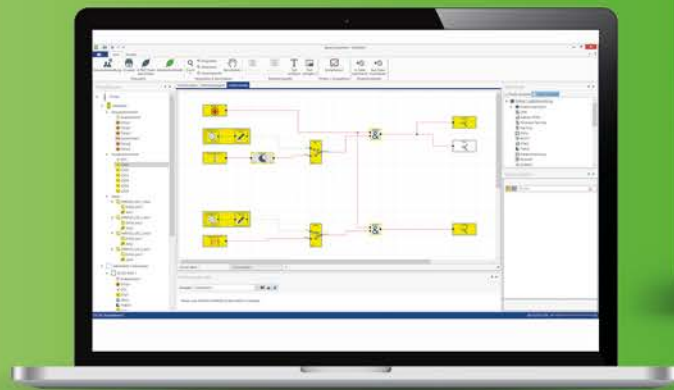




# KeSafe Safety technology



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Automation by innovation.

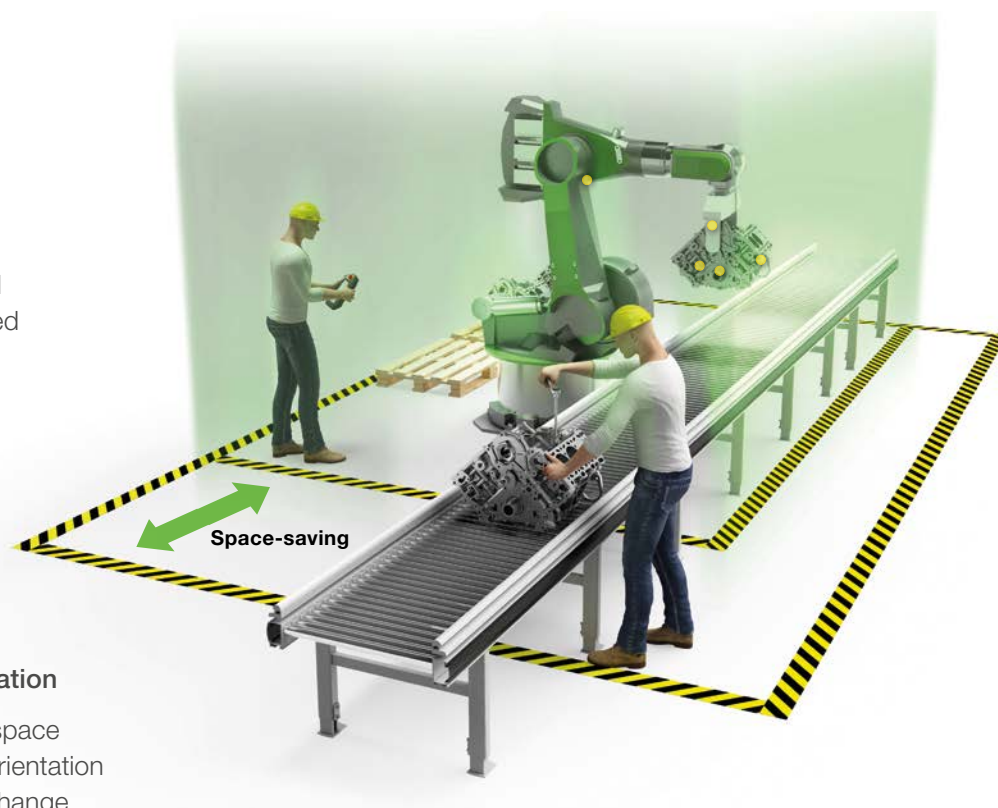
# KeSafe

## Safety technology

The KeSafe safety technology solution comprises a safety CPU including software to operate machines and robots safely in accordance with the currently applicable standards and directives. Safety applications can be implemented simply and efficiently using a series of certified function modules that can be combined individually like in a functional PLC.

### Safe operation

- Safe TCP speed
- Safe guard speed



### Safe cooperation

- Safe workspace
- Safe tool orientation
- Safe tool change

### Suitable for all serial kinematics

- Freely selectable monitoring points on robot and tool
- Including additional axes



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# KeSafe

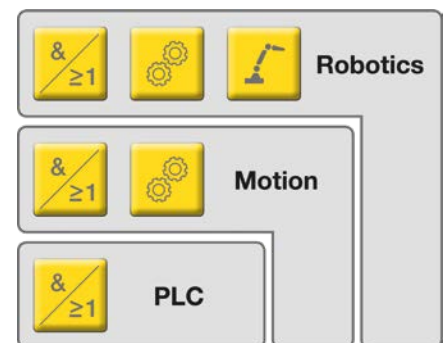
## Safety technology

KeSafe allows fast and flexible implementation of a wide variety of safety-related tasks.

KeSafe is available in combination with the compact control and drive system "KeDrive for Motion". Its functions range from simple logic operations and safe single-axis functions to enhanced safety functions for robot applications with up to 12 axes.

KeSafe is available in 3 functional configuration levels:

- KeSafe PLC
- KeSafe Motion
- KeSafe Robotics



The following standards are met by KeSafe:

- Complete solution up to category 4, PLe according to EN ISO 13849-1 and SIL3 according to EN 62061 and EN 61508
- Safe single-axis functions according to EN 61800-5-2 (KeSafe Motion)
- Safe robot modules according to EN ISO 10218 (KeSafe Robotics)

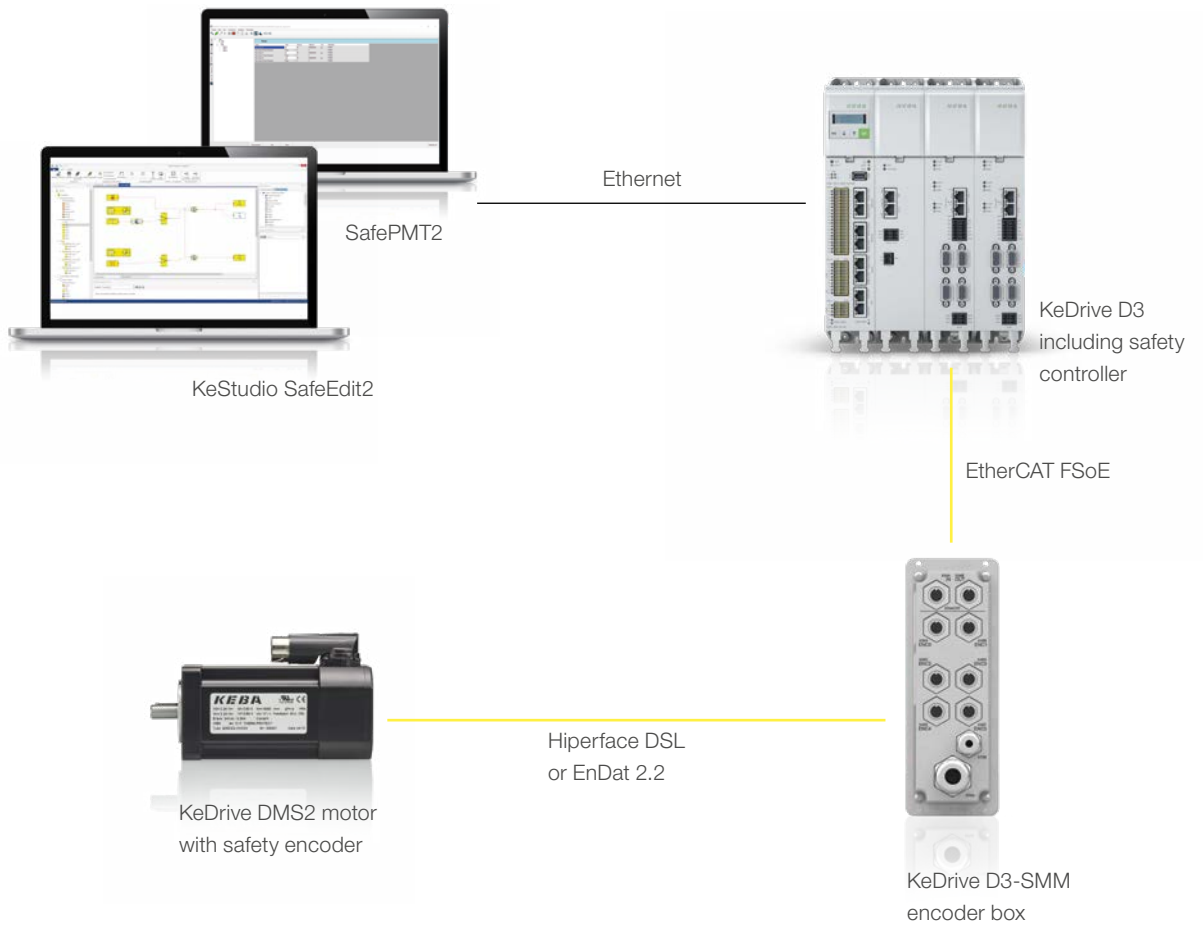
FSoE (Fail Safe over EtherCAT) is used for safe communication between the individual safety components. Safe data exchange to the higher-level safety systems is supported by various interfaces:

- FSoE slave via EtherCAT
- PROFIsafe F-device via PROFINET

The freely programmable safety application is set up with the easy-to-use KeStudio SafeEdit2 application tool integrated in KeStudio. This tool also enables diagnosis of the safety application and is additionally used for validation of the application.

Subsequent parameterization of already pre-validated safety applications can be performed with the KeStudio SafePMT2 parameterization tool. For example, a safety application can be adapted to a variant of the application very easily and in a time-saving manner.

## System layout



# KeSafe PLC

## Safe logic applications

### Product features









- Certified function modules for the integration of commonly used safety elements
- Free programmability by linking safe input modules to safe output elements by means of standard logic modules
- Safe onboard I/Os and additional safe I/O modules can be controlled decentrally via the FSoE master





### Short description

Ready-made modules are used to project standard safety elements such as emergency-stop switches, enabling switches and so on, and to combine these elements to form a complete safety application. Using selectable logic modules, KeStudio SafeEdit2 can be used to freely enable linking of input states and to reliably activate actuators via safe digital outputs. The control of drive-specific safety functions such as STO (Safe Torque Off) and SBC (Safe Brake Control) can also be realized in this way.

## Safe logic functions

	<b>Enabling switch</b>	1- or 2-channel input signals, logical and optional time-based comparison for 2-channel inputs, optional confirmation request after start/actuation.
	<b>Emergency stop</b>	Logical and optional time-based comparison of the two inputs, optional confirmation request after unlocking.
	<b>Door monitoring</b>	2- or 3-channel input signals, logical and optional time-based comparison of the input signals, optional confirmation request after start/actuation.
	<b>2-hand operation</b>	2- or 4-channel input signals, monitoring of the input signals acc. to EN 574. Certified function for 2-hand operation.
	<b>Limit switch</b>	1- or 2-channel input signals, logical and optional time-based comparison of the two inputs
	<b>Light curtain</b>	1- or 2-channel input signals, logical and optional time-based comparison of the two inputs, optional confirmation request after start/triggering and monitored start.
	<b>Operating mode selector switch</b>	2- or 3-channel input signals, logical monitoring of the input signals.
	<b>Sensor input module</b>	1- or 2-channel input signals, logical and optional time-based comparison of the two inputs, optional confirmation request after start/triggering and monitored start.
	<b>Safe digital output</b>	Switches a safe digital output to trigger safety functions on other devices, e.g., STO (Safe Torque Off) or SBC (Safe Brake Control), on the axis controllers or encoder box.
	<b>Safe relay output</b>	1- or 2-channel relay output with static and dynamic testing, optional feedback loop for monitoring the switching function
<b>Logical connections</b>		Standard blocks such as AND, OR, XOR, NOT, RS flip-flop, timer, EDM (External Device Monitoring) etc.

## KeSafe interface

	<b>PROFIsafe</b>	Functional safety via PROFINET as PROFIsafe F-device
	<b>FSoE</b>	Safety over EtherCAT as slave



# KeSafe Motion

## Safe single-axis applications

### Product features

- Versatile, certified safety functions for monitoring single axes according to EN 61800-5-2
- Freely combinable with the range of KeSafe PLC functions
- Requirement: KeDrive encoder box and motors with safe Hiperface DSL or EnDat 2.2 encoders












### Short description

A multitude of safety functions for single-axis monitoring can be realized using the KeSafe safety controller in combination with the KeDrive encoder box and the appropriate motors with safe encoders that support the Hiperface DSL or EnDat 2.2 protocol. In KeStudio SafeEdit2, a module which can be integrated in the safety application is available for each safety function. As a result, almost any safe machine functionality can be mapped on the basis of single axes.



## Safe single axis functions

	<b>SSX safe stop 1/2</b>	Monitoring of the braking ramp/time and shutdown of the motor after standstill (SS1) or monitoring of the braking ramp/time and SOS after standstill (SS2). Corresponds to stop category 1 or 2 acc. to EN 60204-1
	<b>SOS safe operation stop</b>	Standstill monitoring of active motor
	<b>SLS safely-limited speed</b>	Monitoring of a speed limit value
	<b>SLP safely-limited position</b>	Monitoring for exceeding a position limit value
	<b>SEL safe emergency limit</b>	Safe monitoring of the minimum and maximum position or of the permitted position range. Optional monitoring of the speed/position limit curve for minimizing the worst-case travel path.
	<b>SLI safely-limited increment</b>	Adherence to a specified increment size is monitored during movement
	<b>SDI safe direction</b>	Monitoring of the direction of movement
	<b>SCA safe CAM</b>	A safe output signal is generated while the motor position is in a specific area
	<b>SRX safe referencing</b>	Safe calculation and storage of the encoder offset

# KeSafe Robotics

## Safe robot applications

### Product features

- Enhanced, certified safety functions for robot applications with up to 12 axes
- Can be used for any number of serial kinematics
- Freely combinable with the range of the KeSafe PLC and KeSafe Motion functions
- Requirement: KeDrive encoder box and motors with safe Hiperface DSL encoders or EnDat 2.2







### Short description

The range of functions provided by KeSafe Robotics allows enhanced safety functions to be realized for robot applications with up to 12 axes or max. 11 axes in the kinematic chain. This enables customers to implement their products/systems in accordance with the safety requirements for industrial robots as specified in EN ISO 10218. The KeSafe Robotics modules can be selected in KeStudio SafeEdit2 and used in the safety application.




The requirements for KeSafe Robotics are the same as for the range of KeSafe Motion functions, i.e. the combination of safety controller, encoder box and the appropriate motors with safe encoders that support the Hiperface DSL or EnDat 2.2 protocol.

## Safe robotics functions

	<b>Safely-limited cartesian speed</b>	Safe speed monitoring of up to 7 freely selectable points on the robot
	<b>Safe cartesian zone monitoring</b>	Safe Cartesian position monitoring of arbitrary points on the robot
	<b>Safe orientation monitoring</b>	Safe monitoring of the tool orientation
	<b>Safe changing unit (safe tool)</b>	Safe detection of tool and tool changes

# KeSafe Licenses

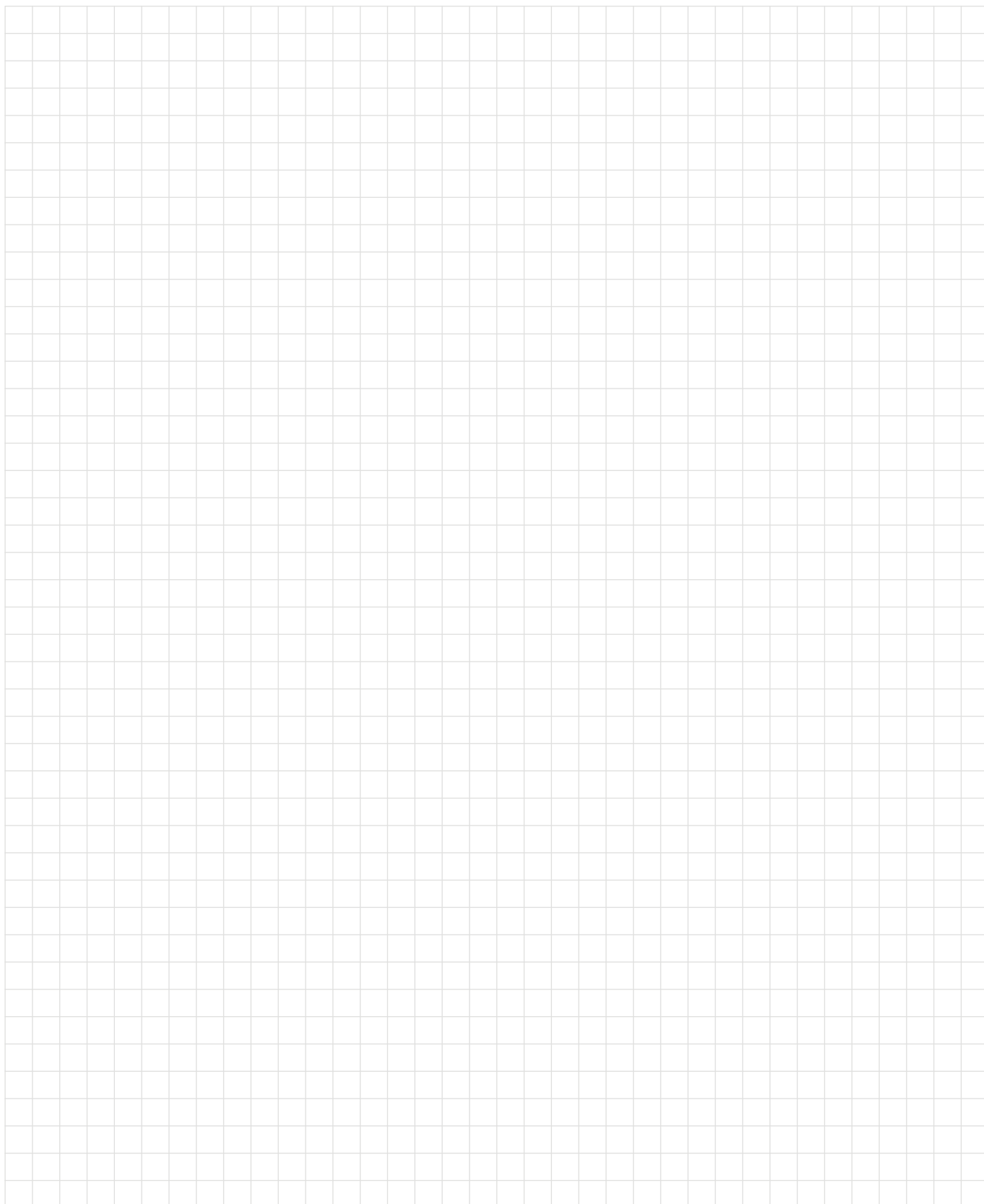
## Safety licensing model

Application area	License <sup>1)</sup>	Function
 <b>Safety functions for robotics</b>	RL Safe Robotics Advanced	SZMc Safe Cartesian Zone Monitoring
		SOMc Safe Orientation Monitoring
		SCUc Safe Changing Unit (Safe Tool)
	RL Safe Robotics	SRTc Safe Cartesian Robot Transformation
		SLSc Safely-Limited Cartesian Speed
 <b>Safety functions for single-axis monitoring</b>	RL Safe Motion Absolute	SLP Safely-Limited Position
		SEL Safe Emergency Limit
		SCA Safe Cam
		SRX Safe Referencing
	RL Safe Motion Relative	SOS Safe Operating Stop
		SDI Safe Direction
		SLS Safely-Limited Speed
		SLI Safely-Limited Increment
		SSx Safe Stop 1/2
 <b>Safety functions for logic</b>	RL Safe PLC	Logical operations/modules: <ul style="list-style-type: none"> <li>• AND, OR, XOR, Timer, RS-Flip-Flop etc.</li> </ul>
		Commonly used safety elements: <ul style="list-style-type: none"> <li>• Enabling button</li> <li>• Emergency stop</li> <li>• Door locking</li> <li>• 2-hand button</li> <li>• Limit switch</li> <li>• Light curtain</li> <li>• Operating mode selector switch</li> <li>• Sensor</li> </ul>
		Output elements: <ul style="list-style-type: none"> <li>• Safe digital outputs <sup>3)</sup></li> </ul>
		Safe interface to KeSafe system components: <ul style="list-style-type: none"> <li>• FSoE master via EtherCAT</li> </ul>
<b>Safe interfaces for data exchange with higher-level safety controller</b>	RLo Safe Interface FSoE-Slave <sup>2)</sup>	FSoE slave via EtherCAT
	RLo Safe Interface PROFIsafe F-Device <sup>2)</sup>	PROFIsafe F-device via PROFINET

<sup>1)</sup> Basic licenses (PLC to Robotics Advanced) always include all the functions of the lower-level basic licenses (for example: Motion Absolute includes the functions from PLC, Motion Relative and those described for Motion Absolute)

<sup>2)</sup> Possible in combination with all licenses

<sup>3)</sup> Can also be used for activating safety functions at the drive axis (STO – Safe Torque Off and SBC – Safe Brake Control) and at the encoder box (SBC)



# KeDrive D3-DU 3x5

## Safety controller

### Product features

- Best performance for I/O, single-axis and robot safety
- Fast response times
- Highly integrated in the functional control
- Expandability through safe bus protocols



### Short description

The safety controller is a safety option integrated in the KeDrive D3-DU. The integrated design means that the requirements with regard to compactness in the switching cabinet are particularly well met. This safety controller combines safety logic and drive monitoring in one device. Additional safety functions in the drive are therefore no longer necessary, with the exception of STO.

Simple safety tasks through to enhanced safety-oriented robotics solutions can be implemented easily and quickly. The safety controller already has 30 fail-safe inputs and outputs and enables expansion via EtherCAT.

The graphical programming tool with numerous predefined functions allows simple configuration of safety sensors and actuators and even entire robots. Inputs and outputs can be easily linked to the safety logic by means of "drag and drop".

### Digital safety inputs

Number of inputs	20
Input type	Type 1 (acc. to EN 61131-2)
Voltage range for "1"	$15\text{ V} \leq U_H \leq 30\text{ V}$
Voltage range for "0"	$-3\text{ V} \leq U_L \leq 5\text{ V}$
Status display	Green LED
OSSD-capable	Yes
Number of test outputs for cross-wire monitoring	4

### Digital safety outputs

Number of digital outputs	10
Nominal voltage	24 V DC
Nominal current of digital outputs	8 x 0.5 A; 2 x 2 A
Number of relay outputs	2
Max. voltage for relay outputs	230 V potential-free, N.O. contact
Nominal current for relay outputs	4 A
Status display	Orange LED
Overload protection / short-circuit proof	Yes

### General

Number of communication partners	8
Safety protocols	FSoE, PROFIsafe
Max. number of safe function blocks	500
Current consumption without I/Os	150 mA
Cycle time - safety controller	16 ms
Cycle time - FSoE	Min. 2 ms
Certification	CE, TÜV, UL
Safety class for I/Os	Up to PLe Category 4 acc. to EN ISO 13849-1 Up to SIL3 acc. to EN 61508
Safety class for axis safety	Depending on the encoder system used up to PLe category 4 according to EN ISO 13849-1 Depending on the encoder system used up to SIL3 according to EN61508



# KeDrive D3-SMM

## Safety encoder box

### Product features

- Decentral encoder evaluation
- Reduction of wiring
- Flexible range of application
- Fast monitoring of dynamics

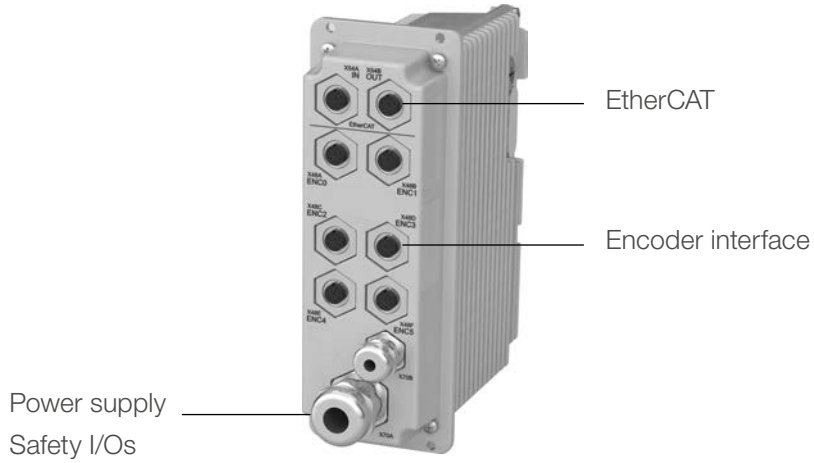


### Short description

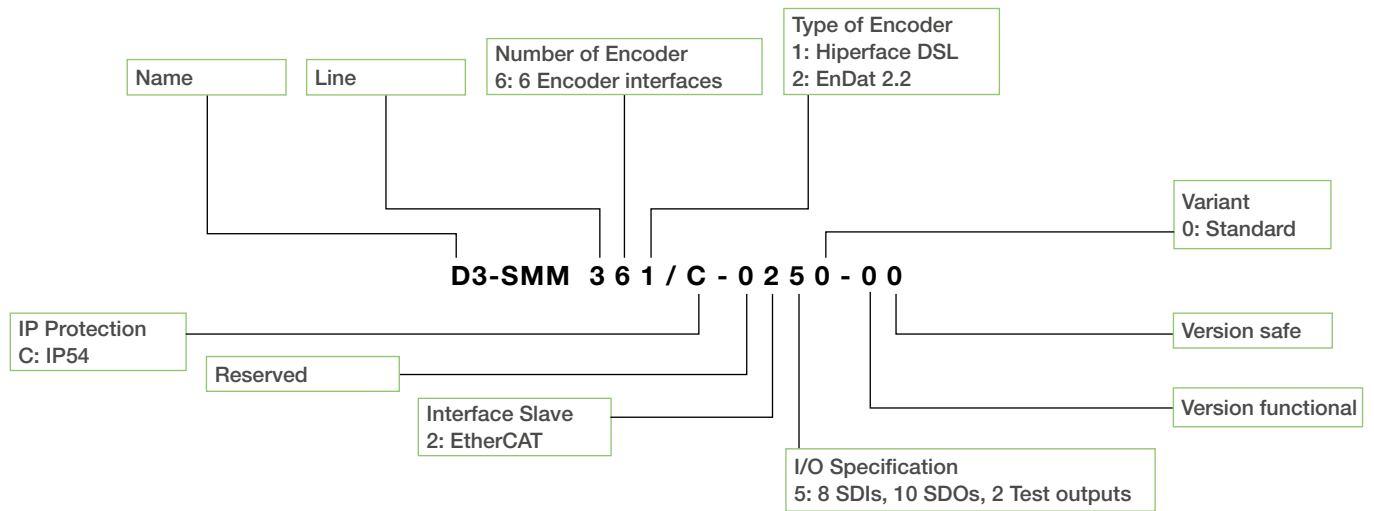
With the certified encoder box, encoder signals as well as additional safe inputs and outputs are read in decentralized and transmitted safely to the control system via a cable. The inputs enable the connection of safe buttons, switches or other operating elements directly at the machine or close to the robot. The outputs are used for safe control of the motor brakes or can be freely assigned to other tasks.

To ensure that the brakes are released safely (even without control cabinet), e.g. to prepare robots for transport, safety functions are implemented directly in the encoder box.

The encoder box is connected via the EtherCAT system bus. The FSoE safety profile enables the safe exchange of actual values and control commands.



## Type code



# KeDrive D3-SMM

## Safety encoder box

### Internal safety functions

SBC safe brake control	Safe control and monitoring of an external brake
SLS safely-limited speed	Monitoring of a speed limit value

### Digital safety inputs

Number	8
OSSD-capable	Yes
Number of test outputs for cross-wire monitoring	2

### Digital safety outputs

Number	10
Nominal voltage	24 V DC
Nominal current of digital outputs	1 x 2 A; 5 x 1 A; 4 x 0.5 A
Overload protection / short-circuit proof	Yes

### Interfaces

EtherCAT	2 connections
Protocols	CoE, FSoE
Encoder interfaces	6 x Hiperface DSL bzw. 6 x EnDat 2.2

### Dimensions, weight

Dimensions HxWxD	62 x 160 x 131 mm
Weight	1,950 g

### Environmental conditions

Operating temperature	+5 °C to +55 °C
Storage temperature	-40 °C to +70 °C
Relative air humidity	10% to 95% (non-condensing)
Vibration resistance / shock resistance	Acc. to EN 61131-2

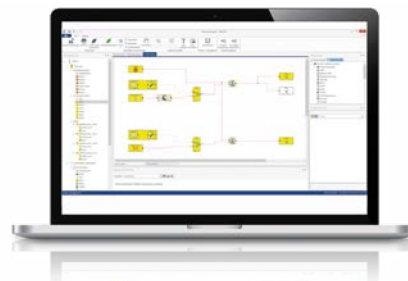
General	
Supply voltage	24 V DC, 19.2 V to 30 V, acc. to EN 61131-2
Current consumption incl. encoder without I/Os	Typ. 600 mA
Max. input current	6.5 A
Max. total power consumption	10 W
Additional power consumption safety technology I/Os	Under load: 144 W
Protection rating	IP54
Certification	CE, ATEX, TÜV, UL
Cycle time	125 µs / 4 ms (safety functions)
Safety class for I/Os	Up to PLe Category 4 acc. to EN ISO 13849-1 Up to SIL3 acc. to EN 61508
Safety class for SBC	PLd category 3 according to EN ISO 13849-1 per brake output SIL2 according to EN 61508 when used per brake output  PLe category 4 according to EN ISO 13849-1 when using 2 brake outputs SIL 3 according to EN 61508 when using 2 brake outputs
Safety class for SLS	PLd category 3 according to EN ISO 13849-1 when using Hiperface DSL encoders SIL2 according to EN 61508 when using Hiperface DSL encoders  PLe category 4 according to EN ISO 13849-1 when using EnDat 2.2 encoders SIL 3 according to EN 61508 when using EnDat 2.2 encoders

# KeStudio SafeEdit

## Safety programming

### Product features

- Graphical editor for safety applications
- Support of all functional KeSafe configuration levels
- Comprehensive diagnostic options
- Support during validation



### Short description

KeStudio SafeEdit is a graphically oriented software used to create applications for the safety controller. The implementation of simple safety applications (KeSafe PLC), applications with safe single-axis functions (KeSafe Motion) and comprehensive, safe robotics tasks (KeSafe Robotics) is supported in a user-friendly manner.

KeStudio SafeEdit2 is divided into three views: the connection diagram, the wiring diagram and the function diagram. The connection diagram is used to define the hardware configuration. The wiring diagram shows a graphical overview of how the projected safety components are interconnected. The function diagram is used for programmatic linking of the input modules and axes to be monitored, to the outputs of the safety controller and the safe peripheral devices by means of the available Safe-PLC, Safe-Motion and Safe-Robotics modules.

Apart from the possibilities for diagnosis, KeStudio SafeEdit2 also provides the functionalities necessary for the validation and documentation of the safety application.

## Hardware configuration

Selection and assignment of the used safety components

Safety control
Encoder evaluation
I/O extension modules
Input/output modules

## Wiring diagram

Display of the interconnection of the safety components used

Safety control
Encoder evaluations
I/O expansion modules
Input/output elements

## Graphical programming

Logical linking of

Input modules
Safe PLC modules
Safe Motion modules
Safe Robotics modules
Outputs of safety controller, encoder evaluations and I/O extension modules
Axis and robot modules

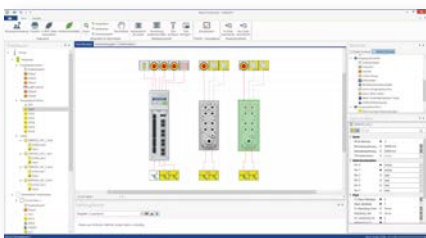
## Diagnosis and validation

Diagnosis

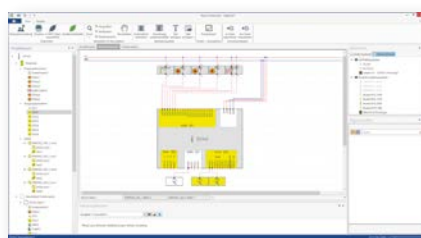
Process mapping (process data and safety application)
System info <ul style="list-style-type: none"> <li>• CRCs of the safety application</li> <li>• HW and FW version</li> <li>• Serial numbers</li> <li>• Transmission counter</li> </ul>
FSoE communication with the slave modules
Online diagnosis of the states of inputs/outputs as well as of function blocks

Validation

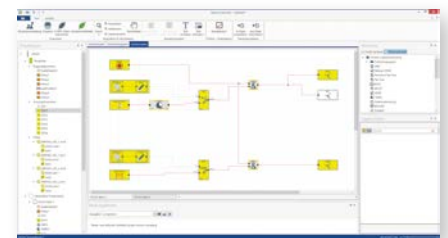
Configuration report generation
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Connection diagram example



Wiring diagram example



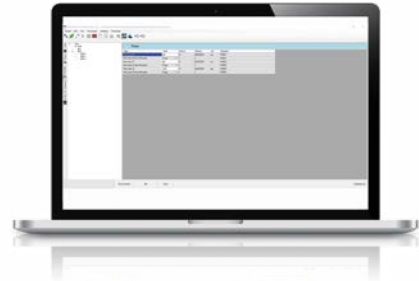
Function diagram example

# KeStudio SafePMT2

## Safety application customization

### Product features

- Graphical editor for safety applications
- Support of all functional KeSafe expansion stages
- Comprehensive diagnostic options
- Support for validation
- Know-how protection for the OEM



### Short description

The KeStudio SafePMT2 parameterization tool can be used to subsequently parameterize safety applications that have already been validated. In this way, the standard safety application of an implementation can be adapted to a specific application variant very easily.

For example, the OEM defines in advance in the SafePMT2 project which parameters of the standard safety application may be adapted in which value range. The user who carries out the parameterization (e.g. service technician, end customer, etc.) can thus only adapt those parameters that have previously been approved by the OEM. The advantage is that the person performing the parameterization does not necessarily have to be a safety expert, because the risks of incorrect parameterization are very limited. In addition, there is know-how protection for the OEM because, in order to be able to perform the adaptation of the safety application, the source code of the safety application (= KeStudio SafeEdit2 project) is not required.

In addition to support for validation and documentation of the adjustments made, KeStudio SafePMT2 also offers comprehensive diagnostic options. Furthermore, a FW update of the safety components can also be performed.



## Parameterization

Adaptation of validated safety applications: any enabled parameters can be set according to the permissible value range.

## Validation support

- Generation of the PMT report: Documentation of the application changes made with SafePMT2
- Setting of the validation status on the SCP: Confirmation of the application changes

## Diagnosis and update

### **Diagnosis:**

- Process image
- System info (CRCs, transfer counter, serial number, version number)
- FW info
- Scope function

### **Update:**

- FW update

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