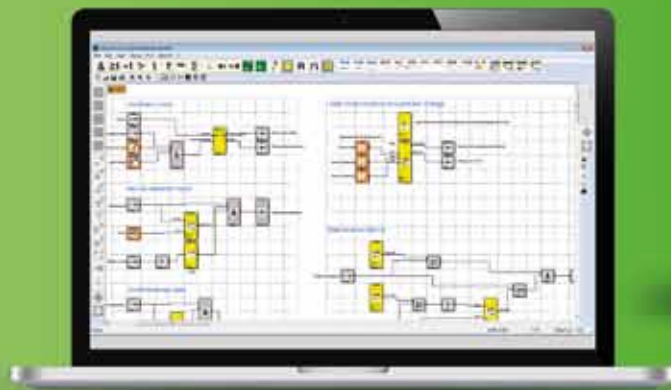




# KeSafe Safety technology



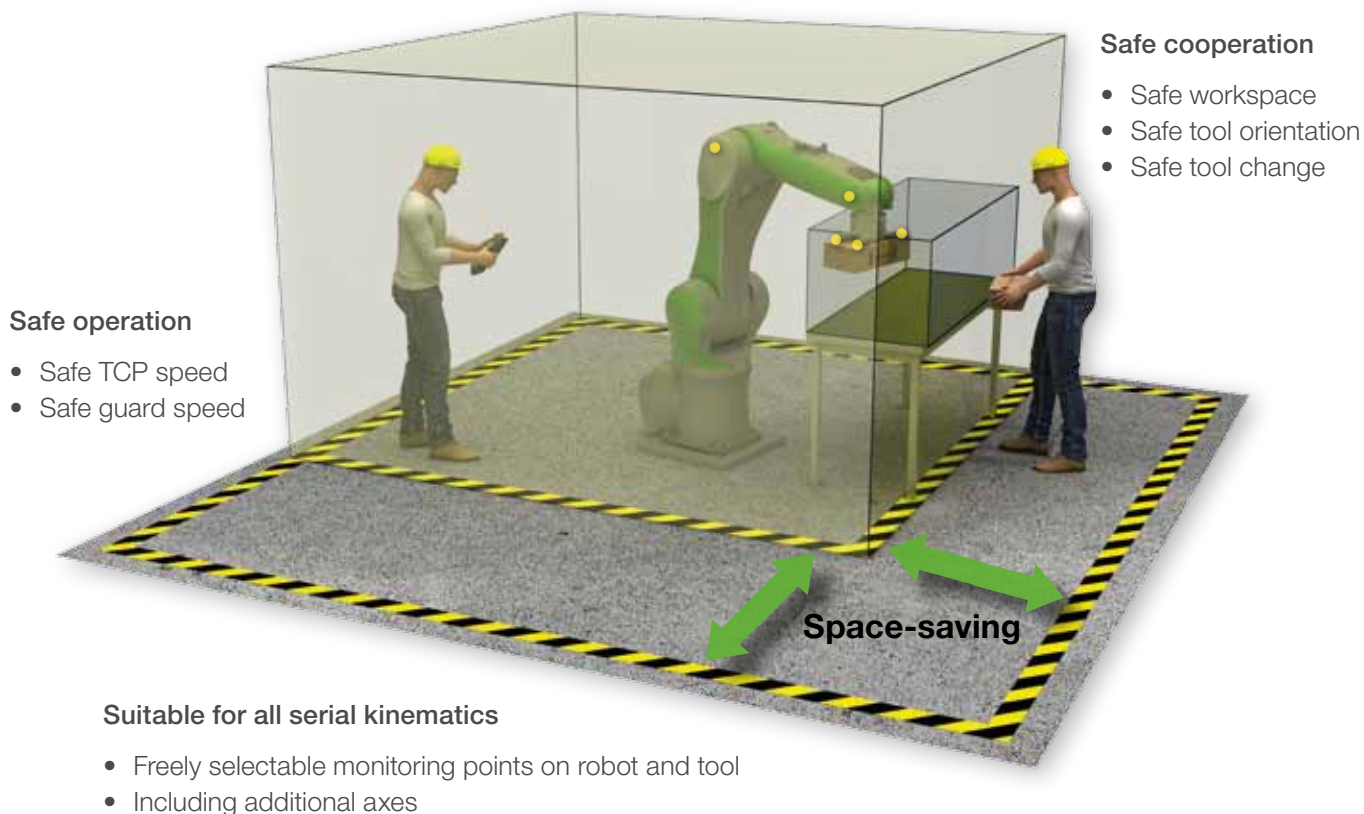
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# KeSafe

## 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.





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# KeSafe

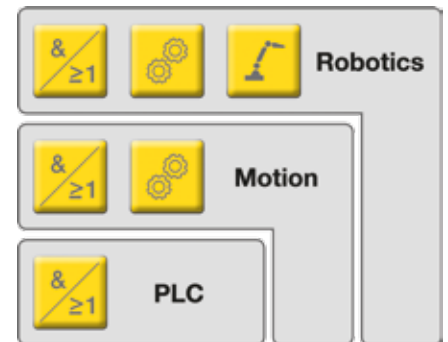
## Safety technology

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 SafeEdit application tool integrated in KeStudio. This tool also enables diagnosis of the safety application and is additionally used for validation of the application.

## System layout



KeStudio SafeEdit

Ethernet



KeDrive D3  
including safety  
controller

EtherCAT FSoE



KeDrive DMS2 motor  
with safety encoder

Hiperface DSL



KeDrive D3-SMM  
encoder box

# 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 SafeEdit can be used to freely enable linking of input states and to reliably activate actuators via safe digital outputs. Drive-specific safety functions such as STO (Safe Torque Off) and SBC (Safe Brake Control) can also be realized in this way.

KeSafe PLC		Function
Logical operations		Standard modules such as AND, OR, XOR, NOT, RS-Flip-Flop, Timer, EDM (External Device Monitoring)
	Enabling button	1- or 2-channel input signals, logical and optional time-based comparison for 2-channel inputs, optional confirmation request after start/actuation.
	Emergency stop	Logical and optional time-based comparison of the two inputs, optional confirmation request after unlocking.
	Door locking	2- or 3-channel input signals, logical and optional time-based comparison of the input signals, optional confirmation request after start/actuation.
	2-hand button	2- or 4-channel input signals, monitoring of the input signals acc. to EN 574. Certified function for 2-hand operation.
	Limit switch	1- or 2-channel input signals, logical and optional time-based comparison of the two inputs
	Light curtain	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.
	Operating mode selector switch	2- or 3-channel input signals, logical monitoring of the input signals.
	Sensor	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.
	Safe digital output	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.
	Safe relay output	1 or 2-channel relay output with static and dynamic testing, optional feedback loop for monitoring the switching function
	FSOE	Safety over EtherCAT as master

## Safe data exchange with higher-level safety controller

KeSafe interface		Function
	PROFIsafe	Functional safety via PROFINET as PROFIsafe F-device
	FSOE	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 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 protocol. In KeStudio SafeEdit, 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.



## Safety functions for single-axis monitoring

KeSafe Motion Relative	Function
 <b>SOS</b>	<b>SOS Safe Operating Stop</b> Standstill monitoring of active motor
 <b>SDI</b>	<b>SDI Safe Direction</b> Monitoring of the direction of movement
 <b>SLS</b>	<b>SLS Safely-Limited Speed</b> Monitoring of a speed limit value
 <b>SLI</b>	<b>SLI Safely-Limited Increment</b> Adherence to a specified increment size is monitored during movement
 <b>SSX</b>	<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

KeSafe Motion Absolute	Function
 <b>SLP</b>	<b>SLP Safely-Limited Position</b> Monitoring for exceeding a position limit value
 <b>SEL</b>	<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>SCA</b>	<b>SCA Safe CAM</b> A safe output signal is generated while the motor position is in a specific area
 <b>SRX</b>	<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








### 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 SafeEdit 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 protocol.




## Safety functions for robots

KeSafe Robotics		Function
	Safe Cartesian Robot Transformation	Safe robot transformation
	Safely-Limited Cartesian Speed	Safe speed monitoring of up to 7 freely selectable points on the robot

KeSafe Robotics Advanced		Function
	Safe Cartesian Zone Monitoring	Safe Cartesian position monitoring of arbitrary points on the robot
	Safe Orientation Monitoring	Safe monitoring of the tool orientation
	Safe Changing Unit (Safe Tool)	Safe detection of tool and tool changes

# KeSafe Licenses

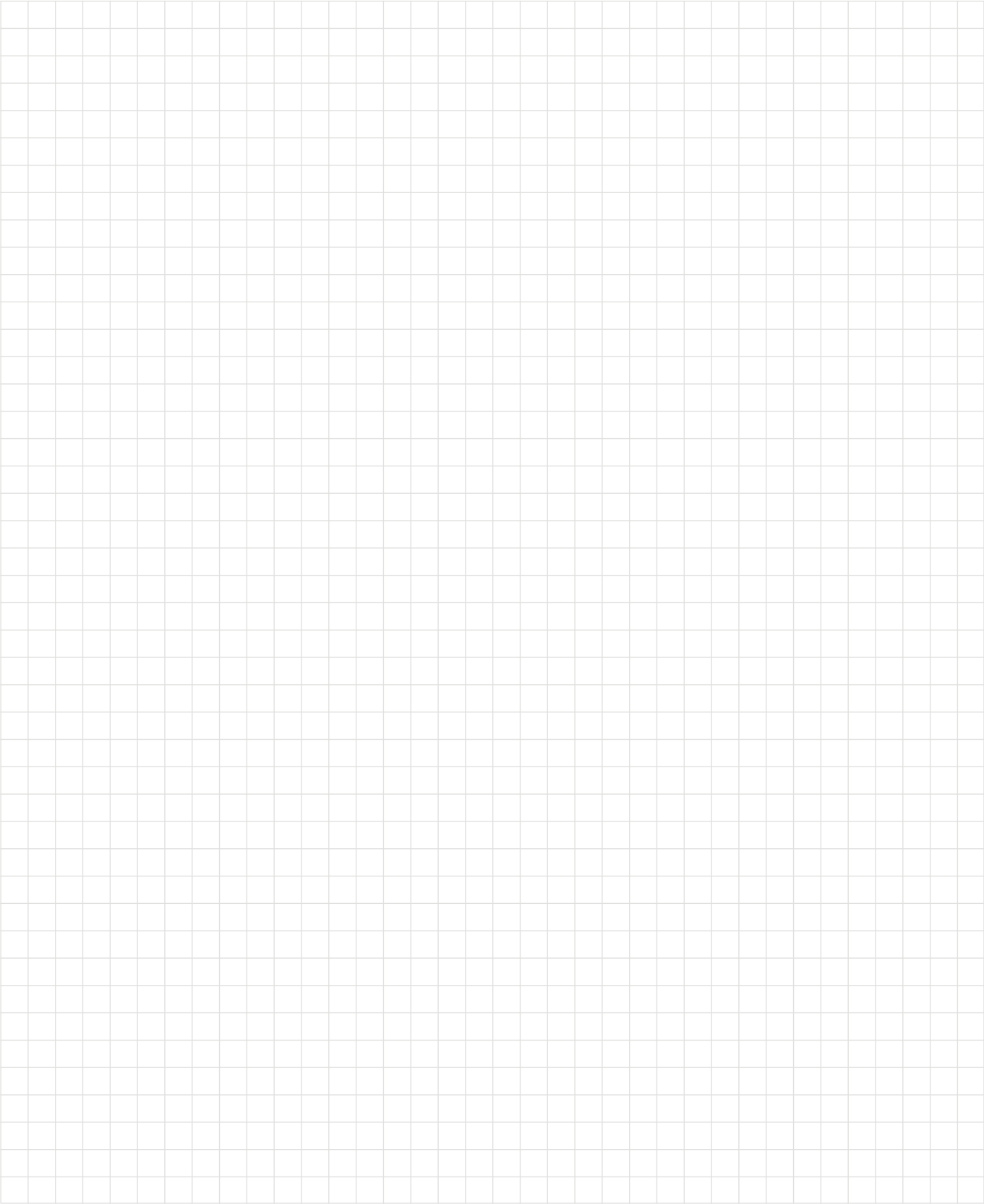
## Safety licensing model

Application area	License <sup>1)</sup>	Function
 <b>Safety functions for robotics</b>	KeSafe Robotics Advanced	SZMc Safe Cartesian Zone Monitoring
		SOMc Safe Orientation Monitoring
		SCUc Safe Changing Unit (Safe Tool)
	KeSafe Robotics	SRTc Safe Cartesian Robot Transformation
		SLSc Safely-Limited Cartesian Speed
 <b>Safety functions for single-axis monitoring</b>	KeSafe Motion Absolute	SLP Safely-Limited Position
		SEL Safe Emergency Limit
		SCA Safe Cam
		SRX Safe Referencing
	KeSafe 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>	KeSafe 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>	KeSafe Interface FSoE-Slave <sup>2)</sup>	FSoE slave via EtherCAT
	KeSafe 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
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	Up to PLd Category 3 acc. to EN ISO 13849-1 Up to SIL2 acc. to EN 61508

# KeDrive D3-SMM

## Safety encoder box

### Product features

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



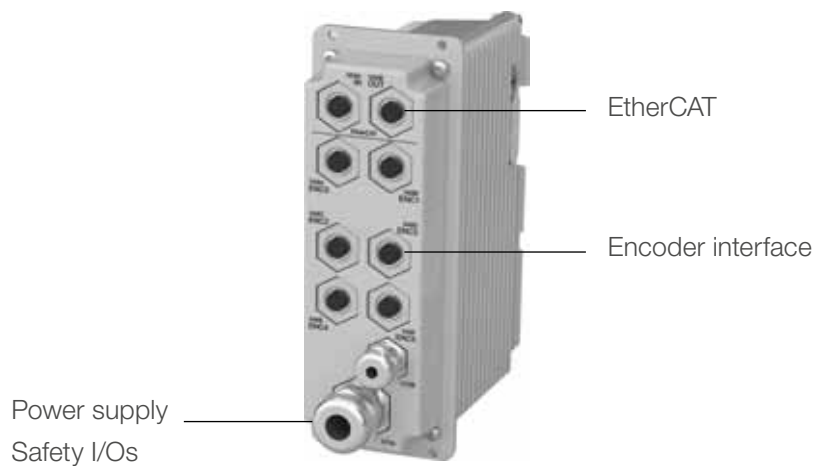
### Short description

The certified encoder box decentrally reads in encoder signals as well as additional safe inputs and outputs and transmits them to the controller 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. All outputs are used for safe control of the motor brakes or can be freely assigned to other tasks.

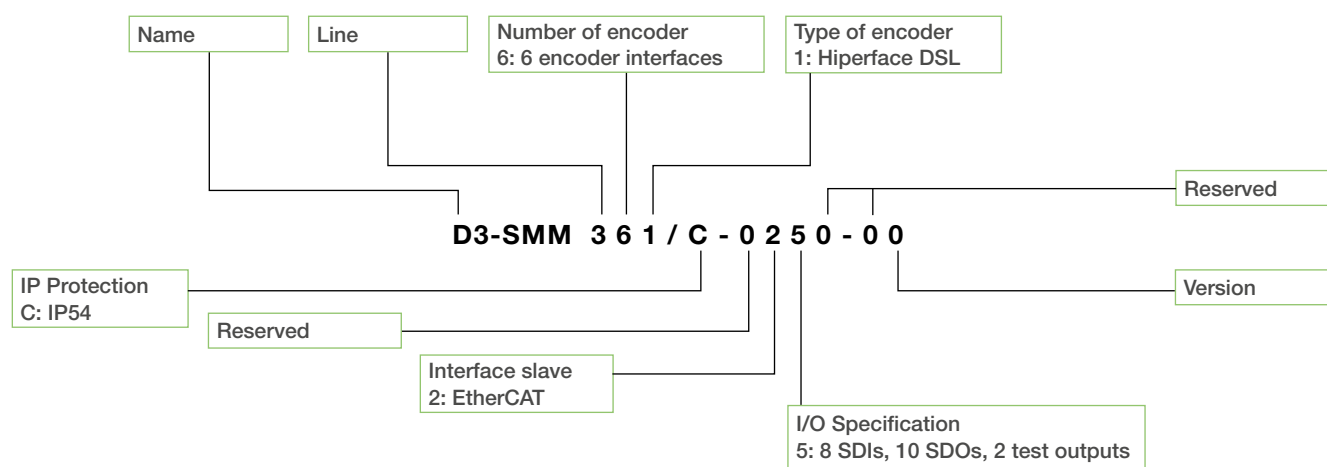
To ensure that the brakes are released safely (even without control cabinet), e.g. to prepare robots for transport, safety functions are implemented directly in the encoder box.

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

### 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

# 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 SafeEdit is split into two views: the terminal diagram and the function diagram. The terminal diagram is used to define the hardware configuration. 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 SafeEdit also provides the functionalities necessary for the validation and documentation of the safety application.

## Hardware configuration

### Selection and interconnection of the used safety components

Safety controller
Encoder evaluation
I/O extension modules
Input/output modules
Axis and robot modules

## 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

## Diagnosis and validation

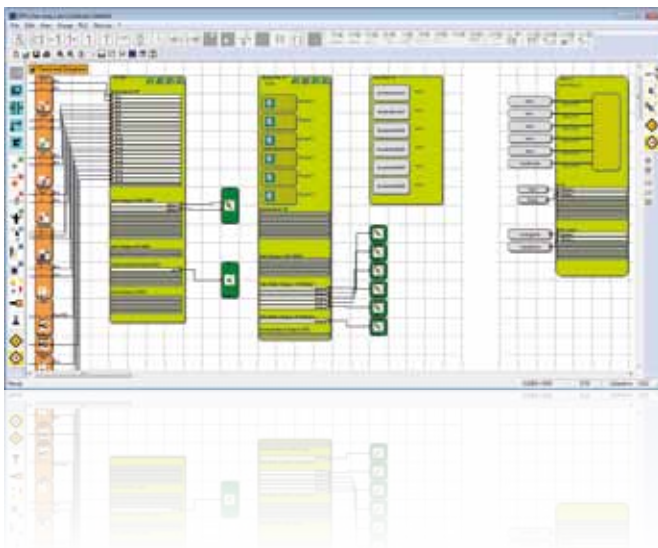
### Diagnosis

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

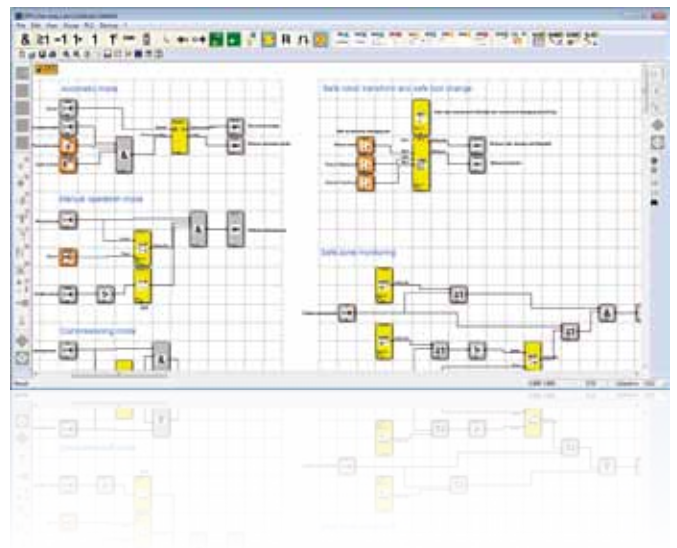
### Validation

Configuration report generation
---------------------------------

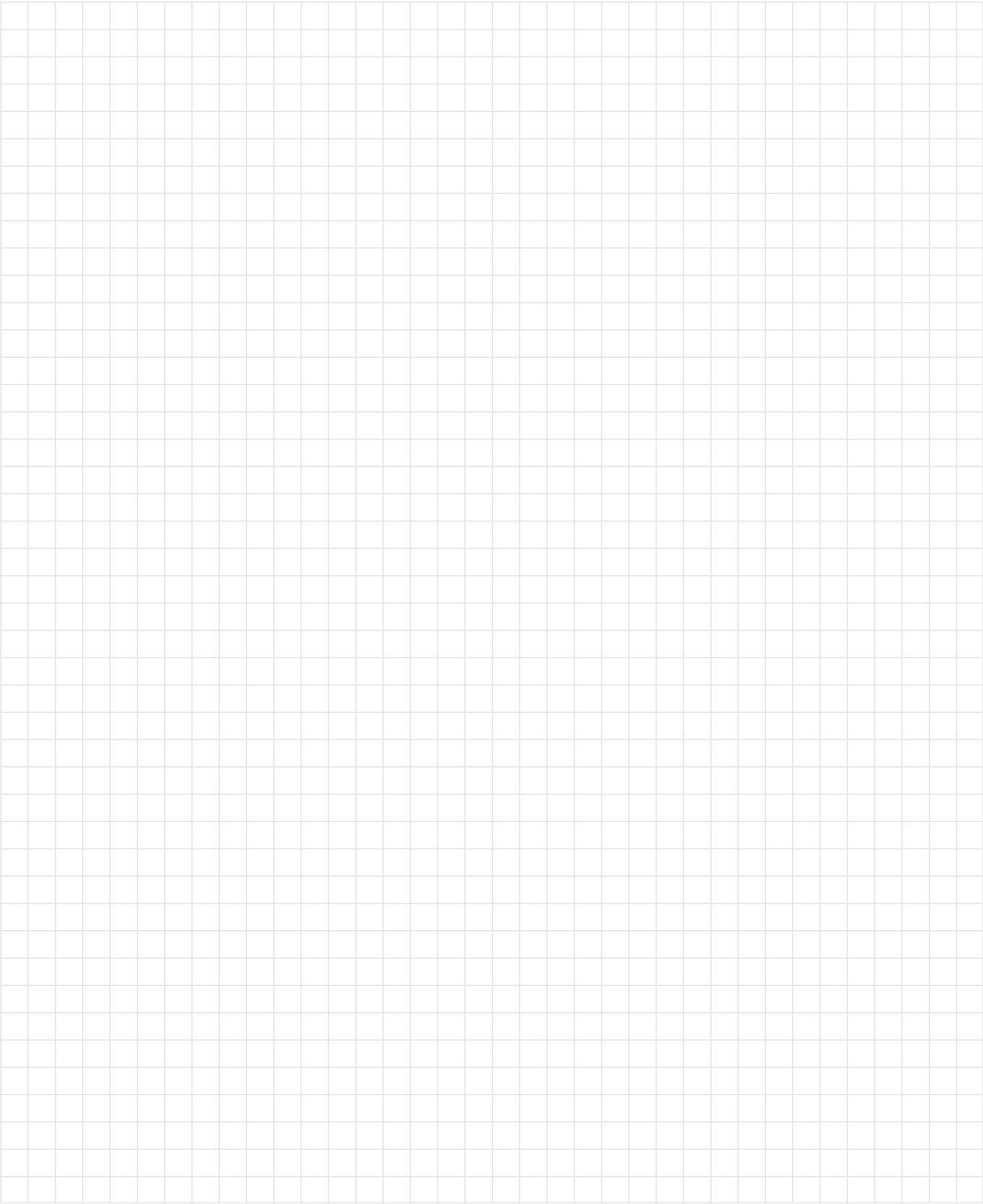
Example of a terminal diagram:



Example of a function diagram:







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