachgerechte Verdrahtung.

Zerstörung durch falsches Werkzeug!

► Nur geeignete Werkzeuge beim Verdrahten der Buchsenleiste verwenden!

► Werkzeug: Schraubendreherklinge 0,4 x 2,5 x 75 (DIN 5264-A)

7.3 Configuration

Überprüfung der Sicherheitsfunktion!

Fehlermöglichkeit durch nicht angepasste Konfiguration

► Führen Sie nach der Erstinstallation oder einem Modultausch eine Prüfung der Sicherheitsfunktionen durch!

7.3.1 Address setting

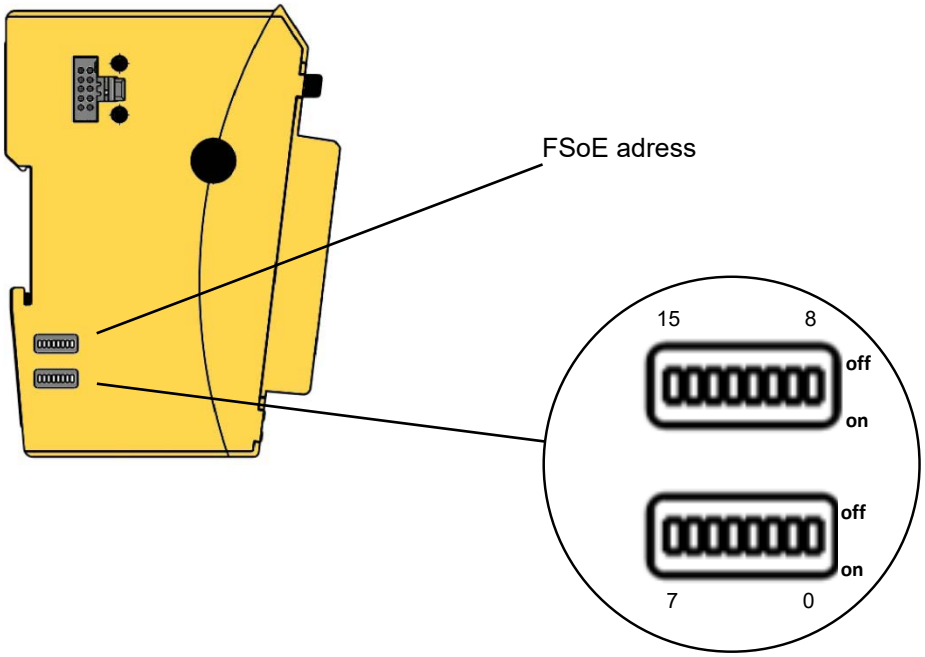
EtherCAT I/O Safety has a safe module address (FSoE slave address) which clearly identifies it in the safe communication network. The address is set manually by means of binary switches on the left side of the module.

Use the 2 x 8 DIP switches to set the FSoE address. Addresses range between 1 and 65535.

Nach der Einstellung der FSoE Adresse muss das Safe I/O Modul einmalig von der Versorgungsspannung genommen werden, damit die Adresse übernommen und ein automatischer Modultest gestartet wird.

Die DIP-Schalter sind bei zusammengefügten Modulen nicht zugängig!

Zum Einstellen der FSoE-Slave-Adresse am DIP-Schalter muss das Modul aus dem Modulverbund gelöst werden.



Zerstörung durch falsches Werkzeug!

Beschädigung des KEB-I/O EtherCAT Safe I/O Moduls

► Nur geeignete Werkzeuge zum Einstellen verwenden!
Die DIP-Schalter dürfen nur mit einem geeigneten Gegenstand (z. B. Kugelschreiberspitze oder Schraubendreher) eingestellt werden.
Keinesfalls darf Druck auf die Schaltelemente ausgeübt werden!

Unsachgemäße Einstellarbeiten am KEB-I/O EtherCAT Safe I/O Modul!

Maschinenausfall und Beschädigung des KEB-I/O EtherCAT Safe I/O Moduls

► Schalten Sie die I/O-Versorgung aus, bevor Sie das I/O Modul zum Einstellen aus dem Modulverbund lösen!

⚠ WARNUNG

Betrieb der Sicherheitsfunktion nicht möglich!

Inbetriebnahme durch falsch eingestellte Adresse nicht möglich!

► Die Einstellung der Adressschalter ist durch einen Funktionstest zu prüfen.

DIP Schalter																
Adresse	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
65535	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON

Table 20: Beispielt zu möglichen FSoE Adressen

Die eingestellte FSoE-Adresse darf im sicheren Kommunikationsnetzwerk nur einmal vorkommen. Eine mehrfach verwendete oder eine nicht genutzte FSoE-Adresse wird vom Master erkannt und dem Anwender gemeldet.

7.3.2 FSoE Parameters

⚠ VORSICHT

Unsachgemäße Bedienung bei der Parametrierung !

Fehlfunktion des KEB-I/O EtherCAT Safe I/O Moduls durch Fehler in der Parametrierung**!**

- ► Das Hinzufügen, Austauschen und Inbetriebnehmen von Safety I/O Modulen darf nur von sicherheitstechnisch sachkundigen Personen durchgeführt werden!
- ► Lesen Sie vor der Installation, Inbetriebnahme und Wartung des KEB-I/O EtherCAT Safety auch die Sicherheitshinweise im Vorwort dieser Dokumentation.
- ► Vor der Inbetriebnahme sind alle Sicherheitsfunktionen auf ihre spezifizierte Wirksamkeit zu prüfen.
- ► Bei Parametrierung außerhalb des gültigen Werte-Bereichs ist keine Funktion des Moduls möglich.

Parameter		Einheit
Einstellbereich [Default]	Beschreibung / Hinweis	
FSoE-Adresse		-
1 ... 65535 [1]	Über DIP-Schalter eingestellte FSoE-Slave-Adresse	
Connection ID		-
1 ... 65535 [1]	Eindeutige ID für die Verbindung zu einem FSoE-Slave	

<table>
<tr><td colspan="2">Parameter</td><td>Einheit</td></tr>
<tr><td>Einstellbereich
[Default]</td><td colspan="2">Beschreibung / Hinweis</td></tr>
<tr><td colspan="2">WatchdogTime</td><td>ms</td></tr>
<tr><td>20…65534 (0xFFFE)
[100]</td><td colspan="2">Watchdog Zeit für ein FSoE Telegramm</td></tr>
<tr><td colspan="2">Used Inputs</td><td>Dez</td></tr>
<tr><td>0 15
[15]</td><td colspan="2">Aktivierung der genutzten Eingänge
Auswahl über eine Dropdown-Liste ist je nach Konfigurator möglich

<table>
<tr><th>Binär</th><th>Dezimal</th><th>Aktive Eingänge</th></tr>
<tr><td>0 0 0 0</td><td>0</td><td>No Inputs used</td></tr>
<tr><td>0 0 0 1</td><td>1</td><td>Input 0 used</td></tr>
<tr><td>0 0 1 0</td><td>2</td><td>Input 1 used</td></tr>
<tr><td>0 0 1 1</td><td>3</td><td>Input 0,1 used</td></tr>
<tr><td>0 1 0 0</td><td>4</td><td>Input 2 used</td></tr>
<tr><td>0 1 0 1</td><td>5</td><td>Input 0,2 used</td></tr>
<tr><td>0 1 1 0</td><td>6</td><td>Input 1,2 used</td></tr>
<tr><td>0 1 1 1</td><td>7</td><td>Input 0,1,2 used</td></tr>
<tr><td>1 0 0 0</td><td>8</td><td>Input 3 used</td></tr>
<tr><td>1 0 0 1</td><td>9</td><td>Input 0,3 used</td></tr>
<tr><td>1 0 1 0</td><td>10</td><td>Input 1,3 used</td></tr>
<tr><td>1 0 1 1</td><td>11</td><td>Input 0,1,3 used</td></tr>
<tr><td>1 1 0 0</td><td>12</td><td>Input 2,3 used</td></tr>
<tr><td>1 1 0 1</td><td>13</td><td>Input 0,2,3 used</td></tr>
<tr><td>1 1 1 0</td><td>14</td><td>Input 1,2,3 used</td></tr>
<tr><td>1 1 1 1</td><td>15</td><td>Input 0,1,2,3 used</td></tr>
</table>
</td></tr>
<tr><td colspan="2">External Inputs</td><td>Dez</td></tr>
<tr><td>Bit 0-3
0000_2....1111_2
[0000_2]</td><td colspan="2">Deaktivierung der moduleigenen Testpulsgenerierung für die Eingänge, bei Sensoren mit eigener Testpulsgenerierung (OSSD) an den Ausgängen oder ohne Testpuls (OSSD) Option, sowie der Sonderfunktionen Drehschalter und Schaltmatte.

Testpulsausgänge Bit 0-3
0 Testpulsausgang wird verwendet
1 Testpulsausgang wird nicht verwendet (Externe Testpulse aktiv)</td></tr>
<tr><td>Bit 4,5
00_2…11_2
[00_2]</td><td colspan="2">Wahlschalter Bit 4 und 5
00 keine Funktion
01 2 Kanäle (Eingang 0 + 1)
10 3 Kanäle (Eingang 0 – 2)
11 4 Kanäle (Eingang 0 – 3)</td></tr>
</table>

Bit 6,7
$00_2 \ldots 11_2$
$[00_2]$

Schaltmatte / Bumper Bit 6 und 7
00 keine Funktion
01 Eingang 0 + 1
10 Eingang 2 + 3
11 Eingang 0 + 1 sowie Eingang 2 + 3

Bit								Dezimal	Einstellung
7	6	5	4	3	2	1	0		
0	0	0	0	0	0	0	0	0	Keine Funktion
0	0	0	0	0	0	0	1	1	Testpulsausgang Eingang 0 deaktiviert
0	0	0	0	0	0	1	0	2	Testpulsausgang Eingang 1 deaktiviert
0	0	0	0	0	1	0	0	4	Testpulsausgang Eingang 2 deaktiviert
0	0	0	0	1	0	0	0	8	Testpulsausgang Eingang 3 deaktiviert
0	0	0	0	1	1	1	1	15	Alle Testpulsausgänge der Eingänge deaktiviert
0	0	0	1	0	0	0	0	16	Wahlschalter zwei Kanäle (Eingang 0 + 1)
0	0	1	0	0	0	0	0	32	Wahlschalter drei Kanäle (Eingang 0 bis 2)
0	0	1	1	0	0	0	0	48	Wahlschalter vier Kanäle (Eingang 0 bis 3)
0	1	0	0	0	0	0	0	64	Schaltmatte an Eingang 0 + 1
1	0	0	0	0	0	0	0	128	Schaltmatte an Eingang 2 + 3
1	1	0	0	0	0	0	0	192	Schaltmatte an Eingang 0 + 1 und Eingang 2 + 3

Rot markierte Bereiche:
- Bei Nutzung der Modi Wahlschalter oder Schaltmatte führt das Deaktivieren eines Testpulsausgangs zu einer Fehlermeldung
- Dementsprechend sind die Werte in den roten Bereichen nicht wählbar

Grün markierter Bereich:
- Betriebsart Schaltmatte für Eingang 0+1 oder 2+3 einstellbar
- Betriebsart Wahlschalter mit Eingängen 0+1, 0-2 oder 0-3 möglich

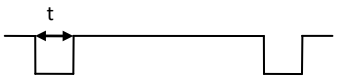
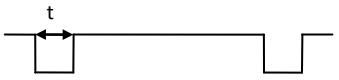
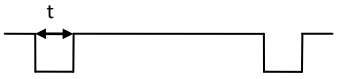
Blau markierter Bereich:
- Testpulsausgänge sind deaktivierbar

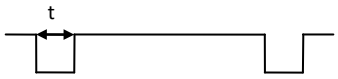
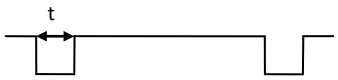
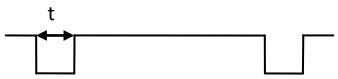
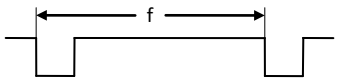
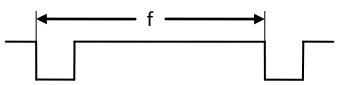
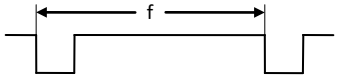
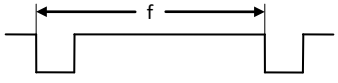
<u>Ein Beispiel:</u>
Sie wollen eine Schaltmatte an den Eingängen 0+1 des KEB-I/O EtherCAT Safety SDI4/ SDO2 Moduls betreiben und die restlichen Eingänge (2+3) sollen ohne Testpulse betrieben werden. Dann müssten Sie folgendes einstellen:

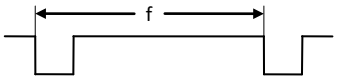
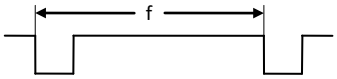
WatchdogTime	100
usedInputs	15
externalInputs	76
usedOutputs	3
extGroundOutputs	3

64 + 4 + 8 = 76

Used Outputs	Dez

00_2.... 11_2 [00_2]	Aktivierung der genutzten Ausgänge (0 und / oder 1) Auswahl über eine Dropdown-Liste ist je nach verwendetem Konfigurator möglich. 00 Ausgänge deaktiviert 01 SO 0 aktiviert, SO 1 deaktiviert 10 SO 0 deaktiviert, SO 1 aktiviert 11 SO 0 aktiviert, SO 1 aktiviert
extGroundOutputs	Dez
00_2.... 11_2 [00_2]	Aktivieren, wenn der Aktor nicht am SOX- des Moduls angeschlossen ist, sondern einen externen Ground-Anschluss nutzt. Auswahl über eine Dropdown-Liste ist je nach Konfigurator möglich
Test pulse duration input 0	µs
300 ... 1500 [500]	Testpulslänge am Eingang 0 Eingangsfilter des Eingangs 0 
	Der digitale Testpulsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Eingänge den Null-Zustand einnehmen können und ob Kurzschlüsse zu Fremdspannungen auf der Signalleitung bestehen. Die Dauer des Testpulses muss an die Peripherie angepasst werden.
Test pulse duration input 1	µs
300 ... 1500 [500]	Testpulslänge am Eingang 1 Eingangsfilter des Eingangs 1 
	Der digitale Testpulsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Eingänge den Null-Zustand einnehmen können und ob Kurzschlüsse zu Fremdspannungen auf der Signalleitung bestehen. Die Dauer des Testpulses muss an die Peripherie angepasst werden.
Test pulse duration input 2	µs
300 ... 1500 [500]	Testpulslänge am Eingang 2 Eingangsfilter des Eingangs 2 
	Der digitale Testpulsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Eingänge den Null-Zustand einnehmen können und ob Kurzschlüsse zu Fremdspannungen auf der Signalleitung bestehen. Die Dauer des Testpulses muss an die Peripherie angepasst werden.
Test pulse duration input 3	µs

300 ... 1500 [500]	Testpulslänge am Eingang 3 Eingangsfilter des Eingangs 3	
	Der digitale Testpulsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Eingänge den Null-Zustand einnehmen können und ob Kurzschlüsse zu Fremdspannungen auf der Signalleitung bestehen. Die Dauer des Testpulses muss an die Peripherie angepasst werden.	
Test pulse duration output 0		µs
500... 1500 [800]	Testpulslänge am Ausgang 0	
	Der digitale Leistungsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Leistungsausgänge abgeschaltet werden können und ob Kurzschlüsse zu Fremdspannungen auf der Ausgangsleitung bestehen. Die Dauer des Testpulses muss an die Last angepasst werden.	
Test pulse duration output 1		µs
500... 1500 [800]	Testpulslänge am Ausgang 1	
	Der digitale Leistungsausgang wird regelmäßig für die Dauer der eingestellten Testpulsdauer unterbrochen. Das KEB-I/O EtherCAT Safe I/O Modul prüft hierbei, ob die digitalen Leistungsausgänge abgeschaltet werden können und ob Kurzschlüsse zu Fremdspannungen auf der Ausgangsleitung bestehen. Die Dauer des Testpulses muss an die Last angepasst werden.	
Test frequency input 0		Hz
0 ... 25 [1]	Testpuls Frequenz (Wiederholrate) am Eingang 0 Wert "0" bedeutet ohne Testpuls	
Test frequency input 1		Hz
0 ... 25 [1]	Testpuls Frequenz am Eingang 1 Wert "0" bedeutet ohne Testpuls	
Test frequency input 2		Hz
0 ... 25 [1]	Testpuls Frequenz am Eingang 2 Wert "0" bedeutet ohne Testpuls	
Test frequency input 3		Hz
0 ... 25 [1]	Testpuls Frequenz am Eingang 3 Wert "0" bedeutet ohne Testpuls	
Test frequency output 0		min^{-1}

0 ... 25 [1]	Testpuls Frequenz am Ausgang 0	
Test frequency output 1		min^{-1}
0 ... 25 [1]	Testpuls Frequenz am Ausgang 1	

7.3.3 Input Parameters

Parameters “Used Inputs” and “External Inputs”

Use these parameters to enable the inputs of the KEB-I/O EtherCAT Safety I/O module and to select the input function. Use parameter "External Inputs" to disable the module's test pulse outputs that deliver test pulses to each of the inputs. Use this setting for sensors generating their own test pulses (some light barriers, for example).

⚠ WARNUNG

Nichtaufdecken einer fehlerhaften äußeren Beschaltung bei deaktivierten Testpulsausgängen!

Unsicherer Zustand der Maschine, Gefährdung der Sicherheit!

- ► Nutzen Sie immer den entsprechenden aktivierten Testpulsausgang für die Versorgung von kontaktbehafteten Sensoren.
- ► Berücksichtigen Sie den Einsatz von geschützter und/oder getrennter Leitungsverlegung, um eine hinreichende Sicherheit zu gewährleisten.

7.3.4 Output Parameters

Parameter "extGroundOutputs“

Enable if the sensor is not connected to module terminal SO X- but uses an external ground connection. Pick from a drop-down list provided by the configurator software. Linking the sensor to an external ground connection instead of terminal SO X- disallows you to control an external 24 VDC power supply.

Also set this parameter if output SO X+ supplies an electronic load such as a digital input of an I/O module.

Parameter "Used Outputs“

Activation of the used outputs. (SO 0 and / or SO 1)

Pick from a drop-down list.

Parameter “Test pulse duration output”

Test pulses cyclically check the digital outputs of the KEB-I/O EtherCAT Safety I/O module for faults such as short circuits or internal defects. Parameter "Test pulse duration output" sets the time of a test pulse allocated to a digital output. If you connect a capacitive load to the digital power output, you may have to modify the test pulse duration.

Testpulse an den Ausgängen

Stimmen Sie die angeschlossenen Lasten und die parametrierte Testpulsdauer so aufeinander ab, dass die Lasten nicht durch die Testpulse geschaltet werden können.

Parameter "Test frequency output“

Test pulses cyclically check the digital outputs of the KEB-I/O EtherCAT Safety I/O module. Parameter "Test frequency output" sets the switching frequency and, thus, the frequency of test pulses allocated to a digital output. Adapt this parameter to real-life conditions particularly when using inductive or capacitive loads.

⚠ VORSICHT

Abschalten der Testpulse am Ausgang !

Durch den Aufbau der Ausgänge werden bei abgeschalteten Testpulsen eines Ausgangskanals dennoch Testpulse an diesem Ausgang erzeugt, wenn für den anderen Ausgangskanal noch Testpulse parametriert sind. Die Frequenz und die Länge dieser Testpulse werden durch den anderen Ausgang bestimmt. Achten Sie darauf, dass diese Testpulse die angeschlossenen Aktoren nicht schalten lassen.

► Damit keine Testpulse mehr erzeugt werden, müssen die Testpulse beider Ausgänge deaktiviert werden.

⚠ WARNUNG

Nichtaufdecken aller fehlerhaften äußeren Beschaltungen bei deaktivierten Testpulsen!

Unsicherer Zustand der Maschine, Gefährdung der Sicherheit

► Nutzen Sie die Ausgangstestpulse, um z.B. Querschlüsse an den Ausgängen zu erkennen.

► Berücksichtigen Sie den Einsatz von geschützter und/oder getrennter Leitungsverlegung, um eine hinreichende Sicherheit zu gewährleisten.

⚠ VORSICHT

Mindestlänge der parametrierten Testpulse !

Durch den Aufbau der Ausgänge werden unterschiedlich parametrierte Testpulslängen der beiden Ausgangskanäle dazu führen, dass auf beiden Kanälen Testpulse mit der minimal eingestellten Testpulslänge beider Ausgänge auftreten.

► Damit eine Mindestlänge der Testpulse eingehalten wird, müssen beide Ausgänge diesen Mindestwert einhalten. Achten Sie darauf, dass diese Mindesttestpulslänge angeschlossene Aktoren nicht schalten lässt.

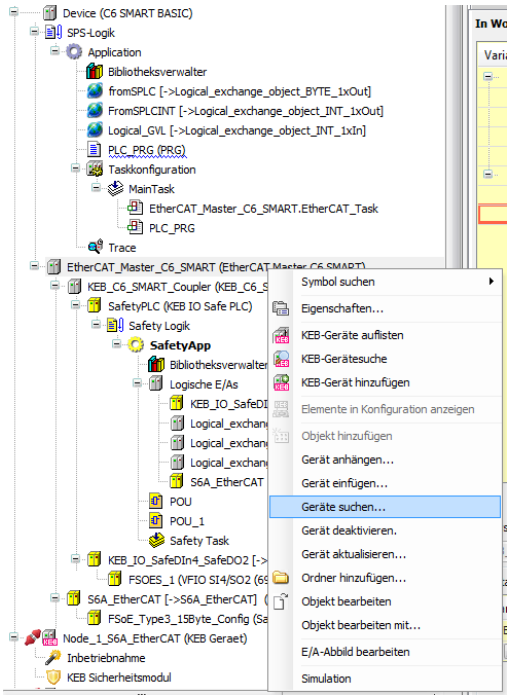
7.4 Initial start-up

Verwendungshinweis

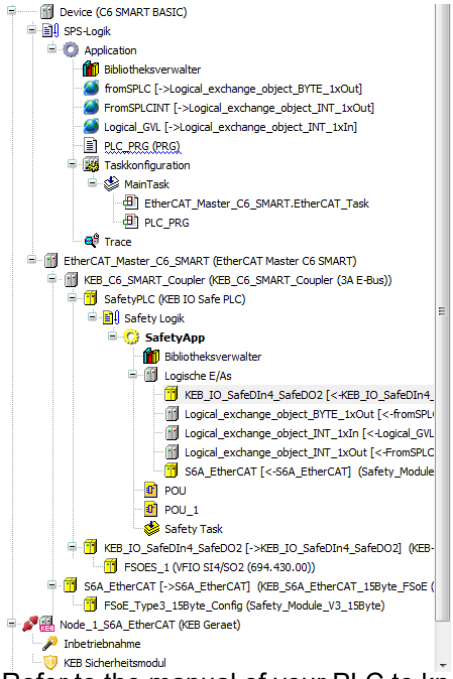
Das KEB-I/O EtherCAT Safe I/O Modul darf nur in ETG-konformen Konfigurationen mit konformen Produkten verwendet werden. Dazu gehören Slave Devices, Master Systeme, Development Systeme und Produkte zur Functional Safety. Produkte, die einen offiziellen Konformitätstest durchlaufen haben, dürfen das EtherCAT Conformance tested-Logo tragen. Alle zertifizierten Produkte sind im EtherCAT Product Guide der EtherCAT Technologie Group gelistet.

Topology of COMBIVIS studio 6 devices

Like in all other CODESYS projects, the project environment of safety projects must identically reflect the hardware topology. You can either set up the topology manually or, provided that all device descriptions have been installed, start a search for devices in COMBIVIS studio 6. Right-click on the EtherCAT master and pick "Geräte suchen..." (Find devices) from the context menu. In the next dialog, you just need to confirm to "Alle Geräte ins Projekt kopieren" (Copy all devices to project).



COMBIVIS studio 6 configuration example:



Refer to the manual of your PLC to know how to set up a COMBIVIS studio 6 project.

7.5 Diagnosis

7.5.1 Self-test

When system voltage is supplied to the KEB-I/O EtherCAT module, it initially runs a complete system test. Only if this system test is passed will the module be able to operate and first of all change to its "fail-safe" state. This is indicated by LED "Safe Status" lighting up red.

The EtherCAT Safety I/O module will retain the fail-safe state until all internal tests have been passed, valid data has been received from the control unit, and faults are not detected in any of the external hardware, sensors, actuators and their wiring.

A safe functional state is indicated by LED "Safe Status" lighting up green.

The module will retain its fail-safe state if it fails to qualify for the safe state, e.g. because of errors in the application's module setup. To find the cause of the problem, check the error code in the service block => 7.5.5 Störungstabelle

In service, the system test is repeated cyclically as a background process.To repeat the initial system test, just turn the power supply off and back on again.

7.5.2 KEB-I/O EtherCAT Safety I/O module faults

The cyclic system test will duly detect all faults in the module within the minimum safe failover time specified in section Technical Data in conformity with the requirements of the standards listed in the certificate. The module will change to its fail-safe state.

This is indicated by LED "Safe Status" lighting up red.

⚠ GEFAHR

Nutzung von Geräten im Fail-Safe Zustand!

Nachfolgende Fehler können eine Gefährung auslösen

► Sorgen Sie eigenverantwortlich dafür, dass nach dem Auftreten eines Fehlers alle notwendigen Reparaturmaßnahmen oder Austauschmaßnahmen eingeleitet werden.

7.5.3 Wrong wiring

Wiring faults such as

- a cross-fault between the inputs,
- external power supplied to the inputs,
- wrong TP allocation to a specific input,
- external power supplied to the outputs, or
- a short at the outputs

will change the KEB-I/O EtherCAT Safety I/O module to its safe state. The red Diagnosis LED of the affected channel lights up.

Error messages may also be provoked by badly adjusted loads. Please refer to sections „4.1.4 Sichere Digitale Ausgänge“and „7.2.8 Aktoranschluss“.

⚠ VORSICHT

Betrieb des KEB-I/O Safety I/O Moduls außerhalb des spezifizierten Bereichs unzulässig

Fehler durch Überlastung von Bauteilen durch Übertemperatur

► Das Modul darf nur entsprechend den in den technischen Daten spezifizierten Umgebungsbedingungen betrieben werden unter gleichzeitiger Berücksichtigung des Deratings der Ausgänge.

The module is designed for ambient temperatures between 0°C and max. 55°C and for being installed in a control cabinet. The Safety I/O module features an extra internal temperature sensor. Excess temperature will change the module to its safe state. You cannot start the module at temperatures below 0°C.

7.5.4 Wrong supply voltage

The supply voltage is rated at DC 24 V. It is monitored. In case of overvoltage (> +20%) and low voltage (> -15%) alike, the module changes to its safe state.

7.5.5 Table of faults

Depending on their type, faults detected are indicated by the diagnosis LEDs of the EtherCAT I/O Safety I/O module and made available as a diagnostic message in error register object 1001_h. Diagnostic messages help you identify the fault and to take the required corrective actions.

The tables below list and describe the faults, their causes, effects and corrective actions.

Whenever a fault occurs, you should first of all remove its cause and acknowledge the fault in the error register according to instructions.

Fehlerbild	Möglich Ursache	Abhilfe
Modul läuft nicht an, Eingänge werden nicht gelesen.	FSoE-Adresse am Binärschalter falsch	• Adresseinstellung am Modul prüfen • Adresswahl in der Safety PLC prüfen • Modul auf mechanische Beschädigung prüfen und ggf. austauschen
Ausgänge sind im sicheren Zustand, Eingänge sind weiterhin aktiv	FSoE-Slave-Adresse im Betrieb verändert Systemversorgung war unterbrochen Systemversorgung war zu gering	• Fehlercode im Servicebaustein auslesen • Adressschalter nicht während des Betriebes verändern • Modul auf mechanische Beschädigung prüfen und ggf. austauschen • Versorgungsspannung prüfen
Modul ist im sicheren Zustand, es leuchten die Diagnose LEDs der Eingänge rot	Verdrahtungsfehler z.B. vertauschte Testpulssignale Querschluss zwischen den Eingängen Fremdeinspeisung an den Eingängen	• Fehlercode im Servicebaustein auslesen • Prüfen Sie die Verdrahtung des Moduls
Modul im sicheren Zustand, eine Diagnose LED am Ausgang leuchtet rot	Überstrom an einem Ausgang Querschluss an einem Ausgang Fremdeinspeisung an einem Ausgang	• Fehlercode im Servicebaustein auslesen • Prüfen Sie die Verdrahtung des Moduls • Prüfen Sie den Ausgangsstrom an dem Ausgang
Modul im sicheren Zustand LED "Safe Status" leuchtet rot	EtherCAT Verbindung wurde unterbrochen Interner Fehler im Modul	• Prüfen Sie die Verdrahtung der EtherCAT Feldbusleitungen • Prüfen Sie die feste Verbindung zwischen den KEB-I/O Modulen
	I/O-Versorgung zu gering	• Prüfen Sie die I/O-Versorgung • Prüfen Sie die Verdrahtung

Table 21: Störungstabelle

7.5.6 Error Codes

Fehlercode (hex)	Fehlerursache	Bemerkung (Modul im sicheren Zustand)	Abhilfe
0x0001	Interner Softwarefehler	Die interne Modulüberwachung hat einen Fehler entdeckt. Die Ein- und Ausgänge gehen in den Sicheren Zustand, die FSoE Kommunikation wird eingestellt.	• RESET des Moduls durch Aus- und wieder Einschalten der Systemversorgung – erneuter Selbsttest. • Modulaustausch, wenn der Fehler bestehen bleibt.
0x0002	Interner Hardwarefehler	Die interne Modulüberwachung hat einen Hardwarefehler entdeckt. Die Ein- und Ausgänge gehen in den Sicheren Zustand, die FSoE Kommunikation wird eingestellt.	• RESET des Moduls durch Aus- und wieder Einschalten der Systemversorgung – erneuter Selbsttest. • Modulaustausch wenn der Fehler bestehen bleibt
0x0402	Unterspannung	Spannungsversorgung des Moduls unterhalb des zulässigen Spannungsbereichs. Die Ein- und Ausgänge gehen in den Sicheren Zustand, die FSoE Kommunikation wird eingestellt.	• Höhe der Versorgungsspannung prüfen. • Länge und Belastung der Zuleitung prüfen.
0x0201	Parameterfehler	Das Modul geht nicht in den funktionalen Zustand über.	• Parametrierung des Moduls überprüfen. • Nur Parameter in den zulässigen Wertebereichen verwenden.
0x0291	Querschnitt oder Fremdeinspeisung am Eingang	Querschluss zu einem anderen Eingang, Testpulsausgang oder Fremdeinspeisung, rote Diagnose LED des betroffenen Kanals aktiv. Eingänge und Ausgänge am Modul und im Prozessabbild nehmen den Wert „0“ an.	• Sensor prüfen. • Testpulsausgänge prüfen. • Stecker und Verkabelung prüfen.
0x0291	Kurzschluss oder Überlast	Kurzschluss in der Verdrahtung der Ausgänge oder falsche Ausgangslast verwendet, rote Diagnose LED des betroffenen Kanals aktiv	• Aktor prüfen. • Stecker und Verkabelung prüfen. • Freilaufbeschaltung am Schütz prüfen.
0302x0280	Querschluss oder Fremdeinspeisung am Ausgang	Querschluss zu einem anderen Ausgang oder zu einem anderen Signal, rote Diagnose LED des betroffenen Kanals aktiv.	• Aktor prüfen. • Stecker und Verkabelung prüfen.

Table 22: Fehlercodes (Objektverzeichnis 0x2007 bzw. 0x2017 - Err.code)

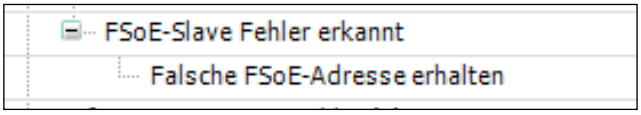
Die detailliertere Bedeutung des Eintrags im Objekt 2007h bzw. 2017h „Err. code“ können Sie der Tabelle in Kapitel „9.1 Objektverzeichnis“ entnehmen.

7.5.7 EtherCAT Link Lost

All modules change to their safe state when the EtherCAT link is lost or interrupted. Once the fault has been removed, an error acknowledge is enough to restart the EtherCAT bus.

7.5.8 Wrong FSoE address

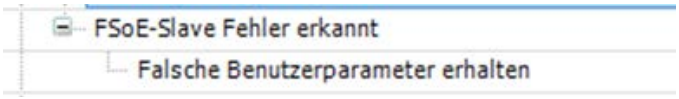
A wrong FSoE address causes all modules to retain their safe state. The fault is detected by the master and cannot be acknowledged.



Once all FSoE addresses are correct, the safety modules will restart normal operation after one power cycle, see section „7.6 Fehler Rücksetzen / Quittieren“.

7.5.9 Damage to KEB-I/O EtherCAT Safety I/O System

Safety control systems are designed by way that configuration errors should not lead to dangerous conditions. Thus, in case of a faulty configuration all safety modules are in a safe state after the download of the faulty safety project. The faulty configuration is displayed in the master.



After the configuration error has been corrected and the project has been downloaded again, the safety modules restart after an error acknoledge (provided that accuracy is given).

7.6 Reset / Acknowledge Error

The error class decides whether and how an error can be acknowledged, see chapter „9.1 Objektverzeichnis“.

Fehler-klasse	Bedeutung	Quittier- /Rücksetzbar durch
0	No Error / Kein Fehler	Nicht notwendig
1	Heavy or synchronization error Schwerer oder Synchronisations-Fehler	PowerCycle
2	Internal communication error interner Kommunikationsfehler	PowerCycle
3	I/O Error E/A Fehler	Error Acknoledge
4	Error in ErrorHandler or at the outputs Fehler im ErrorHandler oder bei den Ausgängen	PowerCycle
5	Fatal error / Fataler Fehler	Nicht quittierbar

Table 23: Fehlerklassen

PowerCycle:

After removing the cause of the error, you can reset the KEB-I/O EtherCAT Safety SDI4/SDO2 module by a power cycle (PowerCycle -> turn off and back on) provided that the automatic self-test is passed.

Error Acknoledge:

Input or output errors can be reset by the safety PLC.

⚠ WARNUNG

Rücksetzen / Quittieren kann zum gefährlichen Zustand führen!

Das Quittieren eines Fehlers führt bis auf die angegebenen Ausnahmen sofort zur Rückkehr des sicheren Ausgangs in den Betriebszustand.

- ► Stellen Sie vor der Quittierung eines Fehlers sicher, dass die Fehlerursache fachgerecht behoben wurde.
- ► Stellen Sie vor der Quittierung eines Fehlers sicher, dass die Quittierung nicht zum gefährlichen Zustand der Maschine führen kann!
- ► Berücksichtigen Sie bei der Planung der Maschine oder Anlage, dass das Quittieren nur dann möglich sein darf, wenn der Gefahrenbereich einsehbar ist.

7.7 Maintenance / Servicing

7.7.1 General

Only qualified persons are allowed to work on FIO Safety.

⚠ VORSICHT

Unsicherer, nicht definierter Zustand der Maschine!

Zerstörung der Fehlfunktion

- ► Im Betrieb Anschlüsse nicht stecken, auflegen, lösen oder berühren!
- ► Schalten Sie vor der Arbeit an den Modulen alle Einspeisungen ab; auch die von angeschlossener Peripherie, wie fremdgespeiste Geber, Programmiergeräte usw..
- ► Alle Lüftungsöffnungen müssen unbedingt freigehalten werden!

7.7.2 Servicing

The EtherCAT I/O Safety requires neither servicing for the specified service life nor any action if it is kept and operated at the admissible ambient conditions specified in section Technical Data.

7.7.3 Maintenance

Prevent inadmissible contamination while operating and storing EtherCAT I/O Safety.Do not use or continue to use the KEB-I/O EtherCAT Safe I/O module in case it has been exposed to inadmissible contamination.

⚠ VORSICHT

Unsicherer, nicht definierter Zustand der Maschine!

Verletzungsgefahr

► Der Betrieb eines unzulässig verschmutzen Moduls ist nicht zulässig. Eine Reinigung des Geräts ist ebenfalls unzulässig.

7.8 Replacing a KEB-I/O EtherCAT Safe I/O module

When you replace a KEB-I/O EtherCAT Safe I/O module, its configuration is retained and transferred to the new module when you restart the system. The programming environment will tell you is the new module is incompatible. You must carry out appropriate tests to verify whether there are any other failure modes such as using the wrong terminals or making wiring mistakes.

The text below describes how to replace a KEB-I/O EtherCAT Safe I/O module with a KEB-I/O EtherCAT Safe I/O module of the same type.

⚠ VORSICHT

Unsicherer, nicht definierter Zustand der Maschine!

Verletzungsgefahr

► Schalten Sie die Versorgungsspannung der Steuerung und der KEB-I/O Module ab, bevor Sie einen Austausch eines KEB-I/O EtherCAT Safe I/O Moduls vornehmen.

► Werden KEB-I/O EtherCAT Safe I/O Module ausgetauscht, ist vor der erneuten Inbetriebnahme der Maschine oder Anlage die zugehörige Sicherheitsfunktion einer zusätzlichen Prüfung zu unterziehen.

► Verdrahtungstests müssen vom Anwender so gestaltet sein, dass ein Vertauschen von Klemmen erkannt wird.

Der Austausch eines KEB-I/O EtherCAT Safe I/O Moduls gegen ein Modul eines anderen Typs ist immer mit einer neuen Projektierung verbunden. Bitte nutzen Sie in diesem Fall das Anwenderhandbuch des neuen Moduls.

7.8.1 Procedure

- Verify that the new module meets the following requirements:
  - Gleicher Gerätetyp
  - Gleiche oder höhere Version siehe „5.1 Kennzeichnung und Identifikation“
- Enable the safe system or machine state.
- Turn off the power supply of the control unit and the KEB-I/O modules.
- Remove the old module => 7.1.4 Trennen zweier Module.
  - Trennen Sie den EtherCAT I/O Modulverbund auf, indem Sie den Entriegelungshebel von dem Modul, das Sie von dem links davon befindlichen Modul trennen wollen, drücken und schieben gleichzeitig beide Module auf etwa 1 cm Abstand auseinander.
  - Drücken Sie das Modul gegen die Metallfeder, die sich auf der Unterseite der Aufnahme befindet nach oben.
  - Schwenken Sie das Modul gemäß Abbildung von der Tragschiene weg nach vorn.
  - Ziehen Sie das Modul nach unten aus der Tragschiene.
- Locate the FSoE address at the address coding switch of the module you are replacing and transfer that address to the new module => 7.3.1 Adresseinstellung.
- Install the new module at the same place within the line of EtherCAT I/O modules as one you just removed => 7.1.2 Aufrasten eines einzelnen Moduls
- Plug the inline connectors to the correct ports!

7.8.2 Restart

- Verify that the machine or system is in a safe state and that there is nothing and nobody in the danger zone.
- Turn the supply voltage back on.
- Start the new safety module as if you initially operate a module => 7.4 Erstinbetriebnahme.
- The configuration of the old module has been retained and will be transferred to the new module when you restart the system.
- Check all safety functions after replacing a module!

7.9 Lifetime

*„„5.1.2 Seriennummer““. Take the module out of service at the end of its useful lifez. erden.

7.9.1 Reparaturen / Kundendienst

Es ist untersagt, das KEB-I/O EtherCAT Safe I/O Modul zu öffnen oder anderweitige Reparaturversuche durchzuführen!

Die Funktion des KEB-I/O EtherCAT Safe I/O Moduls wird in diesem Fall nicht mehr gewährleistet!

Im Fall eines gefahrbringenden Ausfalls

Falls es sich beim Modulausfall um einen gefahrbringenden Ausfall gehandelt hat, muss das Modul zur Fehleridentifikation zum Hersteller zurückgeschickt werden.

► Die Herstelleradresse finden Sie auf der Modulbedruckung desKEB-I/O EtherCAT Safety SDI4/SDO2 Moduls und in dieser Anleitung auf der letzten Seite.

7.9.2 Gewährleistung

Es gilt die gesetzliche Gewährleistung. Sie erlischt, wenn am Gerät / Produkt nicht autorisierte Reparaturversuche oder sonstige Eingriffe vorgenommen werden. Siehe auch Kapitel „Gewährleistung“.

7.9.3 Außerbetriebnahme

Der Maschinen- oder Anlagenhersteller legt die Verfahren zur Außerbetriebnahme fest. Die Außerbetriebnahme darf ausschließlich entsprechend diesem geforderten Verfahren erfolgen.

Stellen Sie bei der Außerbetriebnahme sicher, dass die gebrauchten Module des KEB-IO EtherCAT Safety Systems dem weiteren bestimmungsgemäßen Gebrauch zugeführt werden. Beachten Sie in diesem Fall die Anforderungen an Lagerung und Transport entsprechend den technischen Daten.

7.9.4 Entsorgung

Stellen Sie bei der Entsorgung des KEB-I/O EtherCAT Safety Systems sicher, dass die Module entsprechend den gültigen Umweltvorschriften entsorgt werden und dann keinesfalls wieder in Umlauf kommen.

Die Verpackung ist dem Papier und Kartonage-Recycling zuzuführen, siehe Kaptiel „Hier Text oder Variable eingeben“.

8 Connecting examples

This section describes examples of applications that make use of the KEB-I/O EtherCAT Safe I/O module functions to provide a safety function. It also describes the resulting safety ratings.

⚠ CAUTION

Using the examples described in this section is not enough to obtain the safety function needed to reduce the risk as established in the risk assessment (SIL/Cat./PL)!

Personal injury and damage to property!

- ► Choose suitable and approved sensors (e.g. according to EN 60947-5-1 / -5.) and make sure that your switching devices have the appropriate $B10_d$ value.
- ► You may have to take further actions to obtain the safety function when using the system together with safe devices, sensor and actuators (e.g. reading the relay contact signals). Refer to the user guide of you safe devices for further details.
- ► Configure your KEB-I/O EtherCAT Safe I/O module with reference to the actual environment.

The safety ratings listed for the examples below solely apply to the part of the safety function covered by the safe I/O module. Please note that the safety ratings below only apply if the test pulses are enabled.

⚠ WARNING

Non-detection of incorrect external wiring while test pulse outputs are disabled!

Unsafe machine state, safety hazard!

- ► Always use the correct and enabled test pulse output to supply power to contact-type sensors.
- ► Use the output test pulses to detect cross-circuits at the outputs and other faults.
- ► Note: Consider protecting the cables and/or laying them separately to ensure a sufficient degree of safety.
- ► Switching off the test pulses is explicitly not recommended. It can reduce the safety of the application.

⚠ WARNING

Reduced diagnosis with deactivated test pulses at the outputs. Switching off the test pulses is explicitly not recommended.

Unsafe machine state, safety hazard!

With the test pulses at the outputs switched, the diagnostics of the outputs must be maintained by:

- ► The outputs are switched once a year.
- ► Functional switching is done by the application or by completely switching the device on and off.

8.1 Safety function with single-channel input

⚠ CAUTION

Consideration of the parameterisation

Personal injury and damage to property!

- ► In a single-channel application (inputs and outputs), the test pulse frequency must be adapted to the application.

  It must be ensured that for applications in which there is a frequent change of state, the test pulse frequency is selected at least 100 times higher than the change of state time, see chapter „7.3.2 FSoE Parameterübersicht“.

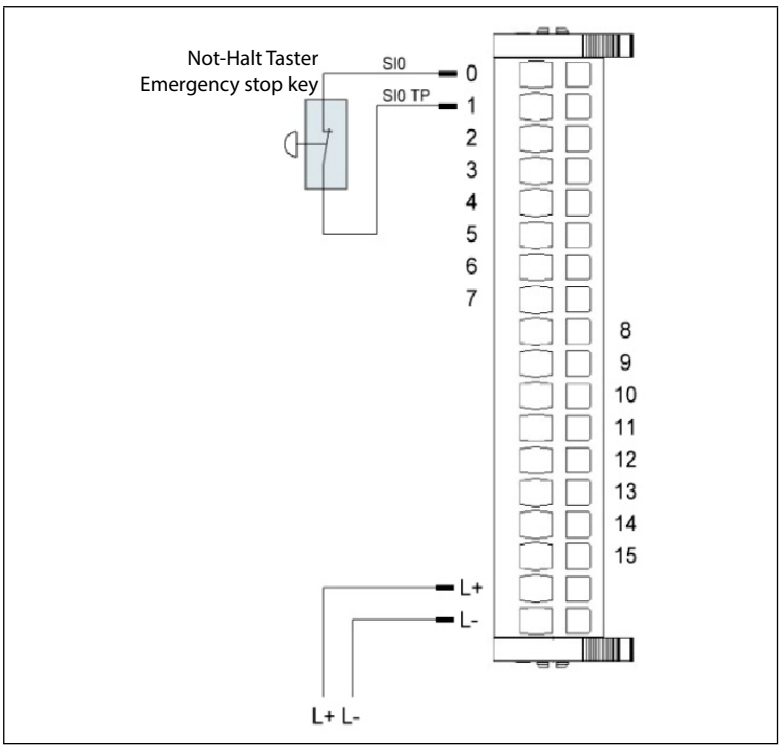


Figure 8: Safety function with single-channel input

You may connect contact-type sensors such as emergency stop buttons straight to a safe digital input.

By default, a test pulse output is dedicated to every input channel. This test pulse output supplies a specific signal you may use to detect wiring problems such as a short circuit to 24 V DC, GND or other signal channels. The state of connected switches is indicated by LEDs allocated to the channels.

Whenever an emergency stop button is pressed, the safety PLC will generate a stop signal. Resetting the emergency stop device must not be enough to initiate a restart signal.

8.1.1 Safety ratings of single-channel sensors

The safety ratings listed in the table below reflect the maximum values a single-channel safety function may achieve when using a single input of the safe I/O module. They solely apply to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved. The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a single-channel sensor. Use approved sensors only (e.g. according to EN 60947-5-1 / -5) and take account of your switching device's $B10_d$ value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings when applying the module's test pulses to single-channel contact-type sensors	
Highest safety integrity level to EN 62061	SIL2
Highest safety integrity level to EN 61508-1...7	SIL2
Category and highest performance level to EN ISO 13849-1	Cat. 2/PL d
Hardware fault tolerance HFT in single-channel application (IEC 61508/EN)	0 (a fault in the application may cause the safeguard to fail)

8.2 Safety function with two-channel input

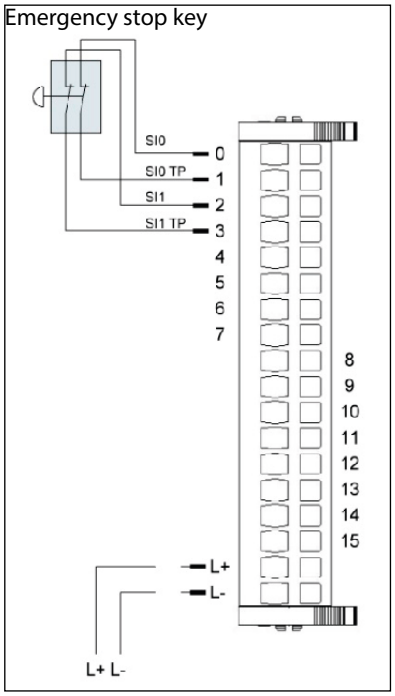


Figure 9: Safety function with two-channel input

For applications requiring single-fault safety such as EMERGENCY OFF, EMERGENCY STOP, you may connect two digital inputs to two switching devices of safe sensors and further to the Safe I/O module.

A software module of the safety PLC provides the required analysis of the switching contacts.

"FB_ESTOP" is a safety-related component intended to monitor an EMERGENCY STOP button. FB_ESTOP can be used for both the emergency switch off function (stop category 0) or – with the assistance of additional peripherals - the EMERGENCY STOP function (stop categories 1 or 2).

FB_ESTOP can be used to monitor single and two-channel EMERGENCY STOP switches. The component's discrepancy time monitoring is enabled for two-channel applications.

Discrepancy time monitoring: The discrepancy time defines as the maximum length of time both inputs may be in different states without the component interpreting this as a fault. Discrepancy time monitoring starts whenever the state of one input changes. The components will detect a fault if, at the end of the discrepancy time, both inputs are in different states.

8.2.1 Safety ratings of two-channel sensors

The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two inputs of the safe I/O module. They solely apply to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved. The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a two-channel sensor. Use approved sensors only (e.g. according to EN 60947-5-1 / -5) and take account of your switching device's $B10_d$ value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings when applying the module's test pulses to two-channel contact-type sensors	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in two-channel application (IEC 61508/EN)	1 (a fault of the application need not cause the safeguard to fail)

8.3 Two-hand actuation

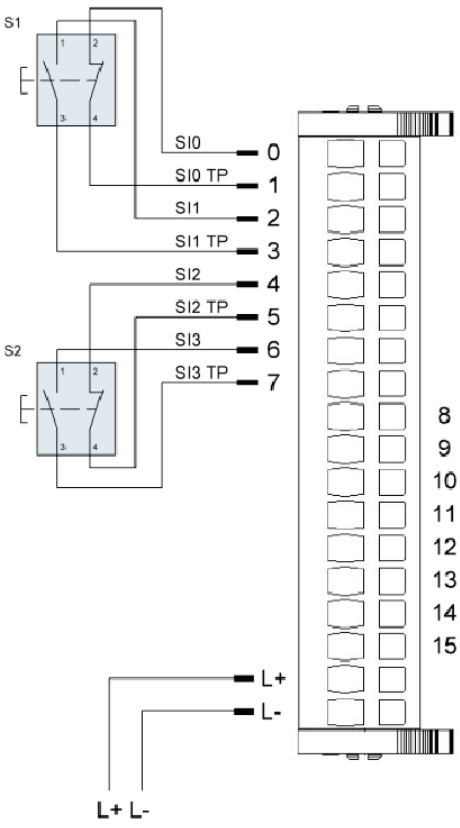


Figure 10: Two-hand actuation

Two contact-type sensors can be connected to four safe digital inputs.

A software module of the safety PLC provides the analysis required for two-hand operation.

Two-hand circuit type2

Software component "FB_TWOHAND_TYP2" supports function "two-hand circuit type2" in conformity with European Standard EN 574:2008. If S1 and S2 are set to TRUE in the correct order "bTwoHandOut“ will also become TRUE. The component also checks that both buttons have been released before setting output "bTwoHandOut“ to TRUE again.

Two-hand circuit type 3

Software component "FB_TWOHAND_TYP3" supports function "two-hand circuit type 3" in conformity with the European Standard. If S1 and S2 are set to TRUE in the correct order and within 500 ms, "bTwoHandOut“ will also become TRUE. The component also checks that both buttons have been released before setting output S_TwoHandOut to TRUE again.

Note: Category 3 does not support more than one two-hand circuit of type III B.

8.3.1 Safety ratings of two-channel sensors

The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using four inputs of the safe I/O module. They solely apply to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved. The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a two-hand operation. Use approved sensors only (e.g. according to EN 60947-5-1 / -5) and take account of your switching device's $B10_d$ value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings for function two-hand operation	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

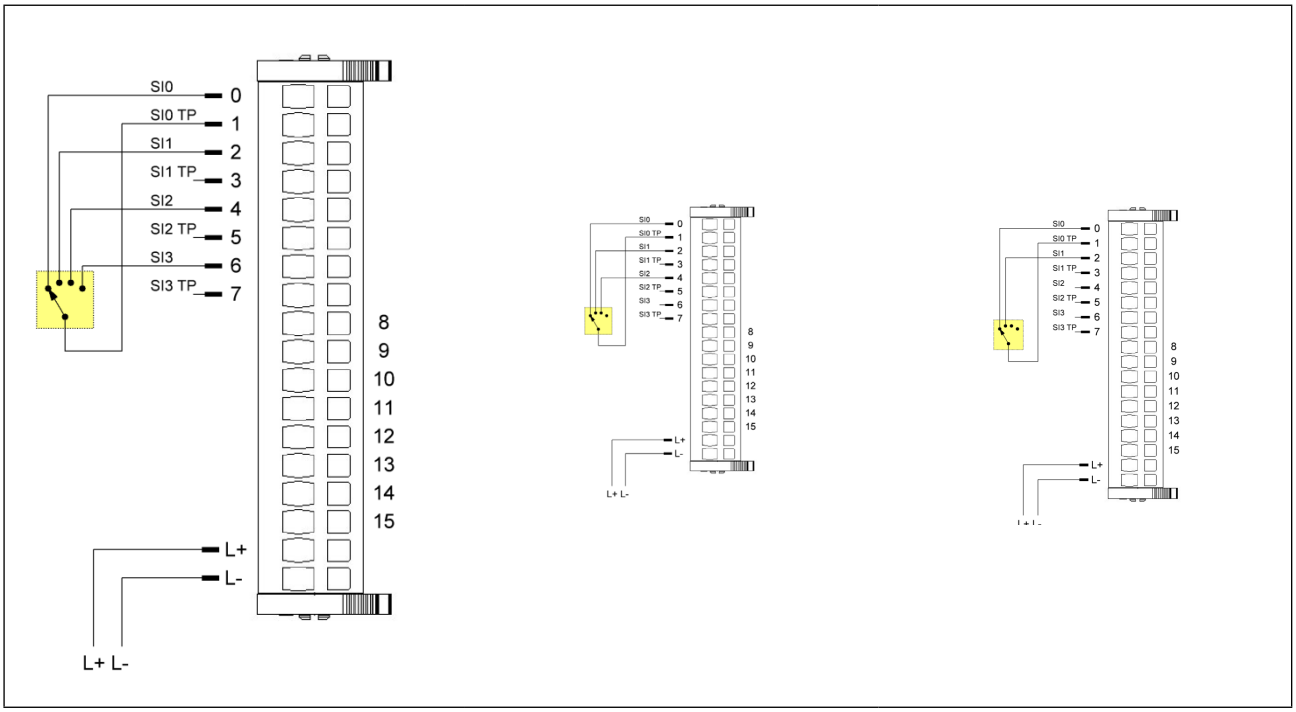
⚠ CAUTION

Safety hazard due to wrong handling of the two-hand circuit!

Avoid personal injury and damage to property!

- ► Comply with EN 574 and other requirements and standards published on two-hand circuits.
- ► Switches/sensors, wiring and application must comply with EN 574.

8.4 Mode selector, rotary table



In "Mode Selector" mode, you can connect 2, 3 or 4 inputs to a mode selector and to test pulse output SI0 TP. Disable the test pulse outputs you do not need. Use this setup together with PLC component FB_MODE to implement a mode selector switch. The associated logical output sets only if an input is set. All other outputs remain in a safe state. If no or more than one input is set, all logical outputs retain their safe state.

Use FSoE parameter "External Input" to enable the "Mode Selector" function.

Safety ratings of mode selector applications in conjunction with switches/sensors approved to EN 13849-2, Table D.3.	
Highest safety integrity level to EN 62061	SIL2
Highest safety integrity level to EN 61508-1...7	SIL2
Category and highest performance level to EN ISO 13849-1	Cat. 1/PL c
Hardware fault tolerance HFT in two-channel application (IEC 61508:2010/EN)	0 (a fault in the application may cause the safeguard to fail)

Safety ratings of mode selector applications in conjunction with certified switches/sensors of the appropriate safety classification	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

Test pulse output

In mode selector mode, test pulse output TP0 can be set to "0". However, this will not affect the test pulse as such since, in mode selector mode, the test pulse always runs at maximum frequency.

Time discrepancy in mode selector/rotary table mode

A set time discrepancy of 100ms has been implemented for signals missing at the inputs when changing to mode selector mode.

8.5 Safety Mats, connecting blocks and bumpers

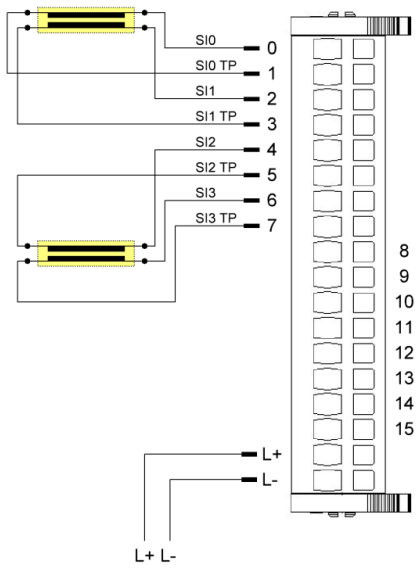


Figure 11: Safety Mats, connecting blocks and bumpers

Safety mats protect operators in danger zones. Connecting blocks and bumpers are normally used as safeguards along closing edges or against potentially hazardous moving objects. They share the same tripping method. Two parallel areas of contact are kept at a certain distance and do not make contact until the device is actuated. An electric current going through the areas of contact ensures that they are ready for use.

The picture illustrates that one area of contact is allocated to one channel and the other area to another channel. Mechanical load on the area of contact makes the inputs connect. This is not interpreted as a short circuit but as actuation. Use FSoE parameter "External Input" to enable the "Bumper" function. Refer to manual section => 7.3.3 Parameter für Eingänge for further details. This mode only supports pressure-sensitive mats working according to the open circuit principle, i.e. the test pulses required to maintain a safe function are supplied by the safe I/O module.

The function uses either inputs SI0 and SI1 and/or inputs SI2 and SI3. The pressure-sensitive mat function achieves a response time of **50ms** between a change in mat state and providing the information on the EtherCAT bus.

8.5.1 Safety ratings of two-channel sensors

The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two inputs of the safe I/O module. They solely apply to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved. The quality of the safe sensor is particularly decisive for the safety function of a safety mat application. Use approved sensors only (e.g. according to EN 60947-5-1 / -5) and take account of your switching device's B10d value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings for pressure-sensitive mat applications	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

Lay the feed lines of pressure-sensitive mats and bumpers together.

In order to avoid influences and malfunctions due to EMC effects, lay the four wires (e.g. SI0, SI0 TP, SI1, SI1 TP) together.

⚠ CAUTION

"Short circuit in mat" fault is not detected!

The safe I/O module fails to detect a short circuit between the mat contacts. This is interpreted as the mat being actuated. You must also verify that the safeguard is wired correctly.

► Periodically check that the mat is working properly.

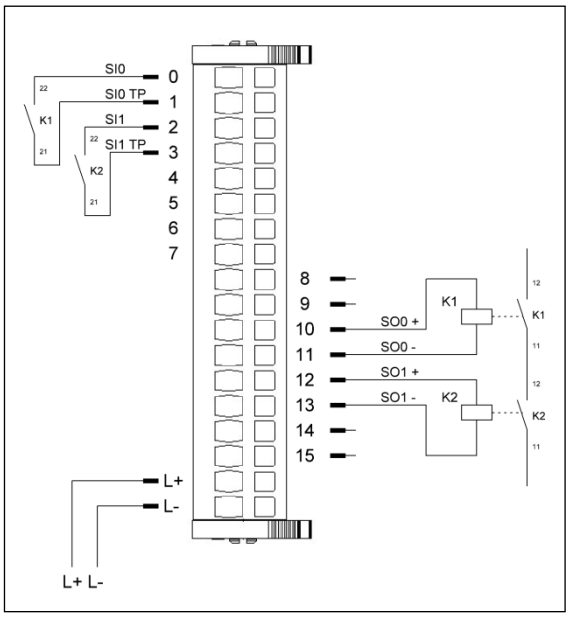
⚠ CAUTION

Safety function pressure-sensitive mat requires a response time of 50 ms!

Avoid personal injury and damage to property!

► The pressure-sensitive mat function achieves a response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

8.6 Connecting two actuators with internal GND reference



The wiring example illustrates how two outputs of the safe I/O module are used to actuate a safety function. Switch contacts K1 and K2 both affect the safety function together.

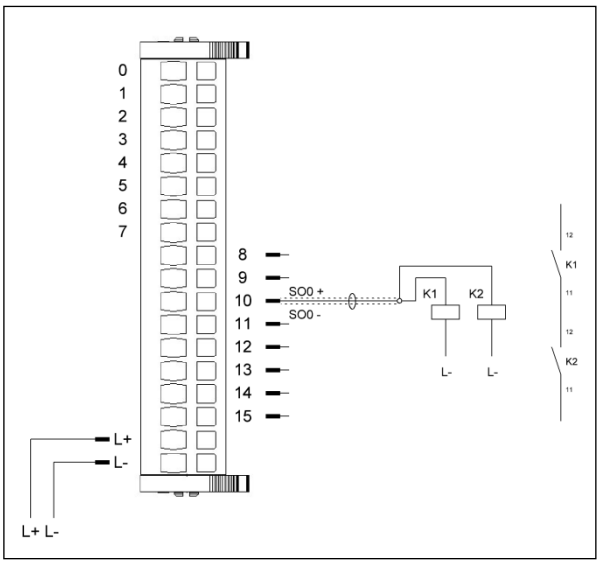
Using the SOX terminals of the outputs allows the actuator to separate from the GND connection and, thus, change to its safe state when external power is supplied and cross-circuits affect the actuator (contact SOX+). Whereas you may set up this circuit without the SOX- terminals, you must ensure that external power and cross-circuits are excluded if you do.

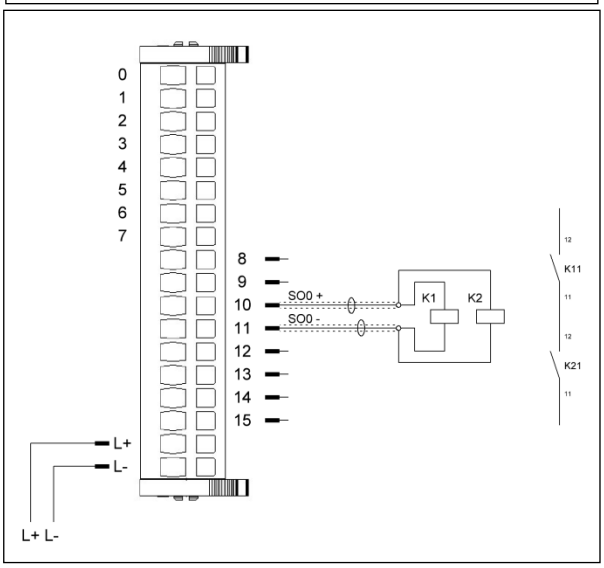
In order to monitor the relay states, you must connect the positively drive n.c. contacts of K1 and K2 to safe digital inputs. Set the safe PLC to analyse the values returned and, thus, the states of the switching devices.

8.6.1 Safety ratings of two-channel actuator

The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two outputs of the safe I/O module. They solely apply to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved. The quality of the safe actuator is of crucial importance with particular regard to the safety function of analysing a two-channel actuator. Only use approved actuators in due consideration of their $B10_d$ value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings of applications using two outputs for a safety function	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application cannot cause the safeguard to fail)





8.7 Connecting two parallel actuators to one safe output

⚠ CAUTION

Consideration of the parameterisation

Personal injury and damage to property!

► In a single-channel application (inputs and outputs), the test pulse frequency must be adapted to the application.

It must be ensured that for applications in which there is a frequent change of state, the test pulse frequency is selected at least 100 times higher than the change of state time, see chapter „7.3.2 FSoE Parameterübersicht“.

The wiring example illustrates how one output of the safe I/O module is used to actuate a safety function.

Use a two-channel actuator to achieve the safety integrity levels of the table below. Before connecting it to the I/O module, verify that short circuits and cross-circuits on the connecting lead are excluded.

Fault prevention required!

Take the actions required to prevent a short circuit or cross-circuit on the lead connecting the KEB-I/O EtherCAT Safe I/O module and the safe actuators. The signal lines between the safe actuator and the KEB-I/O EtherCAT Safe I/O modul must be laid separately and protected according to EN 60204-1 or EN ISO 13849-1 (e.g. as separate coated lines or in separate cable ducts).

⚠ CAUTION

Observe error detection time

Personal injury and damage to property!

► An error detection time of 5 ms must be observed. Faults may therefore produce high impulses of this width.

► Use a two-channel connection of the outputs in case your application responds to these impulses.

In order to monitor the relay states, you must connect the positively drive n.c. contacts of K1 and K2 to safe digital inputs. Set the safe PLC to analyse the values returned and, thus, the states of the switching devices.

Best safety ratings of applications using one output for a safety function	
Highest safety integrity level to EN 62061	SIL3
Highest safety integrity level to EN 61508-1...7	SIL3
Category and highest performance level to EN ISO 13849-1	Cat. 3/PL e
Hardware fault tolerance HFT in single-channel application (IEC 61508:2010/EN)	1 (a fault of the application does not cause the safeguard to fail)

9 Annex

9.1 Object Dictionary

9.1.1 Device Type

Name	Device Type
Index	1000_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	read only
PDO Mapping	No
Value Range	set
Default Value	1389_h

9.1.2 Error Register

Name	Error Register
Index	1001_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	read only
PDO Mapping	No, TX-PDO
Default Value	00_h

In case of an error, the associated error bit is set.

Error bit	Name	Features
0	GEN: Generic fault	non-acknowledgeable, power cycle required
1	CUR: Current	non-acknowledgeable, power cycle required
2	VOL: Voltage	acknowledgeable via EtherCAT or by power cycle
3	TEMP: Temperature	non-acknowledgeable, power cycle required
4	COM: Communication	non-acknowledgeable, power cycle required
5	PROF: Device profile	acknowledgeable via EtherCAT
6	RES: reserved, always "0"	non-acknowledgeable, power cycle required
7	RES: not used, always "0"	non-acknowledgeable, power cycle required

9.1.3 Manufacturer Device Name

Name	Manufacturer Device Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (27)
BitSize	216
Access	read only
PDO Mapping	No
Value Range	set
Default Value	KEB-I/O EtherCAT Safety SDI4/SDO2

Subindex 0 of this object contains the string length. Subindex 1 contains each of the characters. The character string has no terminating zero.

9.1.4 Manufacturer Hardware Version

Name	Manufacturer Hardware Version
Index	1009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (4)
BitSize	32
Access	read only
PDO Mapping	No
Value Range	set
Default Value	$322E3130_h$ (2.10)

9.1.5 Manufacturer Software Version

Name	Manufacturer Software Version
Index	$100A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (4)
BitSize	32
Access	read only
PDO Mapping	No
Value Range	set
Default Value	$312E3030_h$ (1.00)

9.1.6 Identity Object

Name	Identity Object
Index	1018_h
Object Code	RECORD
No. of Elements	5
Data Type	IDENTITY

9.1.6.1 Highest sub index supported

Name	Highest sub index supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	>4<

9.1.6.2 Vendor ID

Name	Vendor ID
Subindex	01_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	14_h (20)

9.1.6.3 Product Code

Name	Product Code
Subindex	02_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	500002_h (5242882)

9.1.6.4 Revision Number

Name	Revision Number
Subindex	03_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	$0000002A_h$ (42)

9.1.6.5 Serial Number

Name	Serial Number
Subindex	04_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	No
Units	YY MM DD NNNNN yyyyyy mmmm ddddd nnnnnnnnnnnnnnnnn 6-bit 4 Bit 5 Bit 17 Bit Year 2014 is coded as '0'.
Value Range	14 01 01 00001 (0x00420001) … 77 12 31 99999 (0xFF3F869F)
Example	16052300001 ⇔ 0x096E0001

The object contains details of the manufacturer, the product code and the revision and serial number.

9.1.7 Supply24Voltage

Name	Supply24Voltage
Index	2000_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

9.1.8 Out1Current

Out 1 Current 2005_h for µC1 and 2015_h for µC2

Name	Out1Current
Index	2005_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Units	mA
Value Range	0 … 2400
Default Value	No default value

9.1.9 Ext Temperature

Name	Ext Temperature
Index	2006_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	0.01 °C
Value Range	0 … 8000
Default Value	No default value

To get the temperature displayed, only the least significant 16-bit can be evaluated.

9.1.10 Err.code

Name	Err.code
Index	2007_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Default Value	00000000_h

The table below explains the entries in object 2007_h or 2017_h „Err.code“.

ID	hex	Explanation
0	0x0000	OK: No Error
1	0x0001	HWT_PARAMETER_ERROR Hardware test parameter error
2	0x0002	HWT_INIT_ERROR Hardware test initialisation error
100	0x0064	HWT_MEM_MARCHC_ERROR Hardware test RAM check error
101	0x0065	HWT_MEM_GALPAT_ERROR Hardware test RAM check error
200	0x00C8	HWT_STACK_UNDERFLOW_ERROR Hardware test stack underflow
201	0x00C9	HWT_STACK_UNDERFLOW_ERROR Hardware test stack underflow
300	0x012C	HWT_CPU_ERROR Hardware test CPU error

ID	hex	Explanation
400	0x0190	WT_FW_ERROR Hardware test firmware error
500	0x01F4	HWT_FWINTERFACE_ERROR Hardware test firmware error
504	0x01F8	HWT_ADC_ERROR: Test handler: error in ADC value range checks Hardware test AD converter error
505	0x01F9	HWT_DMA_ERROR: Test handler: error in DMA check Hardware test DMA checksum error
506	0x01FA	HWT_CRC_ERROR: Test handler: error in CRC check Hardware test checksum error
507	0x01FB	HWT_TIMER_ERROR: Test handler: error in timer check Hardware test CPU timer error
508	0x01FC	HWT_CLOCK_ERROR: Test handler: error in clock signal check Hardware test CPU clock signal check error
509	0x01FD	HWT_SOFTERROR: Softerror detected Hardware test soft error detected
510	0x01FE	HWT_DIVZERO: Division by 0 detected in hardware test
512	0x0200	TIMEOUT_ERR: Timeout detected.Software timeout detected
513	0x0201	OUT_OF_RANGE_ERR: Parameter or value out of allowed range. Parameter range error
514	0x0202	OVERWRITE_ERR: Register buffer data overwrite occured. Data overwrite occurred
515	0x0203	UNDERFLOW_ERR: Register buffer data underflow occured. Data underflow occurred
516	0x0204	PRG_CNTRL_ERR: Program sequence control detected error. Program sequence error detected
528	0x0210	INIT_ERROR: Initialization error Initialization error
592	0x0250	ASSERT_TRUE_ERR: Assertion for expression yields "true" failed.Assertion for "true” failed
593	0x0251	ASSERT_NOT_NULL_ERR: Assertion for unequal to NULL failed. Assertion for unequal "NULL” failed
594	0x0252	ASSERT_GE_ERR: Assertion for ">=" comparision failed. Assertion for ">=” failed
595	0x0253	ASSERT_GT_ERR: Assertion for ">" comparision failed. Assertion for ">” failed
596	0x0254	ASSERT_LE_ERR: Assertion for "<=" comparision failed. Assertion for "<=” failed
597	0x0255	ASSERT_LT_ERR: Assertion for "<" comparision failed. Assertion for "<” failed
598	0x0256	ASSERT_NE_ERR: Assertion for "<>" comparision failed. Assertion for "<>” failed
599	0x0257	ASSERT_EQ_ERR: Assertion for "=" comparision failed. Assertion for "=” failed

ID	hex	Explanation
600	0x0258	ASSERT_FALSE_ERR: Assertion for expression yields "false" failed. Assertion for "false" failed
640	0x0280	TP_OUT_NOT_SPECIFIED: Output test pulse not specified. (ErrReg: 32) Bad output test pulse - internal sequence error
641	0x0281	TP_OUT_NOT_RECOGNIZED: Output test pulse not detected. (ErrReg: 32) Internal input test pulse not detected
642	0x0282	TP_OUT_NOT_ACTIVE: Output test pulse not activated. (Err-Reg: 32) Internal input test pulse not detected
656	0x0290	TP_INP_BUSY: Input test pulse operation is busy. (ErrReg: 32) input test pulse monitoring not completed before a new test pulse occurred
657	0x0291	TP_INP_CROSSTALK: Input test pulse cross talk detected. (ErrReg: 32) Crosstalk of input test pulse signals
658	0x0292	TP_INP_NOT_RECOGNIZED: Input test pulse not detected. (ErrReg: 32) Internal input test pulse not detected
659	0x0293	TP_INTINP_NOT_RECOGNIZED: Internal input test pulse not detected. (ErrReg: 32) Internal input test pulse not detected
660	0x0294	TP_INP_LOST: Internal input test pulse lost. (ErrReg: 32) Internal input test pulse not detected
661	0x0295	TP_INVALID_COUNT_FOR_SELECTOR: (ErrReg: 32) Test pulse error in mode selector mode
661	0x0296	TP_INVALID_OUTPUT_WIRING Ausgangs-Verdrahtungs-fehler662 | 0x2A0 | MRAM_NOT_INITIALIZED MRAM nicht initialisiert
673	0x02A1	MRAM_READ_ERR: MRAM Read error. MRAM read error
674	0x02A2	MRAM_WRITE_ERR: MRAM write error. MRAM write error
675	0x02A3	MRAM_INDEX_OUT_OF_RANGE: MRAM entry index out of valid range. MRAM address error
676	0x02A4	MRAM_CORRUPT_PAGE_SIZE: MRAM page size invalid. MRAM page size error
677	0x02A5	MRAM_CRC_ERR: MRAM data CRC check failed. MRAM checksum error (CRC error)
678	0x02A6	MRAM_MAGICNUMBER_ERR: MRAM magic number not recognized. MRAM error in test number
768	0x0300	RESET_LOW_POWER: Reset due to low power supply. Reset due to low power supply
769	0x0301	RESET_WINDOW_WD: Reset due to window watchdog. Reset due to window watchdog
770	0x0302	RESET_INDEPENDENT_WD: Reset due to independent watchdog. Reset due to watchdog timer
771	0x0303	RESET_SW: Reset due to software reset. Reset due to soft-ware reset

ID	hex	Explanation
772	0x0304	RESET_POWER_ON_DOWN: Reset due to power up or down. Reset due to power up or down
773	0x0305	RESET_NMI: Reset due to non maskable interrupt. Reset due to non maskable interrupt
774	0x0306	RESET_BROWNOUT: Reset by CPU brown out detection. Reset due to low power supply of the CPU
775	0x0307	RESET_NO_REASON: Reset due to unkown reason. Reset due to unkown reason
1024	0x0400	ADC_REF_LOW: Reference voltage too low. AD converter reference voltage too low
1025	0x0401	ADC_REF_HIGH: Reference voltage too high. AD converter reference voltage too high
1026	0x0402	ADC_24V_LOW: 24 V supply voltage too low (< 24V - 10%). (ErrReg: 4) Upper limit of the 24V load supply was exceeded
1027	0x0403	ADC_24V_HIGH: 24 V supply voltage too high (> 24V + 15%). (ErrReg: 4) Upper limit of the internal 24V supply was exceeded
1028	0x0404	ADC_5V_LOW: 5 V supply voltage too low. (ErrReg: 4) Lower limit of the internal 5V supply has been fallen below
1029	0x0405	ADC_5V_HIGH: 5 V supply voltage too high. (ErrReg: 4) Upper limit of the internal 5V supply was exceeded
1030	0x0406	ADC_3_3V_LOW: 3,3 V supply voltage too low. Limit of the internal 3.3V supply has been fallen below
1031	0x0407	ADC_3_3V_HIGH: 3,3 V supply voltage too high. Upper limit of the internal 3.3V supply was exceeded
1032	0x0408	ADC_TEMP_LOW: Onchip temperature too low. (ErrReg: 8) Ambient temperature too high
1033	0x0409	ADC_TEMP_HIGH: Onchip temperature too high. (ErrReg: 8) Ambient temperature too high
1034	0x040A	ADC_CURR_HIGH: Total output current too high. (ErrReg: 2) Ambient temperature too high
1035	0x040B	ADC_24V_FATAL: 24 V supply voltage much too high (> 60V). (ErrReg: 4) 24 V load supply voltage much too high (>60V)
1280	0x0500	LINE_TIMEOUT: Invalid sync line level from base board Sync line level monitoring timeout from base board
1281	0x0501	NOVALIDCPUID: Invalid CPU identifier setting
1282	0x0502	TIMEOUTTIMERERR: Timeout occured
1283	0x0503	DIPSWITCHREADERR: DIP switch could not be read
1284	0x0504	DIPSWITCHCHANGED: DIP switch setting changed in service
1285	0x0505	DIPSWITCHXCHGERROR: Exchange of address DIP settings failed CPU-to-CPU exchange of address DIP settings failed

ID	hex	Explanation
1286	0x0506	DIPSWITCH_INVALID_ADDRESS: Invalid FSoE address selected (ErrReg: 32) invalid address adjusted (address = 0)
1312	0x0520	CLK_ERROR: Partner clock frequency is out of valid range clock monitoring defective
1313	0x0521	CLK_PARTNER_LOW: Partner clock frequency is below lower limit Partner clock frequency too low
1314	0x0522	CLK_PARTNER_HIGH: Partner clock frequency is above upper limit Partner clock frequency too high
1328	0x0530	HW_REVISION_ERROR: Invalid HW revision detected (the SW currently running is not designed for this HW revision)
1536	0x0600	INPUTXCHGERROR: Exchange of safety input information failed CPU-to-CPU exchange of safety input information failed
1537	0x0601	INPUT_TIMEOUT: Input test pulse timed out. (ErrReg: 32)
1552	0x0610	INPUT_EXTMATTE_KS: Short circuit detected in external safety input carpet (ErrReg: 32) not used
1553	0x0611	INPUT_EXTMATTE_OPEN: Safety mat not connected / open load (ErrReg: 32) Error in the wiring of the safety mat: short circuit or wire failure
1792	0x0700	OUTPUTXCHGERROR: Exchange of safety output information failed CPU-to-CPU exchange of safety output information failed
1793	0x0701	OUTPUTFAIL: Output test pulse not detected (ErrReg: 32)
1794	0x0702	OUTPUT_WAITFB: Output test pulse waiting for feedback signal not detected (ErrReg: 32)
1795	0x0703	OUTPUT_TIMEOUT: Timeout in handling of output (ErrReg: 32) Time monitoring error at output control
1796	0x0704	OUTPUT_HSTP_TIMEOUT: Output test pulse of high side switch timed out Output high side switch test pulse time monitoring error
1797	0x0705	OUTPUT_LSTP_TIMEOUT: Output test pulse of low side switch timed out Output low side switch test pulse time monitoring error
1798	0x0706	OUTPUT_LSTP_CONNECT_ERR: Output test pulse of low side switch timed out. Bad wiring - output set to external ground, wrong signal detected on feedback line.
1799	0x0707	OUTPUT_USTP_TIMEOUT: Output test pulse of common high side switch timed out. Output high side switch test pulse time monitoring error
1800	0x0708	OUTPUT_NOPAR_USED: Output is parameterized as not used and shall be switched on (ErrReg: 32)
2048	0x0800	BCOM_NOTREADY: Communication to base board not ready / operational

ID	hex	Explanation
2049	0x0801	BCOM_BUSY: Communication with base board is busy
2050	0x0802	BCOM_NONEWDATA: No new data received from base board Communication with base board - no new data received
2051	0x0803	BCOM_CRCERR: Communication to base board detected a CRC error
2052	0x0804	BCOM_BITERR: Shifted bits detected Communication with base board – shifted bits detected
2304	0x0900	XCOM_NOTREADY: Communication to safety partner MC not ready / operational
2305	0x0901	XCOM_BUSY: Communication to safety partner MC is busy
2306	0x0902	XCOM_NONEWDATA: Communication with safety partner MC – no new data received
2307	0x0903	XCOM_CRCERR: Communication to safety partner detected a CRC error
2560	0x0A00	I2C_TIMEOUT: I2C communication timeout detected
2561	0x0A01	I2C_BUSY: I2C bus is busy
2816	0x0B00	FSOE_RESET_IND: (ErrReg: 16) FailSafeOverEtherCAT – FSoE slave returns error to FSoE master
2817	0x0B01	FSOE_INVALID_CMD: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2818	0x0B02	FSOE_UNKNOWN_CMD: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2819	0x0B03	FSOE_INVALID_CONNID: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2820	0x0B04	FSOE_INVALID_CRC: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2821	0x0B05	FSOE_WD_EXPIRED: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2822	0x0B06	FSOE_INVALID_ADDRESS: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2823	0x0B07	FSOE_INVALID_DATA: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2824	0x0B08	FSOE_INVALID_COMMPARALEN: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2825	0x0B09	FSOE_INVALID_COMMPARA: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2826	0x0B0A	FSOE_INVALID_USERPARALEN: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2827	0x0B0B	FSOE_INVALID_USERPARA: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2828	0x0B0C	FSOE_INVALID_TP_INP_DURATION: Safety parameter input test pulse duration invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety input parameter test pulse duration

ID	hex	Explanation
2829	0x0B0D	FSOE_INVALID_TP_INP_FREQUENCY: Safety parameter input test pulse frequency invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety input test pulse frequency
2830	0x0B0E	FSOE_INVALID_TP_OUT_DURATION: Safety parameter output test pulse duration invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety output parameter test pulse duration
2831	0x0B0F	FSOE_INVALID_TP_OUT_FREQUENCY: Safety parameter output test pulse frequency invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety output test pulse frequency
2832	0x0B10	FSOE_INVALID_WATCHDOG_TIME: Safety parameter watchdog time invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety parameter watchdog time
2833	0x0B11	FSOE_INVALID_INP_EXT_SUPPLY: Safety parameter for inputs having external supply invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid input parameter setting or inputs not used according to parameter setup.
2834	0x0B12	FSOE_INVALID_INP_IN_USE: Safety parameter for inputs in use invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety parameter for inputs in use
2835	0x0B13	FSOE_INVALID_INP_USED_EXT_MISMATCH: Safety parameters for inputs in use and externally supplied mismatch (ErrReg: 16) FailSafeOverEtherCAT – mismatch of safety parameters for inputs in use and externally supplied inputs
2836	0x0B14	FSOE_INVALID_OUT_IN_USE: Safety parameter for outputs in use invalid (ErrReg: 16) FailSafeOverEtherCAT – invalid safety parameter for outputs in use
2837	0x0B15	FSOE_INVALID_OUT_USED_EXT_MISMATCH: Safety parameters for outputs in use and externally grounded mismatch (ErrReg: 16) FailSafeOverEtherCAT – mismatch of safety parameters for outputs in use and externally earthed outputs
2944	0x0B80	FSOE_EXTENDED_ERROR: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2992	0x0BB0	FSOE_ERROR: Invalid internal state in safety stack (ErrReg: 16) FailSafeOverEtherCAT
3072	0x0C00	TH_GLOBAL_ERROR: Global hardware test error
3073	0x0C01	TH_TIMEOUT: Internal test sequence timeout Timeout at hardware test
3329	0x0D01	MC1_ID_INVALID: Identification of MC 1 failed
3330	0x0D02	MC2_ID_INVALID: Identification of MC 2 failed
3331	0x0D03	MC3_ID_INVALID: Identification of MC 3 failed

ID	hex	Explanation
3584	0x0E00	FOREIGN_ERROR_DETECTED: Other MC detected an error
3841	0x0F01	FLASH_TIMEOUT: FLASH operation timeout Timeout writing to FLASH
3842	0x0F02	FLASH_LOCKED: FLASH operation failed because "LOCK" bit could not be reset
3851	0x0F0B	FLASH_BUSY: FLASH operation busy sequence error in FLASH programming
3854	0x0F0E	FLASH_ERROR: FLASH operation error programmer the FLAH memory failed

9.1.11 Err.line CPU 1/2

Name	Err.line CPU 1/2
Index	2008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Default Value	00000000_h

9.1.12 Err.module CPU 1/2

Name	Err.module CPU 1/2
Index	2009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	No
Default Value	00000000_h

The table below explains the entries in object 2009_h or 2019_h „Err.module“.

ID	Explanation
0	OBJ_UNKNOWN_ID – unknown module
4	OBJ_FSOETASK_ID – error occurred in "CFSoETask.cpp"
8	OBJ_INPUT_ID - error occurred in "CInput.cpp"
12	OBJ_MAINTASK_ID - error occurred in "CMainTask.cpp"
16	OBJ_PRGCONTRLTASK_ID - error occurred in "CProgramControlTask.cpp"
20	OBJ_SYNCSAFETYPARTNER_ID - error occurred in "CSyncSafetyPartner.cpp"
24	OBJ_XCOM_ID - error occurred in "CXCom.cpp"

ID	Explanation
28	OBJ_SAFETYHAL_ID - error occurred in "CSafetyHal.cpp"
32	OBJ_YSTIMER_ID - error occurred in "CysTimer.cpp"
36	OBJ_MSTIMER_ID - error occurred in "CmsTimer.cpp"
44	OBJ_BASEBOARDCOM_ID - error occurred in "CBaseBoardComm.cpp"
48	OBJ_DIPSWITCH_ID - error occurred in "CDIPSwitch.cpp"
52	OBJ_HELPER_ID - error occurred in "CHelper.cpp"
56	OBJ_SYNCLINE_ID - error occurred in "CSyncSafetyPartner.cpp"
60	OBJ_TIMETABLE_ID - error occurred in "CTimeTableManager.cpp"
64	OBJ_TESTHANDLER_ID - error occurred in "CTestHandler.cpp"
80	OBJ_TIME_ITERATOR_ID - error occurred in "CTimeTableIterator.cpp"
96	OBJ_SPI_ID - error occurred in "CSpi.cpp"
97	OBJ_TIMER_ID - error occurred in "CTimer.cpp"
98	OBJ_BACKUPSRAM_ID - error occurred in "CBackupSRam.cpp"
99	OBJ_PWR_ID - error occurred in "CPwr.cpp"
100	OBJ_RCC_ID - error occurred in "CRcc.cpp"
101	OBJ_GPIO_ID - error occurred in "OBJ_GPIO_ID"
102	OBJ_DMASTREAM_ID - error occurred in "CDmaStream.cpp"
103	OBJ_ADC_ID - error occurred in "CAdc.cpp"
104	OBJ_WD_ID - error occurred in "CWatchdog.cpp"
105	OBJ_FLASH_ID - error occurred in "CFlash.cpp"
106	OBJ_I2C_ID - error occurred in "CI2c.cpp"
128	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 1)"
129	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 2)"
130	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 3)"
131	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 4)"
144	OBJ_OUTPUT_ID - error occurred in "COutput.cpp (Safe-Out 1)"
145	OBJ_OUTPUT_ID - error occurred in "COutput.cpp (Safe-Out 2)"
148	OBJ_USTESTPULSE_ID - error occurred in "CUSTestOuls.cpp"
160	OBJ_OUTPUTHANDLER_ID - error occurred in "COutputHandler.cpp"
164	OBJ_OUTPFSWITCH_ID - error occurred in "COutpFSSwitch.cpp"

9.1.13 Err.class CPU 1/2

Name	Err.class CPU 1/2
Index	$200A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	No
Default Value	00000000_h

The table below explains the entries in object $200A_h$ or $201A_h$ „Err.class“.

ID	Explanation
0	No Error
1	Serious or synchronization error
2	Internal communication error
3	I/O Error Input /output error
4	Error in ErrorHandler or at the outputs
5	Fatal error

9.1.14 System uptime [s] (implizit MRAM test)

Name	System uptime [s] (implizit MRAM test)
Index	$200C_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	s
Default Value	No default value

9.1.15 Temperature warning

Name	Temperature warning
Index	2016_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	No
Value	0°C – 55°C = 0; <0°C or >55°C = 1
Default Value	No default value

Objects - For internal use only.

The objects listed below are not intended for use by the end user. Some of them are used for configuring and their values cannot be retrieved.

0x10F1h	Error Settings
0x1600h	FSOE Rx PDO Mapping
0x1A00h	FSOE Tx PDO Mapping
0x1C00h	SyncManager type
0x1C12h	Rx PDO assign
0x1C13h	Tx PDO assign
0x1C32h	SM output parameter
0x1C33h	SM input parameter
0x2000h	Ref Voltage for µC1
0x2010h	Ref Voltage for µC2
0x2002h	Supply voltage 5 V for µC1
0x2012h	Supply voltage 5 V für µC2
0x2003h	Supply voltage 3.3 V for µC1
0x2013h	Supply voltage 3.3 V for µC2
0x2004h	IC Temperature (uncalibrated) for µC1
0x2014h	IC Temperature (uncalibrated) for µC2
0x200Bh	Number of CORA test cycles for µC1
0x201Bh	Number of CORA test cycles for µC2
0x2020h	MaxAsicDataUnequalCounter
0x2220h	MC1 main loop cycle time
0x2221h	MC2 main loop cycle time
0x5001h	Id MC1
0x5002h	Id MC2
0x5003h	Id MC3
0x6000h	FSOE Slave Frame Elements
0x6001h	FSOE Inputs
0x7000h	FSOE Master Frame Elements
0x7001h	FSOE Outputs
0x8000h	Input Parameter
0x8001h	Output Parameter
0x8002h	Test pulse duration
0x8003h	Test frequency
0x9001h	FSOE Communication Parameter
0xF980h	Safe Address

10 Certification

10.1 Standards complied with

10.1.1 Product standard applied

- EN 61131-2:2007
  Programmable controllers – Part 2: Equipment requirements and tests

10.1.2 Safety-oriented standards and guidelines

- IEC 61508:2010 Parts 1-7
  Functional safety of electrical/electronic/programmable electronic safety-related systems
- EN ISO 13849-1:2015
  Safety of machinery - Safety-related parts of control systems
  Part 1: General principles for design
- EN 62061:2005 + AC:2010 + A1:2013 + A2:2015
  Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
- EN 60204-1:2006 + A1:2009 + AC:2010 (excerpts)
  Safety of machinery – Safety-related parts of control systems -
  Part 1: General principles for design

10.1.3 EMC standards

The EMC interference immunity in accordance with

- Generic standard DIN EN 61000-6-2:2005
  Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments
- Product standard DIN EN 61131-2:2007
  Programmable controllers – Part 2: Equipment requirements and tests

Increased immunity levels for safety-related applications

- DIN EN 61326-3-1:2008
  Electrical equipment for measurement, control and laboratory use - EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications

EMC emission standard in accordance with

- Generic standard DIN EN 61000-6-4:2007
  Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
- Product standard EN 61131-2:2007
  Programmable controllers – Part 2: Equipment requirements and tests

10.2 Conformity marking

The original EC declarations of conformity and the corresponding documentation are kept available for the responsible authorities. Please contact the product management if required.

EU KONFORMITÄTSERKLÄRUNG

Dokument-Nr. / Monat.Jahr: ce_wp_rsafety-C6E-SafePLC-IO-a_de / 05.2017

Hersteller: KEB Automation KG
Südstraße 38
32683 BARNTRUP

Produktbezeichnung:

Steuerung Modellreihe	yy**C6CE**x – xxxx
Type	yy = 00 x = beliebige Ziffer oder Buchstabe
Spannungsklasse	24V dc

Das bezeichnete Produkt stimmt mit den Vorschriften folgender Europäischer Richtlinien überein:

Number: **Machine: 2006 / 42 / EU**
Text: Directive on machinery.

Nummer: **EMV : 2014 / 30 / EU**
Text: Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedsstaaten über die elektromagnetische Verträglichkeit.

Number: **Gefährliche Substanzen: 2011 / 65 / EU**
Text: Richtlinie des Rates zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten.

Weitere Angaben zur Einhaltung dieser Richtlinien enthält der Anhang.

Anbringung der CE-Kennzeichnung: ja

Aussteller: KEB Automation KG
Südstraße 38
32683 BARNTRUP

Ort, Datum Barntrup, 14.07.2017

Rechtsverbindliche Unterschrift:

i. A. W. Hovestadt / Normenbeauftragter

W. Wiele / Technischer Leiter

Die Anhänge sind Bestandteil dieser Erklärung.
Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften.

Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.

10.2.1 Annex to the conformity marking

EU KONFORMITÄTSERKLÄRUNG

ANHANG 1

Dokument-Nr. / Monat.Jahr: ce_wp_rsafety-C6E-SafePLC-IO-a_de / 07.2017

Produktbezeichnung:	Steuerung Modellreihe	yy**C6CE**x – xxxx
	Type	yy = 00 x = beliebige Ziffer oder Buchstabe
	Spannungsklasse	24V dc

Die Übereinstimmung des bezeichneten Produktes mit den Vorschriften der oben genannten Richtlinien wird nachgewiesen durch die vollständige Einhaltung der folgend Anforderungen und angegebenen Normen.

2006 / 42 / EG Maschinen-Richtlinie
Artikel 2, Anhang V — Definition Begriffe: c) Sicherheitsbauteil
Sicherheitsbauteile: 4. Logikeinheit zur Gewährleistung der Sicherheitsfunktionen

Berücksichtigte harmonisierte Europäische Normen:

EN - Norm	Text	Referenz	Ausgabe
EN 61131 – 2 Ausgabe 2007	Speicherprogrammierbare Steuerungen – Teil 2: Betriebsmittelanforderungen und Prüfungen	VDE 04110-500	04 / 2008
EN 61508-1 bis -7 Ausgabe 2010	Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme	VDE 0803 – 1 bis – 7	2011
EN ISO 13849-1 Ausgabe 2015	Sicherheit von Maschinen – Sicherheitsbezogene Teile von Steuerungen	DIN EN 13849-1	12 / 2015
EN 62061 Ausgabe 2015+ Berichtigungen	Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme	VDE 0113 - 50	05 / 2016
EN60204-1 Ausgabe 2006 + A1 + AC	Sicherheit von Maschinen – Elektrische Ausrüstung - Teil 1: Allgemeine Anforderungen In Auszügen	VDE 0113 - 1	06 / 2007

Die Konformität der gegenüber den Anforderungen der obigen Normen wurde bescheinigt durch:

Notifizierte Stelle: TÜV – Rheinland Industrie Service GmbH
Anschrift : Zertifizierungsstelle für Maschinen (NB Nr. 0035)
Alboinstrasse 56
12103 Berlin

Safe PLC:
Nummer der EG Baumusterbescheinigung 01/205/5600.00/17
Ausstelldatum: 04.07.2017
Gültigkeit: 04.07.2022

Safe I/O:
Nummer der EG Baumusterbescheinigung 01/205/5604.00/17
Ausstelldatum: 17.07.2017
Gültigkeit: 21.07.2021

EU KONFORMITÄTSERKLÄRUNG

ANHANG 2

Dokument-Nr. / Monat.Jahr: ce_wp_rsafety-C6E-SafePLC-IO-a_de / 07.2017

Produktbezeichnung:	Steuerung Modellreihe	yy**C6CE**x – xxxx
	Type	yy = 00 x = beliebige Ziffer oder Buchstabe
	Spannungsklasse	24V dc

Die Übereinstimmung des bezeichneten Produktes mit den Vorschriften der Richtlinie 2014/30/EU wird nachgewiesen durch die vollständige Einhaltung der nachfolgend angegebenen Normen.

Darin berücksichtigte harmonisierte Europäische Normen:

EN 61000 – 6 – 4 Ausgabe 2011	Fachgrundnorm Funkentstörung: Teil 2 Industriebereich	VDE 0839-6-4	09 / 2011
EN 61000 – 6 – 2 Ausgabe 2005 +Ber. Aus 2011	Fachgrundnorm Störfestigkeit: Teil 2 Industriebereich	VDE 0839-6-2	03 / 2006

Grundlage der Messungen ist die Definition eines typischen Aufbaus in einem Steuerungssystem

Die entsprechenden Aufbau - und Verdrahtungshinweise sind der Betriebsanleitung zu entnehmen!

Die Übereinstimmung des bezeichneten Produktes mit den Vorschriften der Richtlinie 2011/65/EG wird nachgewiesen durch die Qualifikation von Bauteilen und Fertigungsverfahren im Rahmen der durch die ISO 9001 vorgegebene Qualitätssicherung. Die entsprechenden Informationen und Beschreibungen sind dokumentiert und abgelegt.

Das bezeichnete Produkt wurde unter einem umfassenden Qualitätsmanagementsystem entwickelt, hergestellt und geprüft.

Die Konformität des Qualitätsmanagementsystems nach DIN ISO 9001 wurde bescheinigt durch:

Notifizierte Stelle:	TÜV - CERT
Anschrift:	Zertifizierungsstelle des RWTÜV Steubenstrasse 53 D - 45138 Essen
Nummer der Bescheinigung	041 004 500
Ausstelldatum:	20.10.94
Gültig durch Nachprüfung bis:	12.2018

10.3 TÜV certificate

EC Type-Examination Certificate

Reg.-Nr./No.: 01/205/5604.00/17

Prüfgegenstand **Product tested**	Sichere digitale Ein-/Ausgabebaugruppe mit sicherer Kommunikation über FSoE Safe digital I/O module with safe communication FSoE	**Zertifikats-inhaber** **Certificate holder**	KEB Automation KG Südstraße 38 32683 Barntrup Germany
Typbezeichnung **Type designation**	KEB-I/O EtherCAT Safe-In4 / Safe-Out2 - 00C6CE1-0100		
Prüfgrundlagen **Codes and standards**	EN ISO 13849-1:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 IEC 61508 Parts 1-7:2010		EN 61131-2:2007 EN 60204-1:2006 + A1:2009 + AC:2010 (in extracts)
Bestimmungsgemäße Verwendung **Intended application**	Das I/O-Modul erfüllt die Anforderungen der Prüfgrundlagen (Kat. 3 / PL e nach EN ISO 13849-1, SIL CL 3 nach EN 62061 / IEC 61508) und kann in Anwendungen bis zu diesen Sicherheitsleveln eingesetzt werden. The I/O module complies with the requirements of the relevant standards (Cat. 3 / PL e acc. to EN ISO 13849-1, SIL CL 3 acc. to EN 62061 / IEC 61508) and can be used in applications up to these safety levels.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sowie des Sicherheitshandbuchs sind zu beachten. The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt.
It is confirmed, that the product tested complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.

Gültig bis / Valid until 2021-07-27
Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/FSP 1259.01/17 vom 17.07.2017 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen. Es wird ungültig bei jeglicher Änderung der Prüfgrundlagen für den angegebenen Verwendungszweck.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1259.01/17 dated 2017-07-17.
This certificate is valid only for products which are identical with the product tested. It becomes invalid at any change of the codes and standards forming the basis of testing for the intended application.

Berlin, 2017-07-17

0035 Notified Body

Notified Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

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10.4 Approvals

The following approvals have been granted for the KEB-I/O EtherCAT Safe I/O module:

	TÜV-certified for the use in safety operations: EN ISO 13849:2015, EN 62061:2005 + AC:2010 + A1:2013 + A2:2015, EN 61131-2:2007, EN 60204-1:2006 + A1:2009 + AC: 2010 (in extracts), IEC 61508 Parts 1-7:2010
	cULus File number: E479848
	Pass conformance test and interoperability test in an EtherCAT Test Center (ETC).
	Complies with RoHS Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

11 Revision history

Version	Date	Description
00	2017-07	Completion of pre-production
01	2017-08	Design to series release
02	2022-05	Annual review
03	2023-05	Annual review

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