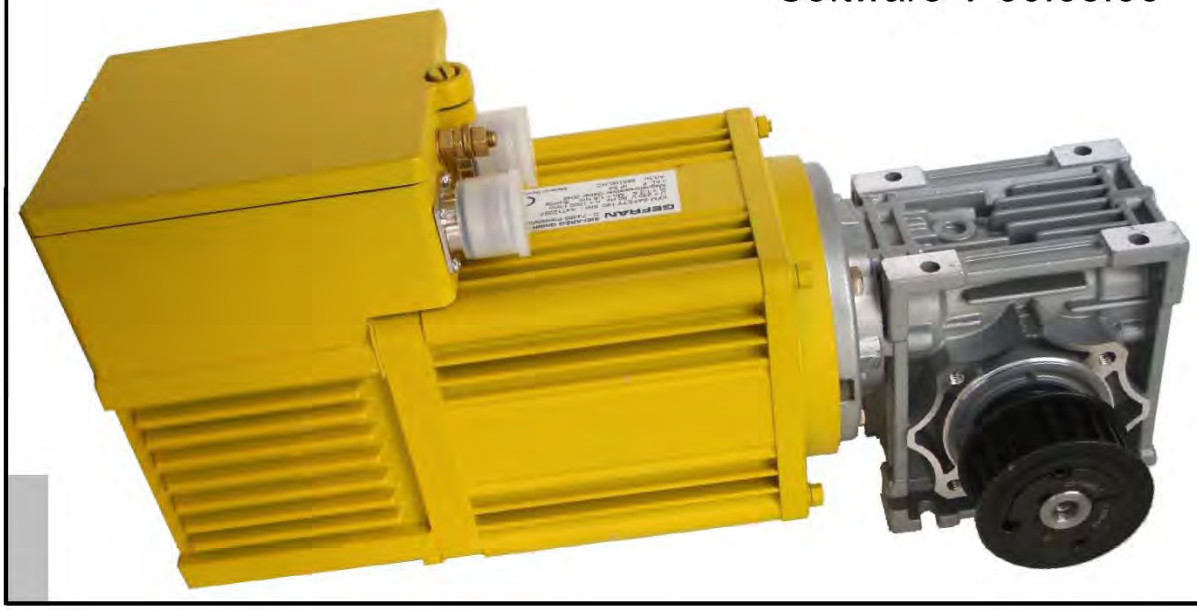
Sinus Motor Drive

Machine protection door drive

Safe function with PL e and Sil 2

PCB LP1271R4 and LP1231R10

Software V 50.03.00



KFM SAFETY 3

.... Manual

including Safety Manual

WEG Automation GmbH

Reserve technical changes

No.: 918 200-e Rev: 01/23

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD Management Service

CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH

certifies that

WEG Automation GmbH
Gottlieb-Daimler-Str. 17/3
74385 Pleidelsheim
Germany

has established and applies
a Quality Management System for

Development, Production and Marketing of Electronically Controlled Drive Systems.

An audit was performed, Order No. **70013772**.

Proof has been furnished that the requirements according to

DIN EN ISO 9001:2015

are fulfilled.

The certificate is valid from **2022-11-23** until **2025-08-27**.

Certificate Registration No.: **12 100 20483 TMS**.

Head of Certification Body
Munich, 2022-11-25

IAF MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT

DAkkS Deutsche Akkreditierungsstelle D-ZM-14143-01-00

MS/01-01/2019

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1 Notice about this document

1.1 About this manual

The information in this manual is non-binding for WEG AUTOMATION GmbH and subject to changes without prior notification.

The reproduction of this document, in full or in part, and by whatever means (including scanning and photocopying) is only permitted with the written consent of WEG AUTOMATION GmbH.

WEG AUTOMATION GmbH shall not be liable for damage arising in connection with errors or omissions in this manual.

This manual must be read prior to the installation, connection, commissioning and operation of the KFM SAFETY 3 and all instructions must be strictly adhered to. This applies in particular to chapter 2 "Safety instructions" and chapter 20 "Safety manual".

This manual refers to the KFM SAFETY hardware and software status as per 06/02/18.

Hardware:	LP1271R4 from 06/04/17 and LP1231R10 from 20/11/17
Software:	Version V50.03.00 of 24/08/2016
Functionality:	Machine protection door actuator according to technical requirement specifications.

The KFM SAFETY 3 software can only be modified and updated at the factory or by WEG Automation Service!

After the software has been released, the relevant information regarding the software is included on the CD-ROM in file LIESMICH.TXT or README.TXT.

! Copyright !

This document is a translation of the original KFM SAFETY 3 Manual.

It contains the SAFETY manual to the KFM SAFETY 3!

2 Safety instructions

Carefully read this document before carrying out any work in connection with the commissioning and installation of the drive with integrated frequency inverter. All instructions in this manual must be strictly adhered to.

2.1 Symbols

The following symbols, pictograms and wordings are used in this manual:

	Danger
	This symbol indicates an imminent danger to life and limb. Non-compliance with the instructions can be fatal!
	Danger
	This symbol indicates an imminent danger to life and limb from electrocution. Strictly follow all safety instructions!
	Warning
	This symbol indicates a potential risk. Non-compliance with the instructions might result in injury or serious damage to property. Always observe warnings!
	Notice
	This symbol highlights important information and operating instructions. Non-compliance with the instructions might result in injury, damage to property or machine malfunction.
	Check
	This symbol highlights individual steps of a test or check. Always perform the tests/checks, following the instructions. They are designed to prevent injury and damage to property.
	ESD
	Special safety measures to be taken when handling electronic components

Figure 1: Warning symbols/pictograms

2.2 General

During operation, exposed parts of the drives with integrated frequency inverter might be energized in line with the protection class. There might also be rotating or moving components and certain surfaces might become hot.

If covers or guards are removed, or if the device is incorrectly installed, operated or used for a purpose for which it is not suitable, there is a risk of serious or even fatal injury and damage to property.

For more information, see the relevant chapters in this document. 

All work in connection with the transport, installation, commissioning and maintenance of the device must be performed by **suitably qualified personnel** (observe DIN IEC 60364, CENELEC HD 384 or DIN VDE 0100 and DIN IEC 60664, or DIN VDE 0110 and applicable statutory health and safety regulations).

For the purpose of these general safety instructions, qualified personnel are persons who are familiar with the tasks involved in the installation, assembly, commissioning and operation of the product and are qualified to perform the assigned tasks.

2.3 Intended use, purpose of device

Drives with integrated frequency inverter are components designed for installation in electrical plants and machines.

For installation in machines, the drives with integrated frequency inverter must not be commissioned or started until the machine into which they are integrated has been found to conform to the requirements laid down in the Machinery Directive 2006/42/EC. Observe the requirements in DIN EN 60204-1.

Commissioning is only permitted, if the requirements of the EMC Directive 2014/30/EG are met.

The drives with integrated frequency inverter meet the requirements of the Low Voltage Directive 2014/35/EG.
The drives with integrated frequency inverter have been designed in accordance with the harmonized standards of the EN 50178 or DIN EN 62477-1, in conjunction with DIN EN 61800-x. (See detailed listing in the appendix of the CE declaration of conformity)

For technical data and details regarding the electrical connection, see rating plate and the relevant chapters in this document. Strictly adhere to these specifications. 

2.4 Transport and Storages

Observe all instructions for transportation, storage and safe handling.

The climate conditions of climate class 3K3 according to EN 50178 must be met. For details, see chapter 10.7.7 and other sections in this manual.

2.5 Installation

The device must be installed and cooled according to the instructions in this document. For details, see chapter 13.

The drives with integrated frequency inverter must be protected against excessive mechanical loads and impacts. When transporting and handling the device, ensure that none of its components become bent and that none of the insulation distances are changed. Avoid touching the electrical components and contacts.

Drives with integrated frequency inverter can be damaged by electrostatic discharge, especially during incorrect handling.
When handling the KFM SAFETY, always observe the ESD instructions.

Electrical components must not be mechanically damaged,
as such damage poses a health and safety risk!

2.6 Electrical connection

General warnings relating to work on electrical components, devices and plants!

Before carrying out any work on devices, components and lines, de-energized them!
When shutting down the machine or plant, secure it against inadvertent or unauthorized switching on!

Check whether the relevant components are de-energized and short-circuit or earth the power supply lines, if necessary.

Drives with integrated frequency inverter contain capacitors that remain powered with high voltage for a time after disconnection from the power supply.

After shutting down the mains power supply, wait for at least 5 minutes (capacitor discharge time) before opening the cover of the KFM SAFETY. Before opening the cover, the residual voltage in the intermediate circuit must have dropped to below 60V. To check whether the device is safe, measure this voltage with the voltmeter.

In the event of a fault, the capacitor discharge time might be much longer than 5 minutes. When working on drives with integrated frequency inverter that are powered, strictly adhere to the applicable health and safety regulations (e.g., BGV A3).

The electrical installation must be carried out according to the relevant regulations and best practice (e.g., wire cross-sections, fuses, circuit breakers, line installation, connection to protective conductors). For additional instructions, see this manual.

Do not perform insulation checks between the terminals or plug-type connectors (mains and signal lines) of the KFM SAFETY and the PE potential. Insulation checks at the KFM SAFETY can damage or even destroy the device. All necessary insulation checks are performed at the factory.

Interference with the electronic or mechanical components of the KFM SAFETY shall void the warranty. The manufacturer shall not be liable for damage arising in connection with or as a consequence of such interference.

This document contains important instructions for EMC-compliant installation, including shielding, earthing, arrangement of filters and line routing. These instructions must also be adhered to for work on drives with integrated frequency inverter that bear the CE mark.

The manufacturer (distributor) of the plant or machine is responsible to ensure compliance with the relevant EMC regulations and for the measurement of the interference level.

2.7 Operation

Plants and machines that feature drives with integrated frequency inverter might need to be equipped with additional monitoring and safety devices, in compliance with the applicable safety regulations, including safety regulations for technical equipment, health and safety regulations, etc. The supplied operating software of the KFM SAFETY might be modified or optimized, if necessary. Always adhere to the statutory regulations regarding the permissible closing force and energy of the moving part of the device.

Depending on the performance level, certain surfaces of the KFM SAFETY might reach temperatures of up to 90°C. Take suitable measures to prevent contact with the KFM SAFETY while it is in operation and ensure that other temperature-sensitive components cannot be damaged.

After disconnecting the drives with integrated frequency inverter from the mains power supply, do not touch electrically powered components, as the capacitors might still retain electric energy.

Wait for at least 5 minutes before opening the cover of the housing (capacitor discharge time). Do not carry out any work on the device until the residual voltage in the intermediate circuit has dropped to below 60V! This voltage must be measured with a voltmeter.

In the event of a failure or malfunction, the capacitor discharge time might be much longer than 5 minutes. Also observe the safety signs and symbols attached to the drives with integrated frequency inverter.

During operation, always keep all covers, guards and doors closed.

2.8 Maintenance and servicing

For all maintenance and servicing tasks, strictly adhere to the instructions in this document. For more information, see chapter 11.4.

Keep a copy of this document and the safety instructions for future reference.

2.9 Warranty and liability

The General Business Terms and Conditions of WEG AUTOMATION GmbH apply.

The manufacturer shall not be liable for personal injuries and damage to equipment caused by:

- Improper use or operation of the door drive
- Incorrect installation, commissioning, operation or maintenance of the door drive
- Operation of the door actuator with defective/malfunctioning guards or safety devices
- Non-compliance with the instructions in this manual regarding the transport, storage, installation, commissioning, operation and maintenance of the door drive
- Interference with electronic or mechanical components of the door drive
- Unauthorized modifications to the door drive or its components
- Unauthorized modifications to the safety device, including disabling, overloading and use for a purpose other than the intended
- Insufficient inspection and monitoring of parts subject to wear and tear
- Incorrectly performed repairs
- Damage caused by force majeure and external influence outside the control of the manufacturer

3 Electromagnetic compatibility

The KFM SAFETY 3 has been designed and manufactured in accordance to the European EMC Directive and meets the relevant limits as regards protective measures and mains filters.

Electromagnetic interference **Electromagnetic immunity**

Figure 2: EMC

The following general measures must be taken to ensure compliance with the relevant standards and limits that form part of the EMC and the Machinery Directives:

- Proper and large metal contact area between the device's rear panel and the installation surface (remove coating, if any), skin effect, in particular in connection with auxiliary filters, if such filters are required
- Proper earthing of housing (brass bolts); auxiliary filters with a cross-section of minimum 10 mm²
- The earth connections must extend in a star pattern from a good earth pole (brass bolt) and must not form any earth loops.
- The mains power and control lines must be installed separately. Crossing between these lines must be at a 90° angle.
- To comply with the EMC Directive, the mains power line should be shielded (e.g. ÖLFLEX® CLASSIC 100 CY 3G1.5 or equivalent/higher), even if this is not specifically required.
- The lines for control signals must be shielded (e.g. UNITRONIC® LiYCY 20 x 0.5 mm² (or equivalent/higher).
- The shielding of the lines must have a large contact area, e.g. by using Omega clamps or similar systems. (See Figure 3)
- Use cable fittings with EMC connectors or shield contacts.
- Prevent twisting of the shielding mesh as the resulting "wire" would act like an antenna.
- Auxiliary figures must be installed as close as possible to the device, in order to minimize EMC emissions.

Figure 3: Shielding contact

Where several devices are operated together, additional EMC measures might be necessary.

Compliance with the limit values is greatly influenced by the installation and combination of other devices on the one hand, and the actual application on the other. It is therefore not possible to make any conclusive statements regarding limit values, as such an assessment can only be made by measuring the relevant values after completion of the installation and when the machine or plant is ready for operation.

The distributor must perform these measurements to ensure that the relevant standards and directives are complied with.
It is the responsibility of the machine manufacturer to provide evidence of compliance with the EMC limit values for emission and immunity, as the CE mark always applies to the complete machine or plant.
In this contact, he must take into account the agreed end customer specifications and the statutory regulations that apply at the location of operation.

4 General information about the KFM SAFETY 3

The KFM SAFETY 3 is a new certificate product that has been developed in accordance with the EN 61508 safety standard under the guidance and supervision of TÜV Nord.
The number 3 in the KFM SAFETY 3 refers to the TÜV Nord safety certificate, which is available in the third version and is valid from 2022 to 2027.
The controller PCB is equipped with two micro-processors and two sensors that measure the speed in a 1oo2 system.
The KFM SAFETY 3 features the safety functions STO, SLT and SLS and is therefore suitable for use in horizontal machine protection doors without the need of additional sensors.
To operate a horizontal machine protection door equipped with the KFM SAFETY 3, the door must feature a suspension and running mechanism as well as a fail-safe limit switch, which might include a locking mechanism so that the machine control system knows when the door is in a safe state (door CLOSED).

The innovative, distributed KFM SAFETY 3 actuator consists of the following components: asynchronous motor, frequency converter, mains filter, communication devices, optional field bus, digital interfaces, encoders and an intelligent control system with two separate micro-controllers. The KFM SAFETY 3 thus forms a complete, universal actuator for horizontal machine protection doors.

It comes in a compact housing so that the KFM SAFETY 3 can be integrated easily into a wide range of horizontal machine protection doors and similar devices. In addition, the KFM SAFETY 3 requires only minimum cabling and takes up little space in the control cabinet. In many cases, it can be installed without the need for a control cabinet. The KFM SAFETY 3 can be adapted by means of gear mechanisms and timing belt pulleys that are part of the drive pack to meet customer requirements.

For hardware control, the device comes with 2 two-channel, safe digital inputs, 4 standard digital inputs and 5 standard digital control outputs for24V_{dc} (galvanically isolated through opto-couplers). There are also 2 analog inputs (switchable, 0 – 10V, 4 – 20 mA) and one10V_{dc} power supply for operation with a potentiometer. The 6 LEDs on the housing indicate its operating and diagnostic states.

Thanks to its safety functions, reliability, optimized secure software, compact dimensions and integrated safety functions, the KFM SAFETY 3 is the ideal solution for the operation of horizontal machine protection doors.

The KFM SAFETY 3 can be controlled through a number of different interfaces.

For fast commissioning and exchange, the KFM SAFETY 3 is also available as a plug-type model (with M23 metal flange). Alternatively, the KFM SAFETY 3 can be connected directly to the terminal cover.

The KFM SAFETY 3 has been designed and optimized for the operation of horizontal machine protection doors.
If the KFM SAFETY 3 is used for other applications, the operator must first assess whether there is a need for additional safety measures or parts such as counterweights, safe components, etc.

For assistance, customers can contact WEG AUTOMATION GmbH.

5 Safety functions of the KFM SAFETY 3

5.1 General safety functions

The KFM SAFETY 3 has been certified by TÜV Nord as a machine protection door actuator for horizontal machine protection doors with safety functions according to EN 61508.
The KFM SAFETY 3 meets the requirements of EN 61508 safety class SIL2 and is classified in EN 13849 category 3 with performance level PL d.

Measured characteristic values: PFH = 1.01 E^{-11}, $MTTF_d$ = 100 years and DC_{avg} = 98.54 %.
For additional characteristic data, see chapter 20.6.2.

Relationship between the various standards and safety levels SIL / PL.

The applied standards are based on IEC 61508.

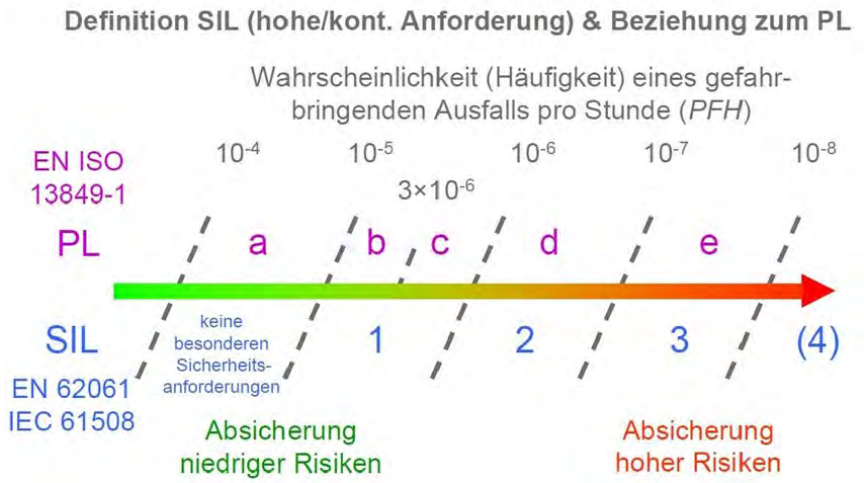


Figure 4: Relationship between standards

The standard defining the requirements of movable guards EN 953 includes limit values for automatically moved guards. This standard also specifies that the kinetic energy in moving guards must not exceed 10J and that the closing force must be maximum 150N.
The draft standard for certain machines might however contain other values for closing force and maximum energy. These values can be adjusted at the KFM SAFETY 3.

For the purpose of this manual, the closing force is set to F = 150N and the energy limit value is E = 10J.

The closing and opening force of the KFM SAFETY 3 is generated by the torque transferred through the gear mechanism or the timing belt coupling to the machine protection door.

Closing force limitation ⟷ Torque limitation

The kinetic energy $E = \frac{1}{2}mv^2$ in the machine protection door must be limited to E = 10J. The mass of the machine protection door is defined by its mechanical construction. To limit the kinetic energy of the machine protection door, the KFM SAFETY 3 must therefore limit the speed of the door movement.

Kinetic energy limitation ⟷ rotary speed limitation

These relationships define the safety functions of the KFM SAFETY 3.

5.2 Safety functions according to EN 61800-5-2 in KFM SAFETY 3

5.2.1 Safe Torque Off STO

This function switches the KFM SAFETY 3 to safe torque off status, i.e., the IGBT amplifier is safely locked and secured against switching on (Safety Safe Mode).
This function can be activated by means of the two safe external input signals / STO. The function is also activated, if the monitoring system detects inconsistencies in other safety or protection functions (SLS, SLT, overheating, etc.).

5.2.2 Safety-limited speed SLS

This safety function limits the speed of the door to a set value in order to limit the energy in the machine protection door to < 10J. The value must be determined based on the mass of the machine protection door (which must be known) and is then set accordingly and validated.

5.2.3 Safety-limited torque SLT

To prevent injury from crushing when the machine protection door closes, this safety function limits the closing force of the door to 150N. If the closing force exceeds 150N, or if an obstacle is detected, the control activates the STO function. As a consequence, the door movement is slowed down along a ramp to zero. The KFM SAFETY 3 moves backwards by a set distance (to release jammed objects) and the door movement is stopped.

5.3 Important information regarding the KFM SAFETY 3

The KFM SAFETY 3 consists only of an actuator for a horizontal machine protection door. The design and installation of the machine protection door and the risk analysis of the entire machine including the machine protection door do not form part of the scope of delivery of the KFM SAFETY 3 system. The risks associated with the KFM SAFETY 3 must be identified, assessed and eliminated or minimized as part of the risk analysis performed by the machine manufacturer. Chapter 20 in the safety manual contains important information for the dimensioning and design of the machine protection door and the use of the KFM SAFETY 3.

5.4 Functions of KFM SAFETY 3

The KFM SAFETY 3 implements all protective and safety functions for the movement of the door. It is able to keep the door open and closed (position control) without the need for external devices (brakes, etc.). All the machine manufacturer needs to do is to install a fail-safe limit switch transmitting the "door CLOSE" signal to the machine control system.

Important!

For the safe operation of the machine or plant, a safe "door CLOSE" signal must be generated by a **fail-safe limit switch**. This switch might also feature a locking mechanism attached to the frame of the machine. Such a locking mechanism is mandatory for high-speed machining units with tools or dies (presses, injection casting, die casting machines).

- Thanks to the resolution of sensor A of 2048 pulses per revolution, the sensor is able to accurately determine the position of the rotor and thus allows for high-performance control and flexible, accurate positioning (32-bit position controller). The machine protection door can be kept in positions "door OPEN" and "door CLOSED" without the need for any additional devices.
  The second sensor B and an additional micro-processor monitor both micro-processor A and sensor A. Both micro-controllers can independently disable the amplifier the moment deviations or faults are detected. The KFM SAFETY 3 is instantly set to a safe state (STO amplifier disabled) and remains in this state until a system reset or mains off.

- For hardware control, the device comes with 2 two-channel, safe digital inputs, 4 standard digital inputs and 5 standard digital control outputs for 24 Vdc (galvanically isolated through opto-couplers).
  The 6 LEDs on the housing indicate its operating and diagnostic states.
  The two safe inputs of the KFM SAFETY 3 are designed as two-channel inputs (1 level, 2 pulse). This ensures that safe inputs work reliably, even if the signal cable is kinked, etc.

- The safe inputs /STO enable the amplifier of the KFM SAFETY 3. To achieve this, the two inputs In5 and In6 must be active. The input /STO-A (level) In5 switches the amplifier directly through the hardware and is connected to micro-processor A. If, during safety operation, one of the two inputs is inactive for 2s or more, the SAFETY LED flashes and the SAFETY output is pulsed. If both outputs are inactive, the system remains in safety mode and LED 4 (safety) is lit while the SAFETY output is activated.

- If an obstacle is encountered during "door OPEN" or "door CLOSE" operation, the KFM SAFETY 3 is instantly stopped, as soon as the set closing force of e.g., 150N is reached. This is done by activating the STO function. The KFM SAFETY 3 is slowed down along a ramp and reverses by a set distance to release any jammed objects. In this process, STO is activated.

- The KFM SAFETY 3 can also be programmed to open the door only by a little (slip-through opening position 6), if that is all that is required (e.g., brief opening for inspection). In injection molding machines, such partial opening of the machine protection door is often required during machine operation, when the door needs to be opened only by the width of the mold opening. The only time the door needs to be opened fully is for mold changes.

- The KFM SAFETY 3 features a second safe input through which the safety function can be activated (/Safety). For normal operation, both inputs must be active. This function is for example used for auxiliary devices installed in the machine, where these devices must be operated slowly and safely during the setup phase or for inspection purposes, while they need to run faster during normal operation in order to minimize the machining time. In this case, it is however necessary to implement additional safety measures, such as light curtains, safety housings, two-hand controls, etc.

- It is also possible to connect a light curtain or similar safety component to the input /Stop. If this input is activated to close the door, the KFM SAFETY 3 is automatically stopped by reducing its speed to zero along the fast deceleration ramp "decstp" (2nd parameter page).

- The status of the machine protection door actuator or the machine protection door is signaled to the control system through optically decoupled outputs (door OPEN, door CLOSE, alarm, safety, option). The safety output indicates that the KFM SAFETY 3 is in "**safe function active"** mode.
- The parameter values of the KFM SAFETY 3 can only be changed by a limited number of persons (password protection). The parameters settings and any changes made to the settings must be documented and filed.
- The KFM SAFETY 3 is also able to detect whether the door is in position "door OPEN". After the KFM SAFETY 3 has reached the "door OPEN" position, it continues moving for a set distance (Pos. 8 "door OPEN" detection), and obstacle detection remains enabled. If the door is blocked, it moves to position "door OPEN" and remains there. The "Door OPEN" output is activated. Through this mechanism, the KFM SAFETY 3 is able to detect a fault of the gear mechanism or the timing belt (break or release).
- If certain safety functions are not required, or if they are implemented by other fail-safe components (light curtain, impact bar, two-hand control), it is possible to safely operate the KFM SAFETY 3 only with the STO function. Safe input STO or enable (normal mode without SLT and SLS).
- These safety and protective functions of the 1oo2 system and the special safety software thus make the KFM SAFETY 3 a versatile and ideal actuator for machine protection doors.
- The KFM SAFETY 3 can also be used for other safety functions and applications with safety functions, such as conveyor belts with safe stop or handling units where workers need to reach into the danger area for assembly, inspection or adjusting tasks, etc.
  In these cases, the operation of the machine or plant must however always evaluate which safety functions, safe auxiliary devices and similar equipment is required for the safe operation of the machine or plant.

6 Application with safety function

Thanks to its versatile design, the KFM SAFETY 3 can be used in a wide range of applications and industries. Its strengths come particularly to the fore in connection with the following applications:

- Movable guards for tooling machines
- Movable guards for injection molding machines
- Movable guards for packaging machines
- Handling technology
- Special machines
- Movable guards for machining centres
- Movable guards for special machines
- Movable guards for automated assembly units
- Check protection/collectors and tool change devices in chip-removing machines

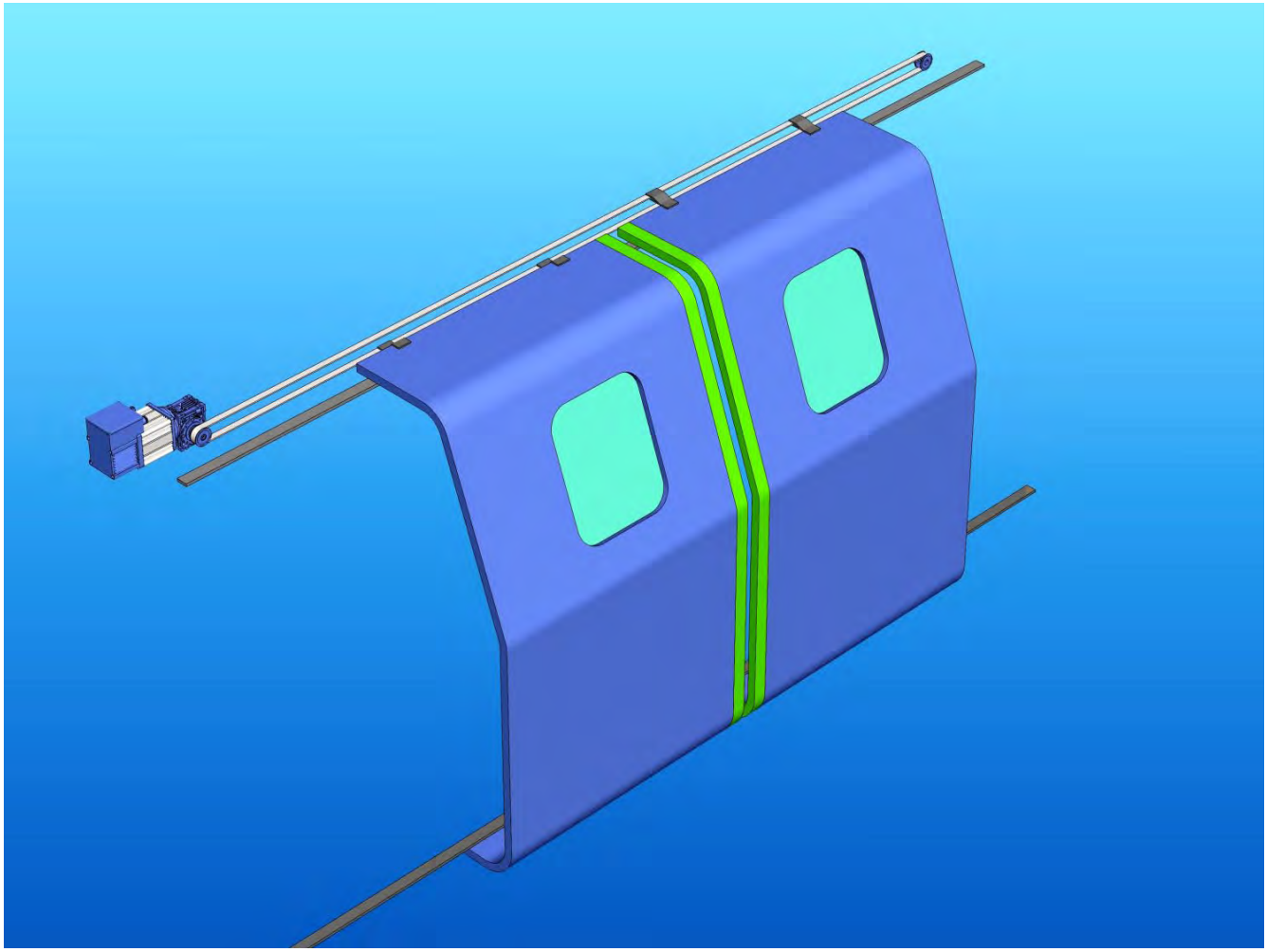
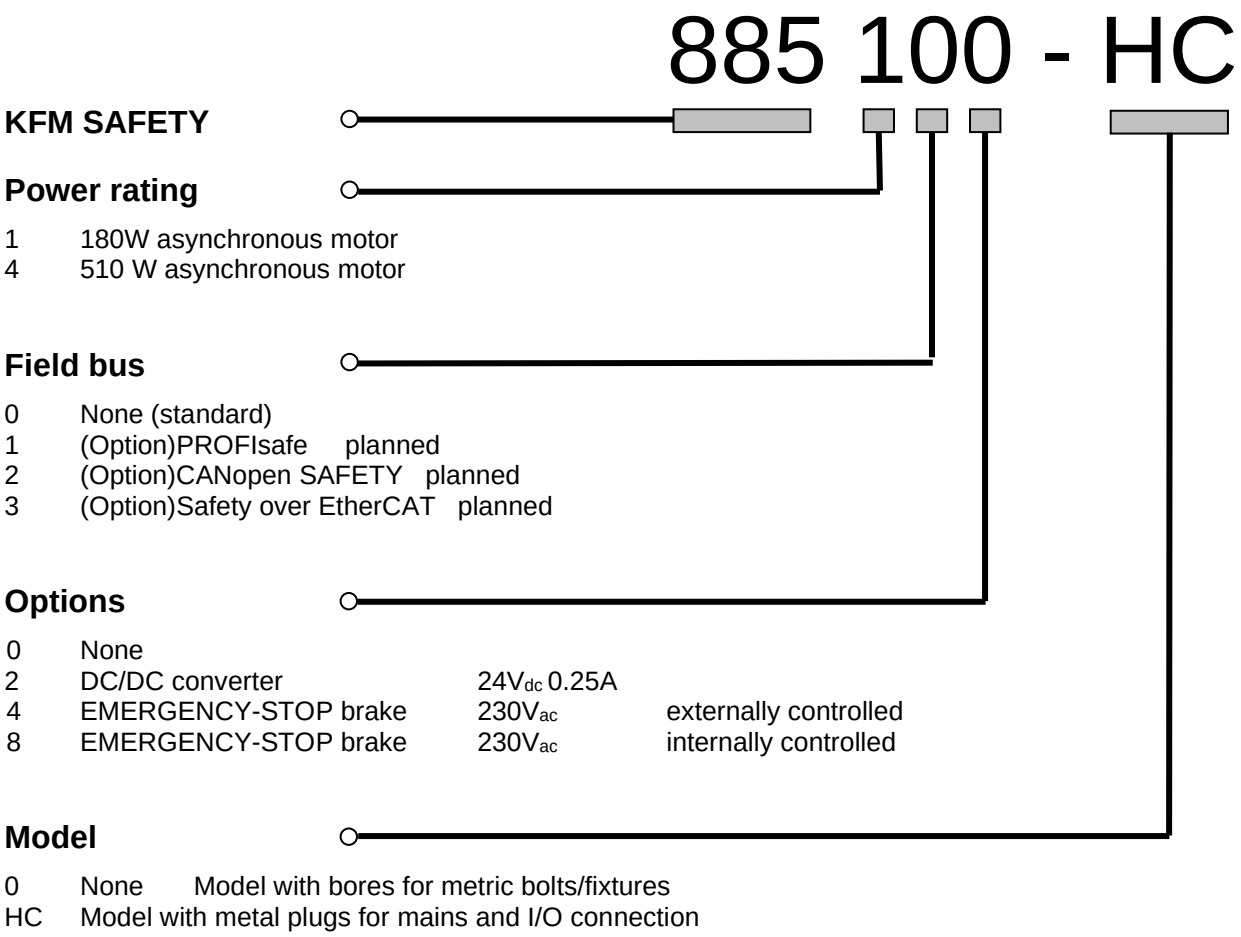


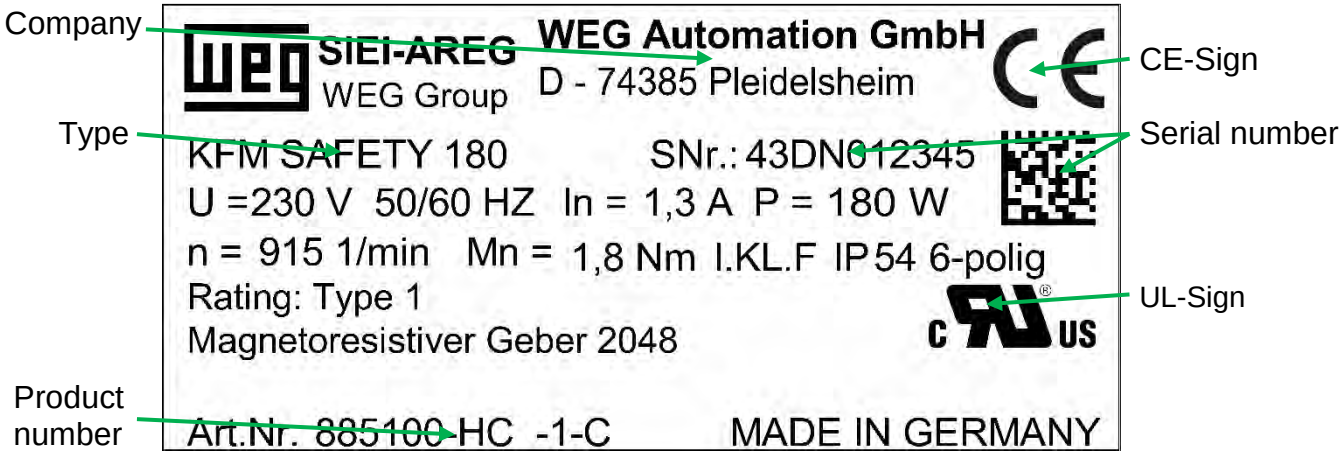
Figure 5: Example of machine protection door

6.1 KFM SAFETY product code



6.1.1 Type plate

The type plate contains the performance data as well as the product and serial number of the machine.



6.2 Schematic diagram of machine protection door

6.2.1 Single or telescopic door

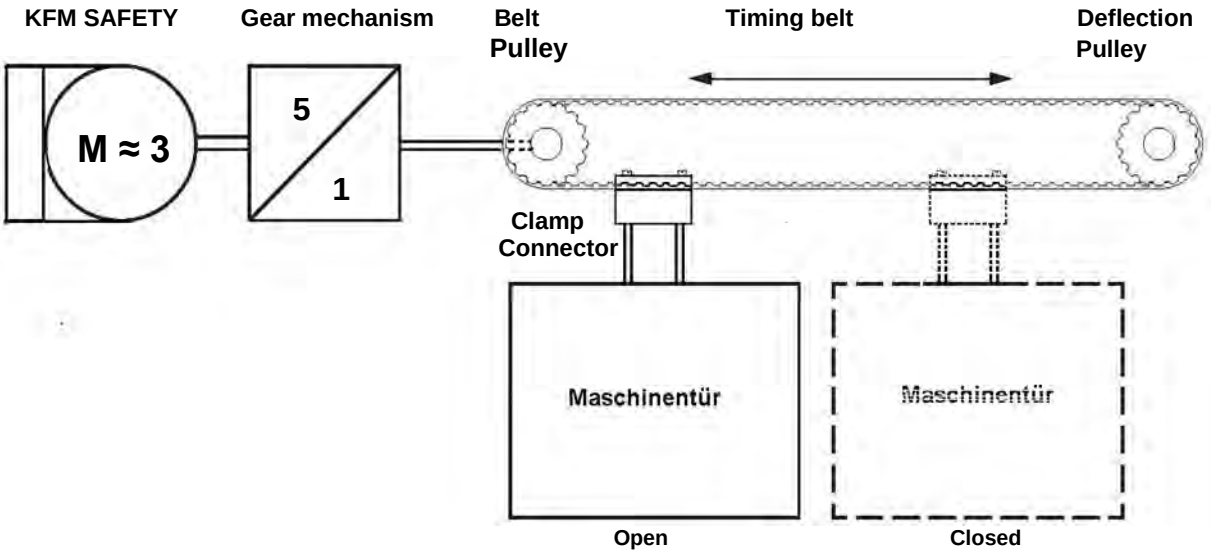


Figure 6: Single guard

6.2.2 Double doors or telescopic double doors

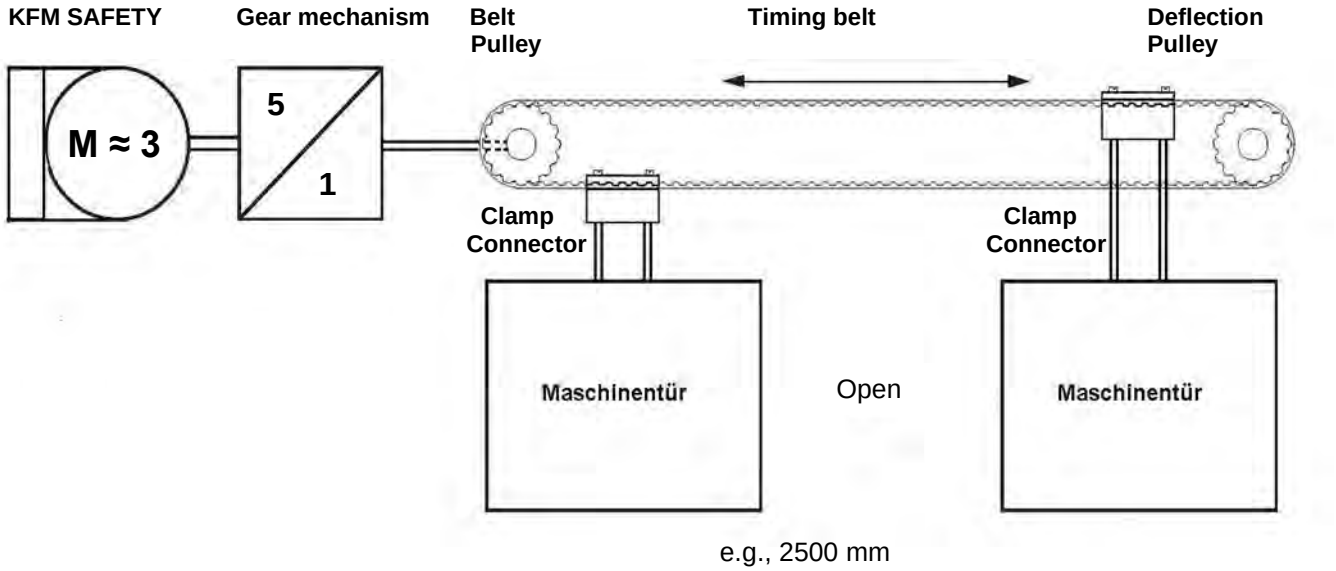


Figure 7: Double doors

7 Technical data of KFM SAFETY 3

Data / drive type		KFM SAFETY / 180	KFM SAFETY / 510
Mains power	U_{line}	230 V_{ac} ±10 % / 50/60 Hz ±10 %	
Rated current (mains)	I_{line}	1.3 A	3.1 A
Rated power	P_N	188 W	512 W
Rated torque	M_N	1.8 Nm	2.8 Nm
Rated speed	n_N	1000 rpm	1750 rpm
Number of pole	p	6 pole	4 pole
Winding resistance	R	23 Ω	5 Ω
Rotor moment of inertia	J	11.7 kgcm²	15.6 kgcm²
Overload		2 x M_N for 60 s (200% M_N or P_N)	
Output frequency	f_{max}	0 - 120 Hz	
Encoder resolution		2048 pulses per revolution, linearity error ± 40 pulses	
Analog Input		AIN1 and AIN2 0 -10V, 0 - 20mA, 2 -10V, 4 - 20mA	
Acceleration, deceleration		1000 to 0.02 Hz/s (0.05 - 2500 s)	
Control signals		2 x 2-channel safe digital IN => STO (enable) and /Safety, 4 digital IN 24 V_{dc} ±20 %; 5 digital OUT 24 V_{dc} 50 mA	
Safety function I/O		Short-circuit proof, optically decoupled	
Function		Positioning operation for machine protection doors, 32-bit position control in	
Positions		3 positions: door CLOSE, door OPEN, intermediate position	
Safety functions		Safety functions **STO, SLS** (< 10 J door), **SLT** (< 150 N closing force)	
Protective functions		Overcurrent, overvoltage, under voltage, over temperature component failure EN 50178, section 5.2.16 overvoltage category III EN 60204, section 9.2.2 STOP category 1	
Interfaces		RS232, RS422, optional field bus	
Operation		Optional control box for parametrization and display	
Programming		Software for the adjustment and optimization of parameters settings, function control and parameter backup (password-protected), including in scope of delivery	
Buffer power Supply		Optional external power 24 V_{dc} ±10 %, 250 mA, through daughterboard	
Brake		Optional 230 $V_{ac,}$ 6 Nm emergency-stop brake, external brake release or	
Mains fuse		External fusing, max. 16 A, internal 5.0 A slow-acting fuses	
Climate category		EN 50178 climate class 3K3	
Safety category		EN 61508 SIL 2 or EN 13849 PL d respectively	
Motor insulation		Class F 155°C	
Connection		External metal plug or terminals (Phoenix) inside housing	
Operating temperature	T_B	+ 5°C to +40°C higher temperature with power derating	
Model		M23 plug (Figure 12), terminals (Phoenix Figure 11)	
Type		BG 71 conforming to IEC, with B14 connecting flange	
Protection class		IP54	IP54
Dimensions without shaft		244 x 171 x 115 mm³	304 x 171 x 115 mm³
Weight		8.3 kg	11.7 kg
Standards		EN 953, EN 50178, EN 60034-1, EN 61000-6-1 to EN 61000-6-4, EN 61800-3, EN 13849-1, EN 13849-2, EN 61508-1 to EN 61508-7, EN 61800-5-2	
Approval		CE, TÜV Safety, UL, CSA, CCC	

Figure 8: Data sheet

8 Three-phase asynchronous motor

8.1 KFM SAFETY performance characteristics

8.2 Speed - torque characteristic

The asynchronous motor is operated with a frequency inverter. It is thus possible to adjust all operating points below the respective characteristic (S1). For short periods of time (60s every 1800s), the KFM SAFETY may supply up to twice the normal S1 torque.

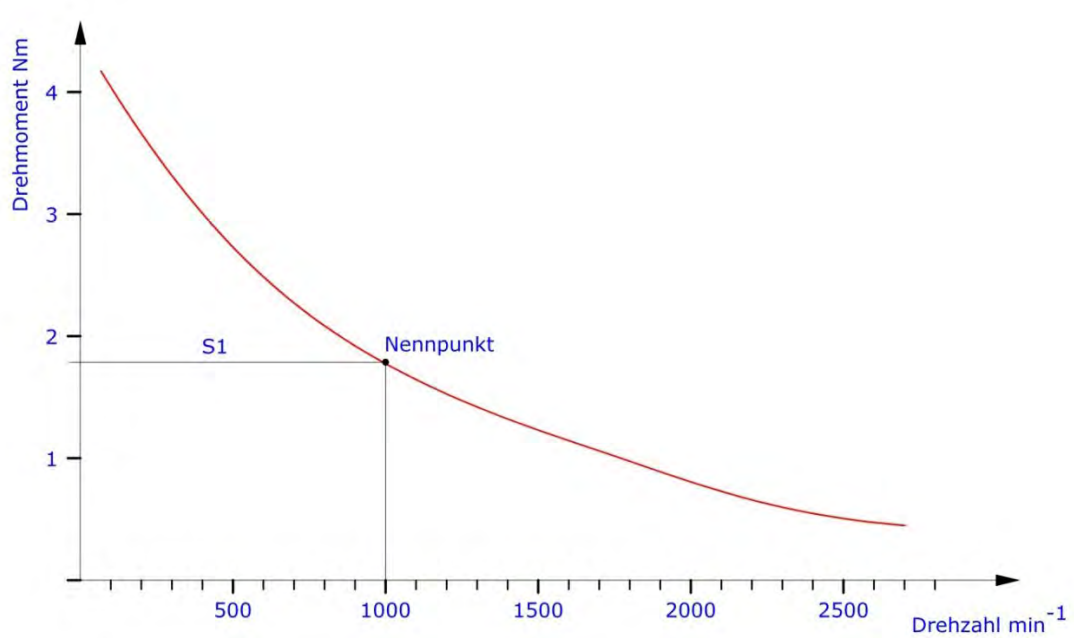


Figure 9: Speed - torque characteristic KFM SAFETY 180

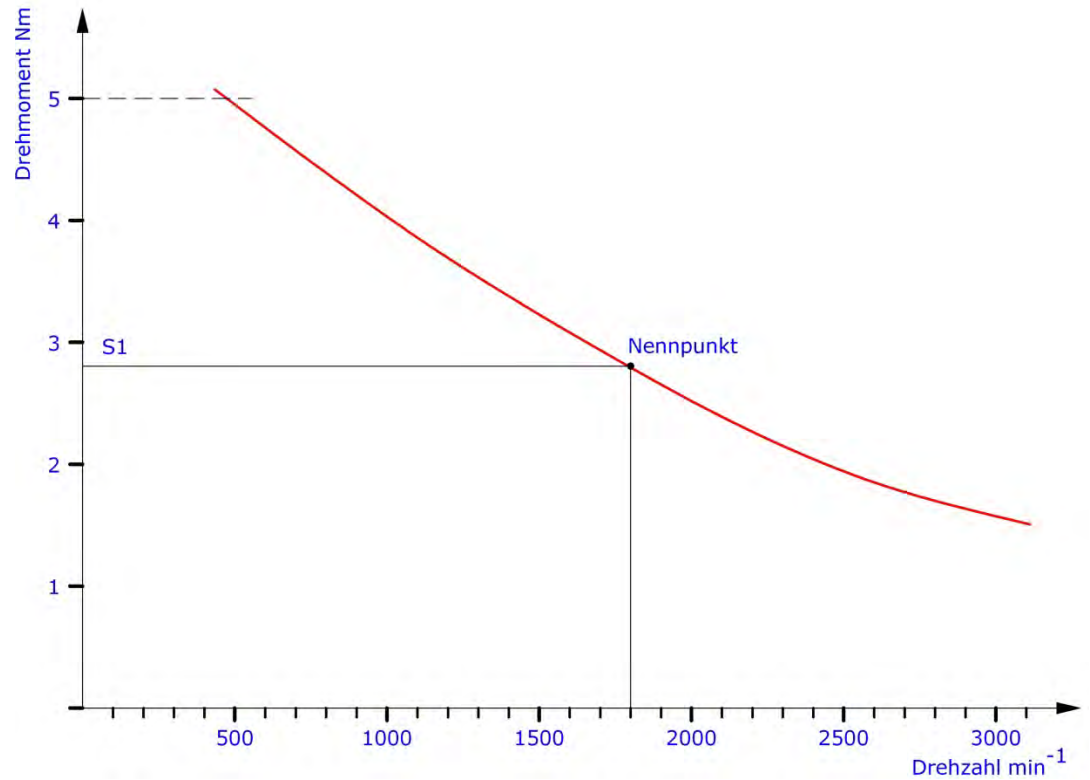


Figure 10: Speed - torque characteristic KFM SAFETY 510

9 Dimensional drawing of KFM SAFETY

9.1 KFM SAFETY 180

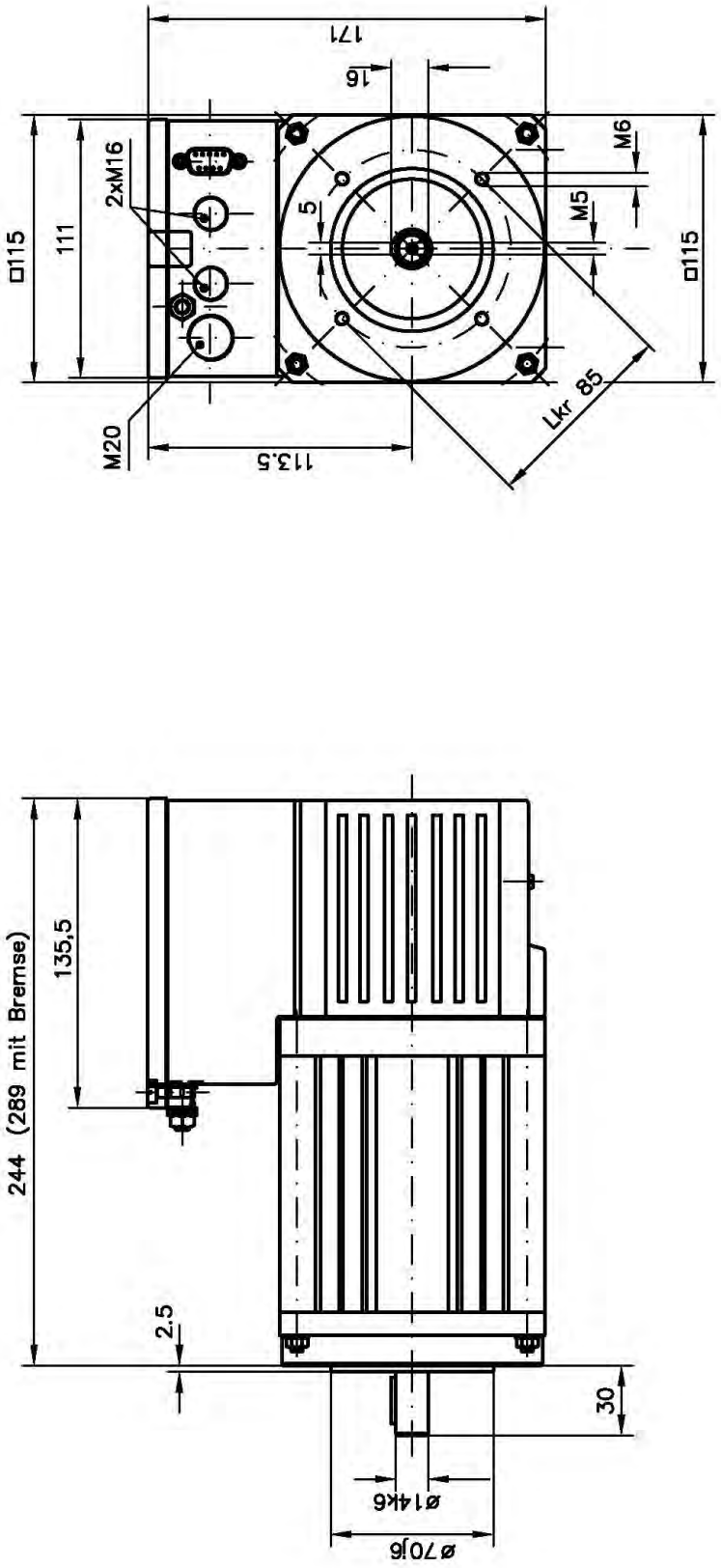


Figure 11: KFM SAFETY 180

9.2 KFM SAFETY 180 with plugs (flange plugs)

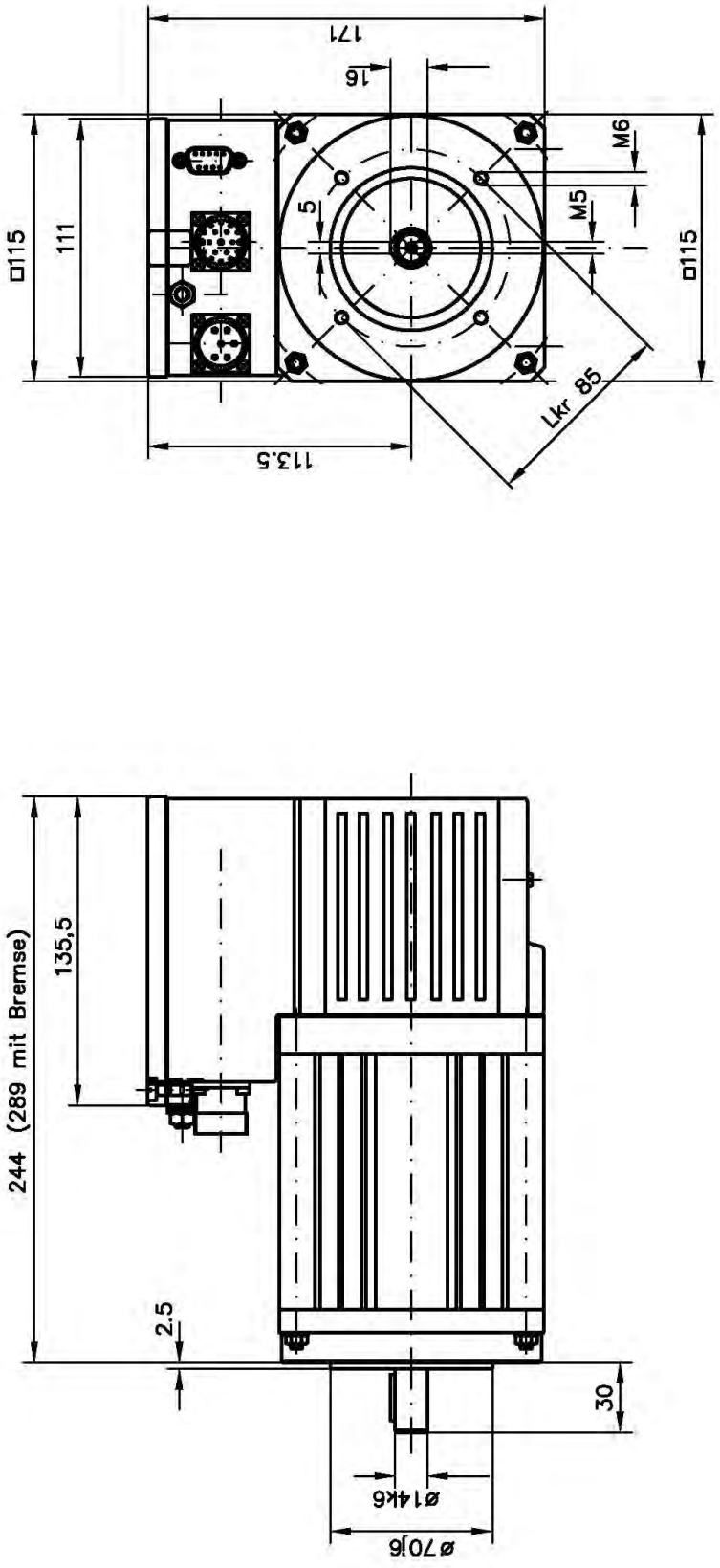


Figure 12: KFM SAFETY 180 with plugs

9.3 KFM SAFETY 510

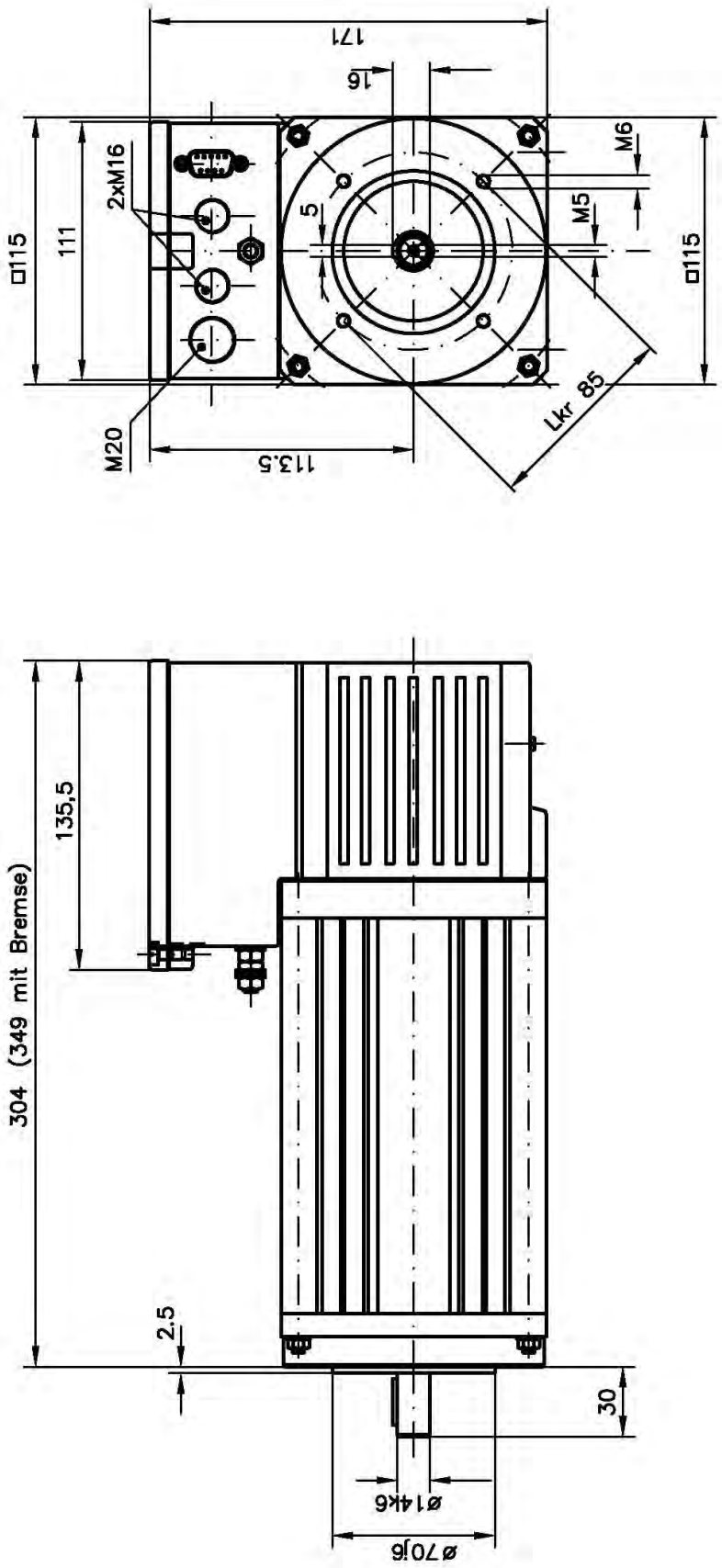


Figure 13: KFM SAFETY 510

9.4 KFM SAFETY 510 with plugs (flange plugs)

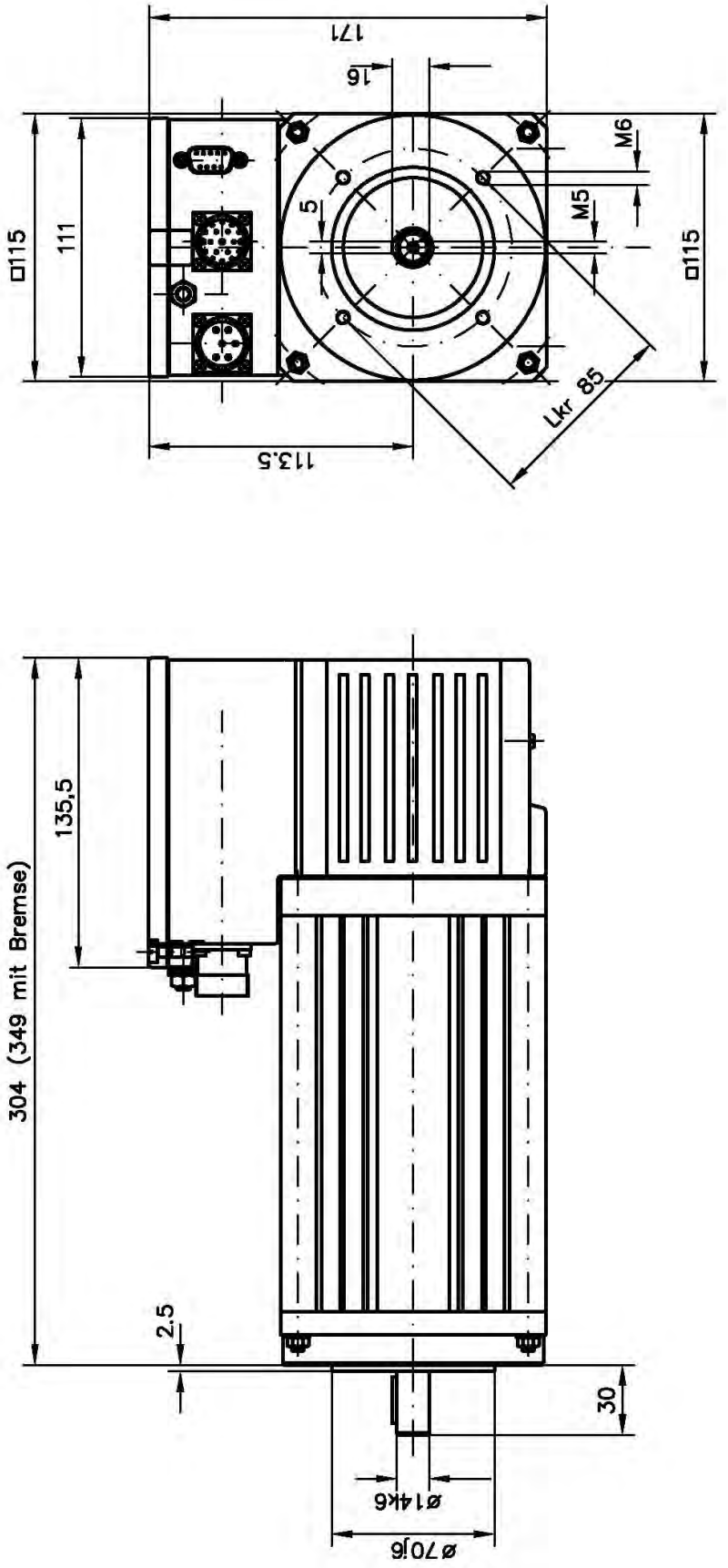


Figure 14: KFM SAFETY 510 with plugs

9.5 KFM SAFETY, complete

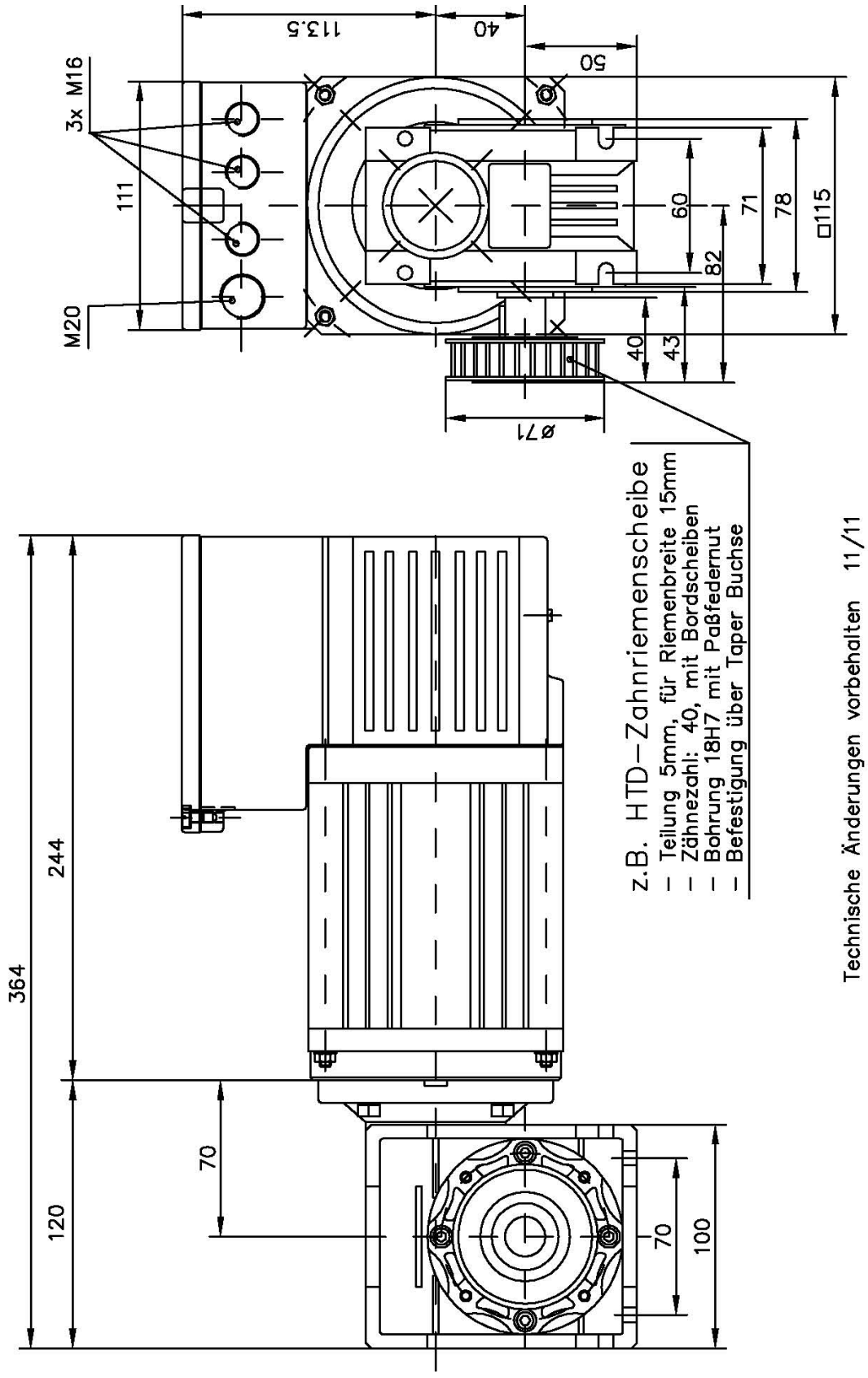


Figure 15: KFM SAFETY, complete with gear mechanism

9.6 3D model of KFM SAFETY

3D drawing of KFM SAFETY: The 3D pdf file is included on the CD-ROM and can be viewed from various angles in Acrobat Reader (also on CD-ROM).
The CD-ROM also contains the 3D drawings in DWG and STEP format.
For customers and other interested parties, we provide the 3D drawing in other combinations and for use in CAD programs (various standard formats, for integration into own design drawings). Please let us know which format you require.

9.6.1 3D drawing of KFM SAFETY

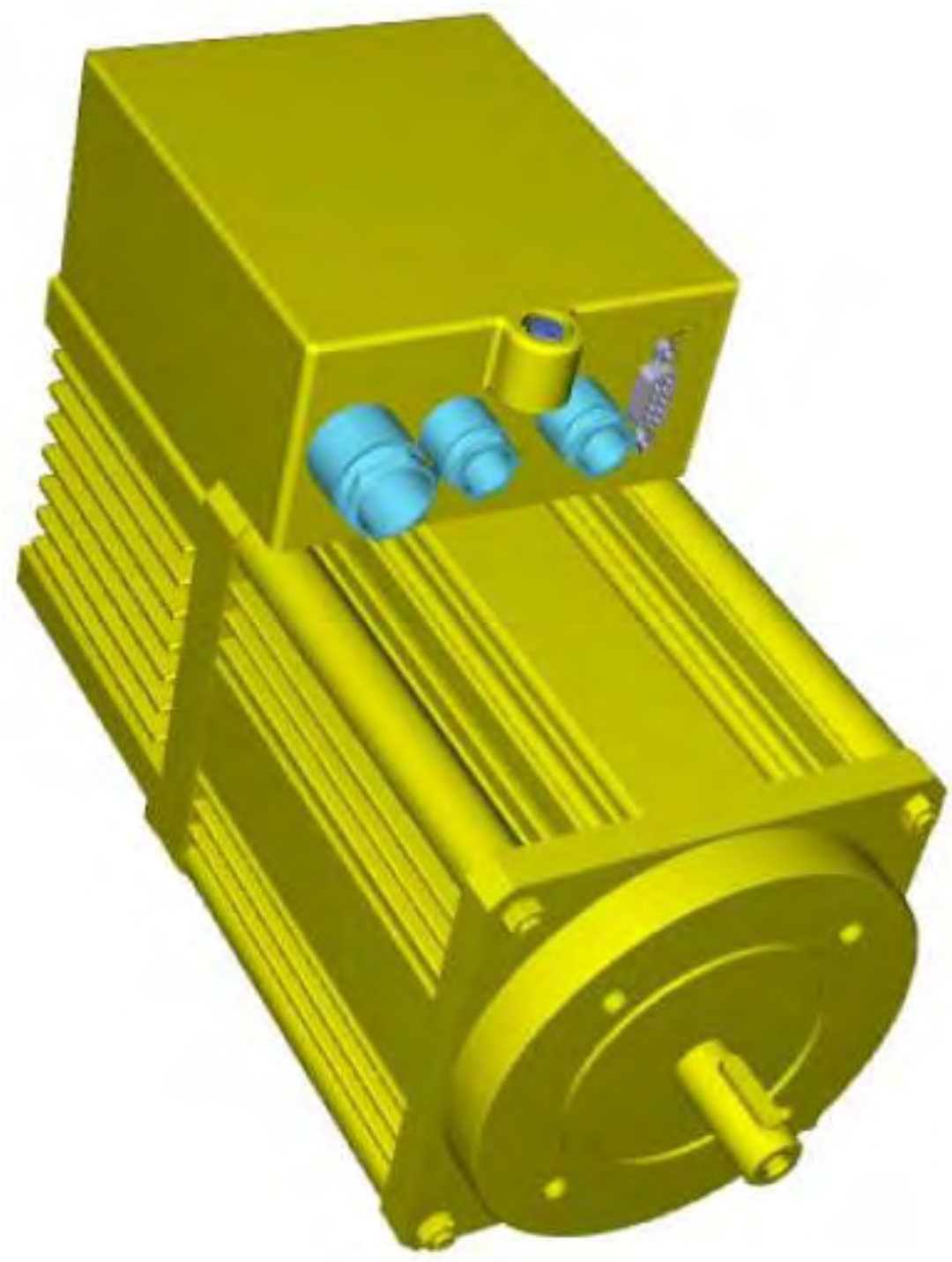


Figure 16: 3D model of KFM SAFETY

9.6.2 KFM SAFETY, complete (exploded view)

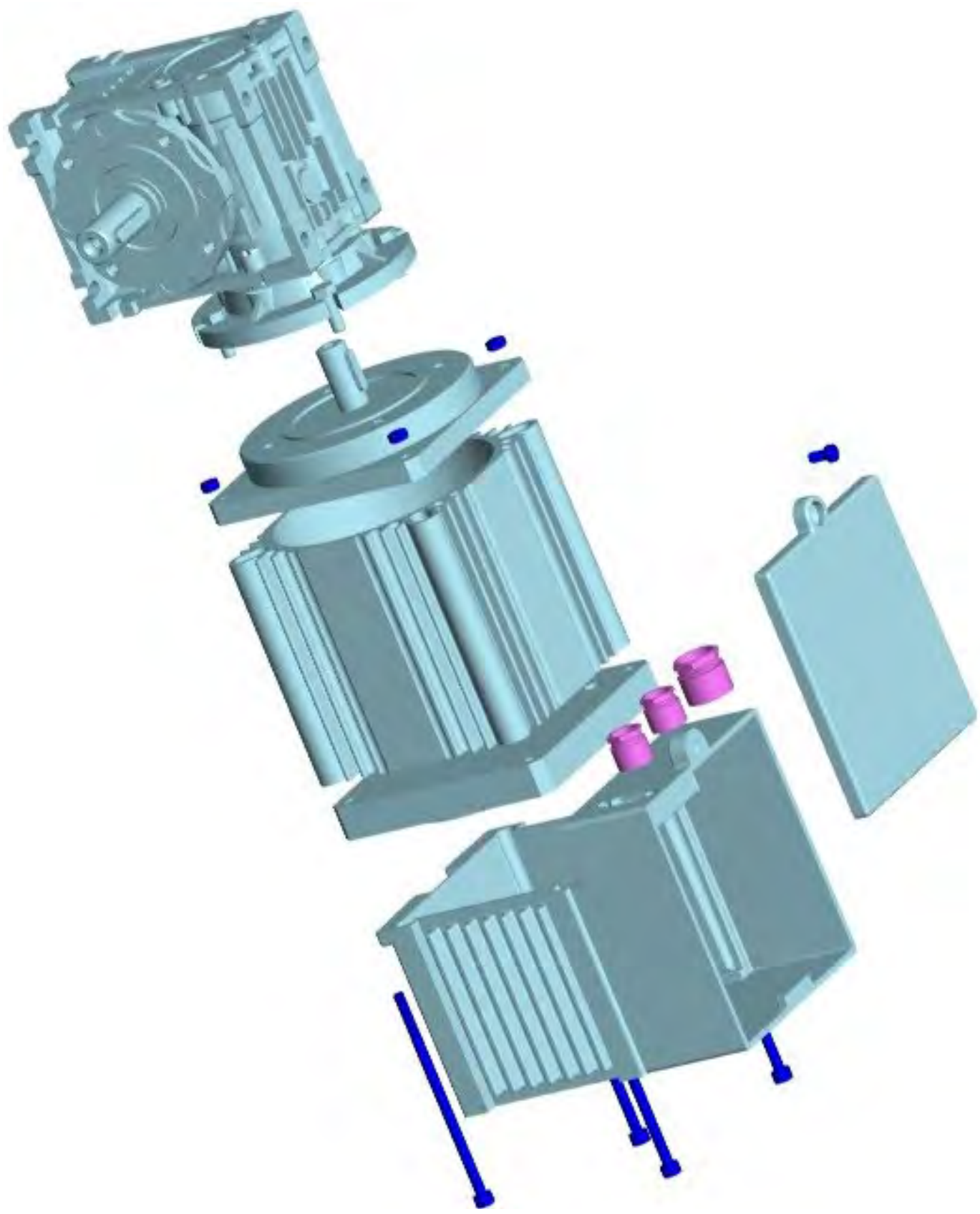


Figure 17: 3D model (exploded view)

10 Optional equipment and accessories for KFM SAFETY

10.1 DC/DC converter and relay PCB (optional)

To save the positions and retain the micro-processor data when the KFM SAFETY is not powered (mains off), the device can be equipped with an optional DC/DC converter for external 24 V_{dc} power. This daughterboard features a relay for an emergency-stop brake, which is activated by the KFM SAFETY to release the brake. Emergency-stop brake monitoring by means of brake current measurement has not yet been implemented in the software.
This additional power supply powers the micro-processors through a DC/DC converter with galvanic isolation. It retains data regarding the status, position, residual path, etc. until 230 V_{ac} power supply is restored. Subsequently, the KFM SAFETY runs as usual. This auxiliary power supply is recommended for the following applications:

- **Safety functions.**
  Applications where, for safety reasons (interference for inspection or troubleshooting), it is necessary to shut down the 230 V_{ac} mains power.

- **Data retention.**
  Applications where it is important that the position data and other recent data/parameter values are retained.

- **Field bus option (not yet implemented).**
  There is no interference with the field bus in the event of a 230V_{ac} mains power failure, so that status, position and other data can be exchanged as normal.

The DC/DC converter relay board prod. no.: 440145-01 is not suitable for retrofitting. It must be installed at the factory. Please specify in your order whether you need this device.

10.2 Control box (optional)

The control box allows for user-friendly adjustment and optimization of the KFM SAFETY. Through the control box, the user can view and adjust position values, ramps, frequencies etc. online.

The KFM SAFETY parameters that are relevant for the safety functions are only displayed on the control box and cannot be changed!

WEG AUTOMATION GmbH control box prod. no.: 730200-204

Figure 18: Control box

10.3 Emergency-stop brake

The KFM SAFETY can be equipped with an optional emergency-stop brake integrated into the housing (which therefore needs to be approx. 50 mm longer). The emergency-stop brake is released externally or by the DC/DC converter relay PCB of the KFM SAFETY.

The emergency-stop brake keeps the KFM SAFETY in place when it is not powered (mains off) and also assists braking process. The emergency-stop brake does however not form a safety feature of the system, as it does not implement an SBC safety function!
The emergency-stop brake can stop the KFM SAFETY when it is in motion (no SBC). The number of braking process depends on the mass of the door and the speed.
The brake pad state (wear) of the KFM SAFETY emergency-stop break is **not monitored ➔ there is no warning signal if the brake pad is serious worn!!**

The emergency-stop brake generates a friction and holding torque M_N of >= 6 Nm. Prod. no.: 564309

10.4 Safety brake

If the application requires a reliable brake, install a brake with safety function whose brake pad is monitored. A safety brake (with certification) can only be installed externally, as it needs to be regularly serviced.
The safety brake is sourced from a manufacturer specializing in brakes.

10.5 Gear mechanism

The gear mechanism shown and described here is only an example. This low-cost model is however very popular.

On request, we offer other gear types, such as

- spur gears
- mitre gear
- planetary gear
- special gear

with various transmission ratios.

If required, we will adjust the KFM SAFETY to fit a gear of your choice.

10.6 400V transformer

Some machines and plants are powered by $400V_{ac}$ only and do not have a $230V_{ac}$ power supply. In such machines, the KFM SAFETY can be equipped with an auto-transformer for operation with $400V_{ac}$. For this purpose, we offer a 500VA IP00 auto-transformer, prod. no.: 161142 for installation in the control cabinet. For attachment to the machine, we offer an IP54 auto-transformer, prod. no.: 161141.
On request, we offer auto-transformers for other input voltages.

10.7 KFM SAFETY actuator pack

10.7.1 Content of actuator pack

The actuator pack includes the compact KFM SAFETY for machine protection doors with i = 5 :1 gear mechanism (standard) and all parts required for mounting of the drive on the machine protection door. Prod. no.: 579632

- timing belt pulley, e.g., HTD 22-8M-20, installed on the gear output shaft
- Deflection pulley with integrated 6602 ZZ bearing, e.g., HTD 22-8M-20 timing belt pulley
- 20 HTD 8M HP timing belt, e.g., 5000 mm long (length based on customer requirements)
- 2 clamp connectors to secure the timing belt to the movable machine protection door or the driver
- Screws, fittings and other small parts for the installation of the deflection pulley and the clamp connectors

10.7.2 Timing belt

The timing belt (material, width, toothing, tooth width, etc.) must be chosen based on the application and customer requirements. The following factors must be taken into account:

- Ambient conditions (temperature, humidity, chemical substances, etc.)
- Speed
- Door dimensions (mass, width, guide mechanism)
- Operating frequency
- Noise emissions

We recommend using a HTD timing belt, as this type of belt is particularly sturdy while noise emissions are minimized by the rounded tooth design. Available by the meter, prod. no.: 579624
On request, we can show you other options for attachment of the KFM SAFETY to the machine protection door.

10.7.3 Timing belt pulley with taper lock bush

The timing belt pulley (e.g., HTD TB 22-8M) has 22 teeth and is designed for timing belts with a pitch of 8 mm and a width of 20 mm. Model 5F in steel for taper lock bush 1108.

d_a = 54.65 mm
d_w = 56.02 mm
D_B = 60.00 mm
D_i = 37.00 mm
B = 28.00 mm
N = 22 teeth
Z = 6.00 mm

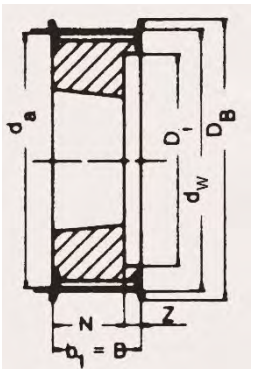


Figure 19: Timing belt pulley with taperlock bush

10.7.4 Deflection pulley

The deflection pulley is a timing belt pulley modified according to our specifications, e.g., type HTD 22-8M 20 model 6F made in steel.
The timing belt pulley is modified so that an internal type 6002 grooved ball bearing can be installed. The deflection pulley is supplied with a mounted grooved ball bearing.

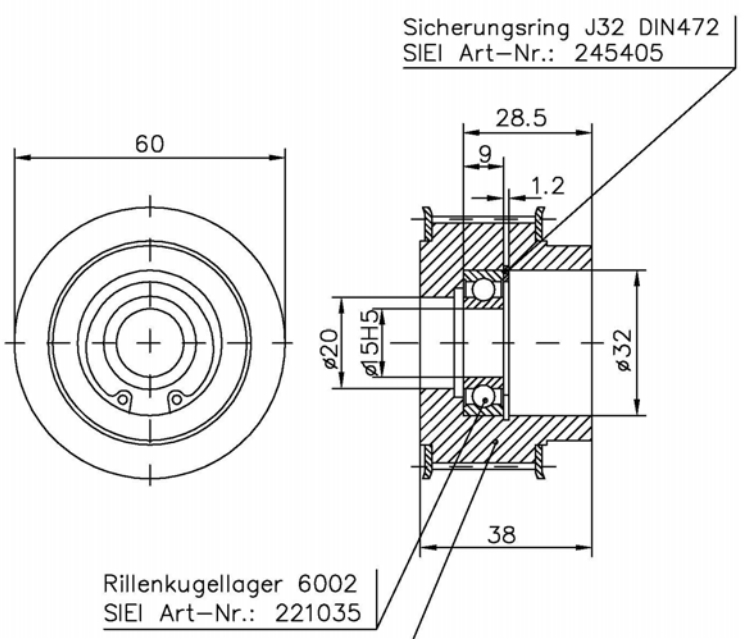


Figure 20: Deflection pulley with bearing

10.7.5 Fixtures

The following fixtures are included in the drive pack:

- 1 shim, P15 x 21x 0.5 mm
- 1 washer 6.4 x 20 x 1.25 mm
- 1 detent-edged washer M6
- 1 bolt DIN912 M6x 20mm
- 8 bolts DIN912 M8x40
- 8 washers DIN125 B8,4V

10.7.6 Clamp connectors

The clamp connectors (e.g., CP-8M 20) are secured with 4 bolts each to the machine protection door. The clamp connector secures the timing belt ends.

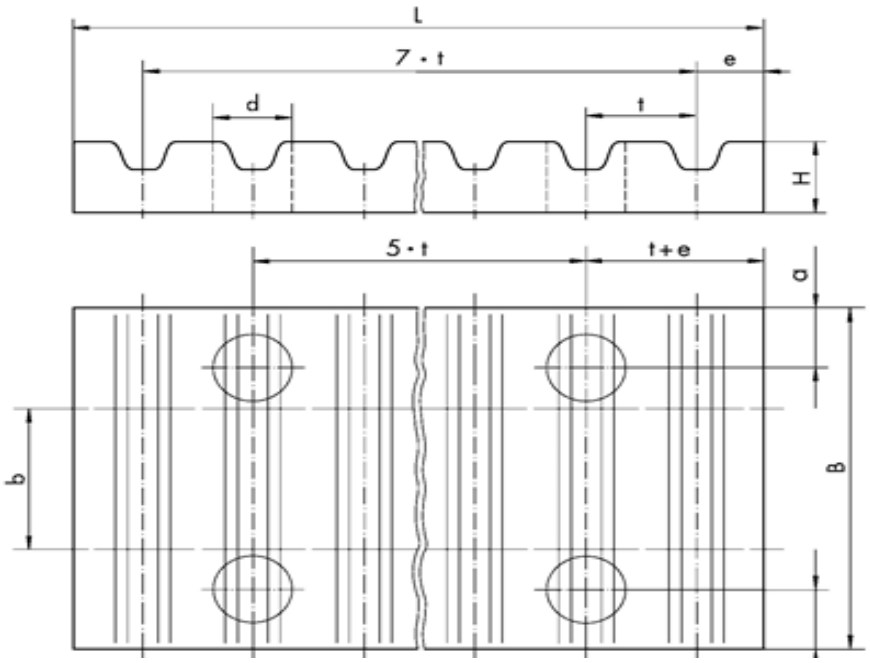


Figure 21: Clamp connectors

Artikel-Bezeichnung *Designation*	Teilung *Pitch* t (mm)	Riemenbreite *Belt width* b (mm)	Material	B (mm)	a (mm)	L (mm)	e (mm)	H (mm)	d (mm)	Gewicht *Weight* ≈ (kg)
CP-XL 025	5,080	6,35	Al	25,5	6,0	42,5	3,5	8,0	5,5	0,020
CP-XL 037	5,080	9,53	Al	28,5	6,0	42,5	3,5	8,0	5,5	0,025
CP-XL 050	5,080	12,70	Al	32,0	6,0	42,5	3,5	8,0	5,5	0,027
CP-XL 075	5,080	19,05	Al	38,0	6,0	42,5	3,5	8,0	5,5	0,032
CP-XL 100•	5,080	25,40	Al	45,0	6,0	42,5	3,5	8,0	5,5	0,038
CP-5M 06	5,000	6,00	Al	25,0	6,0	41,8	3,2	8,0	5,5	0,015
CP-5M 09	5,000	9,00	Al	28,0	6,0	41,8	3,2	8,0	5,5	0,018
CP-5M 15	5,000	15,00	Al	34,0	6,0	41,8	3,2	8,0	5,5	0,022
CP-5M 25	5,000	25,00	Al	44,0	6,0	41,8	3,2	8,0	5,5	0,030
CP-8M 10	8,000	10,00	Al	35,0	8,0	66,0	5,0	15,0	9,0	0,075
CP-8M 15	8,000	15,00	Al	40,0	8,0	66,0	5,0	15,0	9,0	0,085
CP-8M 20	8,000	20,00	Al	45,0	8,0	66,0	5,0	15,0	9,0	0,100
CP-8M 30	8,000	30,00	Al	55,0	8,0	66,0	5,0	15,0	9,0	0,120
CP-8M 50	8,000	50,00	Al	75,0	8,0	66,0	5,0	15,0	9,0	0,170
CP-8M 85	8,000	85,00	Al	110,0	8,0	66,0	5,0	15,0	9,0	0,250

Table 1: Clamp connector dimensions

Note:
Devices, screws or rollers for the tensioning of the timing belt are not included in the scope of delivery and might need to be purchased separately.

10.7.7 Other accessories

Additional accessories and parts are available from WEG AUTOMATION GmbH on request.

11 Transport, storage and maintenance

11.1 Notes

Strictly adhere to the instruction for the safe transport, storage, maintenance and handling of the KFM SAFETY in this manual.
Upon receipt of the delivery, inspect the KFM SAFETY for damage. If there is damage, notify the carrier company without delay.
Do not commission a damaged KFM SAFETY before having notified the supplier.
The climate conditions of climate class 3K3 according to EN 50178 must be met.

11.2 Storage

In order to prevent damage or excessive ageing of the KFM SAFETY during storage, observe the permissible storage conditions below.

Temperature:	-25 °C to +55°C
Air humidity:	5 % to 95 % or 1 g/m³ to 29 g/m³ respectively
Air pressure:	86 kPa to 105 kPa

No condensation, no formation of ice!

Prolonged storage reduces the service life of the KFM SAFETY.
Every two years, run the KFM SAFETY for 2 hours powered by the mains and without a load in order to keep the intermediate circuit electrolytic capacitor alive. Observe the service life (chapter 20.6.3).

11.3 Transport

To prevent damage from transport to the KFM SAFETY, observe these limit values:

Temperature:	-25 °C to 70°C
Air humidity:	95 %
Air pressure:	70 kPa to 105 kPa
After impact:	After an impact from fall, return the KFM SAFETY to the factory for examination!

Tipping the device during transport or installation is permitted. In this case, check the KFM SAFETY for damage and loose parts.

To return the device to the factory, use suitable packaging material.

Short-term condensation during transport is permissible.

11.4 Maintenance

The KFM SAFETY is a maintenance-free device.
The housing should be inspected regularly (once a year). Remove deposits to ensure proper cooling.
The bearings should be checked regularly (once a month) for unusual noises, as they generally indicate damage to the bearing, which should be repaired without delay.
Defective bearings might result in a failure of the horizontal machine protection door.
The set closing force and speed of the machine protection door and the motor speed must be validated at regularly intervals.

Important:

The running behavior, the runner guides, the speed and the closing force must be regularly checked and validated. The intervals depend on the number of movement cycles and should be between 6 and 24 months. The validation must be documented.

12 Block diagram of electronics

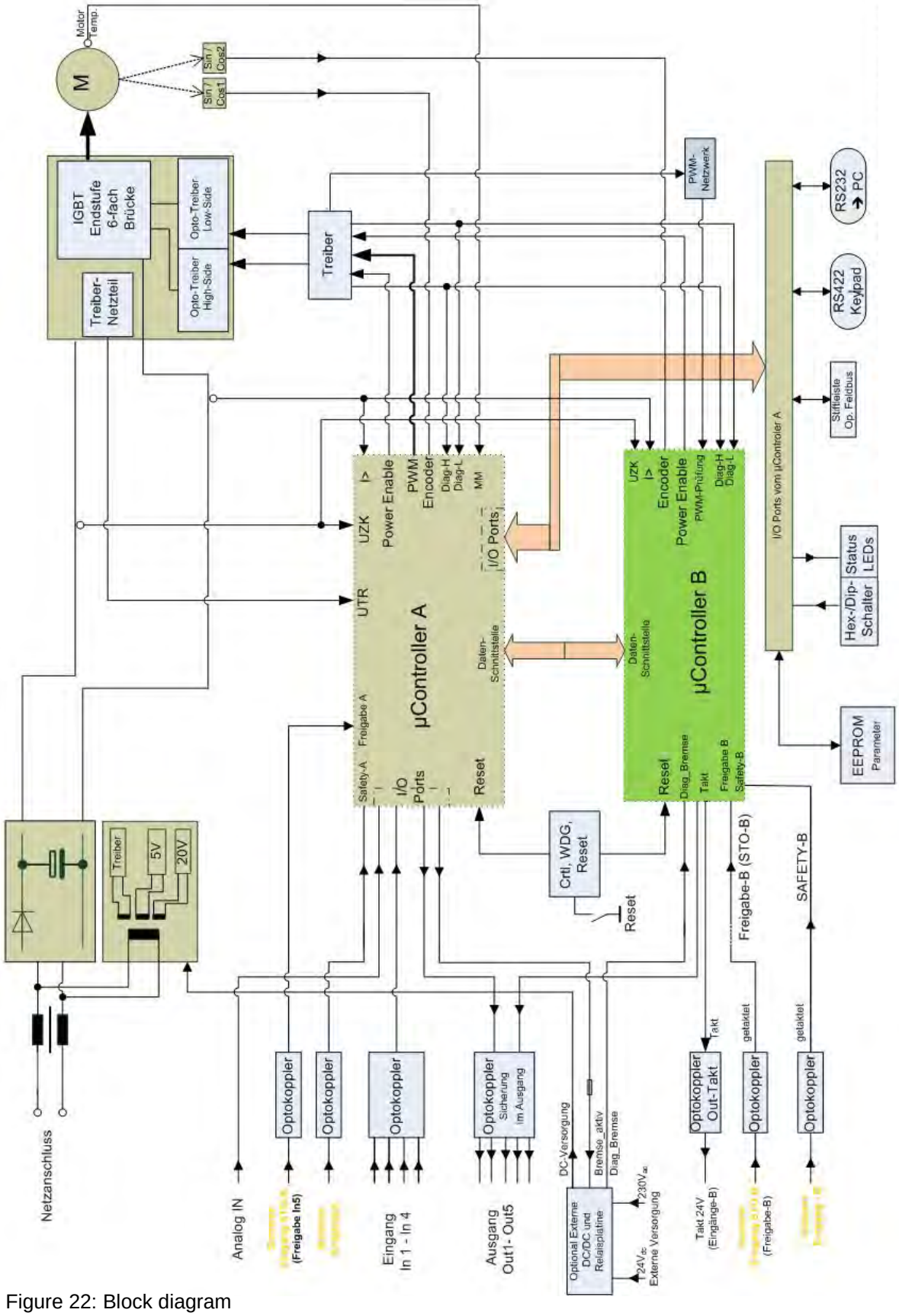


Figure 22: Block diagram

13 Installation and commissioning

13.1 Installation instructions for KFM SAFETY

When installing the KFM SAFETY, keep adequate distances to adjacent devices, motors, panels, etc. to ensure proper cooling.

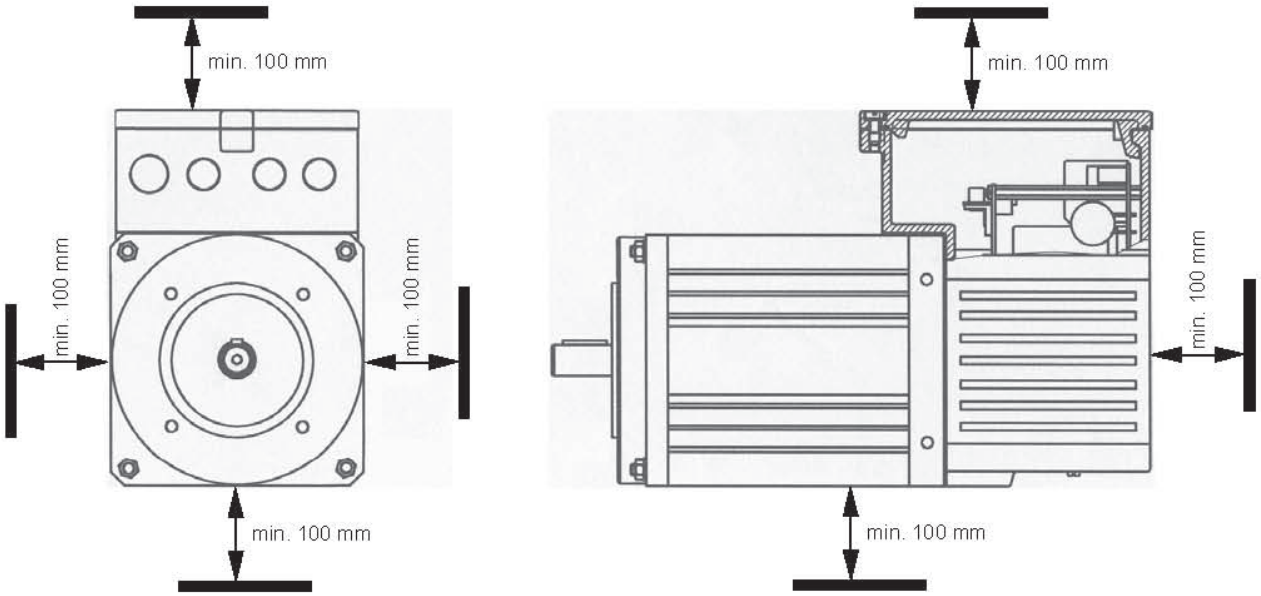


Figure 23: Distances around KFM SAFETY 180 and 510

13.2 Installation instructions for KFM SAFETY

The KFM SAFETY is attached with the B14 flange of the output side and secured with 4 M6 bolts arranged on a Ø 85 mm hole circle to a gear mechanism or directly to the machine.
The cover of the KFM SAFETY is secured with a M5 x 16mm Torx screw that can only be opened with a Torx 25 key.

13.3 Mechanical load on motor shaft

The grooved ball bearings installed in the KFM SAFETY determine the maximum forces acting on the motor shaft:

- Ball bearing service life: 20,000 hours
- Application of radial force F_R to shaft center at motor speed n = 1000 rpm
- No simultaneous application of maximum F_R and F_A
- F_R = 500 N
- F_A = 140 N

CAUTION!

If the KFM SAFETY is connected through belts (flat belt, V-belt or timing belt), the belt tension must be adjusted to ensure that the maximum permissible radial forces are not exceeded.

13.4 Electronic components (device cover removed)

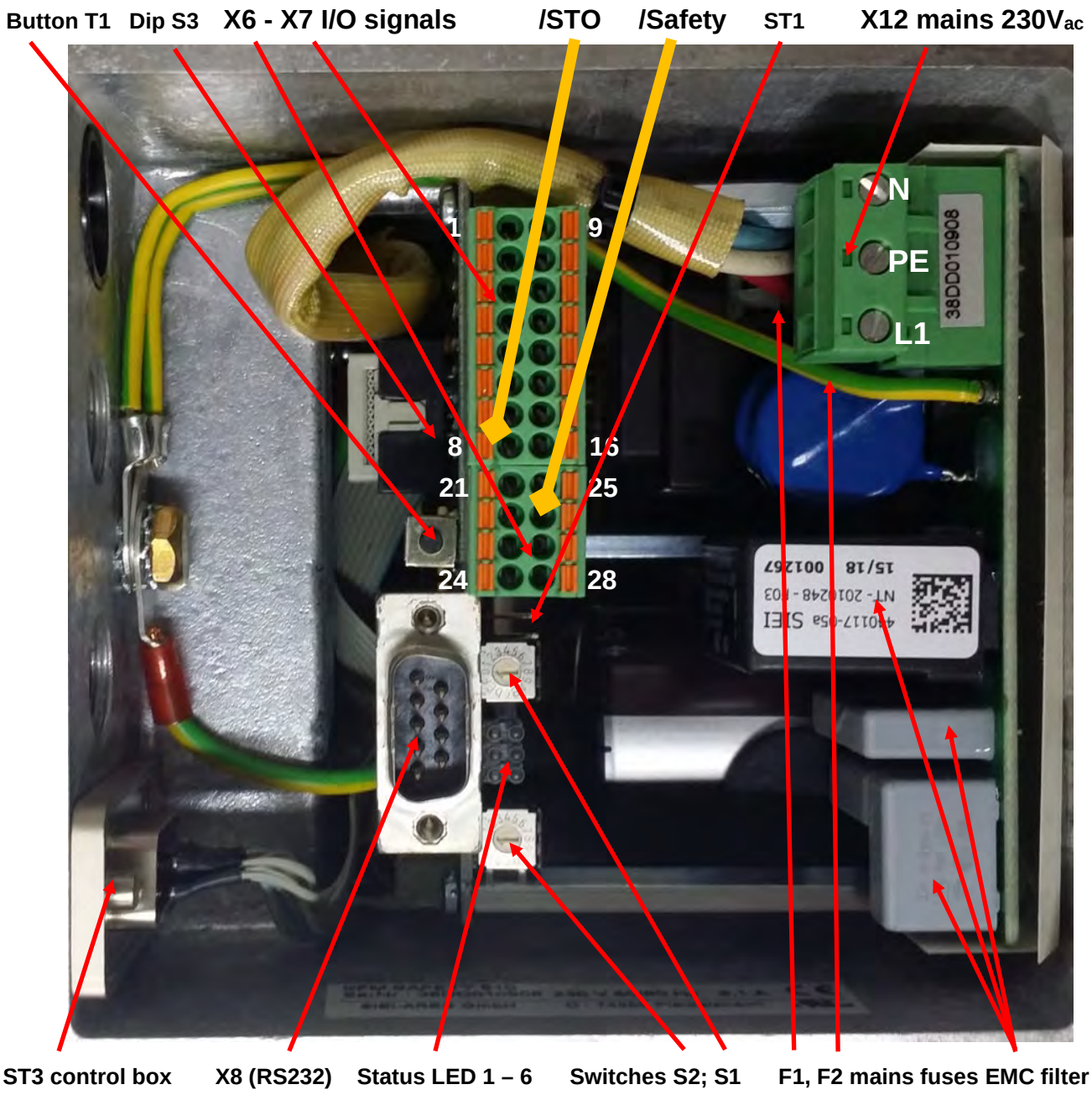


Figure 24: KFM SAFETY connections

The cover can only be opened with a Torx 20 key.

!!! Caution !!!

Before opening the cover, shut down the mains power and wait for at least 5 minutes.
It takes 5 minutes for the voltage levels in the KFM SAFETY to drop to below 60V.
Only then is it safe for a qualified electrician to touch the parts.

13.5 Definition of mains and I/O signal terminals

13.5.1 Mains connection X12 or ST1 respectively

The power mains (230 Vac ± 10 %) are connected to terminal X12 or the ST1 flange plug, using a mains cable with a cross-section A >= 1.5 mm², e.g.: H05VV-F 1.5 or equivalent.
Depending on the ambient conditions, a higher mains cable type might be required.
The connection must be protected by fuses that match the line cross-section.

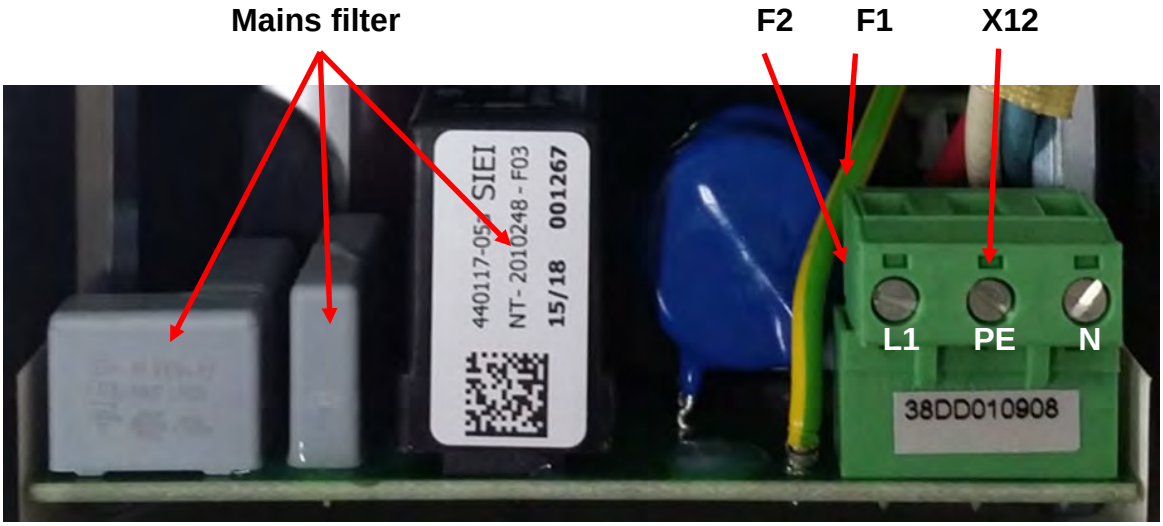
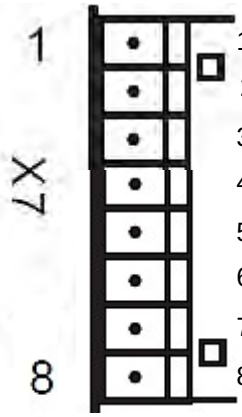


Figure 25: Mains power connection

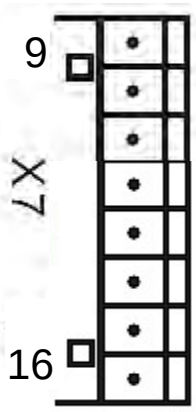
13.5.2 Fuses F1 and F2

The actuator is protected by two internal 5 A fuses.
These fuses are soldered and can only be exchanged at the factory.

13.5.3 Terminal X7 inputs



1. PLC +24 V external
2. PLC 0 V external
3. Input 1 Door close
4. Input 2 Door open
5. Input 3 Stop
6. Input 4 Partial opening
7. Input 5 Enable /STO
8. Input 6 Enable /STO (pulsed signal)



9. +10 V max. 10 mA for potentiometer
10. GND for analog input / potentiometer
11. Analog input 1 Speed
12. Analog input 2 Speed
13. Shielding for analog inputs
14. +15 V 100 mA auxiliary voltage
15. GND auxiliary voltage
16. Pulsed auxiliary voltage for safety Input (X7:8 and X6:26)

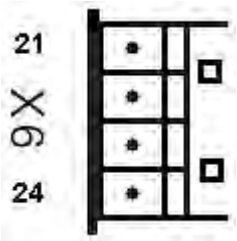
Figure 26: Terminal X7

The logic (positive PNP / negative NPN) of the inputs is defined by the voltage applied to terminals X7:1 and X7:2.

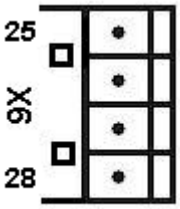
Caution! This applies only to inputs In 1 – In 8.

Note:
No reference to GND or PE, as all inputs are optically insulated by opto-couplers.

13.5.4 Definition of terminal signals X6



21. Output 1 Alarm
22. Output 2 Door open
23. Output 3 Door close
24. Common output



25. Input 7 /Safety mode (level)
26. Input 8 /Safety mode (pulsed)
27. Output 4 Safety mode active
28. Output 5 Optional (configurable)

Figure 27: Terminal X6

The outputs Out 1 – Out 5 are designed for 24 V_{dc} and max. 50 mA.
To protect the device against overloads, he outputs are protected by PTC fuses (self-resettable) and are thus short-circuit-proof.

The logic of the outputs is defined by the potential at X6:24.

Note:
No reference to GND or PE, as all outputs are optically insulated by opto-couplers.

The logic (positive PNP / negative NPN) of the inputs In 7 and In 8 is defined by the voltage applied to terminals X7:1 and X7:2.

Terminals X7:7 – X7:8 In 5 and In 6 are the two safe inputs for /STO. Terminals X6:25 – X6:26 In 7 and In 8 are the safe inputs for /Safety mode. The voltage for inputs In 6 and In 8 is provided at terminal X7:16.
The other inputs are connected to 24V_{dc}. See chapter 13.8.

13.5.5 Status LEDs

LED 1 GREEN:	Light Flashing	Door open position Automatic commissioning
LED 2 GREEN:	Light Flashing	Door closed position Automatic commissioning
LED 3 RED:	Light Flashing Off	CPU fault Error Normal mode
LED 4 YELLOW:	Light Flashing Off	Safety mode active STO, SLT, SLS active Normal mode
LED 5 YELLOW:	Light Off	Enable active Amplifier disabled
LED 6 GREEN:	Light Off	Power supply ready OK Reset active

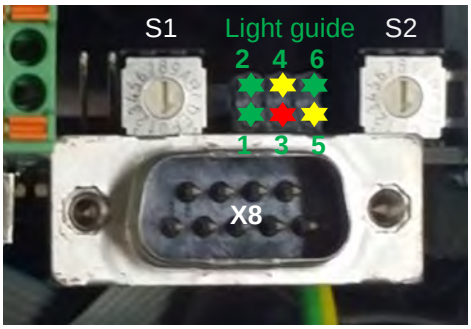


Figure 28: Status LEDs 1 - 6

13.5.6 Control box connection ST3 D-Sub9 socket

The ST3 D-Sub9 socket ST3 is the control box interface. For pin assignment, see below. RS422 interface with WEG AUTOMATION GmbH protocol.

Pin assignment:

Pin 1 : not assigned
Pin 2 : +8V control box power supply
Pin 3 : Tx_/Z data out (inverted)
Pin 4 : Rx_A data in
Pin 5 : GND
Pin 6 : not assigned
Pin 7 : Tx_Y data out
Pin 8 : Rx-/B data in (inverted)
Pin 9 : not assigned

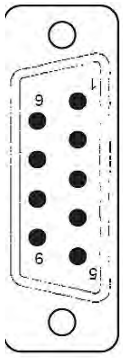


Figure 29: D-Sub9 socket ST3

13.5.7 RS232 interface plug X8 D-Sub9

For programming and diagnosis via RS 232 (1 : 1 cable).
A 3-pin line is sufficient for connection.

13.5.7.1 Pin assignment

Pin 1 : not assigned
Pin 2 : TxD data out
Pin 3 : RxD data in
Pin 4 : not assigned
Pin 5 : GND connected through PE
Pin 6 : not assigned
Pin 7 : not assigned
Pin 8 : not assigned
Pin 9 : not assigned

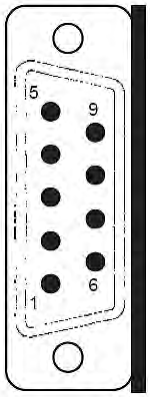


Figure 30: D-Sub9 plug X8

CAUTION!
Before establishing a connection between a PC and the KFM SAFETY, shut down both devices to prevent damage to the interfaces from potential differences, group loops or electrostatic discharge.

13.5.7.2 RS232 connection

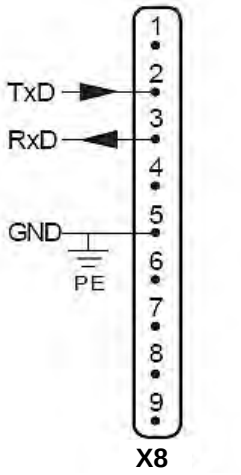


Figure 31: RS232 connection

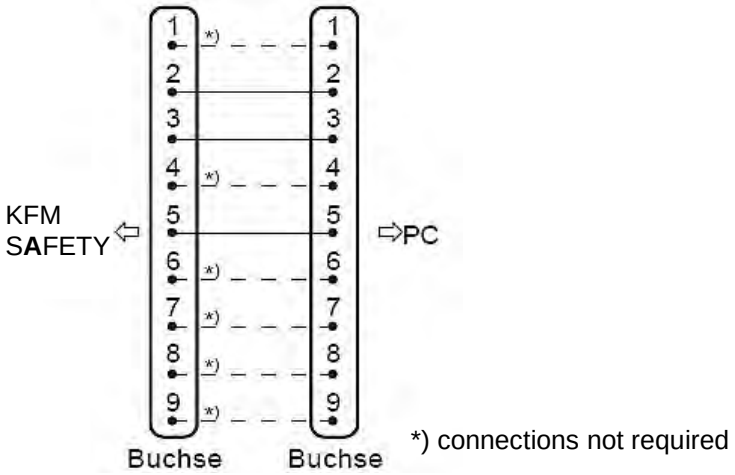


Figure 32: Connecting cable 1 : 1

As many laptops and similar devices do not feature an RS232 interface, use a USB-serial adapter. These adapters come in different models, and not all USB-serial adapters work properly when connected to a drive system.
Galvanically isolated adapters provide the best safety for the PC and the KFM SAFETY, and such an adapter with a 2-m cable is available from WEG AUTOMATION GmbH (prod. no. 751000-017).

CAUTION!
Connect the D-Sub socket to the KFM SAFETY, making sure that the plug is not in any way damaged (bent or broken pins) and that no parts become detached, damaging the electronic components.

13.5.8 Button T1

Press this button to start the automatic commissioning process. For a description of the function, see chapter 14.6.1.

13.5.9 Hex switches S1 and S2

The hex switches are used to configure the field bus address. This function is not yet implemented.

13.5.10 Dip switch S3

Dip switch	S3:1	ON	not assigned (brake monitoring)		
Dip switch	S3:2	ON	not assigned		
Dip switch	S3:3	ON	not assigned		
Dip switch	S3:4	ON	Control box active	OFF	Control box display off
Dip switch	S3:5	ON	Analog 1 0 – 20 mA	OFF	Analog 1 0 – 10 V
Dip switch	S3:6	ON	Analog 2 0 – 20 mA	OFF	Analog 2 0 – 10 V

For details, regarding these functions, see chapters 14.6 and 17.1.

13.5.11 Pin bar ST1

The pin bar ST1 is located at the input of the reset generator. A connection between the two pins instantly sets the two micro-processors to reset state and the amplifier is enabled. (STO active)

Caution!
Do not short-circuit these pins while the device is in operation!

13.5.12 M6 brass bolt

The brass bolt is used to earth the KFM SAFETY, using a suitable protective earth conductor. To improve electromagnetic compatibility and to prevent leakage currents and uncontrolled earth currents, the KFM SAFETY must be connected with this bolt to the PE conductor with a cross-section of minimum 10 mm². The connection distance must be kept as short as possible.

Note:
The above description of the terminals and plugs also applies to the plug model of the device, where the terminal signals are internally connected to the plugs, so that the customer does not need to establish these contacts.

13.6 KFM SAFETY plug pin assignment

13.6.1 General overview of "Heavy" plug

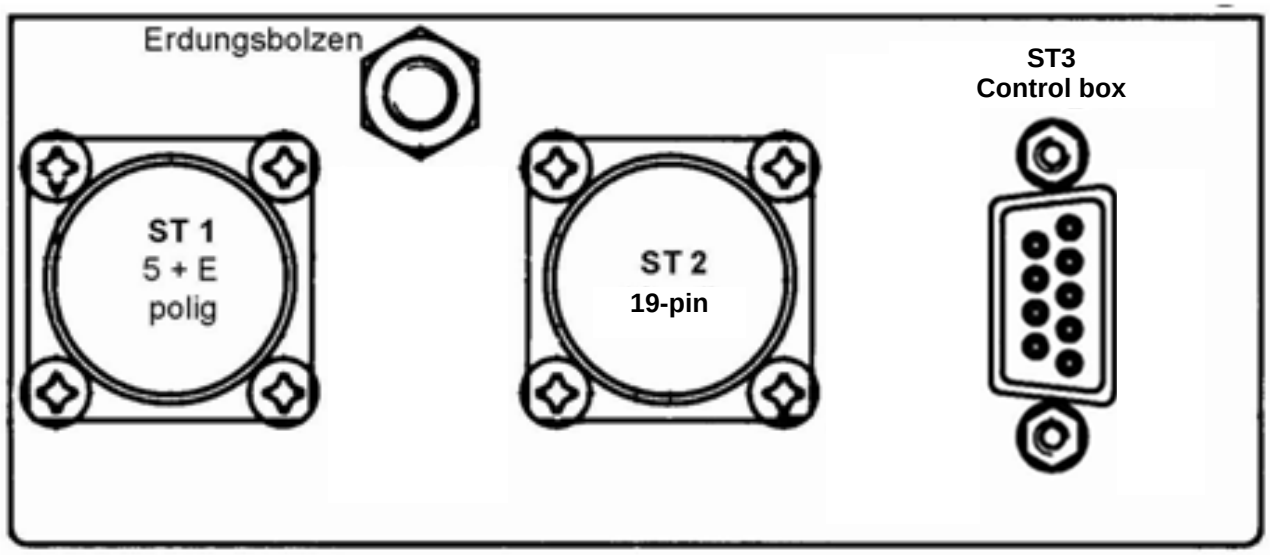


Figure 33: KFM SAFETY plug

13.6.2 ST 1 mains connection

The mains power is connected to ST 1 with a cable box and a series 623 binder, prod. no.: 99 4646 00 06 and standard cable with A>=1.5mm², e.g. H05VV-F1.5 or equivalent.

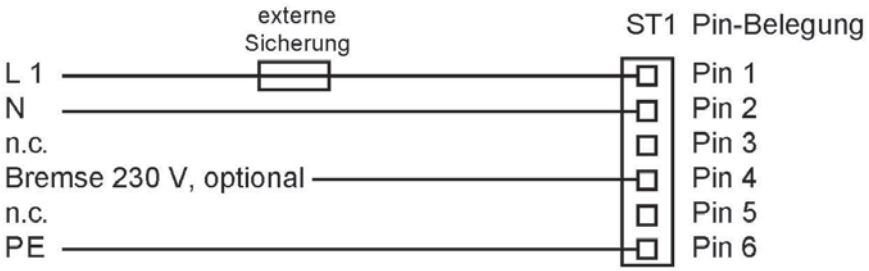


Figure 34: ST 1 assignment

The external fuse must be suitable for the line and power rating. The KFM SAFETY must be earthed with earthing bolts.

13.6.3 ST 2 control connection

The control line is connected to ST 2 with a cable box and a series 623 binder, prod. no.: 99 4644 00 19

Pin assignment:

Pin 1 :	PLC +24 V external	X7:1	Pin 11 :	Pulsed auxiliary voltage for safety (input (X7:8 and X6:26))	X7:16
Pin 2 :	PLC 0 V external	X7:2			
Pin 3 :	Input 1 Door close	X7:3	Pin 12 :	Output 1 Alarm	X6:21
Pin 4 :	Input 2 Door open	X7:4	Pin 13 :	Output 2 Door open	X6:22
Pin 5 :	Input 3 /Stop	X7:5	Pin 14 :	Output 3 Door close	X6:23
Pin 6 :	Input 4 Partial opening	X7:6	Pin 15 :	Output 4 Safety mode active	X6:27
Pin 7 :	Input 5 Enable /STO	X7:7	Pin 16 :	Output 5 Option (brake)	X6:28
Pin 8 :	Input 6 Enable /STO (pulsed signal)	X7:8	Pin 17 :	Common output	X6:24
			Pin 18:	Input 7 /Safety mode (level)	X6:25
Pin 9 :	+15 V 100 mA auxiliary voltage	X7:14	Pin 19 :	Input 8 /Safety mode (pulsed signal)	X6:26
Pin 10 :	GND auxiliary voltage	X7:15			

For the control signals, use shielded cables, e.g. UNITRONIC® LiYCY 20 x 0.34 or equivalent.

13.6.4 Control box connection ST 3

The ST 3 D-Sub9 socket ST3 is the control box interface. For pin assignment, see chapter 13.5.6.

13.6.5 Status LED, optional

Not yet implemented; can only be implemented in conjunction with the DC/DC converter relay option.

13.6.6 M6 brass bolt

The brass bolt is used to earth the KFM SAFETY. For more information, see chapter 13.5.12.

13.7 Notes for the connection of the KFM SAFETY

13.8 KFM SAFETY wiring diagram

Sample wiring diagram for the KFM SAFETY

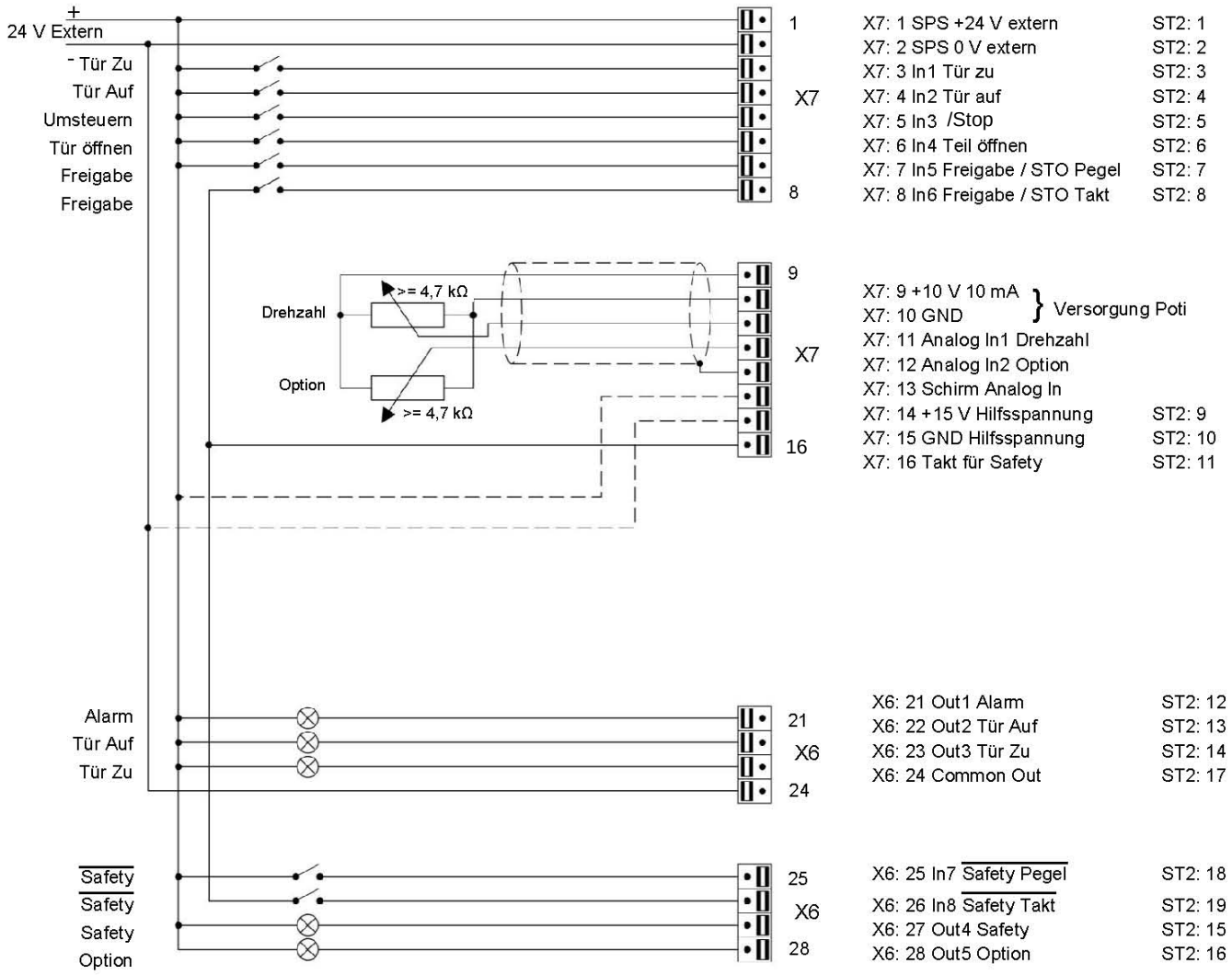


Figure 35: Wiring diagram

The following connections must be established as a minimum: PLC supply X7:1 and X7:2; enable inputs X7:7 and X7:8; pulse for safety X7:16; inputs door close X7:3 and X7:4.

The pulse for safety X7:16 is generated from the voltage at X7:1. X7:1 must therefore always have an electric potential.

Should no external 24V power supply be available, the internal auxiliary voltage at X7:14 and X7:15 may be used. This voltage is not suitable to power external relays or lamps.

The analog inputs may be used to control the rotary speed. The relevant settings are made in E@syDrives on parameter page 2.

14 Function of KFM SAFETY

14.1 General function

The KFM SAFETY is optimized for the operation of machine protection doors.

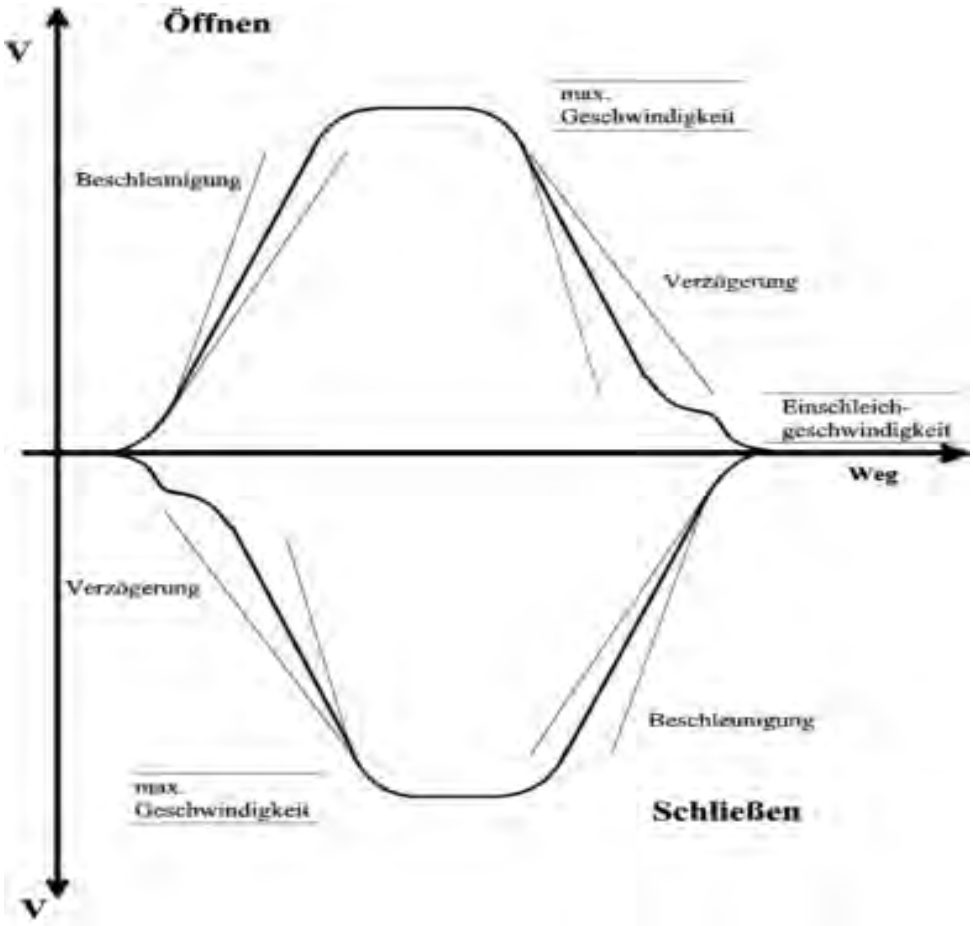


Figure 36; KFM SAFETY travel curve

The KFM SAFETY opens and closes a machine protection door. To prevent injury to persons standing inside the range of movement of the door, the KFM SAFETY features three safety functions that make it possible to operate the door safely without the need for additional sensors. On the machine, all that is needed is a fail-safe switch for the safe "door CLOSED" signal to the machine control.
The door movement is essentially a positioning process, and the various sections of the path are therefore identified by specific positions.
Position 1 corresponds to "door CLOSED". Position 2 corresponds to "door OPEN".
Position 6 is the partial opening position.
To shorten the running time of the door, a reduced torque and speed are only applied in the last section of the path (body width 500mm, adjustable). Position 3 is the point from which the safe function "door CLOSE" is controlled with In 1. Position 4 is the point from which the safe function "door OPEN" is controlled with In 2 (limitation of closing force and speed). Positions 3 and 4 might be identical to position 1 and 2 respectively.

➔Safe door movement along the complete door way

The parameters are configured with the E@syDrives program.

14.1.1 Safety mode

In safety mode, all safety functions are active and the door actuator is operated at a limited speed and torque. Safety mode is active, if one or both signals /Safety mode In 7 X6:25 and /Safety mode In8 X6:26 are inactive (LOW). In safety mode, LED 4 is lit in yellow and output signal Safety X6:27 is active (HIGH).
If a safety function (STO, SLS or SLT) is active in safety mode, the KFM SAFETY is set to safe state (amplifier disabled), and the yellow LED (LED 4) flashes while the safety output emits a pulse signal with f = 1Hz. ➔ Safety safe mode. No movement possible!
To exit this mode, reset the device.

Detect wire break.
If one of the two inputs /STO In5 X7:7 and /STO In6 X7:8 becomes inactive (LOW) more than 2s after the other, the KFM SAFETY registers a fault or wire break. The KFM SAFETY is torque-free and is set to safety safe mode (LED 4 flashes, pulse output safety mode Out 4 X6:27). This status can be reset. For details, see chapter 14.6.6.

14.1.2 Normal mode

In normal mode, the KFM SAFETY can be operated at maximum speed and rated torque (short-term torque of 2 x M_N permissible). In normal mode, the safe speed and the safe torque are not monitored, so that the doors can move faster.
This state is however only permissible, if additional fences, guards or similar safety barriers are in place, preventing persons from entering the danger area of the guard, for instance in machining centers with robot loading and unloading and auxiliary housing. Fast movements - short standstills. During setup, a person must however monitor the processes. For setup, the machine protection door must be operated in safety mode so as not to harm persons. While standstills become longer, they are still possible. Before setting the door to normal mode, ensure that no persons are standing near the machine protection door. If normal mode is active, the two signals X6:25 and X6:26 /Safety mode are active. As soon as at least one signal, from the control or generated by a wire break, is inactive, the KFM SAFETY is automatically set to safety mode.
In normal mode, LED 4 (yellow) is off and output X6:4 is inactive.

14.1.3 Safety safe mode (operation)

If a safe function (e.g. SLS) is activated in safety mode, the KFM SAFETY attempts to drop its speed to below the threshold. If an obstacle is detected, SLT moves the KFM SAFETY along the ramp to speed zero, and then back again by a set distance to ensure that the obstacle is not blocked. Subsequently, STO is activated. The KFM SAFETY is now in safety safe mode. Through the activation of STO, the amplifier is disabled and the KFM SAFETY remains in this state. Safety safe mode is indicated by LED 4 flashing, and a pulse signal at output 4 Safety. The KFM SAFETY does no longer respond to the commands "door OPEN", "door CLOSE", "stop", etc. To exit this mode, reset the system or shut down the mains power.

14.1.4 Fail safe mode (operation)

In the event of a hardware fault, the amplifier (STO) is disabled, the fault is logged and the system remains in this mode. The energy flow of the KFM SAFETY is stopped and the machine protection door is moved until all residual energy has been converted into friction. At this point, control commands from the KFM SAFETY are no longer accepted.
The horizontal machine protection door can now only be moved by hand.
Fail safe mode can only be reset by shutting down the mains power. Fail safe mode is indicated by a flashing LED 3 (red).

14.1.5 Resetting safety safe mode

If the KFM SAFETY is in safety safe mode, LED 4 (yellow) flashes and there is a pulse signal at output 4. To leave this mode, reset the device or shut down the mains power.
To reset the KFM SAFETY when in safety safe mode, first deactivate commands IN 1 "door CLOSE" and IN 2 "door OPEN". When the two commands are inactive, the two signals (STO and /STO) must be inactivated for minimum 3s. After 3s, LED 4 (yellow) does no longer flash and the KFM SAFETY is again in safety mode.

14.1.6 Resetting by shutting down mains power

Safety safe mode and fail-safe mode can be reset by shutting down the mains power after the cause of the error has been eliminated.
In the process, the power supply to the KFM SAFETY is shut down. If necessary, the $24V_{dc}$ power supply for the optional PCB is also shut down. After 5s, the power supply can be switched on again. The KFM SAFETY is again ready for operation. It is however necessary to first perform a reference run.

14.2 Operating modes

The operating mode is set by means of the E@syDrives software. Parameter pages 1 and 2 for operating mode:

01	**Door 1**	**2 positions (CLOSED In 1; OPEN In 2;) with stop In 3**
02	**Door 2**	**3 positions (CLOSED In 1; OPEN In 2; partial opening In 4) with stop In 3**
03	**Door 3**	**2 positions (CLOSED In 1; OPEN In 2;) without stop In 3**
04	**Door 4**	**3 positions (CLOSED In 1; OPEN In 2; partial opening In 4) without stop In 3**
05	**Door 5**	**3 positions (CLOSED In 1; OPEN In 2; partial opening to ramp In 4) and with stop In 3**
06	**Door 6**	**3 positions (CLOSED In 1; OPEN In 2; partial opening to ramp In 4) and without stop In 3**

In this version, only modes 01 - 06 are implemented.

14.3 Execution of input signals

All digital input signals are fed through a protection network and a bridge rectifier to an opto-coupler for galvanic isolation. The signals are connected to a share reference point located at terminal X7:2 PLC 0V GND or Pin2 of the plug. This reference point must be connected to the PLC output GND and is not connected to the reference point of the digital outputs. The 24V of the PLC must be connected to X7:1. As the inputs are protected, $24V_{dc}$ is always required at the KFM SAFETY. From the external $24V_{dc}$, the KFM SAFETY generates the 24V pulse signal at X7:16 for the 2 two-channel inputs.

The inputs are designed so that a HIGH level > 12 V_{dc} relative to X7:2 activates the opto-coupler so that the signal is fed to the micro-controller (positive logic).

Should the device work with negative logic, i.e., with a HIGH signal from the control to ground, reference point X7:2 must be connected to $+24V_{dc}$ and X7:1 must be connected to PLC GND.

The safe inputs are designed as two-channel inputs and work with different signals, so that short circuits can be quickly detected. Like all other inputs, the inputs X7:5 STO and X6:25 /Safety mode are level-sensitive: a level of 12 – 24V activates these inputs; a level of 0 – 5 V deactivates the inputs.
The inputs X7:6 STO and X6:26 /Safety mode work with the pulse signal from X7:16. The signal X7:16 can be used for both inputs. At the control unit and other devices, the signal must be fed through a contact (e.g. safe relay contact) or low-ohmic semiconductor, to keep interference with the signal to a minimum.
Only when both channels receive a signal (level and pulse signal) is the input function activated.

The KFM SAFETY requires no switches to switch from positive to negative logic. All that must be done is changing the polarity at the terminals X7:1 and X7:2!

The KFM SAFETY always requires $24V_{dc}$ at the terminals X7:1 and X7:2!

14.4 Execution of output signals

The output signals (not X7:16) also have a shared reference point X6:24 "Common output". The polarity of the power supply ($24V_{dc}$) determines the logic of the outputs.

+24V => positive logic ➔ 24V HIGH Signal level at the outputs

GND => negative logic ➔ Outputs switch the signal to GND

Reference point X6:24 is not connected to reference point X7:2.
The inputs and the outputs can therefore operate at different logics.

14.5 Function of I/O signals

14.5.1 Signals PLC +24V external and PLC 0V external

These two levels must always be connected to the KFM SAFETY, as the 24V signal is used to generate the pulse signal for the second channel of the safe inputs. If the optional DC/DC converter PCB is used, at least 250 mA must be available. The voltage at these terminals is completely isolated from the electronics of the KFM SAFETY.

14.5.2 Signal door CLOSED In 1

With signal In 1 door CLOSE => HIGH, the door is moved to position 1 door CLOSE. When position 1 is reached, output X6:23 "door CLOSE" is activated. The KFM SAFETY holds this position with the set closing force. This closing force is implemented by means of a position controller and set with the UF4 parameters on the 2nd parameter page.
To reduce performance loss, the signal to In 1 should be switched off, if possible. Alternatively, use a safety switch with lock.
If the signal is switched off while the door is in motion, the KFM SAFETY moves along the set ramp to speed zero and becomes torque less until the next signal arrives (no position control, no holding torque).
After switching on the mains power, signal In 1 activates the reference run. When signal In 1 is active, the KFM SAFETY closes the door at reference speed until it encounters an obstacle. This position is saved as the door CLOSED position, so that the KFM SAFETY is ready for operation.
To keep the reference run time short, the horizontal machine protection door should be closed when the reference run starts. If output function 01 (2nd parameter page) is set, the reference run is completed successfully and indicates such by setting output Out 5 to active.

14.5.3 Signal door OPEN In 2

With signal In 2 door OPEN => HIGH, the door is moved to position 2 door OPEN. When position 2 is reached, output X6:22 door OPEN is activated. The KFM SAFETY holds this position with the set torque. During prolonged breaks, the signal at In 2 should be switched off.
If the signal is switched off while the door is in motion, the KFM SAFETY moves along the set ramp to speed zero and becomes torque less until the next signal arrives (no position control, no holding torque).

14.5.4 Signal /Stop In 3

In operating modes 1, 2 and 5, the signal /Stop In 3 results in an instant stop of the door movement triggered by an external sensor (light curtain, impact bar, etc.). The signal is LOW active, i.e., HIGH level is applied until an obstacle is encountered. When an obstacle (object or person) is encountered in the monitored range, the sensor switches to LOW level. The signal is thus wire break proof. In normal mode, the signal is always HIGH. This function is only active in operating modes 1, 2 and 5.

14.5.5 Partial opening signal In 4

With the partial opening signal In 4 (HIGH), in operating modes 2 and 4 and by activating In 2 "door OPEN", the door is opened only to position 6 "partial opening". As the door is only partially opened, shorter cycle times can be achieved, as the door movement times are shorter.
In operating modes 5 and 6, the positive ramp of In 4 is used as the sensor signal to terminate the opening movement of the door with ramp. This allows for flexible partial opening without position 6 parameter (e.g., for injection molding machine).

14.5.6 Signal /STO In 5 and In 6

The amplifier, and safety or normal mode are only activated, if the two safe signals /STO In 5 (level) and /STO In 6 (cycle) are in place or if enable is active.

14.5.7 Signal /Safety mode In 7 and In 8

The two safe signals /Safety mode In 7 (level) and /Safety mode In 8 (pulse) activate normal mode. If one of these signals is inactive, the KFM SAFETY is switched to safety mode. If one of the two signal becomes inactive (e.g., due to wire break) while the KFM SAFETY is running in normal mode, it is instantly set to safety mode. In this case, the speed and the torque of the KFM SAFETY are limited by the set ramp to safe values.

14.5.8 Signal safety mode triggered

if one of the /STO signals In 5 or In 6 drop off, or if a safe function is active as SLS or SLT is activated by the micro-processors, LED 4 flashes, a pulse signal is generated at the safety mode output and the KFM SAFETY disables the amplifier and remains in this state (safety safe mode, see chapter 14.1.3) until it is reset.

14.5.9 Signal Safety Out 4 reset

If a safe function has been triggered in the KFM SAFETY (safety safe mode) and a pulse signal is generated at output X6:27, the control system can be reset. Before doing this, the machine operator must identify the mechanical part or the person that has triggered the safe function. After it has been established that there is no longer a risk of injury or damage, reset the device as follows:
Initially, movement command "door CLOSE" / "door OPEN" is inactive.
Subsequently, the two inputs enable STO are inactive for minimum 3s.
After this time has elapsed, the two inputs STO can be again be activated and the movement command can be started.

14.5.10 Signal Error Out 1 reset

If the KFM SAFETY detects an internal error, the amplifier is disabled and the KFM SAFETY goes into fail safe mode. This mode can only be reset by shutting down the mains power. If a hardware fault occurs, the KFM SAFETY instantly returns to fail safe mode. In this case, return the KFM SAFETY for repair.

14.5.11 Analog inputs AIn1 and AIn 2

The analog inputs can be used to set the rotary speed. Depending on the position of S3-5 Analog 1 and S3-6 Analog 2, a current of 0 - 20 mA_{dc} S3-x => ON or a voltage of 0 -10V_{dc} S3-x => OFF is applied to the terminals to set the speed (parameter mode V3, V4 on 1st parameter page). The adjustment range and the assignment are configured on the 2nd parameter page.

14.5.12 Signal Alarm Out 1

The output Out 1 X6:21 is active, if the KFM SAFETY is in fail safe mode.

14.5.13 Signal door OPEN Out 2

The output Out 2 X6:22 is active, if the door is in open position or within the tolerance window.

14.5.14 Signal door CLOSED Out 3

The output Out 3 X6:23 is active, if the door is in closed position or within the tolerance window.

14.5.15 Signal safety mode Out 4

The output Out 4 X6:24 is active, if the KFM SAFETY is in safe mode.
If normal mode is active with unlimited speed and torque, Out 4 is inactive.
If a safe function (STO, SLS, SLT) is set to active, the KFM SAFETY is set to safety safe mode and the output emits a pulse signal with f = 1 Hz.

14.5.16 Signal Option Out 5

The output Out 5 X6:28 can indicate various different states. The function is selected with the output function parameter in E@syDrives, on the 2nd parameter page.

Output function 01: Reference run completed; door positions known

Output function 02: not assigned

Output function 03: not assigned

Output function 04: not assigned

In this version, only output function 01 is implemented.

14.6 Additional functions of KFM SAFETY

14.6.1 Automatic door teach-in function

The KFM SAFETY features a partly automatic door teach-in function for horizontal machine protection doors. This function is used to set the direction for door CLOSE, door OPEN, the door width and the friction coefficient. The function is activated by pressing button T1.

Before starting the automatic door teach-in function, the machine protection door must be closed by hand. When the machine protection door is closed, the two /STO inputs are activated. The KFM SAFETY is now preparing itself for the automatic door teach-in function.

Before starting the teach-in process, the operator must ensure that no person stands in the movement range of the horizontal machine protection door, as the KFM SAFETY will perform a number of movements without control signal. The teach-in process can be stopped with /STO inactive, pressing button T1 or by shutting down the mains power. During the teach-in process, the commissioning technician must constantly monitor the movement range of the machine protection door so that he can abort the process, if necessary.

Press the button T1 for minimum 5s until LED 2 (GREEN) flashes. The KFM SAFETY now moves with the reference torque value for max. 10,000 increments in clockwise direction and checks for an obstacle in the door CLOSE path. When the KFM SAFETY reaches the obstacle, the respective position is saved as door CLOSED position 1 = 0 and the direction of rotation is saved as the door CLOSE direction of rotation.
If no obstacle is encountered after 10,000 increments, the direction of rotation is reversed and 20,000 increments are performed in anticlockwise direction. If the KFM SAFETY encounters again no obstacles, the commissioning procedure is terminated and the KFM SAFETY returns to normal mode (LED 2 is off).
If the torque reference is set too low, the KFM SAFETY is unable to start, thus encounters an obstacle and changes direction of rotation. The KFM SAFETY is also unable to start in the opposite direction, and the torque reference value is increased until the KFM SAFETY starts or torque reference maximum is reached. If the KFM SAFETY starts, the torque reference value is increased by a safety margin of 0.1 Nm, to ensure smooth running. The KFM SAFETY then runs until it encounters and obstacle or until 10,000 increments are completed. If no obstacle is detected, the KFM SAFETY changes the direction of rotation after 10,000 increments and moves in the new direction to search for an obstacle. If an obstacle is detected, the KFM SAFETY saves the current direction of rotation as the "door CLOSE" direction of rotation, and position "door CLOSE" position 1 = 0 => direction of rotation is taught in; LED 2 flashes.
The commissioning technician must ensure that the door CLOSED position is reached and that there is no obstacle before the door CLOSED position!

The next parameter to be taught in is the door width. The KFM SAFETY moves in "door OPEN" direction until an obstacle is encountered. This position is saved as "door OPEN" position => door with taught in. The operator must again check whether this position has actually been reached.

The safety zone is also saved as 2048 increments less than the "door OPEN" position. If the torque reference value has been increased when a direction change was detected, all torque values are now saved without a safety margin. Automatic commissioning is completed and the determined values are saved in RAM.

At this stage, the values should be checked again and then written to EEPROM. In E@syDrive, press the  button. After all values have been written to EEPROM, perform a reset and start the KFM SAFETY with the values in EEPROM.

14.6.2 "Door OPEN" detection

The KFM SAFETY is also able to detect whether the door is in position "door OPEN". This function is activated, if parameter "Pos. 8 (door OPEN detection)" on the 1st E@syDrives parameter page is set to a value > 2047. The value set here is a relative value and refers to the door OPEN parameter "Pos. 2 (OPEN)", i.e., the KFM SAFETY moves by maximum the set number of pulses, checking the path for obstacles. If no obstacle is encountered, the KFM SAFETY goes into safety safe mode. A pulse signal is generated at output 5 and LED 4 flashes to indicate this. The "door OPEN" output remains inactive.
If the door encounters an obstacle along the set path, it returns to position "door OPEN" and remains in this position (output "door OPEN" becomes active).
Through this mechanism, the KFM SAFETY is able to detect a fault of the gear mechanism or the timing belt (break or release).
If the value of parameter "Pos. 8 (door OPEN detection)" < 2048, the KFM SAFETY moves only to the "door OPEN" position and function "door OPEN detection" is not active.

14.6.3 Partial opening with sensor

During production, downtimes and idle times should be prevented. That is why the KFM SAFETY comes with function "partial opening". Depending on the operating mode (OM) settings, this function enables the operation to choose no partial opening (OM 01, OM 03), partial opening to set position 6 (OM 02, OM 04) via In 4 or partial opening to In 4 active.

In operating modes OM 01 and OM 03, the KFM SAFETY opens the machine protection door to the set door OPEN position pos. 2. A signal at In 4 "partial opening" is ignored.

Function "partial opening to position via In 4 (partial opening)" allows for the partial opening of the machine door, e.g. to perform a measurement or to move parts.
If, upon activation of the "door OPEN" signal, input In 4 is inactive, the machine protection door is opened to the door OPEN position pos 2. Otherwise, it behaves as described in chapter 14.1. If input In 4 is again active, the machine protection door opens only to position 6 (partial opening) and the machine protection door is kept in this position with the same torque that is applied for "door CLOSED", position 2. If In 4 is active, only the "door OPEN" position changes.

Function "partial opening" to ramp In 4 is for example designed for injection molding machines. During operation, the machine protection door must only be opened by as much as the mold is opened. As a different mold might be used, the opening widths might therefore vary. If absolute positions were used, they would need to be changed regularly. This function does away with repeat changes of the position values. A sensor is installed in the injection molding machine, which is always located at the position at which the door movement is to be halted, depending on the installed mold. When the KFM SAFETY is set to operating mode OM 05 or BM 06, the machine protection door is opened until a ramp from the door sensor is detected at In 4 or until door OPEN position pos. 2 is reached. This ensures that, if there is a sensor signal fault (e.g. due to a wire break), the machine protection door only moves to its maximum door OPEN position. Should the machine protection door be opened fully (door OPEN position pos. 2), the sensor signal must be suppressed. That is why it is useful to send the sensor signal to the external control, which can then forward it to the KFM SAFETY, depending on its operating status, to stop the door movement.

14.6.4 Releasing locking mechanism

The machines are equipped with a safe switch with lock for the "door CLOSE" signal to the control. Alternatively, a different mechanism for the locking of the machine protection door might be chosen, so that the KFM SAFETY can be switched off during prolonged machining times, saving energy. To open the machine protection door, switch on the KFM SAFETY and then release the electrical, pneumatic or hydraulic lock. In this process, it might occur that the locking bolt of the machine protection door becomes jammed and therefore fails to return to its open position. The KFM SAFETY can handle this situation. Before signal "door OPEN" In 2 for the opening of the machine protection door is activated, signal "door CLOSE" In 1 is activated for t = 200 – 500 ms after the locking mechanism has been released. As a result, the machine protection door is briefly pushed into its closed position, so that the locking bolt is released.
This is not a separate function that needs to be activated, but a feature that can be implemented using the KFM SAFETY standard functions.

14.6.5 Reference run

After the power supply is switched on, a reference run must be completed so that the KFM SAFETY knows where the machine protection door is positioned.
Make sure that, during the reference run, no persons are standing within the movement range of the machine protection door!

After both STO inputs have been activated, input In 1 "door CLOSE" is activated and the KFM SAFETY moves along the reference characteristic of the door to obstacle. If output function 01 is set, output Out 5 is activated.

14.6.6 Detecting wire break

The key inputs of the KFM SAFETY are implemented as two-channel inputs (/STO and /Safety mode). Different levels (level 24V and pulse 24V) are used for the two channels so that short circuits can be detected. Depending on the control and the pulse rate, there might be a short delay until both signals are recognized as active or inactive respectively. This delay is set to 2s.
If one of the two inputs /STO In5 X7:7 and /STO In6 X7:8 becomes inactive (LOW) more than 2s after the other, the KFM SAFETY registers a fault or wire break. The KFM SAFETY becomes torque less, LED 4 is off and output Safety mode Out4 X6:27 is set to inactive (LOW) (safety safe mode). The state can be reset after the cause of the fault has been eliminated. For details, see chapter 14.1.5.

15 Signal diagram

15.1 I/O signal diagram

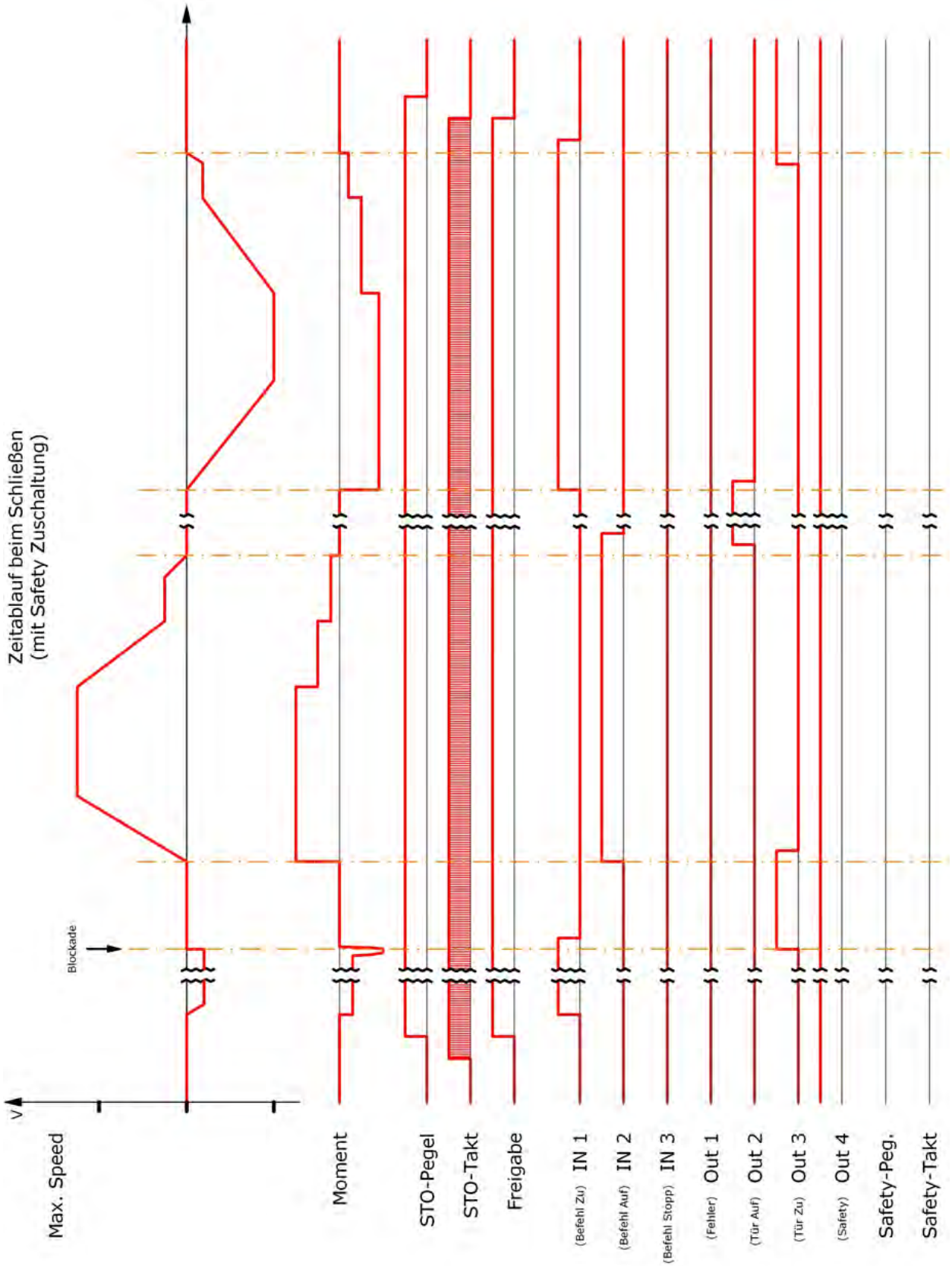


Figure 37: I/O signal curve

15.2 Safety and normal mode

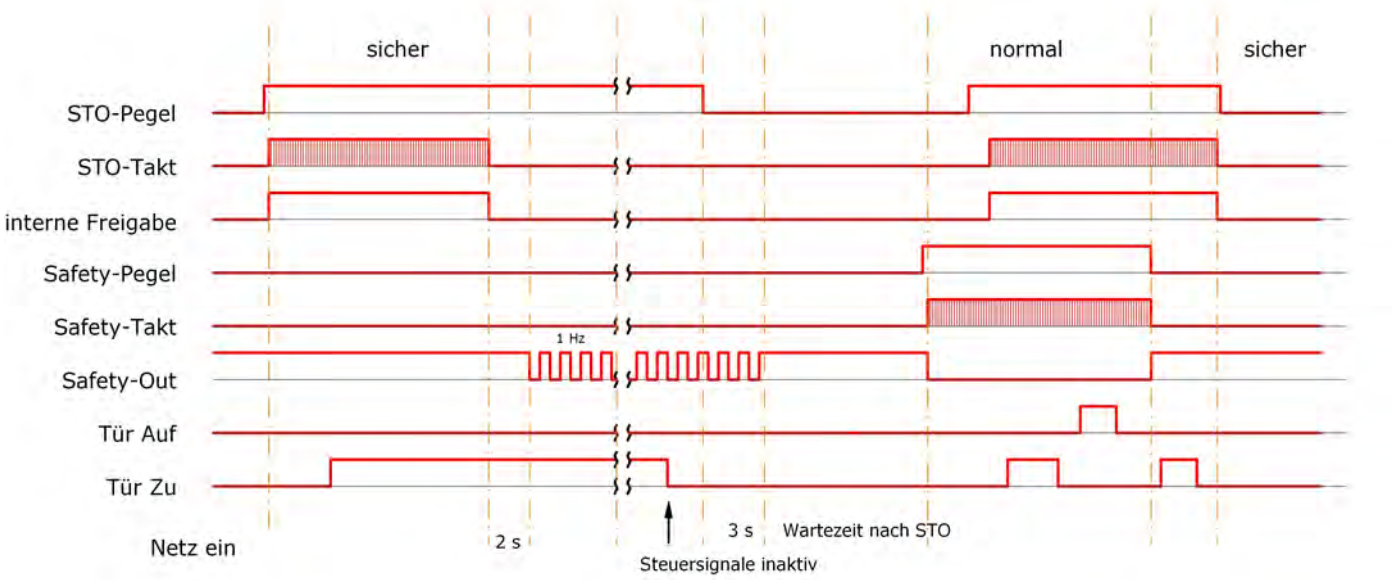


Figure 38: Signal diagram - safety and normal mode

15.3 Safety reset

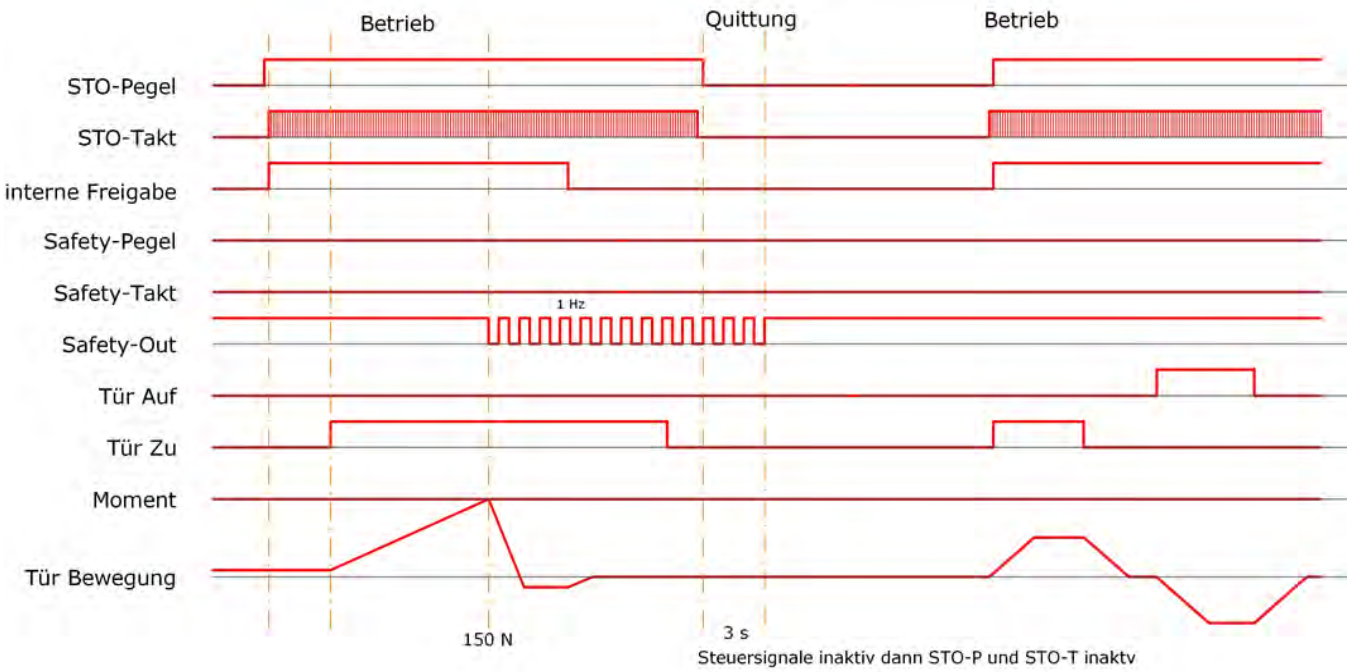


Figure 39: Signal diagram - reset

16 KFM SAFETY 3 software

16.1 General

The KFM SAFETY 3 comes with an integrated menu and configuration program called E@syDrives that features a software oscilloscope for optimized setup, adjustment of the drive and diagnosis (WINDOWS® operating system, on request in German or English). The determined parameters can be saved with this menu program to a PC or similar device and loaded to another KFM SAFETY 3.

The menu program runs in WINDOWS® XP or WINDOWS® 7 with Internet Explorer.
To run the program in WINDOWS® 7, it is necessary to activate **XP Compatibility mode**.

Most modern laptops come with USB ports and do not feature an RS232 interface. In this case, use a USB-RS232 adapter to run the menu program.
The WEG AUTOMATION team recommends using a USB-serial adapter with galvanic isolation, type ICUSB2321FIS from StarTech.com.
This adapter with a cable length of approx. 2m and galvanic isolation at both ends is available with prod. no. 751000-017.

Use the Device Manager to identify the interface number and enter it in the E@SyDrive configuration.

The menu software is included in the scope of delivery of the KFM SAFETY 3.
It is currently only available in German.

16.2 E@syDrives

After installation of the E@syDrives software on the PC or laptop, accept the installation default settings to place a shortcut to the E@syDrives program on the desktop.
In WINDOWS® 7, this shortcut must be activated. In addition, **XP compatibility mode** must be activated. In Windows XP, E@syDrives runs properly without any need for further adjustments.

Start E@syDrives and test the connection to the KFM SAFETY 3:
Start E@syDrives. On the start page, select "Sinus Motor KFM05".
On the next page, click **KFM-SAFETY series** "KFM-SAFETY, Ver.50.03". The E@syDrives interface is displayed.
If the connection to the KFM SAFETY is working properly, the KFM SAFETY version page is displayed. Otherwise, error message "Fehler vom Com-Server" is displayed. Confirm this message with "OK". For instructions on how to deal with connection errors, see chapter 16.4.

The E@syDrives menu program is self-explanatory.

On the version page, you have the option to select and open a number of documents.

The integrated help function of E@syDrives can be called up by selecting the parameter you wish to know more about and pressing the F1 key.
A help file is displayed in a new browser window, focusing on the selected parameter/topic.

Note:
In WINDOWS XP and the last Internet Explorer version IE8, you must first open Internet Explorer to establish the help link.

16.3 Menu pages of E@syDrives

16.3.1 Start page

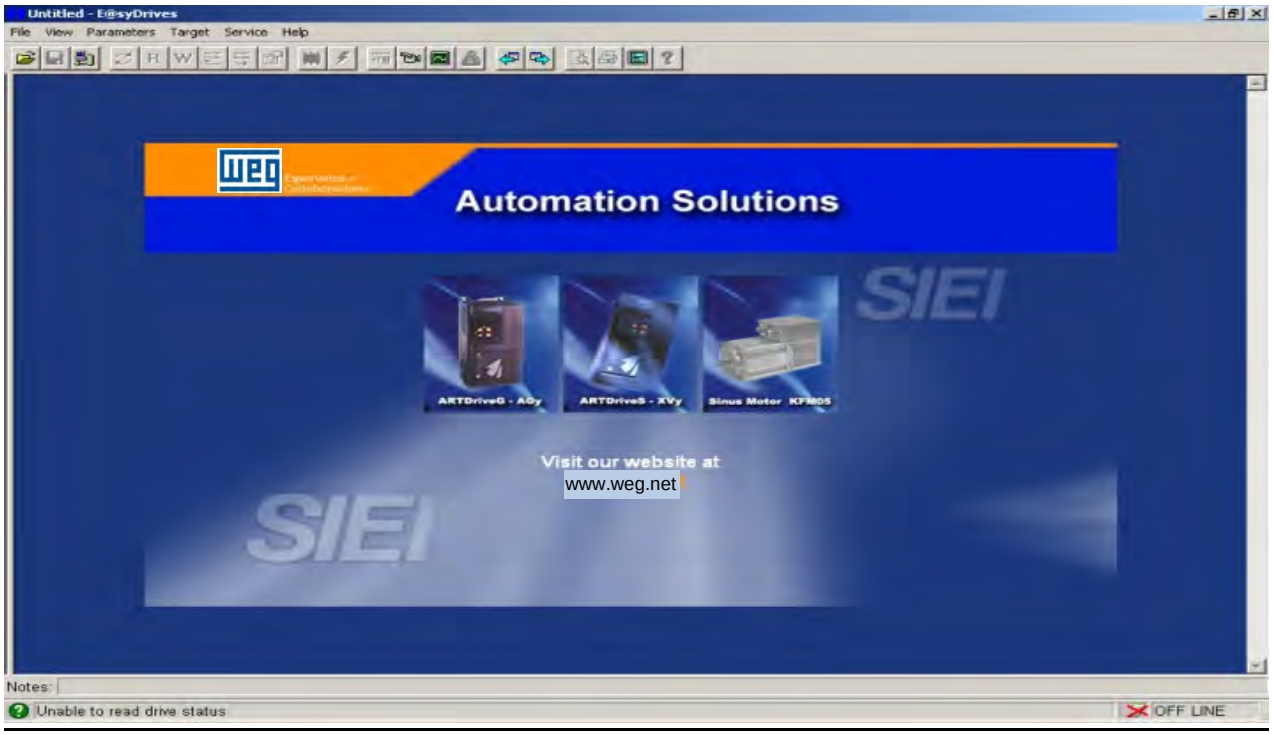


Figure 40: Start page - menu selection

16.3.2 E@syDrives page

Figure 41: E@syDrives page

16.3.3 KFM SAFETY version page

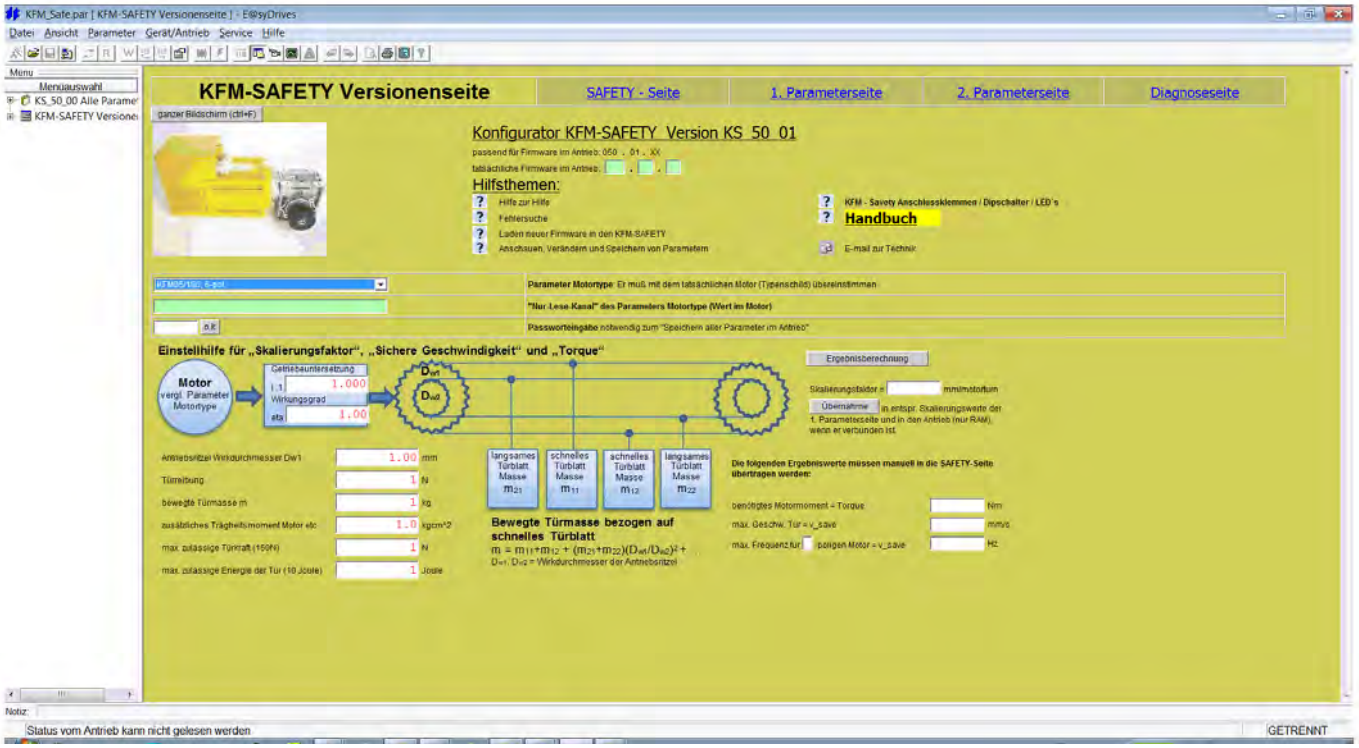


Figure 42: KFM SAFETY version page

16.3.4 SAFETY page

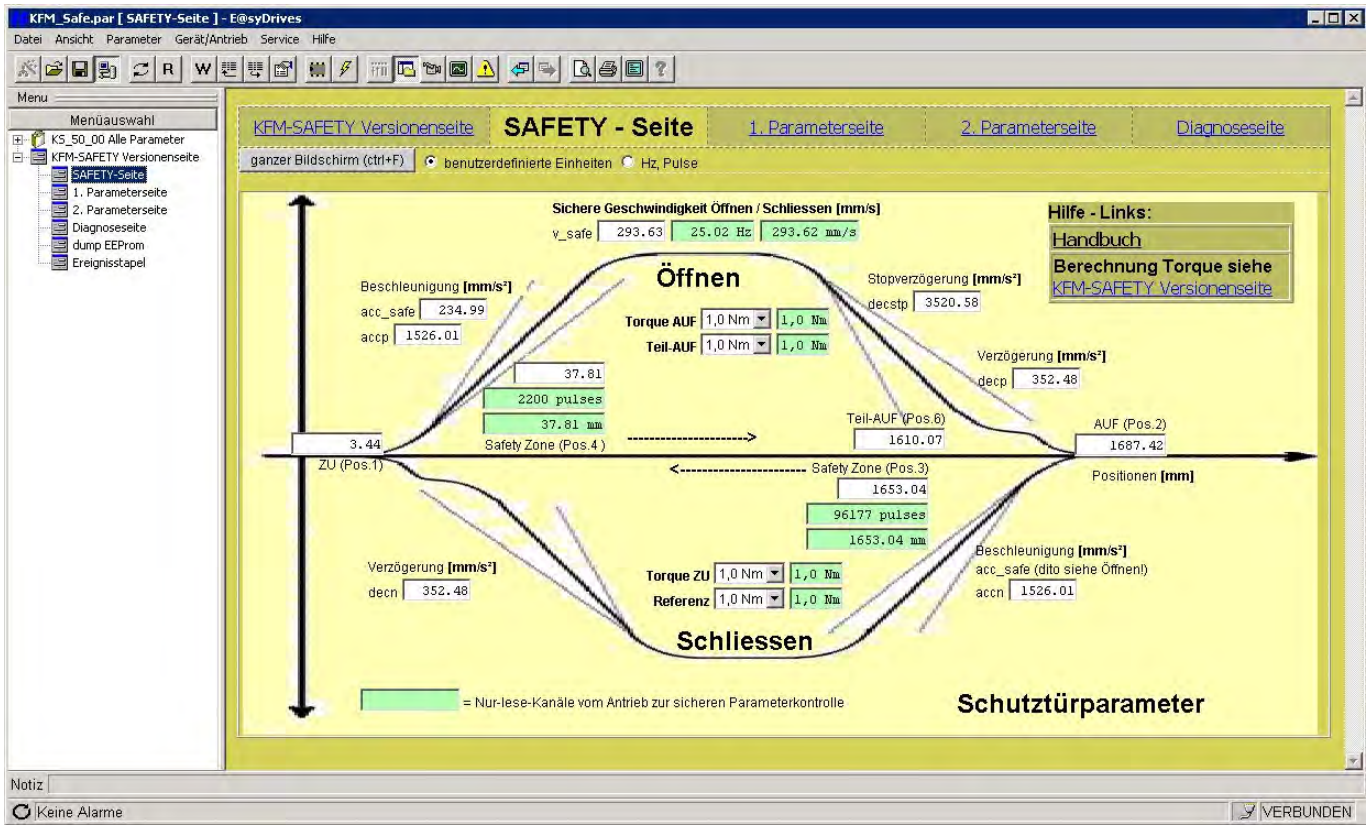


Figure 43: Safety page

16.3.5 1st parameter page

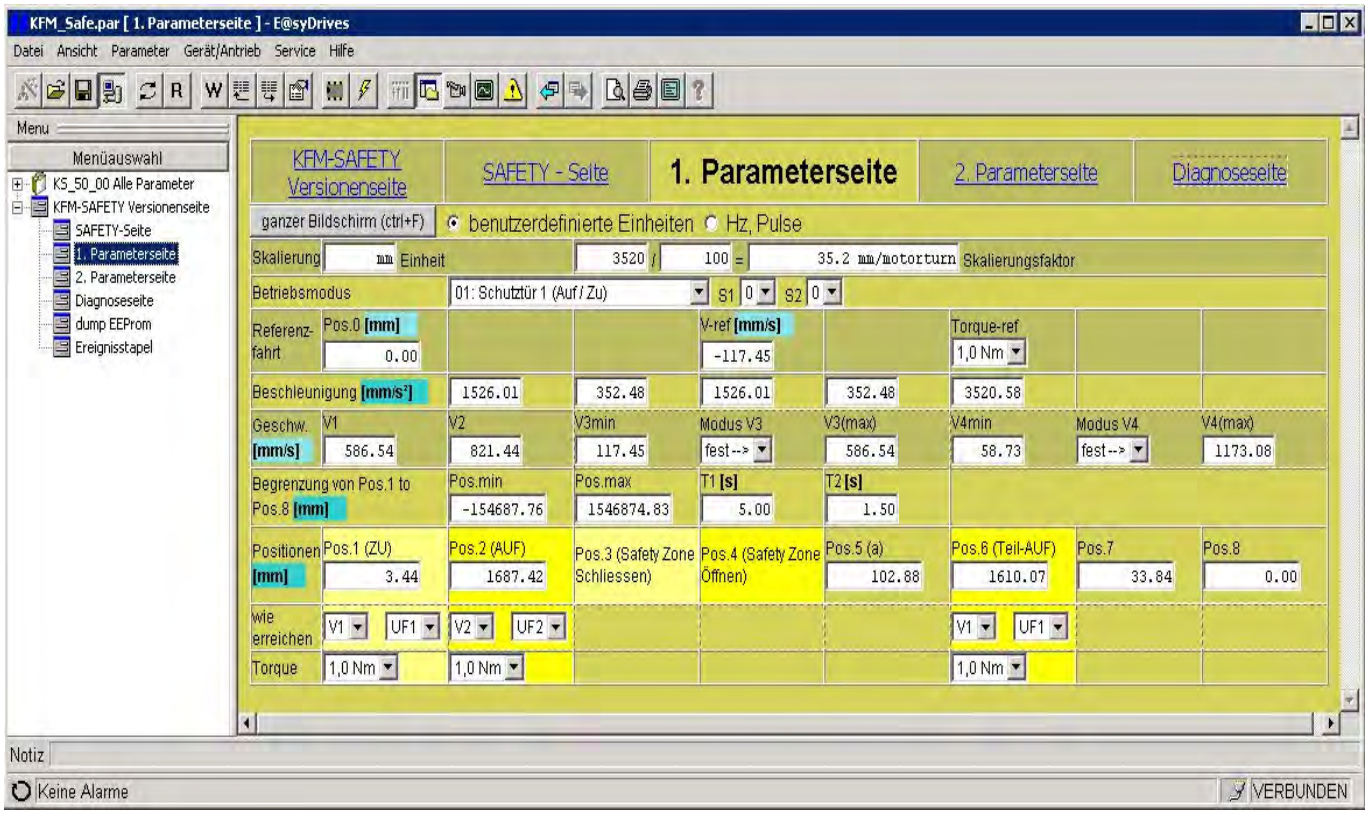


Figure 44: 1st parameter page

16.3.6 2nd parameter page

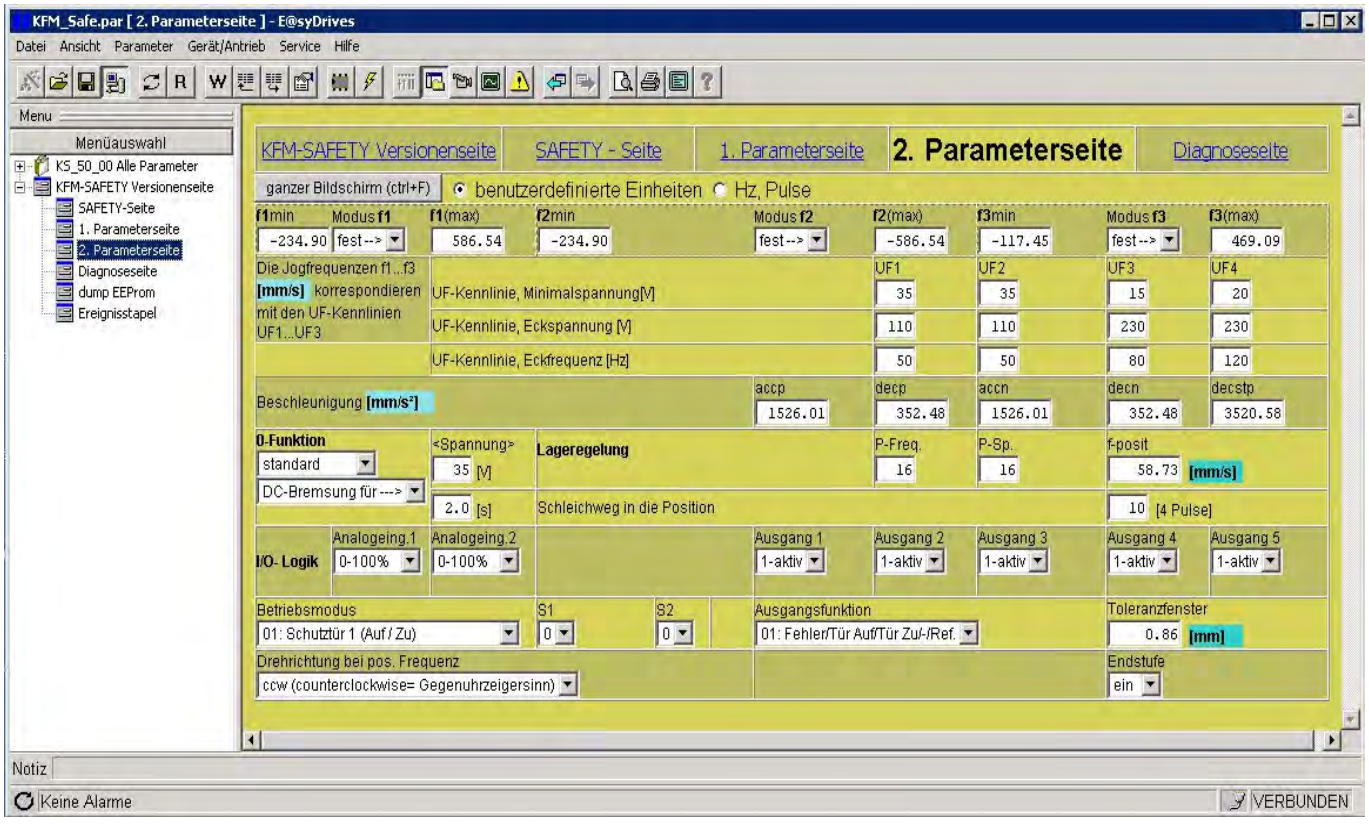


Figure 45: 2nd parameter page

16.3.7 Diagnostic page

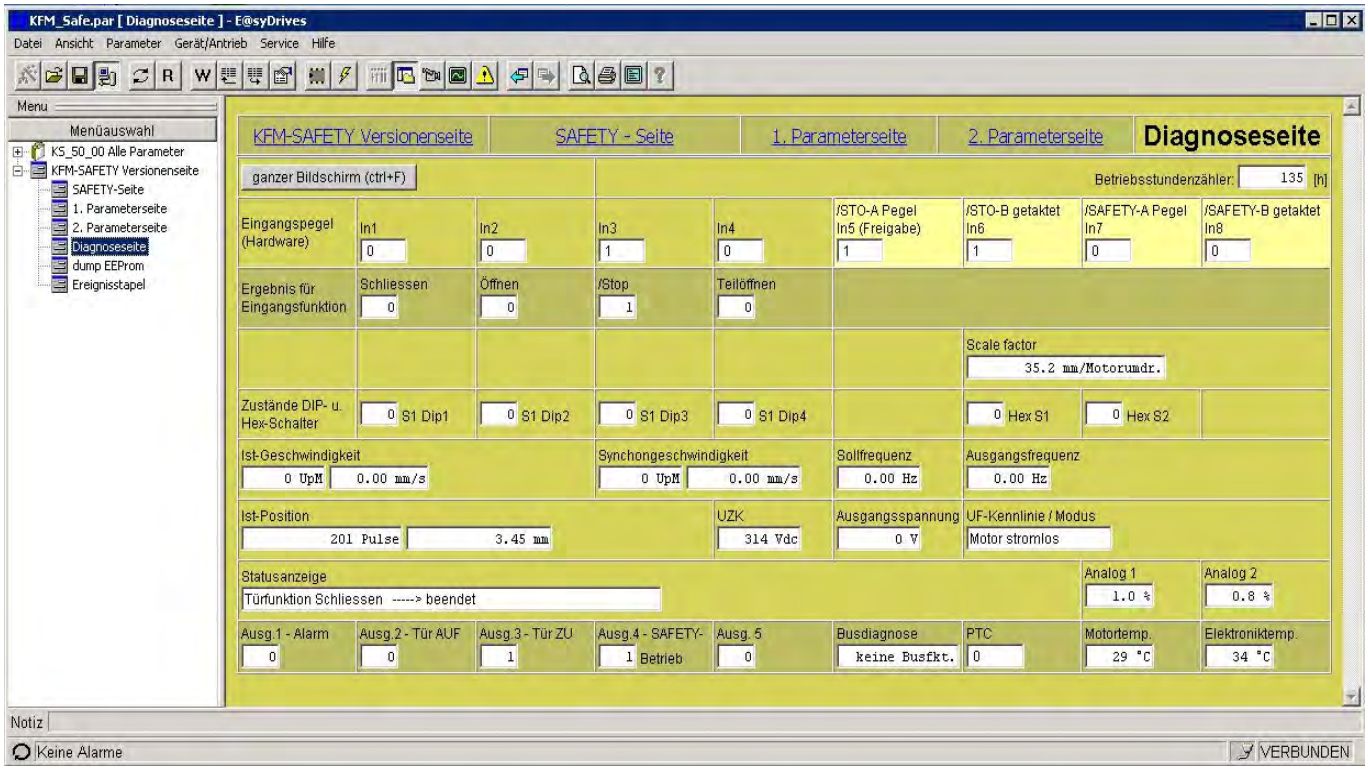


Figure 46: Diagnostic page showing actual values

16.4 Configuring interface

On the version page, select "Gerät/Antrieb" menu.

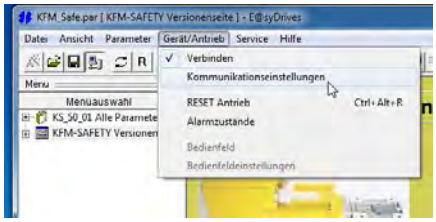


Figure 47: Device/actuator view

Select "Kommunikationseinstellungen".

In the next window, set "Modbus" to "Activate".

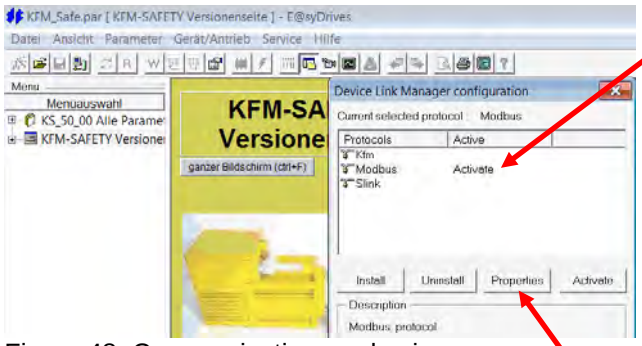


Figure 48: Communication mode view

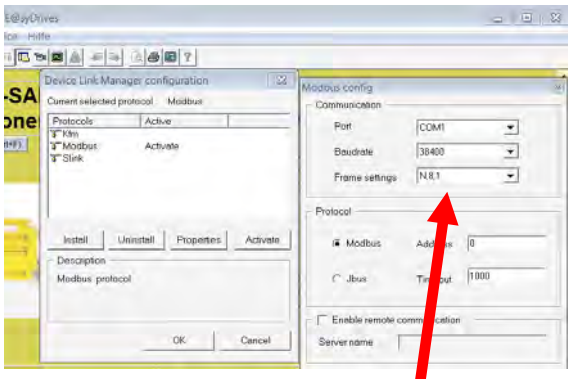


Figure 49: Interface view

When Modbus is activated, the interface (COM Nr.) and the baud rate (38400 Bd) can be set and checked with the "Properties" button. Close the window. The connection can now be activated by pressing the  button.

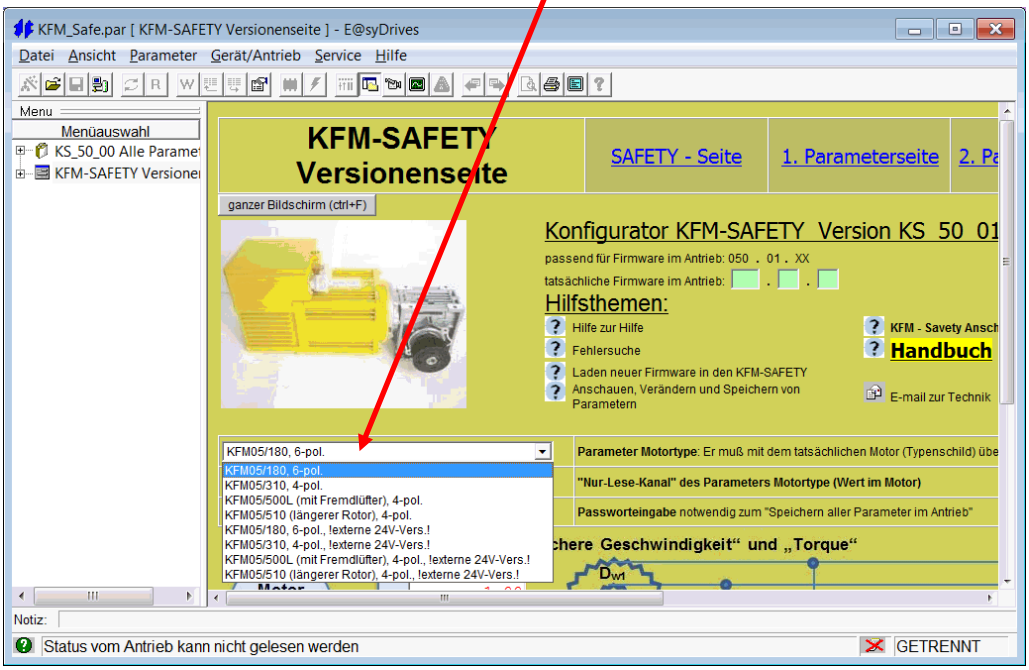
16.5 Calculating parameters for safe functions

The parameters are calculated on the KFM SAFETY version page, based on the mechanical requirements. These calculations can also be performed off-line.

16.6 Operation of E@syDrives

The E@syDrives menu program is self-explanatory.

E@syDrives can also be run off-line, for instance to view and adjust parameter settings.
On the version page, enter the KFM SAFETY type and compare it with the value returned by the software.



.

On the version page, you have the option to select and open a number of documents.

Figure 50: Operation - version page

The integrated help function of E@syDrives can be called up by selecting the parameter you wish to know more about and pressing the F1 key.
A help file is displayed in a new browser window, focusing on the selected parameter/topic.

To access certain program features, you must enter a password on the KFM SAFETY version page. Otherwise, it is not possible to save parameter values to EEPROM.

Password: Operating hours, see diagnostic page, top right

Enter a value and confirm with the "OK" button.

17 Function of control box (optional)

The control box is used to view and adjust parameters and to call up status information. For the control box to work properly, the dip switch S3:4 must be set to ON.

17.1 Control box overview

The control box is a product of WEG Automation Europe and does not contain any software.
The functions of the buttons, LEDs and displays are described below.
The memory is not yet activated.
With the magnets at the rear of the box, it can be attached anywhere on the machine.

Figure 51: Control box as shipped

Caution!
The parameters of the safety functions cannot be modified with the control box. These parameters are only displayed on the box.

17.2 Control elements and display functions

17.2.1 Status LED of control box

Indication of KFM SAFETY status by control box LEDs.

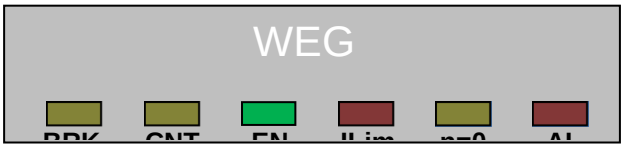


Figure 52: Status LEDs

Meaning and colour

BRK:	(not in use)	yellow
CNT:	(not in use)	yellow
EN:	Enable KFM SAFETY	green
ILim:	Current limit reached (not in use)	red
n=0:	Standstill	yellow
AL:	Alarm	red

In this version, not all LED are yet in use.

17.2.2 Control box display

The 4-line display shows menu options, parameters, values and the status of the KFM SAFETY.
It can also be used to change parameter values or for online positioning.

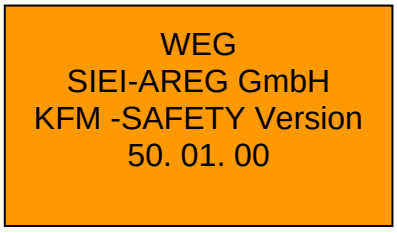


Figure 53: Start display

17.2.3 Control box buttons

The buttons are used to navigate the menus and parameters. Pressing these buttons does not activate any KFM SAFETY functions. Not all buttons have yet been assigned a function in this version.

ESC - Abort **DISP - Display**
SAVE - Save data **CUST - Customer menu**
FIND - not in use **RST - not in use**
▲ - Arrow UP **► - Arrow RIGHT**
◄ - Arrow LEFT **▼ - Arrow DOWN**
E - Enter

Figure 54: Control box buttons

17.2.4 Button functions

At menu level: press arrow buttons ▲ and ▼ to select a menu option.

▲ - At parameter level / value input: increase value.

▲ - At parameter level / value input: decrease value.
Press and hold to quickly scroll through values.

► - At menu level: go to parameter level of selected menu.
At parameter level: select a parameter; when the end of the parameter list is reached, the displayed shows again the first parameter.

◄ - At parameter level: select a parameter. No changes can be made to the start of the parameter list.

E - At menu level: go to parameter level of selected menu.
At parameter level: open parameter field for input. Letter "E" is shown in the display status bar.

Press the arrow buttons ▲ and ▼ to change the value.

Note:

Changes are made in volatile memory and apply instantly. For permanent storage in non-volatile EEPROM, see menu option saving.

ESC - At parameter level and when parameter is open: termination of entry.
At parameter level and when parameter is closed: back to menu level.

DISP – Shortcut key to display

CUST- Shortcut key to customer menu

SAVE - Shortcut key to save data

The shortcut keys DISP, SAVE and CUST can be pressed at any time to call up the respective menu option.

17.2.5 Control menu and functions

Monitor menu

The status bar shows the current system status.
Value 0 indicates that there is no error.

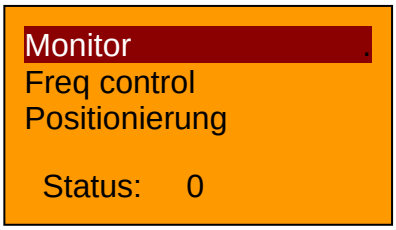


Figure 55: Monitor menu

Parameter display in monitor menu.

Monitor menu, read-only.

Parameter values cannot be changed!

Figure 56: Speed display

Parameters in positioning menu

Parameter values can be changed.
Only if "E" is shown in status bar.

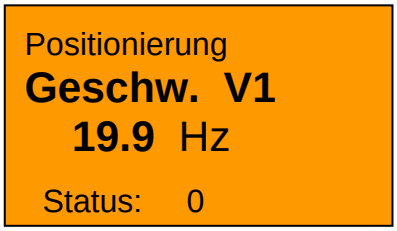


Figure 57: Positioning display

Saving data in volatile memory.

In the data saving menu, change the **savepara** value from **0** to **7** to activate automatic saving to EEPROM. When the data has been saved, savepara is reset to 0.

Error log:

The error log shows the last 10 errors.
To view the log, the data must be read from EEPROM.
To do this, set parameter **neu auslesen** from **0** to **1**. The last occurred error is shown as error 0.

Error display

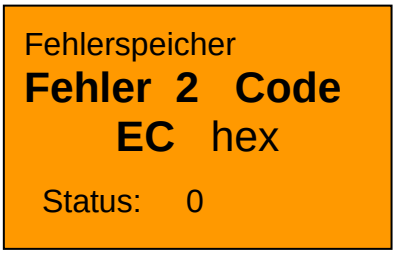


Figure 58: Error code

Error log menu
Error no. display
Error code operating time
Current status

Operating hour display

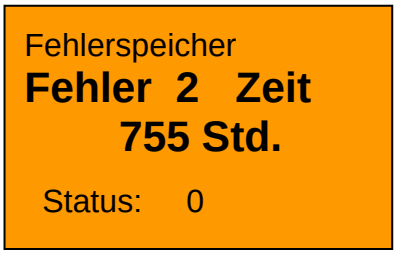


Figure 59: Time to error

For a list of the error codes, see chapter 17.3

17.3 Error codes of KFM SAFETY

Watchdog errors

err138	0x8a h	Watchdog uC-A!
err139	0x8b h	Hardware trigger watchdog uC-A!
err140	0x8c h	Watchdog uC-B!
err141	0x8d h	Hardware trigger watchdog uC-B!

Limit value errors

err160	0xa0 h	Monitoring 150N / SLT (uC-B)
err161	0xa1 h	Monitoring v_safe / SLS (uC-B)

External hardware errors/warnings

err176	0xb0 h	Warning re line enabling (level/pulse)
err177	0xb1 h	Warning re. safety lines (level/pulse)

EEPROM errors

err196	0xc4 h	CRC16 checksum hf EE-addr.4 was wrong!
err200	0xc8 h	Pointer - error state reinitialised

Controller errors

err208	0xd0 h	Encoder-A SSI error
err209	0xd1 h	Encoder-A evaluation error
err210	0xd2 h	SPI- CRC16 / general error
err211	0xd3 h	Encoder-B SSI error
err212	0xd4 h	Encoder-B evaluation error
err213	0xd5 h	Error Power_Enable Highside diagnosis
err214	0xd6 h	Error Power_Enable Lowside diagnosis

Performance, amplifier and motor errors/warnings

err225	0xe1 h	Power electronics shut-down, overcurrent!
err226	0xe2 h	Power electronics shut-down, overvoltage!
err227	0xe3 h	Power electronics shut-down, heatsink overtemperature!
err228	0xe4 h	Power electronics shut-down, motor overtemperature!
err229	0xe5 h	Power electronics shut-down, driver voltage too low!
err230	0xe6 h	Power electronics shut-down, charger relay inverter disabled!
err236	0xec h	Power electronics shut-down, motor overtemperature!
err237	0xed h	Power electronics shut-down, driver voltage too low!
err238	0xee h	Power electronics shut-down, heatsink temperature too high!

17.4 Structure of control menu

17.4.1 Monitor (display values)

Ausgangs-Spg.	(output voltage, V)
Ausgangs-Frq.	(output frequency, Hz)
Drehzahl	(speed, rpm)
Ist-Position	(actual position, increments (pulses))
Positions Nr.	(position number)
Uzk-Spg.	(link voltage, V)
Treiberspg.	(amplifier driver voltage, V)
C-Board Temp.	(controller board temperature, °C)
Motortemp.	(motor temperature, °C)
Status	(drive status message [0: all OK])
Digital Input	(status of digital inputs/ port pins at MP)
Analog1	(analog input 1, %)
Analog2	(analog input 2, %)
hex1hex2	(hex switch status, hex)
Dip-Schalter	(dip switch status, binary)
A-/E-Funktion	(output function and operating modes, hex)
Betriebszeit	(operating hours, h)

17.4.2 Frequency control (setpoint values)

Beschlg. pos.	(pos. acceleration, Hz/s [accp])
Verzoeg. pos	(pos. deceleration, Hz/s [decp])
Beschg. neg.	(neg. acceleration, Hz/s [accn])
Verzoeg. neg.	(neg. deceleration, Hz/s [decn])
Stop-Verzoeg.	(stop delay, Hz/s [decstp])
P-volt	(P-share, position controller voltage)
P-freq.	(P-share, position controller frequency)
DC-Spg.	(brake voltage, V)
Bremszeit	(brake time DC braking, s)

17.4.3 Customer menu (key values for door functions)

Ist-Position	(actual position, increments (pulses))
Position 1	(position 1, door CLOSE, increments (pulses))
Position 2	(position 2, door OPEN, increments (pulses))
Position 3	(position 3, increments (pulses))
Position 4	(position 4, increments (pulses))
Geschw. V1	(positioning speed 1, Hz)
Geschw. V2	(positioning speed 2, Hz)
Geschw. V3	(positioning speed 3, Hz)
Geschw. V4	(positioning speed 4, Hz)
Geschw. V_ref	(reference run speed, Hz)
Beschlg. pos.	(pos. acceleration, Hz/s [accp])
Verzoeg. pos	(pos. deceleration, Hz/s [decp])
Beschg. neg.	(neg. acceleration, Hz/s [accn])
Verzoeg. neg.	(neg. deceleration, Hz/s [decn])
Stop-Verzoeg.	(stop delay, Hz/s [decstp])

17.4.4 Positioning

Geschw. V1	(positioning speed 1, Hz)
Geschw. V2	(positioning speed 2, Hz)
Geschw. V3	(positioning speed 3, Hz)
Geschw. V4	(positioning speed 4, Hz)
Geschw. V_ref	(reference run speed, Hz)
Wartezeit T1	(waiting time T1, s)
Wartezeit T2	(waiting time T2, s)
Referenzpos.	(reference position, increments (pulses))
Position 1	(position 1, door CLOSE, increments (pulses))
Position 2	(position 2, door OPEN, increments (pulses))
Position 3	(position 3, safety zone CLOSED, increments (pulses))
Position 4	(position 4, safety zone OPEN, increments (pulses))
Position 5	(position 5, increments (pulses))
Position 6	(position 6, partial opening, increments (pulses))
Position 7	(position 7, increments (pulses))
Position 8	(position 8, door OPEN detection, increments (pulses))

17.4.5 Error log

Firmware Vers.	(Firmware version, e.g. 50 SAFETY)
Modifikation	(modification subgroup, e.g. 01 version)
neu auslesen?	(read errors from EEPROM, Y/N (code, time))
Fehler 0	(latest error, error code in hex, time since reset)
Fehler 1	(2nd latest error)
Fehler 2	(3rd latest error)
"	" " " "
Fehler 9	(10th latest error)

17.4.6 Data saving

Savepara	(save parameters, Y/N [to activated, set value to 7])

Data can only be saved with E@syDrives after the correct password has been entered. After all values have been saved in EEPROM, perform a reset. The KFM SAFETY can now be run with the values stored in EEPROM.

18 Commissioning

18.1 First commissioning steps

18.1.1 Installing E@syDrives (safety) on a laptop

If you encounter problems when installing the program in WINDOWS® Win7, activate XP-SP3 compatibility (in menu "Eigenschaft").

18.1.2 Calculating torque and max. speed

With the adjusting aid on the KFM SAFETY version page of the E@syDrives software, it is possible to calculate the maximum torque (closing force) and the maximum speed (v-Safe) for safe operation of the installed mechanism, even when the KFM SAFETY is offline. For details, see chapter 16.2.

18.1.3 Laptop

Determine the com. no. at the laptop. This is particularly necessary when using a USB ←→ RS232 adapter. Start E@syDrives and select the KFM SAFETY.
Select the KFM SAFETY from the list. E@syDrives is run in German.
In the "Konfiguration" menu, select the communication interface and Modbus. E@syDrives is now ready for operation. The above steps must only be performed once when E@syDrives is started for the first time. For subsequent start-ups, you only need to select the matching KFM SAFETY. For details, see chapter 16.1.

Note:
By default, parameters are only saved in RAM (with save function on parameter page).
In order to retain the parameter values after a main shut-down, write the parameters also to EEPROM by pressing the IC symbol button (safe all parameters to drive). For safety reasons, this is only possible after a valid password has been entered on the KFM-SAFETY version page (see chapter 16.6). After the values have been saved to EEPROM, a checksum is calculated and saved, and a reset is triggered.
The KFM SAFETY is not started with the values from EEPROM. This mechanism ensures that only one set of values is used in the system.

18.1.4 Opening KFM SAFETY and connecting to laptop

The cover of the KFM SAFETY can only be opened with a Torx 25 key.

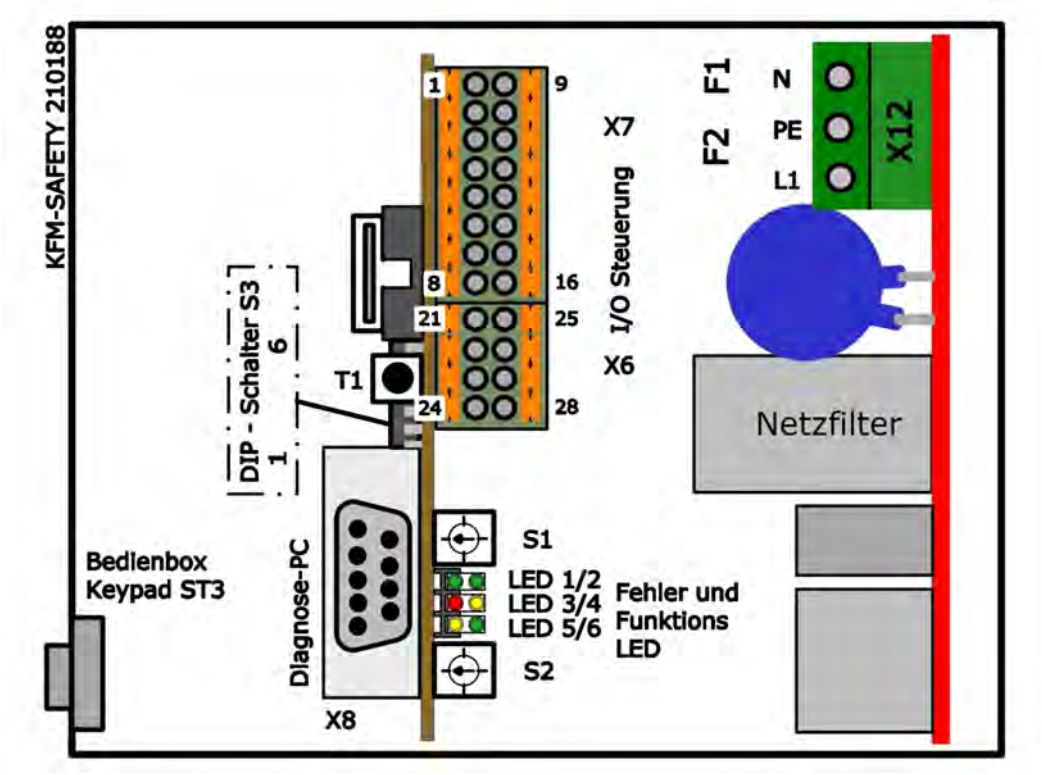


Figure 60: Wiring diagram printed at the inside of the cover

Connect KFM SAFETY X8 to the laptop (directly or through USB adapter, preferably with galvanic isolation). The KFM SAFETY is now powered from the mains.

18.1.5 Adjusting parameters in E@syDrives

First choose the operating mode (see chapter 16.2) and then enter the parameters determined by means of the calculation program on the **SAFETY page**:

- Reference run
- Torque reference
- Torque at position 1 (door CLOSE)
- Position 2 (door OPEN)
- Position 6 (partially open) (if applicable)
- v_safe (safe speed)

Save parameters to RAM and then press the  button to save them permanently in EEPROM.

18.2 Manual commissioning

18.2.1 Starting KFM SAFETY

The KFM SAFETY should be installed in the machine and connected to the door by means of the timing belts. The door should be positioned at the centre of the movement range.
Close inputs Enable STO X7:7 and X7:8. Move the door for a short moment.
Briefly activate In 1 "door CLOSE" and verify that the door moves in closing direction. Then briefly activate In 2. The door should now move in opening direction. If the directions are OK, the test is completed. If the directions are reversed, change direction of rotation CW<=>CCW on 2nd parameter page and test again. If the door moves correctly, proceed to the next parameter.

18.2.2 Determining width of door

Before performing a teach-in or reference run for closing after the mains power is switched on, ensure that the runner rails, guides, etc. are clean, not damaged and not obstructed.
With signal "door CLOSE" In 1 at X7:3 HIGH, close the door to the stop (door CLOSE => reference run). The KFM SAFETY registers this position as position "door CLOSE = position 1 = 0
With signal "door OPEN" In 2 at X7:4 HIGH, open the door to the desired (or already set) open position = position 2. If necessary, use the signal in jog mode to reach the desired position. Enter the value as position 2. Save the entered values.

18.2.3 Friction coefficient

On the 1st parameter page, set the two software switches S1 and S2 in the "Betriebsmodus" section to active. As a consequence, the torque shut-off threshold (150Nm) is deactivated while setup mode is activated.

18.2.3.1 Friction coefficient for closing

With signal "door CLOSE", close the door and gradually reduce the torque value for position 1 until the door can no longer be moved by the KFM SAFETY. Then increase the torque value by 0.1 N. The door should now complete the entire closing path without any problems. Add the calculated torque value to the above torque value. The total of these two torques corresponds to that of the 150 N threshold. Save this value.

18.2.3.2 Friction coefficient for opening

Proceed as described in chapter 18.2.3.1 for the friction coefficient for closing, but this time using the "door OPEN" signal. Add the values and save.

18.2.3.3 Torque for partial opening

Corresponds to the value at position 2.

18.2.3.4 Torque during reference run

Torque ref corresponds to torque at position 1. Enter the torques and save.

18.3 Automatic commissioning

18.3.1 Starting automatic door teach-in function

Before starting the automatic door teach-in function the machine protection door must be closed by hand. For detailed instructions, see chapter 14.6.1.
When the machine protection door is closed, the two /STO inputs are activated. The KFM SAFETY is now preparing itself for the automatic door teach-in function.

Before starting the teach-in process, the operator must ensure that no person stands in the movement range of the horizontal machine protection door, as the KFM SAFETY will perform a number of movements without control signal. The teach-in process can be stopped with STO or /STO inactive, pressing button T1 or by shutting down the mains power.

Press T1 to start the automatic door teach-in process and monitor the door movement. During the teach-in process, the commissioning technician must constantly monitor the movement range of the machine protection door so that he can abort the process, if necessary.
After the values have been determined and saved, proceed with the next step.
If the automatic door teach-in process could not be completed successfully, identify the cause of the problem and eliminate it. If required, contact the WEG Automation team for assistance.

18.3.2 Friction coefficient

On the 1st parameter page, set the two software switches S1 and S2 in the "Betriebsmodus" section to active. As a consequence, the torque shut-off threshold (150Nm) is deactivated while setup mode is activated.

18.3.2.1 Friction coefficient for closing
With signal "door CLOSE", close the door and gradually reduce the torque value for position 1 until the door can no longer moved by the KFM SAFETY. Then increase the torque value by 0.1 N. The door should now complete the entire closing path without any problems. Add the calculated torque value to the above torque value. The total of these two torques corresponds to that of the 150 N threshold. Save this value.

18.3.2.2 Friction coefficient for opening
Proceed as described in chapter 18.2.3.1 for the friction coefficient for closing, but this time using the "door OPEN" signal. Add the values and save.

18.3.2.3 Torque for partial opening
Corresponds to the value at position 2.

18.3.2.4 Torque during reference run
Torque ref corresponds to torque at position 1. Enter the torques and save.

18.4 Completing commissioning

18.4.1 Configuring safety parameters

18.4.1.1 Acceleration

For machine protection doors with a mass between 200 and 300kg, the safe acceleration rate acc_safe must be set to 20 Hz/s.

18.4.1.2 Speed for safe operation

Calculate v_safe as described in chapter 18.1.2 and enter it here.
For way_back, enter 1024. This figure might need to be adjusted at a later stage.

18.4.1.3 Speed for normal operation

For normal operation, enter the values for V1 to V4. For initial testing, these values should only be slightly higher than v-safe.

18.4.1.4 Safety zone position 3 and position 4

These are the positions from which the door moves at a safe speed and with a safe torque. Depending on the machine, the distance should be minimum approx. 500mm (body width).

18.4.1.5 U/f characteristics

Starting with the default U/f characteristics gradually optimise them. For details, see online help.

18.4.1.6 Saving settings

Set software switches S1 and S2 to 0 and save all parameters.

18.4.2 Testing

After all parameter values have been determined, entered and saved, perform a test run of the machine protection door actuator. For this purpose, shut down the mains power.

18.4.3 Mains power shut-down

After switching on the mains power, the KFM SAFETY must detect its position for "door CLOSE". For this purpose, a reference run (input "door CLOSE" active) with reduced speed (parameter v-ref on 1st parameter page) and reduced torque (parameter "torque reference" on 1st parameter page) to the "door CLOSE" stop is performed. After the position has been detected (obstacle), it is set to zero, and the KFM SAFETY applies the saved value for the "door OPEN" position. The KFM SAFETY 3 is now ready to work as a machine protection door actuator.

18.4.4 Testing of machine protection door functions

Proceed by testing all functions and/or optimizing the parameter settings.
After completion, you are ready to perform the last step in the commissioning process.

18.5 Validating safety functions (force measurement)

18.5.1 General

After installation and/or assembly, the safety function of the KFM SAFETY 3 must be validated on site by a qualified commissioning technician, who tests the function and measures and documents the closing force, the energy and the speed of the machine protection door.

Subsequently, the safety function and closing force must be validated every 6 to 24 months, depending on the operating time of the drive. These validations must be carried out by a suitably qualified person.

The validation process must be documented (see sample report in appendix). For recommended testing instruments, see chapter 18.5.2.

Alternatively, use equivalent or higher measuring and testing equipment.
All measuring and testing equipment must be regularly calibrated.

When measuring forces, energies and speeds, only persons who are directly involved in the measuring process may stand near the machine protection door.
When performing the measurements, strictly adhere to all safety instructions.

Caution!
Risk of injury from crushing!

Due to the safe function, the KFM SAFETY 3 detects any obstacle and is instantly stopped, so that it is not possible to accurately measure the closing force. In order to apply the closing force for a time that is sufficient for an accurate measurement, the safe function can be temporarily disabled in the E@syDrives software with switches S1 and S2 on the 1st parameter page (section "Operating modes").

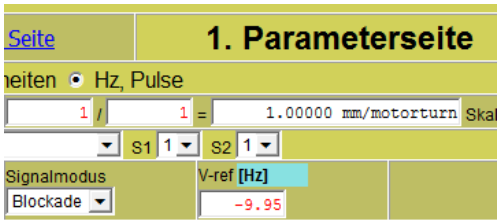


Figure 61: Switches S1 and S2 for torque off

To measure the closing force, set software switches S1 and S2 in E@syDrives to 1. At the next reset or mains power switch-on, the switches S1 and S2 are automatically set to 0, so that the safe function is again enabled.

18.5.2 Recommended measuring and testing instruments

1. Revolution counter, e.g., Pantec DTM30
2. Load cell 5A11080899, Sauter FH 1K
3. Swiss door force measuring tool 7-1644-E, Müller-Leuthold AG

18.5.3 Preconditions

The required torque and the maximum permissible speed have been calculated (by means of the PC program on the version page) and the values have been applied to the KFM SAFETY 3.
The movable door has been commissioned, all values have been entered and optimized, and saved in EEPROM.
The door actuator is operated in safety mode, with inputs Safety and /Safety inactive!

18.5.4 Speed measurement

The speed should be measured at the gear output or another easily accessible point, using a revolution counter (see list of recommended equipment above). Measure the constant speed that is achieved during the "door CLOSE" and the "door OPEN" movement.
Using In 1, close the door and measure the speed. Then use In 2 to open the door and measure the speed. The achieved constant speed needs to be documented. Convert the measured speed by applying the actual gear ratio and compare it with the set speed.
Conversion: **v_safe [Hz] = (speed [rpm] * number of pole pairs) / 60**

For KFM SAFETY 180: v_safe [Hz] = (speed [rpm] / 20
For KFM SAFETY 510: v_safe [Hz] = (speed [rpm] / 30

Figure 62: Speed measurement at gear mechanism

18.5.5 Closing force measurement

For the force measurement, use a suitable, calibrated measuring instrument (load cell, see list of recommended equipment above). Connect the KFM SAFETY to a PC or laptop and start E@syDrives.
To measure the closing force, first deactivate the torque limiter function. To do this, set the two software switches **S1 and S2** (1st parameter page) to 1.

Caution! Risk of injury from crushing!

Open the machine protection door with In 2 "door OPEN" and hold the load cell between the door leaf and the frame (at right angles to the leaf). Close the door with In 1 "door CLOSE" until the closing force acts on the measuring instrument. The "door CLOSE" control command remains active. Read the measured value. If necessary, adjust the closing force to max. 150 N by changing the parameter value for **torque close**.
To minimize the effect of the door friction and gear self-locking effect, push the door leaf by hand and open it slightly, and then close it again with the KFM SAFETY.

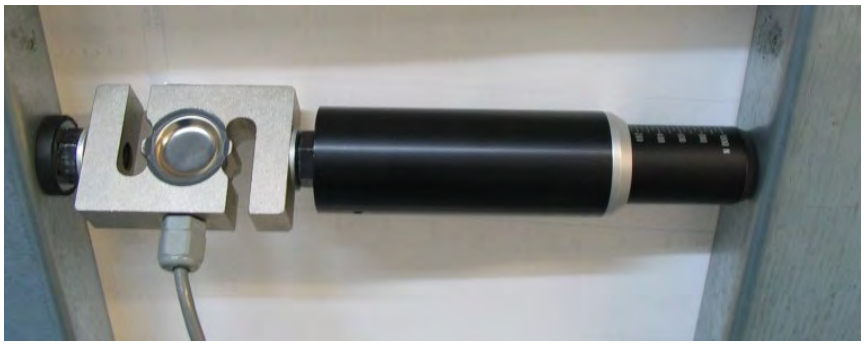


Figure 63: Arrangement of measuring instruments

Figure 64: Marks on analog measuring instrument

Figure 65: Indicator of digital measuring instrument

Use the determined torque value also for the **torque ref** reference run.
If, due to the design of the machine protection door, a limit torque of 150 N is also required for opening the door, repeat the above measurement while opening the door.

18.5.6 Energy measurement

To measure the kinetic energy, using a suitable, calibrated measuring instrument (e.g. door force measuring tool, see list of recommended measuring instruments above).

To measure the kinetic energy, first deactivate the torque limiter function. To do this, set the two software switches S1 and S2 (1st parameter page) to 1.

Caution! Risk of injury from crushing!

Measure the impact of the door on the instrument at maximum door speed. The kinetic energy is converted by the spring mechanism into a displacement value. The catch of the instruments indicates the maximum displacement (energy value).

Figure 66: Energy measurement: 8 Joule

If the door is equipped with flexible edge seals, the result of the test is normally not accurate (measured value lower than actual energy). Therefore, always perform the test with non-cushioned surfaces. If the door edge features a soft plastic seal that cannot be removed, provide some rigid devices that can be attached to the door for the validation.

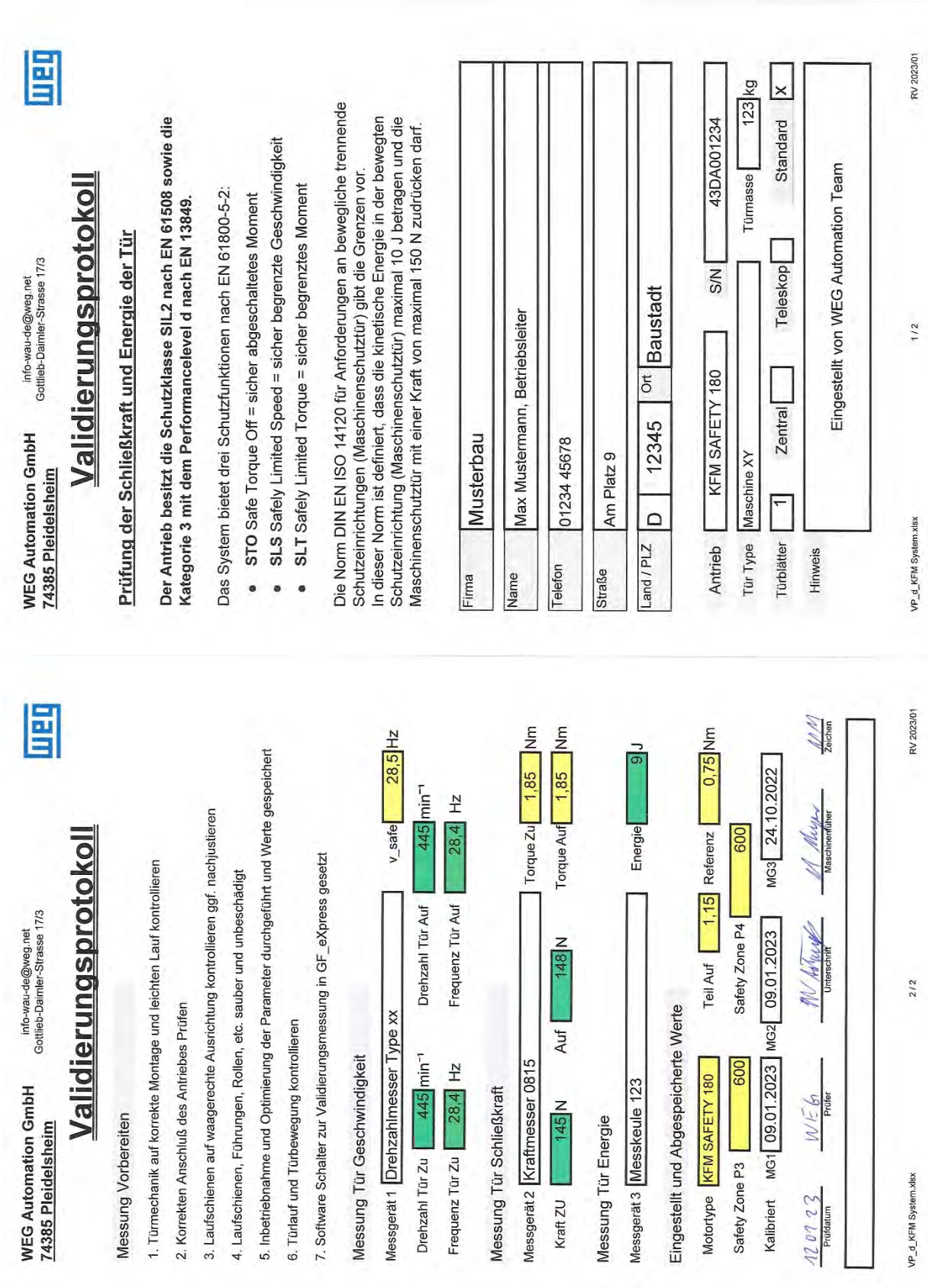
After all values have been checked and the necessary parameter values have been determined and entered, save these to RAM and then to EEPROM.

To save the values to EEPROM, you must enter the correct password. After the values have been saved, the KFM SAFETY is automatically reset.
In E@syDrives, ensure that the software switches S1 and S2 are set to 0. The KFM SAFETY is now ready for operation.

Document the parameter settings (see template on next page).

The fields shown in yellow contain the values from the E@syDrives software. The fields shown in green contain the measured values.

18.5.7 Sample validation documentation



WEG Automation GmbH
74385 Pleidelsheim
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Gottlieb-Daimler-Strasse 17/3

Validierungsprotokoll

Prüfung der Schließkraft und Energie der Tür

Der Antrieb besitzt die Schutzklasse SIL2 nach EN 61508 sowie die Kategorie 3 mit dem Performancelevel d nach EN 13849.

Das System bietet drei Schutzfunktionen nach EN 61800-5-2:

- **STO** Safe Torque Off = sicher abgeschaltetes Moment
- **SLS** Safely Limited Speed = sicher begrenzte Geschwindigkeit
- **SLT** Safely Limited Torque = sicher begrenztes Moment

Die Norm DIN EN ISO 14120 für Anforderungen an bewegliche trennende Schutzeinrichtungen (Maschinenschutztür) gibt die Grenzen vor. In dieser Norm ist definiert, dass die kinetische Energie in der bewegten Schutzeinrichtung (Maschinenschutztür) maximal 10 J betragen und die Maschinenschutztür mit einer Kraft von maximal 150 N zudrücken darf.

Firma	Musterbau
Name	Max Mustermann, Betriebsleiter
Telefon	01234 45678
Straße	Am Platz 9
Land / PLZ	D 12345 Ort Baustadt

Antrieb	KFM SAFETY 180	S/N	43DA001234
Tür Type	Maschine XY	Türmasse	123 kg
Türblätter	1 Zentral ☐ Teleskop ☐	Standard	X
Hinweis	Eingestellt von WEG Automation Team		

VP_d_KFM System.xlsx 1 / 2 RV 2023/01

WEG Automation GmbH
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Validierungsprotokoll

Messung Vorbereiten

1. Türmechanik auf korrekte Montage und leichten Lauf kontrollieren
2. Korrekten Anschluß des Antriebes Prüfen
3. Laufschienen auf waagerechte Ausrichtung kontrollieren ggf. nachjustieren
4. Laufschienen, Führungen, Rollen, etc. sauber und unbeschädigt
5. Inbetriebnahme und Optimierung der Parameter durchgeführt und Werte gespeichert
6. Türlauf und Türbewegung kontrollieren
7. Software Schalter zur Validierungsmessung in GF_eXpress gesetzt

Messung Tür Geschwindigkeit

Messgerät 1	Drehzahlmesser Type xx	v_safe	28,5 Hz
Drehzahl Tür Zu	445 min⁻¹	Drehzahl Tür Auf	445 min⁻¹
Frequenz Tür Zu	28,4 Hz	Frequenz Tür Auf	28,4 Hz

Messung Tür Schließkraft

Messgerät 2	Kraftmesser 0815	Torque Zu	1,85 Nm
Kraft ZU	145 N	Auf 148 N	Torque Auf 1,85 Nm

Messung Tür Energie

Messgerät 3	Messkeule 123	Energie	9 J

Eingestellt und Abgespeicherte Werte

Motortype	KFM SAFETY 180	Teil Auf	1,15	Referenz	0,75 Nm
Safety Zone P3	600	Safety Zone P4	600		
Kalibriert	MG1 09.01.2023	MG2 09.01.2023	MG3 24.10.2022		

12.01.23 WEG
Prüfdatum Prüfer Unterschrift Maschinenführer Zeichen

VP_d_KFM System.xlsx 2 / 2 RV 2023/01

Figure 67: Validation document

19 Timing belt installation

These instructions refer to the installation of timing belts in single and double machine doors.
The timing belt pack contains the parts described in chapter 10.7:
The pulley is already mounted on the KFM SAFETY or the gear mechanism (see Figure 15). The pulleys feature taper lock bushes, which means that they are secured with 2 M6 setscrews in the taper lock bushes. To correct the shaft position, loosen the setscrews of the pulley and slide the pulley along the shaft until the timing belt runs smoothly. Re-tighten the setscrews.
For attachment of the deflection pulley, the machine must feature a peg with the dimensions specified below.

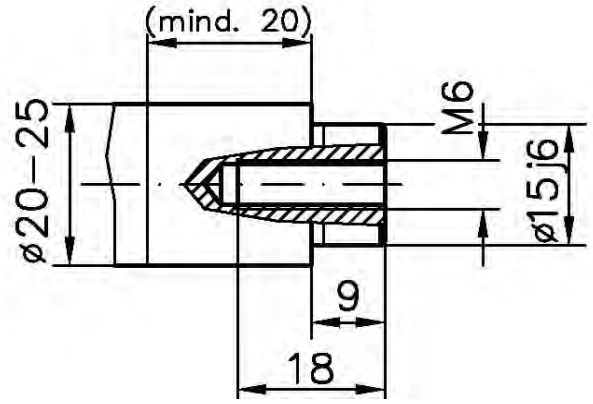


Figure 68: Peg for deflection pulley

The peg must be mounted on a plate that can be moved, for instance by turning a screw, for tensioning the timing belt.
To mount the deflection pulley, first mount a P15 x 21x 0.5 mm shim on the peg and then the deflection pulley. To keep the deflection pulley in position, place a 6.4 x 20 x 1.25 mm washer on the peg and secure the pulley with a M6X20mm screw with a M6 detent-edged washer. The deflection pulley is now properly secured.

A timing belt of the requested quality grade, design and length is supplied with the device.
Using the clamping plates, install the timing belt to connect the door leaf with the connecting mechanism:

One door on machine ➔ both clamping plates attached to door
Double door (right and left) ➔ one clamping plate each per door

If the peg and thus the deflection pulley is mounted on a sliding plate, it can be used to tension the timing belt.

Depending on the design of the machine protection door, additional deflection, guide or tensioning rollers might need to be installed (parts not yet included in our product range).

19.1 Installed deflection pulley

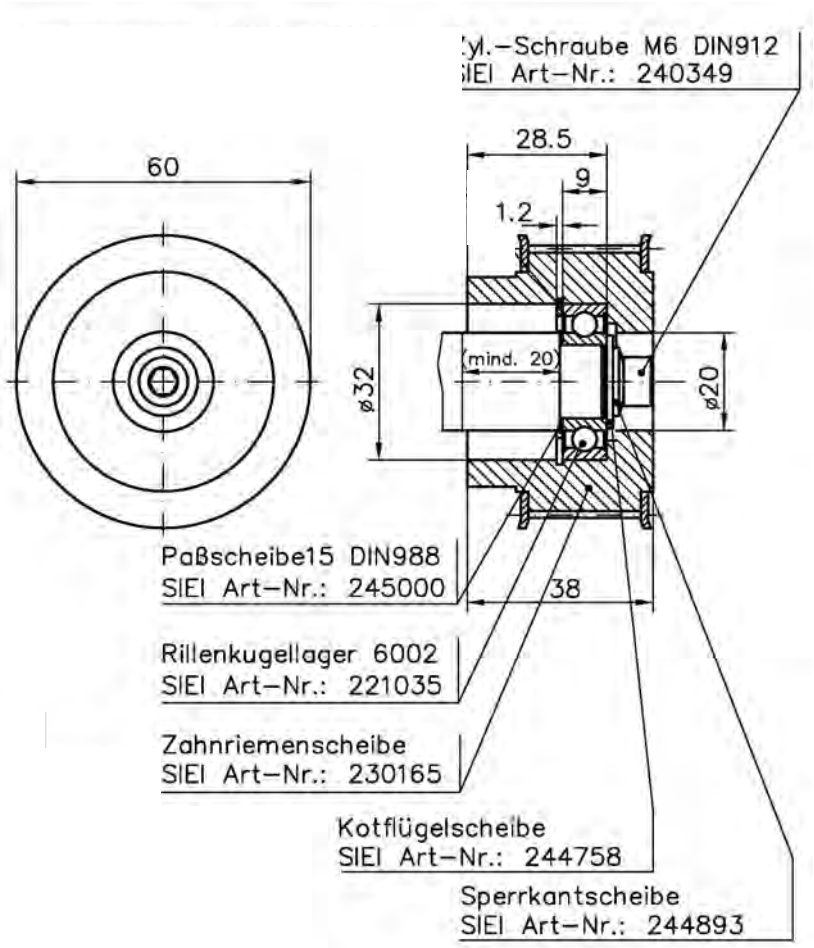


Figure 69: Installed deflection pulley

19.2 Tensioning timing belt

19.2.1 Calculating and adjusting preload

For proper force transfer and economical operation, correct preloading of the timing belt is crucial. The static preload makes sure that the timing belt is correctly tightened during operation.

- If the preload is too low, there is a risk that timing belt teeth are skipped or the timing belt tears when a high load is applied.
- If the preload is too high, the timing belt teeth might shear or become worn, while bearings might become damaged. There might also be excessive noise.
- We therefore recommend calculating and testing the static preload for each drive.
- The timing belt is an important component of the safety function and must therefore be installed correctly and checked regularly.

The preload factor c_v takes into account all loads that form the total load factor.

19.2.2 Adjusting static preload

For the adjustment of the static preload, only one pulley of the drive may be blocked. All other pulleys must be freely rotating.
The test force F_v must be applied at the center of the run and at right angles to the tensioned run with length L. Do not use sharp implements to push down the timing belt, as it might otherwise become damaged.

After the static preload has been correctly set, the measured value corresponds to the calculated impression depth e_v.
Instead of measuring the preload between the two main pulleys (see Figure 70), it can be measured between other pulleys and roller pairs of the drive. In this case, at equal test force F_v, the impression depth e_v might vary, depending on the run length L.

Alternatively, the belt may be statically preloaded by means of the required axis force S_a.
As the belt is not prone to elongation, there is no need to regularly check the preload after installation.

19.2.3 Timing belt

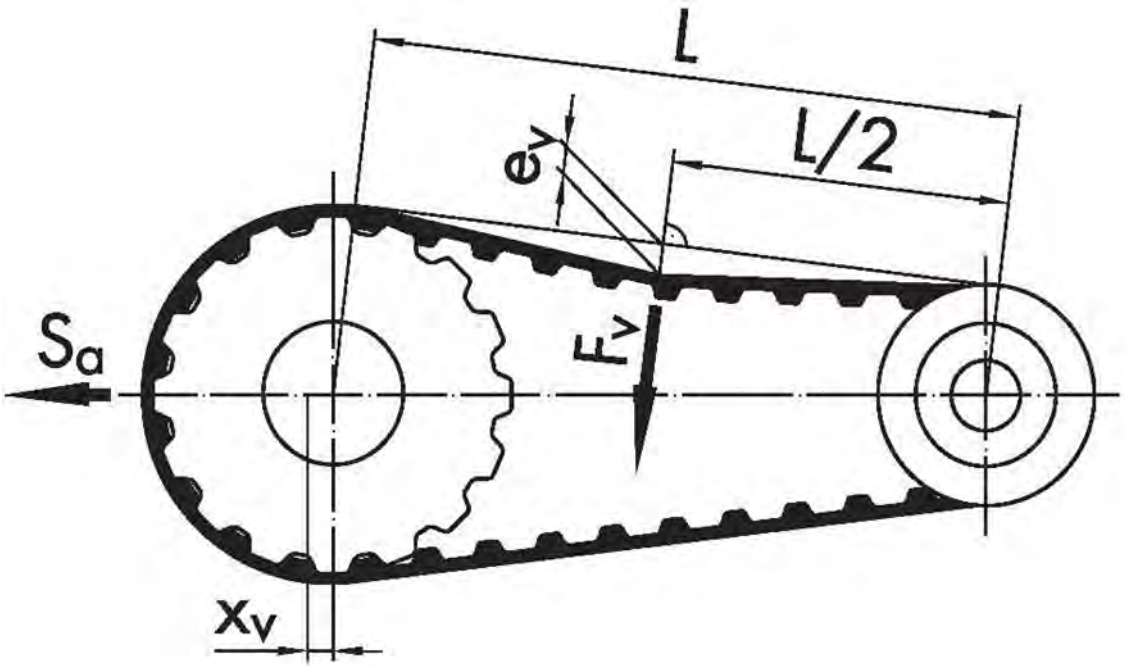


Figure 70: Forces and dimensions of installed timing belt

F_v	= Test force to check preload (N)
S_n	= Longitudinal force (N)
S_a	= Axis force (N)
e_v	= Impression depth of belt run to check preload (mm)
L	= Belt run length (mm)
c_v	= Preload factor, typically 1.3
P_{Ab}	= Drive power (kW)
v_{eff}	= Effective speed (m/s)
d_w	= Effective diameter (mm)

Static axis force	Longitudinal force	Effective speed
$S_a = c_v \times S_n$;	**$S_n = P_{ab} \times 1000 / v_{eff}$;**	**$v_{eff} = d_w \times n / 19100$;**

Test force	Impression depth
$F_v = c_v \times S_n / 20$;	**$e_v = L / 50$;**

Additional drawings and information are available on request.

If required, we would be delighted to work with you to develop solutions for existing parts and constructions.

20 Safety manual

20.1 General safety instructions

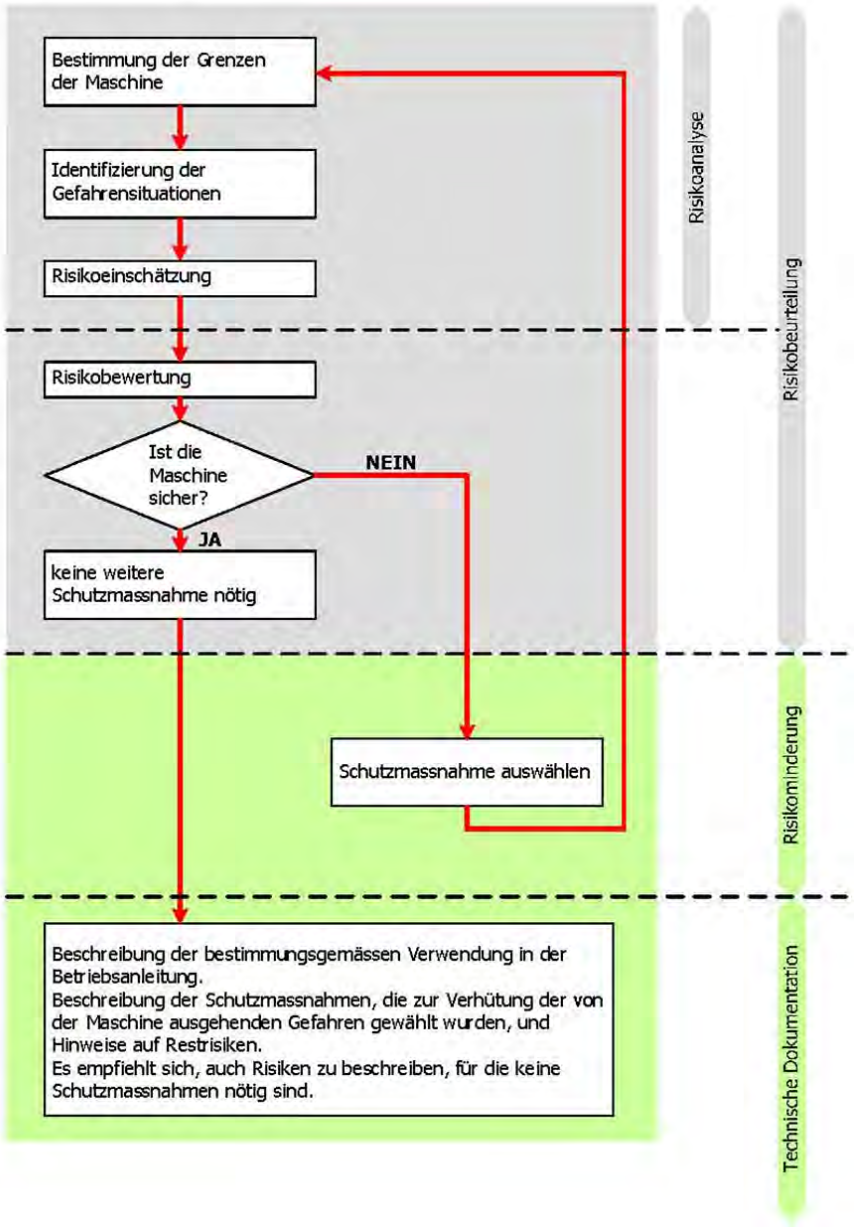
For the safe and trouble-free operation of the device, personnel must understand and adhere to the safety and operating instructions in this manual. The safety manual contains important instructions for the safe operation of the device dumper. All persons working with or on the device must adhere to all instructions in this manual, and in particular the safety instructions. Also observe all statutory regulations and rules that apply at the location of operation of the device.

20.2 General remarks and instructions regarding this safety manual 

- A copy of this manual must be filed near the device.
- In addition to this manual, always comply with the general safety standards and the statutory regulations on occupational safety, accident prevention and environmental protection.
- Warning signs and instructions that are required by law must be attached in positions where they are clearly visible to personnel.
- Ensure that all safety and warning signs on/at the machine are legible at all times!
- All work on the KFM SAFETY 3 must be carried out by persons who have the necessary technical qualification and are familiar with the relevant occupational safety and accident prevention regulations.
- All persons working with or on the KFM SAFETY 3 must have read the safety manual and the warnings in this document. Before carrying out any work, they must be instructed in the correct handling of the device.
- The instructions in this manual refer exclusively to the KFM SAFETY 3 and do not cover the horizontal machine protection door or the machine into which the door is integrated.
- This safety manual therefore contains only a few references to the design of the machine protection door and the integration of the KFM SAFETY 3 into the machine's control system.
- It is the responsibility of the manufacturer of the machine or plant to carry out a risk analysis of the machine protection door and the complete machine.

20.3 Risk analysis

For a risk analysis, the machine or plant must be broken up into its various components, assemblies and sections. For each component, assembly or section, all relevant risks must be identified and suitable measures to eliminate or minimize these risks must be planned, evaluated, implemented and described according to the flow diagram below.



This process must be repeated until all risks have been minimised to an acceptable level. After all components, assemblies and sections of the machine have been fully assessed and modified, the same procedure must be applied to evaluate the risk posed by the machine or plant as a whole. All steps, tests and measures that form part of the risk analysis must be documented.

Figure 71: Risk analysis procedure

Important!

As we are not familiar with your application, your machine or your machine protection door, we are not in a position to carry out a risk analysis according to EN 12100 for the machine protection door actuator. According to the European Machinery Directive, the risk analysis of the complete machine/plant must always be performed by the machine/plant manufacturer.

20.4 Notes regarding machine protection door

The KFM SAFETY 3 can only perform its safety functions, if the following issues have been addressed in the construction of the machine protection doors:

- According to EN 953, the kinetic energy of machine protection doors is limited to 10 J. The constructions should therefore be as light in weight as possible but without compromising stability, so that the door can be operated at relatively high speeds.
- If the machine features two doors actuated by a single KFM SAFETY 3, the mass of the two doors must be combined when calculating the kinetic energy.
- Ensure that the edge of the door and the mating frame section are not too narrow (> 30mm), sharp or excessively angled.
- Cushion the edges of the machine protection door with a soft rubber lip seal.
- The suspension mechanism and the rails of the machine protection door must be perfectly horizontal.
- If the machine protection door is designed for operation by hand (e.g. in the event of a power failure), install recessed (not protruding) handles. The recessed handles must be designed so that they cannot become caught in clothing (on buckles, buttons, etc.).
- For the operation of the KFM SAFETY 3 as an actuator for horizontal machine protection doors, there is no need for any additional limit switches or hardware components.
- If the machine requires a safe signal for "door CLOSE", install an additional safety limit switch, possibly with locking mechanism, to generate this signal.
- The machine control must ensure that the machine protection doors can only be opened after all movements of the machine have slowed down so that they do no longer pose a danger.
- To improve safety, additional safety bars, light barriers and light curtains might be connected through the digital input (STOP) to the KFM SAFETY 3 to stop the movement and reverse it so that the door is opened by a little.
- The machine must be equipped with devices that enable service personnel to safely shut down the door actuator and to prevent inadvertent start-up (main switch with padlock, lock at door, etc.).
- During automatic commissioning, the direction of movement, the door closed position, the dimensions and the friction forces are determined. For this procedure, the machine protection door path must be clean and unobstructed.
- Commissioning, service and operating personnel must be instructed accordingly.
- The machine manual must include instructions and check lists for the automatic commissioning procedure.
- According to the new European Machinery Directive 2006/42/EC, the KFM SAFETY 3 is defined as a component with safety function.

20.5 Notes regarding safety functions

The KFM SAFETY 3 implements all protective and safety functions for the movement of the door. It is able to keep the door closed or open (holding torque). The KFM SAFETY 3 is also able to open the door partially. The machine manufacturer only needs to ensure that the machine itself is safe.
The status of the machine protection door is signaled to the control system through optically decoupled outputs (door OPEN, door CLOSE, alarm, safety, option).
The safety output indicates that the KFM SAFETY 3 is in "**safe function active"** mode.

Important!

For the safe operation of the machine or plant, a safe "door CLOSE" signal must be generated by a **fail-safe limit switch**. This switch might also feature a locking mechanism attached to the frame of the machine. Such a locking mechanism is mandatory for high-speed machining units with tools or dies (presses, injection casting, die casting machines).

It is important that the guide rail of the machine protection door is perfectly horizontal, so that it cannot move inadvertently when the power/mains power is shut down.

After installation and/or assembly, the safety function of the KFM SAFETY 3 must be validated on site by a qualified commissioning technician, who tests the function and measures and documents the closing force, the energy and the speed of the machine protection door.
Subsequently, the safety function and closing force must be validated at regular intervals. These validations must be carried out by a suitably qualified person.

The results of these validation tests must be documented (for template, see chapter 18.5.7.)

The parameter values of the KFM SAFETY 3 can only be changed by a limited number of persons (password protection). The parameters settings and any changes made to the settings must be documented and filed.

For safety reasons, the three screws securing the cover of the KFM SAFETY can only be removed with a Torx 20 key.

Important:

To complete the commissioning procedure of the door actuator and after each test, measure the kinetic energy and the closing force according to EN 953, using calibrated measuring and testing equipment (Swiss door force measuring tool, etc.).
All measurements and changes to parameters must be documented.

If you have any queries regarding the safety of the device or any other issue, please contact us. We will assist you with know-how and practical advice wherever we can.

The WEG AUTOMATION team would be delighted to be of assistance.

20.6 Safety data

20.6.1 Safety class

The KFM SAFETY 3 comes with the safe functions STO, SLS and SLT for horizontal machine protection doors and meets the requirements of the following safety classes:

SIL 2

according to DIN EN 61508 or

PL_e category 3

according to DIN EN ISO 13849

20.6.2 Characteristic data of KFM SAFETY 3

The various calculations, FMEAs and FMEDAs revealed the following characteristic values for all three safe functions STO, SLS and SLT.

Safe Failure Fraction **SFF = 99.8 %**

Average Diagnostic Coverage **DC_{avg} = 98.54 %**

Safe Detected Failure Rate **λ_{SD} = 487.3**

Safe Undetected Failure Rate **λ_{SU} = 110.4**

Dangerous Detected Failure Rate **λ_{DD} = 67.9**

Dangerous Undetected Failure Rate **λ_{DU} = 1.0**

Probability Failure Per Hour **PFH = 1.01 E-11** ($1.01 * 10^{-11}$)

Average Probability of Failure on Demand **PFDavg = 3.02 E-7** ($3.02 * 10^{-7}$)

Mean Time To Dangerous Failure **MTTFd =** 1657 years **=> 100 years**

(capped at 100 years for subsystems, in accordance with DIN EN ISO 13849)

Mean Time To Repair **MTTR = 0 h**

(If a safety function is triggered and in the event of failure of a component, the KFM SAFETY 3 is instantly shut down)

Response Time **t = 250 ms**

The response time is the time between the detection of the obstacle and switching to safe mode. As the KFM SAFETY 3 always closes the machine protection door with the set safe closing force, this time is not relevant.
SLS and STO are detected much quicker and result in a safe shut-down of the actuator.

20.6.3 Life Time

The life time of the KFM SAFETY 3 is 10 years. The date of manufacturer is encoded in the serial number: S/N 43DA001323 => Production month January 2023.

At the end of its life time, the KFM SAFETY 3 can be returned to the manufacturer where it is tested and fitted with a new electronic module and wear parts (bearings), should this be a viable option.

A proof test of the KFM SAFETY 3 is not possible, as it would require the replacement of the entire electronic module, subsequent to which the KFM SAFETY 3 would need to be considered a new device.
Wear parts such as bearings can always be replaced, if necessary, as they are not safety relevant parts.

20.7 Sistema

The safety-relevant data are compiled in a KFM SAFETY 3 Sistema module.
The KFM SAFETY 3 Sistema module can be integrated into the Sistema library. The KFM SAFETY 3 Sistema module is included on the CD-ROM in the Tools directory.

21 Appendix

All documents and other important information are included on the CD-ROM.
The E@syDrives program, software tools and utilities, this manual and other important information is shipped with the KFM SAFETY on the CD-ROM.
KFM SAFETY 3 software is not found on the CD-ROM, as updates to the latest version must be made at the factory or by the WEG Automation Service team.

21.1 Declaration of Incorporation/Conformity

The KFM SAFETY 3 is accompanied by a Declaration of Incorporation in accordance with the European Machinery Directive.
As the KFM SAFETY contains electronic components, it must comply with the European EMC and Low Voltage Directives and a Declaration of Conformity is shipped with the device.
In addition, the KFM SAFETY 3 features safe functions that have been examined and assessed by TÜV Nord. The relevant safety certificate is enclosed.

21.2 Safety certificate

The KFM SAFETY 3 has been developed under the supervision of TÜV Nord.

TÜV Nord is also the certification and supervision body for the KFM SAFETY 3.
This cooperation guarantees
the quality of the safety function
in the future.

Figure 72: Test mark

21.3 Certificates

The certificates are included at the CDROM under CD/Zertifikate:

a. Safety certificate of TÜV Nord
b. Declaration of Incorporation in accordance with European Machinery Directive
c. EC Declaration of Conformity in accordance with European EMC and Low Voltage Directives
d. UL-Certification and CSA-Certification
e. CCC-Certification
f. Validation report (template)

21.4 KFM SAFETY 3 CD-ROM

CD-ROM containing the GF_eXpress software, E@syDrives software, software tools and utilities, this manual and other useful documents in PDF:

Figure 73: CD-ROM attached here

21.5 List of safety functions

Abk.	Bezeichnung	DE	Funktion
STO	Safe torque off	Sicher abgeschaltetes Moment	Motor erhält keine Energie, die eine Drehbewegung erzeugt (Stopp-Kat 0 nach IEC 60204)
SS1	Safe Stop 1	Sicherer Stopp 1	Motor verzögert; Überwachung Bremsrampe und STO nach Stillstand oder STO nach Ablauf einer Verzögerungszeit (Stopp-Kat 1 nach IEC 60204)
SS2	Safe Stop 2	Sicherer Stopp 2	Motor verzögert; Überwachung Bremsrampe und SOS nach Stillstand oder SOS nach Ablauf einer Verzögerungszeit (Stopp-Kat 2 nach IEC 60204)
SOS	Safe Operating Stop	Sicherer Betriebshalt	Motor steht still und widersteht externen Kräften
SLS	Safely-Limited Speed	Sicher begrenzte Geschwindigkeit	Das Überschreiten eines Geschwindigkeits-Grenzwerts wird verhindert
SLT	Safely-Limited Torque	Sicher begrenztes Moment	Das Überschreiten eines Drehmoment/Kraft-Grenzwerts wird verhindert
SLP	Safely-Limited Position	Sicher begrenzte Position	Das Überschreiten eines Positions-Grenzwerts wird verhindert
SLI	Safely-Limited Increment	Sicher begrenztes Schrittmaß	Der Motor wird um ein spezifiziertes Schrittmaß verfahren und stoppt anschließend
SDI	Safe Direction	Sichere Bewegungsrichtung	Der Motor kann nur in die spezifizierte Richtung verfahren werden
SMT	Safely Motor Temperature	Sichere begrenzte Motortemperatur	Das Überschreiten eines Motortemperatur-Grenzwerts wird verhindert
SBC	Safe Brake Control	Sichere Bremsenansteuerung	Sichere Ansteuerung einer externen Bremse
SCA	Safe Cam	Sicherer Nocken	Die Position des Motors in einem spezifiziertem Bereich wird durch ein sicheres Ausgangssignal angezeigt (Sicherer Nocken)
SSM	Safe speed monitor	Sichere Rückmeldung der begrenzten Geschwindigkeit	Die Drehzahl des Motors unterhalb eines spezifizierten Wertes wird durch ein sicheres Ausgangssignal angezeigt

Table 2: Safety functions

21.6 Table of figures

21.7 Table of tables

21.8 List of abbreviations and acronyms

Abbreviation	Term	Description
1oo2	1 out of 2	Two-channel system
ASIL	Automotive Safety Integrity Level	
B_{10d}	B_{10d}	Number of cycles until 10% of the components have a dangerous failure (EN 13849-1).
	Specified normal operation	If one or more specific conditions occur, a device such as an actuator is disconnected from the power supply within a permissible period of time.
	Low Demand Mode	Safety function where the frequency of demands for operation made on a safety-related system is no greater than one per year.
	High Demand Mode	Safety function where the frequency of demands for operation made on a safety-related system is greater than one per year.
	Continuous Mode	Safety function results safe state of EUC ➔ normal mode
β	Susceptibility to Common Cause Failure	
λ	Failure Rate	
λ_s	Failure Rate Safety	
λ_d	Failure Rate Dangerous	
C	Duty Cycle	Number of duty cycles (per hour) of an electromechanical component
CCF	Common Cause Failure	
DC	Diagnostic Coverage	
DC_{avg}	Average Diagnostic Coverage	
	Designated Architecture	Calculated structure of a SRP/CS
E/E/PES	Electric / Electronic / Programmable Electronic System	
EMC	Electromagnetic Compatibility	
EUC	Equipment under control	
FIT	Failure in Time	1 FIT corresponds to 1 failure per 10^{-9} hours
FMEA	Failure Mode and Effects Analysis	
FMEDA	Failure Modes, Effects and Diagnostic Analysis	
FTA	Fault Tree Analysis	
FSM	Functional Safety Management	

Table 3: Abbreviations part 1

Abbreviation	Term	Description
	Functional Safety	Part of the overall safety relating to the EUC (Equipment Under Control) and the EUC control system which depends on the correct functioning of the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities
	Failure to Danger	Failure that prevents of delays disconnection of a drive from the power supply, e.g. due to failure of relay to open (which would be the specified normal operation of the relay), in response to a condition that would normally result in disconnection from the power supply
h	Hour	
HFT	Hardware Fault Tolerance	Capability of functional unit to continue performing a function following the occurrence of errors or deviations
LFM	Latent Faults Metric	
HW	Hardware	Printed circuit board with components and cables
	Machine safety	Reduction of risk to acceptable residual risk, following risk analysis and risk minimisation
MTBF	Mean Time Between Failures	
MTTF	Mean Time To Failure	
$MTTF_d$	Mean Time To Dangerous Failure	
MTTR	Mean Time To Repair	(always much shorter than MTTF)
	Non-dangerous Failure	Failure that might disconnect a drive or similar component from the power supply, although this would not be the case in the specified normal operation, in response to one or more conditions that would normally not result in disconnection from the power supply
n_{op}		Mean number of actuations per year
PFD	Probability Failure Dangerous	Average probability of a failure of a safety function on demand
PFD	Probability of Failure on Demand	Probability of a dangerous failure of a safety function on demand
PFD_{avg}	Average Probability of Failure on Demand	Average probability of a dangerous failure of a safety function on demand, relative to planned life time
PFH	Probability Failure Per Hour	Probability of a failure per hour
PFH_D	Probability of Dangerous Failure Per Hour	Probability of a dangerous failure per hour

Table 4: Abbreviations part 2

Abbreviation	Term	Description
PL	Performance Level	Capability of safety-related parts to perform a safety function under foreseeable conditions, in order to achieve the expected risk reduction
PL_r (3)	Performance Level Required	
OPL		Open point list
Q	Quality	
QM	Quality Management	
QMM		Quality Management Manual
QMS	Quality Management System	Contains at least the following documented definitions: What is quality? How is it planned, examined, verified and controlled?
QA		Quality Assurance
	Safety	General term referring to functional safety, machine safety, etc.
	Security	General terms referring to protection by security service, etc. Security aims at protecting persons and property
SF	Safety Function	
SFF	Safe Failure Fraction	Share of "safe" failures, i.e. share of failure that cannot potentially set the safety-related system into a dangerous or inadmissible functional state
SIL	Safety Integrity Level	IEC 61508 defines four discrete safety integrity levels (SIL 1 to SIL 4). Each level represents a specific probability range for the failure of the safety function. The higher the safety integrity level of a safety-related system, the lower the probability that the required safety functions cannot be performed.
SILCL	Safety Integrity Claim Limit	
	Safety Function	Function performed by a E/E/PE safety-related system, or a safety-related system using different technology or external equipment, for the purpose of risk minimisation, aimed at achieving and maintaining a safe state for the EUC in the event of a defined dangerous incident or condition (see IEC 61508-4 3.4.1)
	Safe state	Example: drive is disconnected from power supply

Table 5: Abbreviations part 3

Abbreviation	Term	Description
SLS	Safety Limited Speed	
SLT	Safety Limited Torque	
SLC	Safety Life Cycle	
SP	Safety Parameter	
SPFM	Single Point Faults Metric	
SRS	**S**afety **R**equirement **S**pecification	
SRP/CS	Safety Related Parts of a Control System	
SRECS	Safety Related Electrical Control Systems	
STO	Safe Torque Off	
	Structure	Classification of safety-related parts of a control system, based on their tolerance to hardware failures (classification categories B to category 4)
SW	Software	
T_{10d}		Safety function mission time
T1	Lifetime	Assumed lifetime of the safety system
T2	Diagnostic Test Interval	
TM	Mission Time	Time for which safety function is applied
TI	Test Interval between life tests of the safety function	

Table 6: Abbreviations part 4

21.9 Notes

The scope of WEG Group solutions
is not limited to products and solutions
presented in this catalogue.
To see our portfolio, contact us.

For WEG's worldwide
operations visit our website

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Cod: 918 200-e | Rev: 06 | Date (m/y): 01.2023