Kemro

KeTop T70
Project engineering manual V0.02

Translation of the original manual

KEBA
Automation by innovation.

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Record of Revision

Version	Date	Change in chapter	Description	changed by
1.00	02-2014		Newly created	swb

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1 Introduction

1.1 Purpose of the document

This document describes the hand-held terminal KeTop T70.

This document contains all specifications required by machinery directive 2006/42/EC.

Information

This manual is not adressed to end costumers! Necessary safety notes for the end costumer have to be taken into the costumer manual in the respective national language by the machine builders and system providers.

1.2 Preconditions

This document contains information for following persons with corresponding preconditions:

Target group	Prerequisite knowledge and ability
Project engineer	Technical basic education (advanced technical education, engineering degree or corresponding professional experience), Knowledge about: ● the method of operation of a PLC, ● safety regulations, ● the application.
Electrician	Specialized training in the electro-technical field (in accordance with industrial training guidelines). Knowledge in: ● safety regulations, ● wiring guidelines, ● circuit diagrams, ● correct installation of electrical connections.

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Target group	Prerequisite knowledge and ability
Start-up technician	Technical basic education (advanced technical education, engineering degree or corresponding professional experience), Knowledge about: ● safety regulations, ● the method of operation of the machine or system, ● fundamental functions of the application, ● system analysis and troubleshooting, ● the setting options at the operating devices.
Service technician	Technical basic education (advanced technical education, engineering degree or corresponding professional experience), Knowledge about: ● the method of operation of a PLC, ● safety regulations, ● the method of operation of the machine or system, ● diagnosis possibilities, ● systematic error analysis and troubleshooting

1.3 Intended Use of the Handheld Terminal

The intended use of the KeTop T70 covers tasks from watching and parametrizing up to operating of machines e.g.:

- Injection moulding machine
- Robots
- Machine tools
- Textile machines
- Printing machines
- Theater backdrops
- and similar

in normal operating modes

- Automatic

as well as

- Setting
- Teaching
- Testing
- and similar

in half automatic or manual mode.

Enabling control devices and an optional emergency stop button or halt-button are available as savety features.

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Handheld terminals which are not connected permanently must not be equipped with a red-yellow emergency shutdown button, therefore a gray stop button is available.

All savety function are realized with two circuts in order to meet the requirements of category 4 PL e in accordance with EN ISO 13849-1 considering m the B_{10d} values of the savety elements.

The selection of the Handheld Terminal which is suitable for the machine and the projecting of the additional functions must obey the necessary hazard analyses and risk assessment bounded by law.

For intended use of the Handheld Terminal also please pay attention to the appendices.

1.4 Notes on this document

This manual is integral part of the product. It is to be retained over the entire life cycle of the product and should be forwarded to any subsequent owners or users of the product.

Information

This manual also applies to identically constructed and functional identically costumer variants of the KeTop T70.

Because of the fact that costumer variants may differ in their appearance (e.g. with a different front cover) from the KEBA standard variant, the pictured devices used in this manual may differ in their appearance from the devices used by you.

Information

Note the datasheet provided in the delivery if there are any differences between the KEBA standard variant and the costumer variant.

1.4.1 Contents of document

- Safety notes and transport conditions
- General product description
- Display, operating elements and keypad
- Connection and wiring
- Configuration and operating instructions
- Options
- Accessories
- Technical Data
- CE Conformity, Directives and Standards

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1.4.2 Not contained in this document

- Mask description of the application
- Software

1.5 Documentation for further reading

Doc.No.	Description	Target group
1007622	KeTop CB211 Drilling template	Start-up technician

If certificates (e.g. UL certificate) are required they can be purchased from KEBA on request.

1.6 Information about MD 2006/42/EC

1.6.1 Definition of terms

This user's manual corresponds to machinery directive 2006/42/EC.

To avoid ambiguity for users the following table shows the comparison of the old terms of MD 98/37/EC and the new ones of MD 2006/42/EC.

This term replacement is also fulfilled in the corresponding standard EN ISO 13850:2008.

98/37/EC	2006/42/EC
emergency switching off (chap. 1.2.4)	emergency stop (chap 1.2.2)

Within standard EN 60204-1 the following term has changed:

EN 60204-1:1997	EN 60204-1:2006
Enabling device	Enabling control device (chapter 10.9)

In this manual the new terms of MD 2006/42/EC are used.

1.6.2 Quantitative safety relevant specifications for emergency stop-button and enabling control device

Emergency stop and enabling control device

KEBA specifies a B_{10d}-value. Other values (e.g. SIL, PL, Category) **cannot** be specified by KEBA.

Explanation: KEBA solely delivers the control element, but no evaluation of the element. The customer has to connect the emergency stop and the enabling control device to his application on his own. Depending on the connection of the emergency stop and the enabling control device to the machine the SIL- or category and PL-value can be determined.

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The B_{10d}-value is declared in the manuals at chapter "Technical Data" ("Emergency stop" respective "Enabling Control Device".

1.6.3 Relationship between Performance Level and Safety Integrity Level

When evaluating safety functions by IEC EN 62601 the PL can be transformed into SIL by following the equivalence table of EN ISO 13849-1.

Table 4 (EN ISO 13849-1) - Correlation of Performance Level (PL) and Safety Integrity Level(SIL)

Performance Level (PL) by EN ISO 13849-1	Safety Integrity Level (SIL) by IEC 61508-1
a	no corresponding value
b	1
c	1
d	2
e	3

Table 3 (EN ISO 13849-1) - Performance Level (PL)

Performance Level (PL)	Average probability of a dangerous breakdown per hour 1/h
a	$\geq 10^{-5}$ to $< 10^{-4}$
b	$\geq 3 \times 10^{-6}$ to $< 10^{-5}$
c	$\geq 10^{-6}$ to $< 3 \times 10^{-6}$
d	$\geq 10^{-7}$ to $< 10^{-6}$
e	$\geq 10^{-8}$ to $< 10^{-7}$

1.6.4 Abbreviations

Abbreviation	Term	Meaning
B_{10d}	-	Number of cycles until 10% of the components fail dangerously (per channel)
$MTTF_d$	Mean Time to Dangerous Failure	Mean time to dangerous failure (per channel)
DC	Diagnostic Coverage	Diagnostic coverage
PL	Performance Level	Discrete level that specifies the capacity of safety devices to execute a safety function under foreseeable conditions.
PFH	Probability of Failure per Hour	Probability of failure per hour
SIL	Safety Integrity Level	Safety integrity level

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2 Safety notes

2.1 Representation

At various points in this manual you will see notes and precautionary warnings regarding possible hazards. The symbols used have the following meaning:

DANGER!

- **indicates an imminently hazardous situation which will result in death or serious bodily injury if the corresponding precautions are not taken.**

WARNING!

- **indicates a potentially hazardous situation which can result in death or serious bodily injury if the corresponding precautions are not taken.**

CAUTION!

- **means that if the corresponding safety measures are not taken, a potentially hazardous situation can occur that may result in property injury or slight bodily injury.**

CAUTION

- **CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in damage to property.**

- **This symbol reminds you of the possible consequences of touching electrostatically sensitive components.**

Information

Useful practical tips and information on the use of equipment are identified by the “Information” symbol. They do not contain any information that warns about potentially dangerous or harmful functions.

2.2 General safety instructions

The device was developed, manufactured, tested and documented in ac-cordance with the applicable safety standards. If you follow the instructions regarding safety and use as described in this manual, the product will, in the normal case, neither cause personal injury nor damage to machinery and equipment.

The instructions contained in this manual must be precisely followed in all circumstances. Failure to do so could result in the creation of potential sources of danger or the disabling of safety features integrated in the handheld terminal.

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Apart from the safety instructions given in this manual, the safety precautions and accident prevention measures appropriate to the situation in question must also be observed.

Handling of KeTop

You have chosen a high-quality KeTop that is equipped with highly sensitive state-of-the-art electronics. To avoid malfunctions or damage through improper handling, follow these instructions during operation.

WARNING!

The following application areas are expressly excluded for the KeTop:

- **Use in areas prone to explosion or fire**
- **Use in mining**
- **Outdoor use**

Other products must be used for these applications!

The KeTop housing must not be opened (exception: cable entrance area) , as the KeTop is sensitive to electrostatic discharge.

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CAUTION

- **Turn off the power supply before opening the cable entrance area of the KeTop. Otherwise the components could be destroyed or undefined signals could occur.**
- **Make sure that nobody can fall over the cable to avoid that the device falls to ground.**
- **Take care not to squeeze and thus damage the cable with any object.**
- **Do not lay the cable over sharp edges to avoid damaging the cable sheath.**
- **Do not lay down the device with the operating side facing down to avoid damaging the operating elements.**
- **Never lay the device onto unstable surfaces. It could fall to ground and thus be damaged.**
- **Never lay the device close to heat sources or into direct sunlight.**
- **Avoid exposing the device to mechanical vibrations, excessive dust, humidity or to strong magnetic fields.**
- **Never clean the device, operating panel and operating elements with solvents, scouring agent or scrubbing sponges. For cleaning the device, use a soft cloth and a bit of water or a mild cleaning agent.**
- **Make sure that no foreign objects or liquids can penetrate into the device. Check at regular intervals and especially after a hard hit (e.g. a fall) the protective covers of the device, if all housing screws are firmly tightened and if the housing or the cable entry is damaged.**
- **If the device shows any defect, please send it, including a detailed error description, to your supplier or the relevant after-sales service office.**
- **If the KeTop is equipped with a touch screen, then operate the touch screen with fingers or use a touch-pen. Never use sharp objects (e.g. screwdriver,...) for operating the touch screen. This could damage the touch screen.**
- **The KeTop is equipped with a MLC NAND-Flash mass storage. Those memories have limited writing cycles. Avoid cyclic writing on the NAND-Flash storage. The KeTop provides a temporary file system in the RAM storage. For cyclic logging in the application use this file system.**

2.3 Personnel safety instructions

WARNING!

Danger of personal injury due to electric shock!

- **Supply the device exclusively from power sources that have an extra low voltage (e.g. SELV or PELV according to EN 61131-2)**
- **When using a SELV power source it can become PELV by reason of the module construction and the connectors (grounding!).**
- **Protective low voltage circuits must always be installed safely insulated separated from circuits with dangerous voltage.**

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CAUTION!

Danger of fire in case of component failure!

- **In final application, make sure that the 24 V DC power supply to the operator panel is adequately fused! Therefore a fuse that complies with UL 248 and is rated max. 3,15 A must be used.**

WARNING!

- **For the right projecting of the Handheld Terminal the manufactorer must enforce a hazard and risk analysis. The following safety aspects must be considered:**
  - **Right cable length for limitation of workspace.**
  - **Is an emergency stop button necessary and permissible?**
  - **Is the safety category for the application sufficient?**
- **From the operating place the operator must have a good view at the hazard area.**
- **The device may be operated in faultless condition only and the operating instructions must be observed.**
- **The operator must have a sufficient educational level and must know details of intended use described in the user's manual.**
- **The safety advices in the following chapters must be considered absolutely.**
- **Further informations to safety and EMC are included in the appendices.**

2.4 Transport Conditions

To avoid damaging the KeTop during further or return transport, the following transport conditions must be fulfilled:

- Always use the original packaging for the transport.
- The environmental conditions for the KeTop (see chapter "Technical Data") must also be fulfilled during transport.

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3 General product description

The handheld terminal KeTop is a portable operating and display device with rugged design. Using a high-performance processor and providing an Ethernet interface, the KeTop is ideal for a great variety of applications.

All tasks can be solved graphically and in color, and operation is intuitive using a touch screen.

3.1 Front view

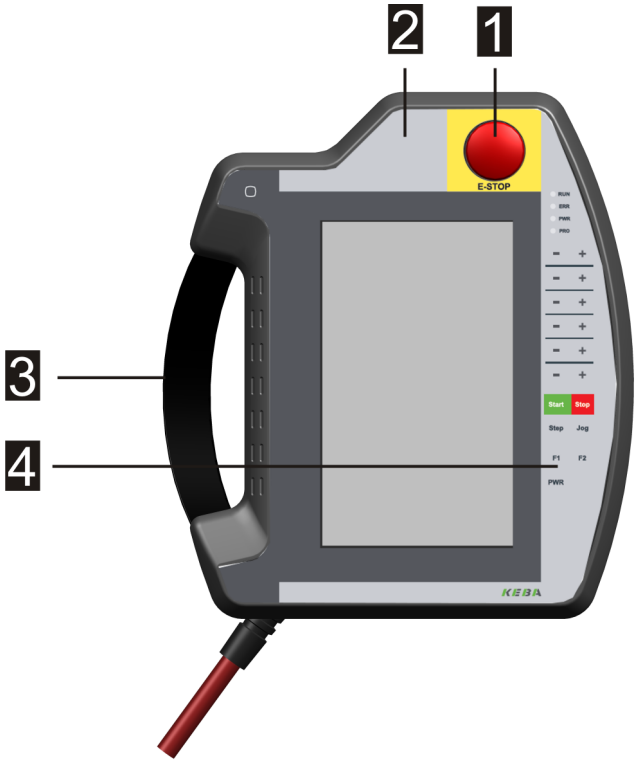

Fig.3-1: Front view of the KeTop T70

1 ... emergency stop switch or grey stop button (twin circuit)	2 ... Location for options
3 ... Hand strip	4 ... Membrane keypad

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3.2 Rear view

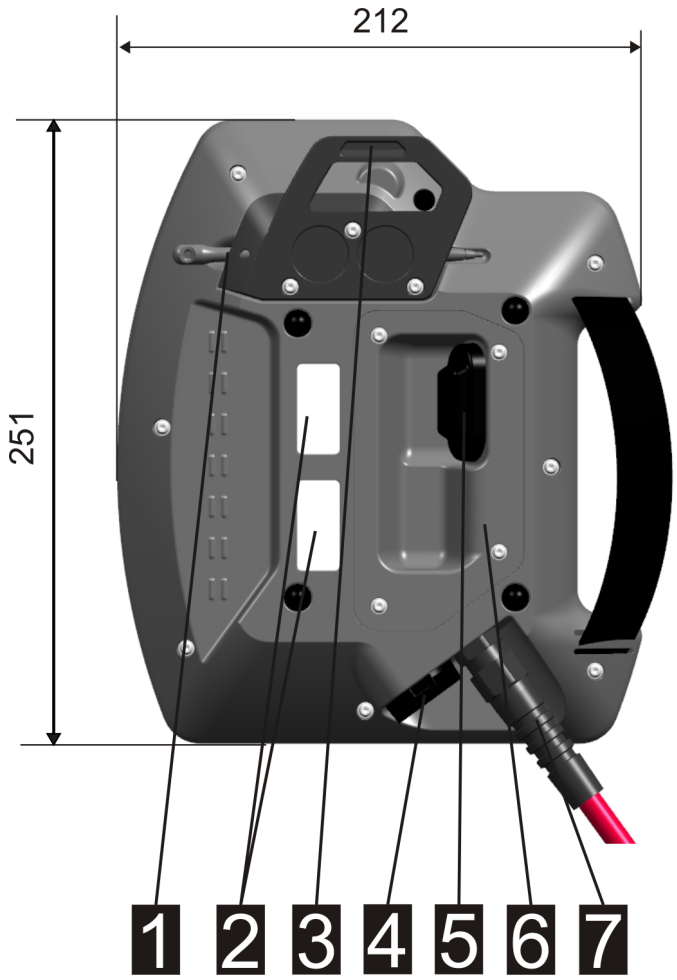

Fig.3-2: Back side of the device

1 ... Touchstift Halterung	2 ... Type plate
3 ... Mounting bracket	4 ... USB-Port
5 ... Enabling control device	6 ... Cable entrance area
7 ... Strain relief and bend protection for connection cable	

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3.3 Side view

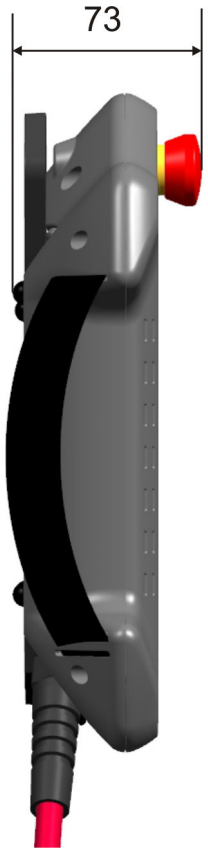
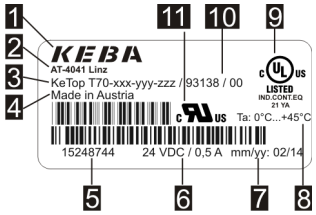
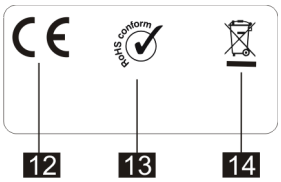


Fig.3-3: Side view of the device

3.4 Type plate

Sample of a KeTop T70 type plate:

device specific data	Certificate
	

1	... Manufacturer	2	... Manufacturer's address
3	... Material name	4	... Country of origin
5	... Serial number	6	... Technical data (Voltage / power supply)
7	... Date of production (month/year)	8	... Ambient temperature
9	... UL marking	10	... Material number / revision
11	... UR marking	12	... CE marking of conformity
13	... ROHS marking	14	... Advice for electronic scrap regulation

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4 Display and operating elements

- Membrane keys with tactile feedback
- 4 status LEDs
- Resistive touch screen, to be operated with finger or stylus
- Backlit color LC display 7“ TFT in WSVGA resolution (1024x600 pixels)

4.1 Membrane keypad

For the KeTop T70 different membrane keypads with up to 21 keys and 4 status LEDs are available.

4.1.1 Standard keypad

Option of the membrane keypad. Layout with 20 keys and 4 status LEDs. Depending on the availability of an emergency stop or a grey stop button there are two different standard keypads.

With emergency stop	With grey stop button
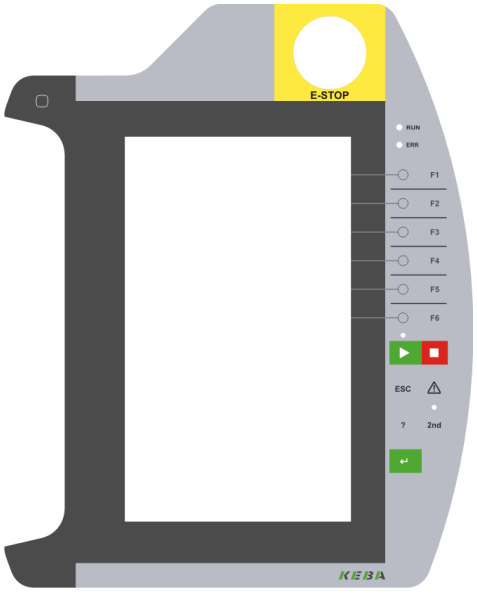	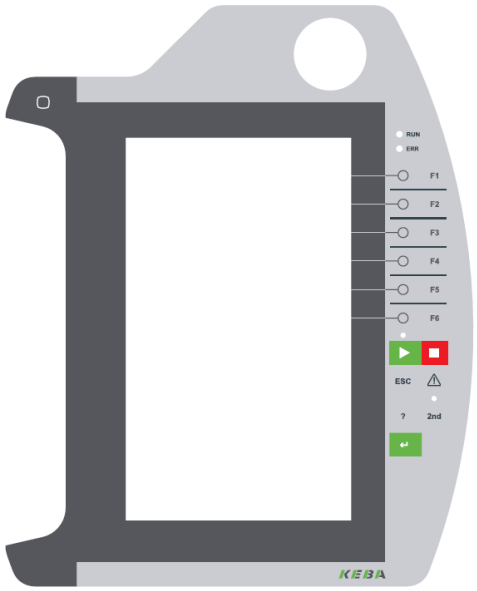
Fig.4-1: Standard membrane keypad for KeTop T70 with emergency stop	Fig.4-2: Standard membrane keypad for KeTop T70 with grey stop button

4.1.2 Robotic keypad

Option of the membrane keypad. Layout with 20 keys and 4 status LEDs. If the KeTop T70 is equipped with a robotic keypad there is a membrane keypad with 3 more keys available at the rear side of the device.

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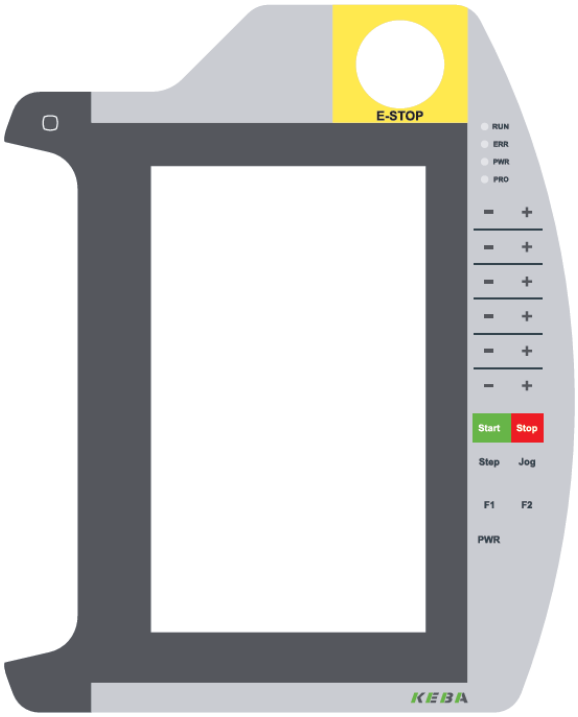

Fig.4-3: Robotik membrane keypad for KeTop T70 front view

Fig.4-4: Robotik membrane keypad for KeTop T70 rear side

4.1.3 IMM keypad

Option of the membrane keypad. Layout with 21 keys and 4 status LEDs.

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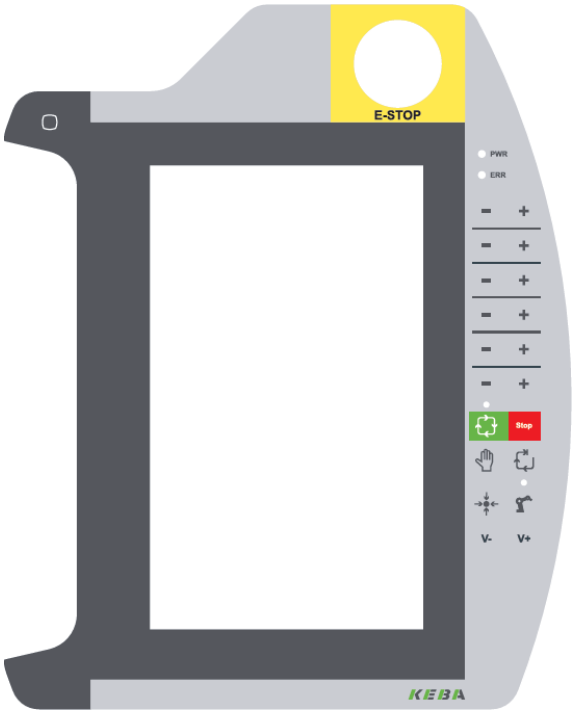

Fig.4-5: IMM membrane keypad for KeTop T70

4.2 Touchscreen

An analog-resistive touchscreen is used..

Operation

The touch screen may be operated with a finger (with or without glove) or a touch stylus. For long durability of the touch screen, the following points should be observed:

CAUTION

Damage to the touch screen for improper handling!

- **Use only a soft cloth with mild detergent (e.g. soapsuds) to clean the touch screen, see *chapter 8.1 "Cleaning the touch screen" on page 42*.**
- **When operating with gloves, ensure that no metal filings or sharp objects (sand, grinding paste, etc.) are embedded in the surface of the glove.**
- **The touch screen may not be operated with sharp, metallic objects or with ball point pens or pencils.**
- **The touch screen my not be exposed to continuous direct sunlight.**

Information

Light pillowing of the touch film can occur in rare instances. This is allowed and does not lead to any restriction of the functionality and service life.

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5 Connection and wiring

5.1 Cable Entrance Area

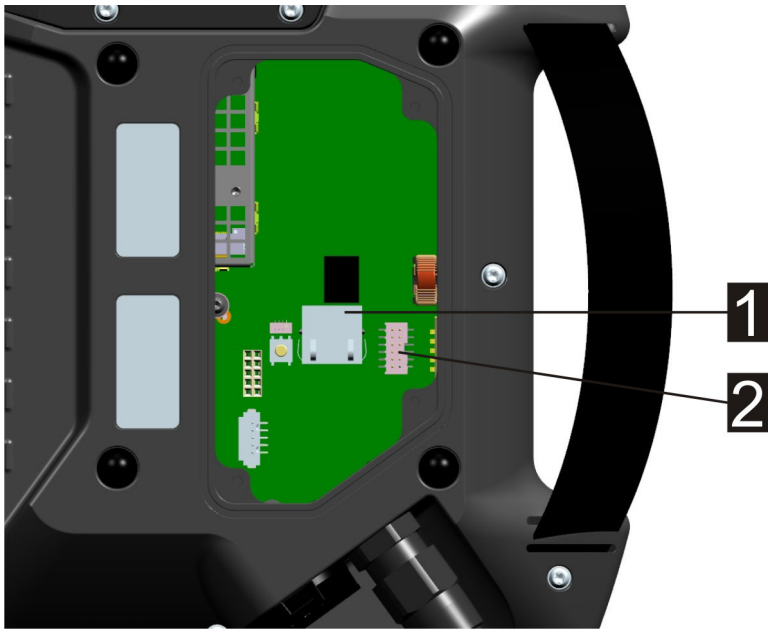

Fig.5-1: Cable entrance area of the KeTop T70

1	... ETHERNET connector / Communication interface
2	... Female conductor -Main plug / Power supply and control wires

5.2 Cable Routing in Cable Entrance Area

After opening the cable entrance area, the connecting lines can be routed as described in the following chapters. Before opening the KeTop please pay attention to the following safety instructions:

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Information

Instructions for opening the cable entrance area:

- *Lay the KeTop with the display facing down onto a plane and clean table (preferable on ESD pad) and take care not to damage the KeTop and its operating elements.*
- *For opening and closing the cable entrance area use the following type of screwdriver: "Torx size 10".*

Instructions for modifications in the cable entrance area:

- *Unplug the main connector by pulling on its wires with your fingers. Do not use any sharp objects.*
- *For unplugging the RJ-45 jack, actuate the locking lever:*

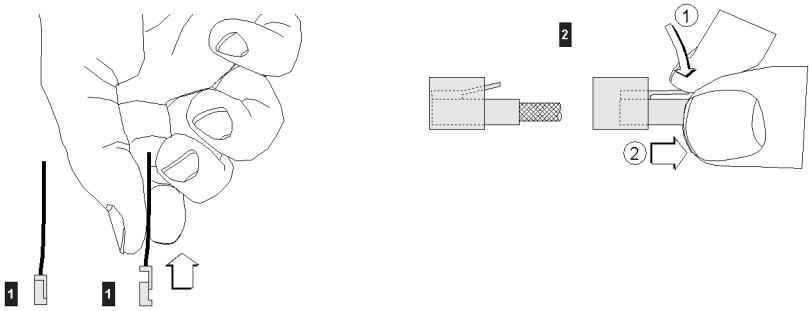

Fig.5-2: Uplugging main connector and RJ-45 jack

1	... main connector
2	... RJ-45 jack

WARNING!

- **Make sure that the main connectors and the RJ-45 jack correctly snap in when you plug them in. Otherwise the emergency stop functionality or the enabling functionality or the correct shielding might not be given any more.**
- **Validate the emergency stop and enabling functionality before restarting the KeTop.**

Information

Instructions for closing the cable entrance area: Make sure that

- *the sealing is clean, not damaged and correctly positioned in the cable entrance area,*
- *no cables are squeezed in,*
- *the cover of the cable entrance area is attached again with all 4 screws (torque: 0,8 to 1,0 Nm). Otherwise the protection degree cannot be guaranteed.*

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5.3 Assembling of the connection cable

In this chapter is documented how to assemble the connection cable to the KeTop T70. The available connection cables can be found at *chapter 12.1 "Connection cable for KeTop TTxxx-eaa" on page 49*.

5.3.1 Tools needed

For assembling you need:

- Open-end wrench (size 19)
- Torx size 10

5.3.2 Cable assembling

Information

- *Lay down the KeTop with the display facing onto a plane and clean table (preferable on ESD pad) and take care not to damage the KeTop and its operating elements.*

1) Loosen the 4 TORX screws of the cover plate with a Torx size 10.

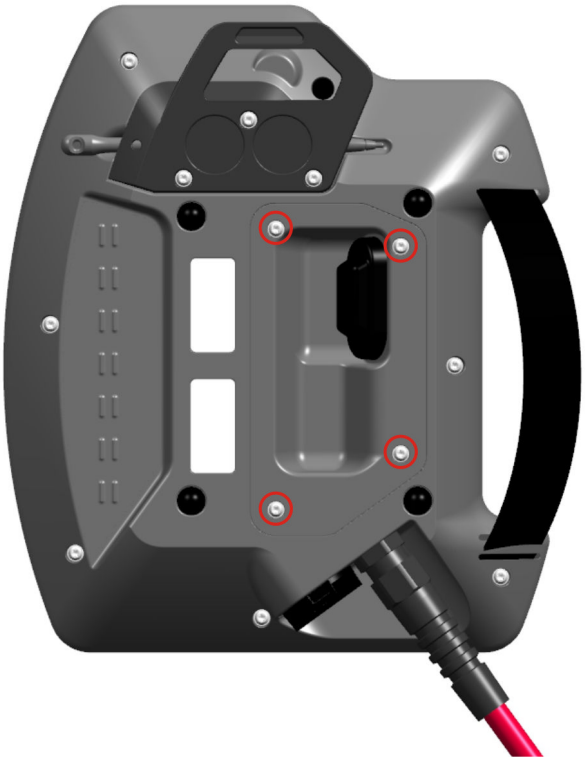

Fig.5-3: Position Torx screws

2) Open the cover plate. Thereby take care not to damage the wires of the enabling control device.

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3) Loosen grey screw nut and the cable grommet of the connection cable. The grey screw nut will not be needed afterwards.

Fig.5-4: Screw nut and cable grommet of connection cable

4) Put the connection cable threw the therefore provided opening into the KeTop T70. In this opening a grey screw nut is actually integrated for fasten the connection cable.

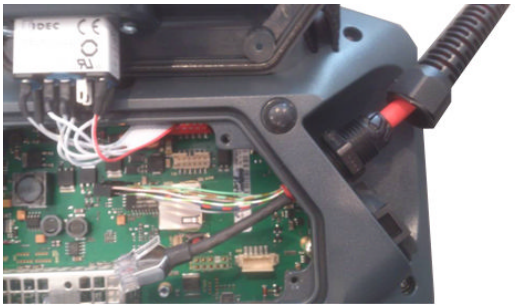

Fig.5-5: Inserting connection cable

5) Fasten grommet with the open-end wrench size 19 and a torque of 3 Nm.

6) Plug in main connector and the RJ45 jack.

Information

Make sure that the main connector and the RJ-45 jack are snapped in correctly.

7) Fasten stain relief with the open-end wrench. Thereby a little bit of the stain-relief should be inside of the enclosure. Make sure that the rubber ring for the stain-relief is lying correctly under the grommet.

8) Put cover plate on cable entrance area and fasten TORX screws (torque: 0,8 to 1,0 Nm).

Information

- *Check if sealing is clean and not damaged.*
- *Check if cables are not squeezed*
- *Check if all screws of cover plate are fastened - otherwise the degree of protection can not be guaranteed.*

For unplugging cables

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Information

- *Unplug the main connector by pulling on its wires with your fingers. Do not use any sharp objects.*
- *For unplugging the RJ-45 jack, actuate the locking lever:*

5.4 Power supply

WARNING!

Please observe the safety-relevant information in the *chapter 2.3 "Personnel safety instructions" on page 16*.

Specification of power supply lines in the TTxxx connection cable:

- Cross section: AWG24 (0.24mm²)
- Material: zinc-coated copper strand
- Line resistance: ≤ 90 Ohm/km (≤ 145 Ohm/mile)

Information

The values for power supply specified in the technical data are only valid for device side. Voltage loss for connection cable must also be taken into consideration depending on cable length.

5.5 Emergency Stop Button and grey Stop Button

The emergency stop button respectively the grey stop button used on the KeTop features two circuits. The contacts are normally closed.

The red-yellow emergency stop button of the handheld terminal meets the requirements of the EN ISO 13850. It must be designed as an emergency stop of category 0 or category 1 (see EN 60204-1 chapter 9.2.5.4.2) on the basis of the risk assessment for the machine. The connection of the positive-break contacts to an appropriate monitoring system must meet the safety category (in accordance with EN ISO 13849-1) which is defined by means of the risk assessment (in accordance with EN ISO 14121-1) of the machine.

Optionally the KeTop is also available with a grey stop button instead of the red-yellow emergency stop button. In principal the grey stop button has the same functionality as the red-yellow emergency stop button. If the handheld terminal is not plugged in, the grey color of the stop button should avoid the usage of the non-effective (emergency) stop button in dangerous situations. For a more information about this topic see chapter "CE Conformity, Directives and Standards".

The grey stop button fulfils also all mechanical aspects of the EN ISO 13850 and differs from the emergency stop button only by its color.

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WARNING!

- **Not fully functional emergency stop devices may have fatal consequences! Emergency stop switches which are red-yellow marked must be effective under all circumstances in all operating modes of a machine or plant.**

  Store handheld terminals with not operational red-yellow emergency stop switches on a place where the operator cannot see it, so that he can not mistake the device.

  Handheld terminals which are plugged in and out frequently for temporarely use, must not have a red-yellow emergency stop switch. Such devices must be equipped with a grey stop switch.
- **Resetting an activated emergency stop facility must not result in uncontrolled start-up of machines or installations.**
- **The emergency stop button does not replace other safety facilities.**
- **The emergency stop button on the handheld terminal does not replace the emergency stop buttones to be mounted directly on the machine.**
- **Some mechanical errors in emergency stop switches can be recognized at operation only.**

  Test the function of the emergency stop switch when the device had been exposed to mechanical shock (e.g. it had been fallen on the ground).

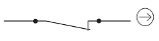
  Additionally the emergency stop switch must be tested cyclic (6 monthly). Watch the machine stopping after the emergency stop switch had been pushed.
- **For further informations to emergency stop switch observe chapter "Directives and Standards".**

5.6 Enabling Control Device

The KeTop is equipped with one enabling control device. The enabling control device consists of a 3-position operating element. An essential feature are the two-channel circuits and the forced opening according to EN 60947-1 and EN 60947-2 to the third switch position.

5.6.1 Functioning

The enabling control device can be in the following three positions:

Position	Function	Enabling control device	Contacts
1	home position	is not pressed	enabling outputs are open
2	enabling	is pressed	enabling outputs are closed
3	panic	is pressed strong	enabling outputs are open 

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WARNING!

The enabling control device must be tested cyclic (6 monthly) by pressing the panic position. Watch the machine performing the panic function after pressing the enabling switch.

Enabling

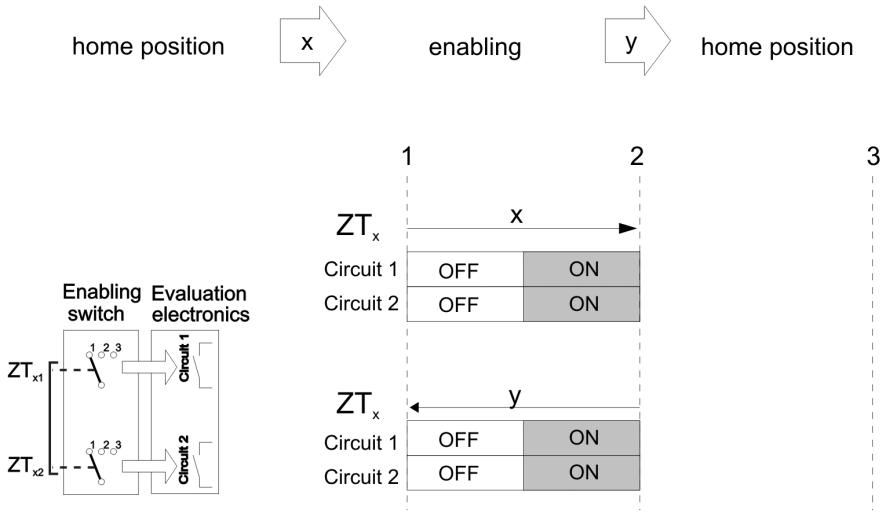

Fig.5-6: Contact travel diagram for enabling

Panic

The pushing of the actuating elements into the panic position is evaluated in a way that the enabling position is skipped when the actuating elements are released.

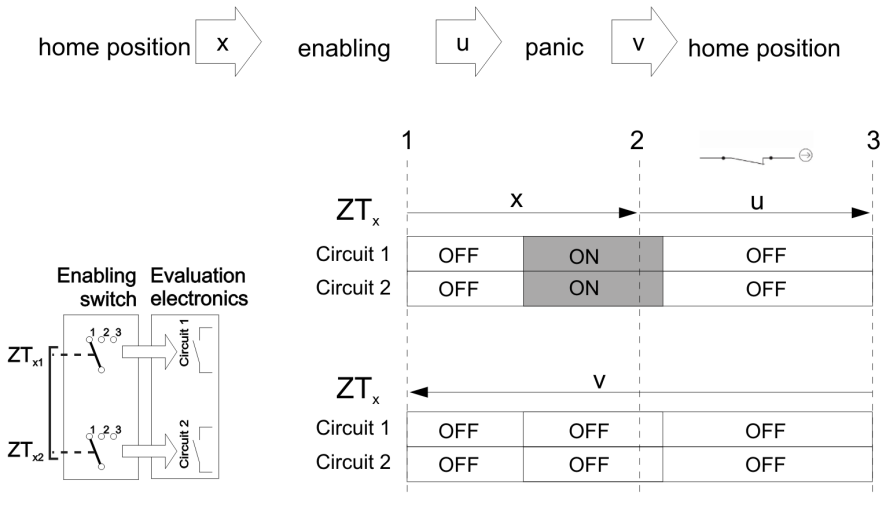

Fig.5-7: Contact travel diagram for panic

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Information

At the KeTop, the enabling control devices always feature two circuits.

To meet the safety category 4 PL e in accordance with EN ISO 13849-1, the enabling control device must be realized with 2 circuits and these circuits have to be dynamically monitored on short circuits and shunt currents. These two circuits have to be concurrent considering the operating cycle with respect to the B_{10d} value of the safety device. The safety category 4 PL e means that one single failure most not lead to the loss of the safety function and one single failure is detected during or before the next request (e.g switching-on or at the end of a machine cycle).

The monitoring of the simultaneity by the control relay is necessary, because otherwise maybe a failure culmination would not be recognised and this would cause the loss of safeness.

According to the EN60204-1 the enabling control devices shall be implemented in such a way, that at position 1 (Off function - the control element is activeted) and position 3 (Off function - the control element is pressed down to panic position) at least one of the stop categories 0, 1 or 2 is initialized.

For calculation of the PL for the safety function "enabling" the safety-related characteristic values (PL- and B_{10d}-values) of all involved components have to be included. For details for calculating the PL for the whole safety function see EN ISO 13849-1, chapter 6.3, appendix H and appendix I.

5.6.2 Example of Connection with control relay (PILZ PNOZ)

CAUTION

Technical data of the control relay have to be observed in the final application! Otherwise it is possible that the rated voltage tolerance of the KeTop is limited.

The following example is a support for realizing the end application.

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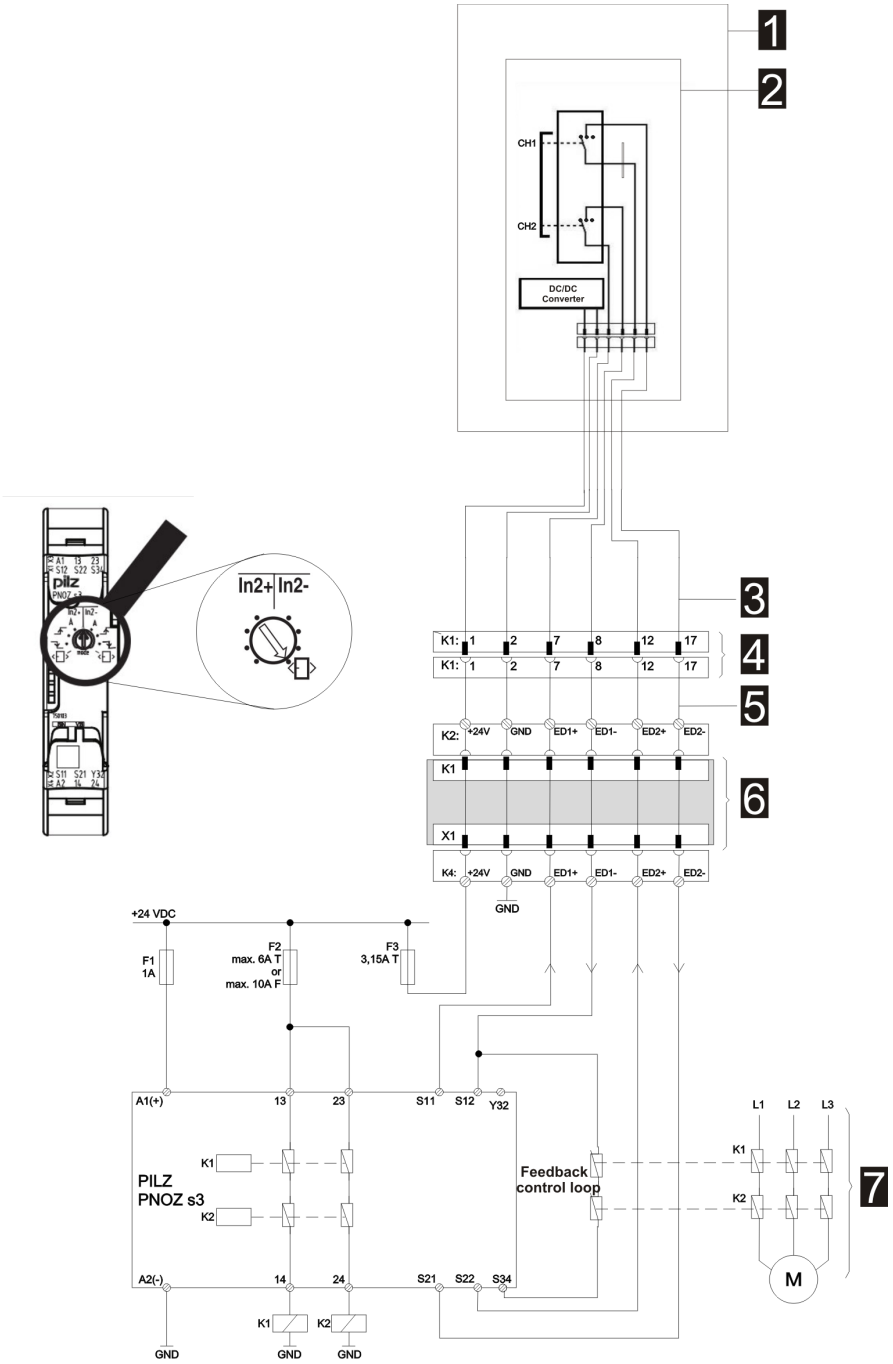

Fig.5-8: Suggested wiring

1 ... Hand-held terminal	2 ... Enabling control device
3 ... Hand-held terminal connection cable	4 ... 17 pin male connector
5 ... Intermediate cable	6 ... Connection box
7 ... Enabling of dangerous movement!	

The grafic shows a suggested wiring of enabling switches to fulfill safety category 4 PL e for the enabling switch with PILZ control relay. Also follow the instructions described in the PILZ operating manual about the device

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PNOZ s3. For calculation of the whole safety function "enabling" the control relay and all subsequent components have to be considered.

5.7 Foreseeable Misuse of Enabling control device

Foreseeable misuse means the not allowed fixing of the enabling control device in the enabling position. The foreseeable misuse of the enabling control device must be restricted.

The following measures causing the stop of the machine in the manual mode are recommended:

- Inquiry of the enabling control device when turning on the machine/plant and inquiry of the enabling control device when changing the operating mode from automatic to manual (The enabling control device must not be in the enabling position.).
- The enabling control device must be released within a defined period and pushed into the enabling position again. The length of the period must be defined according to the activity.

WARNING!

- **The enabling control device is only suitable as safety function if the operator activating the enabling control device recognizes the dangerous situation in time so that he can immediately take the necessary measures to avoid such situations. As additional measure reduced speed of the movement can be necessary. The allowed speed must be determined by means of a risk assessment.**
- **The enabling control device is only used to enable commands for performing dangerous movements. The commands themselves must be activated by a separate operating element (key on handheld terminal).**
- **Only the person who operates the enabling control device is allowed to work in the dangerous area.**
- **For further informations regarding the enabling control device please pay attention to chapter "Machinery Safety".**

5.8 Ethernet

This interface is based on the 10BaseT specification and suitable for the full-duplex mode (the operation with 100Mbit (100Baset specification) requires a special connection cable).

The following interface parameters are defined and cannot be changed:

- 10 MBit (100MBit with appropriate cable possible)
- Protocol TCP/IP

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5.8.1 Pin assignment

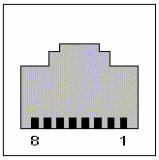

Fig.5-9: RJ45 plug

Pin no.	Signal designation		Input / Output
1	Tr. Data +	Transmit Data +	Output
2	Tr. Data -	Transmit Data -	Output
3	Re. Data +	Receive Data +	Input
4	n.c.	n.c.	---
5	n.c.	n.c.	---
6	Re. Data-	Receive Data -	Input
7	n.c.	n.c.	---
8	n.c.	n.c.	---

5.9 USB-Port

Information

The USB interface is not designed as an operational interface for ongoing operations. It is used exclusively in the service and startup event for connecting USB devices.

A list of recommended USB devices can be ordered from KEBA.

Plug the USB memory stick

For plugging the USB memory stick proceed as following:

1) Open the USB protection cover.
2) Push-in the USB memory stick until it snaps in.

The USB memory stick will be detected from the operating system and will be shown.

Unplug the USB memory stick

Information

Never unplug the USB memory stick during read/write operations! Otherwise it will lead to loss of data.

To unplug the USB memory stick proceed als following:

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1) Unplug USB memory stick from the device.
2) Press down the protection cover.

Information

The protection cover must be closed completely, to guarantee IP65!

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6 Operating behaviour

6.1 Start-up

After supplying the KeTop with power, startup operations begin. You can follow these steps on the display in the following order:

1) Loading the boot loader
2) Loading and starting firmware
3) Request, if the setup menu (`Setup Mask`) should be opened (2 sec.).
4) Requesting the time from the host. If no host is found time synchronization will be skipped after 2 min or via pressing any button.
5) Synchronize the system and application directories between host and KeTop
6) Starting the visualization.

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7 Configuration and operating instructions

Further information: See system manual.

7.1 Connect the KeTop to a host control

The KeTop has to be connected via Ethernet to the host control to allow start-up and serial operating. Usually this happens via a junction box JB 001 in which the separation of the signals (Ethernet, supply, safety engineering) is carried out. As soon as the KeTop is supplied the start-up begins.

7.2 Setup menu

In the setup menu the following basic configurations of the KeTop T70 can be done:

- Configuration of the network address and the host IP address
- Calibration of the touch screen
- Configuration of the brightness of the display
- Configuration of the time until start of the screen saver
- Information of installed software version

7.2.1 Setup menu entrance

The setup menu can only be opened during start-up of the KeTop. As soon as the KeTop is supplied the start-up begins. After some time a the message `Press any key to enter setup` appears for 2 seconds. In this case any key has to be pressed to open the setup menu.

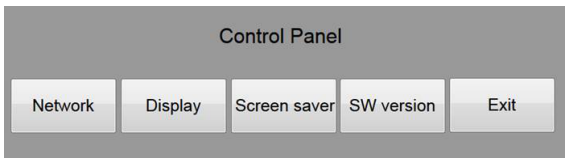

Fig.7-1: Setup manu main mask

The masks ***Network***, ***Display***, ***Screen saver*** and ***SW version*** are described in the following chapters.

Via ***Exit*** the setup menu is closed and the start-up of the KeTops continues.

7.2.2 Network

Via ***Network*** the network mask will be opened. In this mask the network settings for ***IP-Config*** and ***Host-IP*** can be changed.

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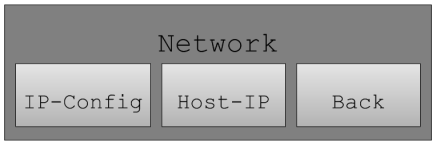

Fig.7-2: Network mask

Back returns to the main mask.

IP-Config

Via ***IP-Config*** the IP-Config mask opens. The network address can either:

- obtained via DHCP (thereby the automatical integration into an existing network is possible without configuration)
- or defined by own. Each of the four segments of the network address must be inserted manually via the numeric input panel (simply select the single segments).

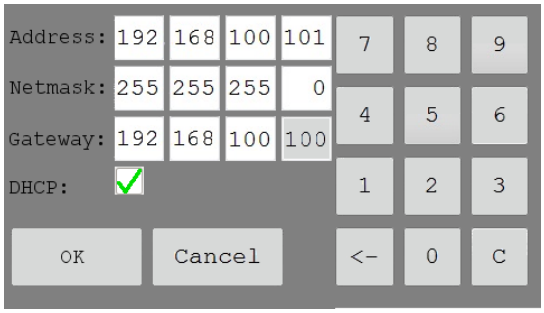

Fig.7-3: IP-Config configuration mask

Designation	Description
Adress:	IP address of the visualization communication
Netmask:	Corresponding subnet mask
Gateway:	Standard gateway
DHCP:	Via activating of "DHCP" the IP address will be obtained automatically via a DHCP server and the other input lines will be disabled.

Via ***OK*** the configuration will be saved and the previous mask will be opened. With ***Cancel*** the mask will be closed without saving the configuration.

Host-IP

Via ***Host-IP*** the Host-IP mask will be opened. The inserting of the address will be executed via the numeric input panel.

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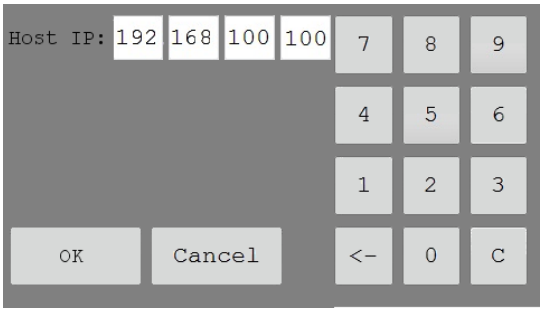

Fig.7-4: Host-IP configuration mask

Viag ***OK*** the configuration will be saved and the previous mask will be opened. With ***Cancel*** the mask will be closed without saving the configuration.

7.2.3 Display

Via ***Display*** the Display mask will be opened. In this mask the display settings ***Calibrate*** and ***Brightness*** can be done.

Fig.7-5: Display mask

Back returns to the main mask.

Calibrate

Information

Use a touch stylus while calibrating the display

Via ***Calibrate*** the touch screen calibration will be started. To calibrate the display proceed as follows:

1) Touch the screen to activate the reference points.
2) Select the reference points in sequence. Make sure to select the reference points quickly - pressing too long cause wrong calibration!
3) After selecting the reference points the calibration has to be checked.
   Choose the displayed marker in sequence (timeout of 10 sec per marker)

Information

If the inserting time is elapsed the calibration will be started again because no checking could be done.

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4) After successful inserting of the marker the message `Calibration data successfully verified` will be displayed for 3 seconds and the calibration will be assumed.

Afterwards the mask ***Display*** will be displayed again.

Brightness

Via ***Brightness*** the mask for configuration of the brightness will be opened. By using the slider the brightness will be configured.

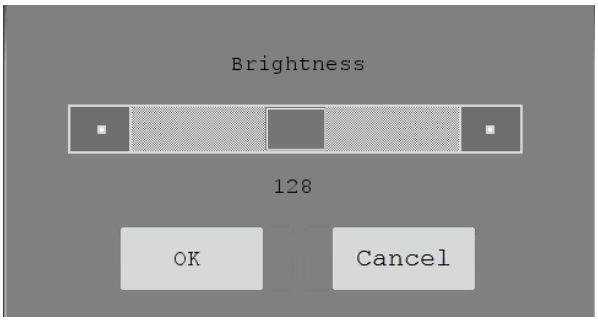

Fig.7-6: Configuration of brightness

Via ***OK*** the configuration will be saved and the previous mask will be opened. With ***Cancel*** the mask will be closed without saving the configuration.

7.2.4 Screen saver

Via ***Screensaver*** the time until the screen saver starts can be configured.

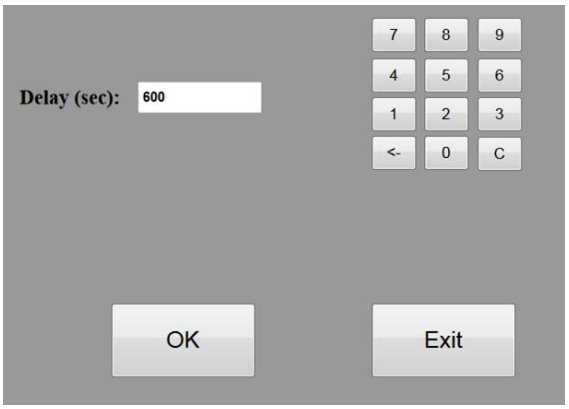

Fig.7-7: Screen saver configuration

In the field ***Delay*** the time in seconds can be inserted. Via ***OK*** the configuration will be saved and the previous mask will be opened. With ***Exit*** the mask will be closed without saving the configuration.

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7.2.5 SW version

Via ***SW version*** the current software of the KeTop will be shown.

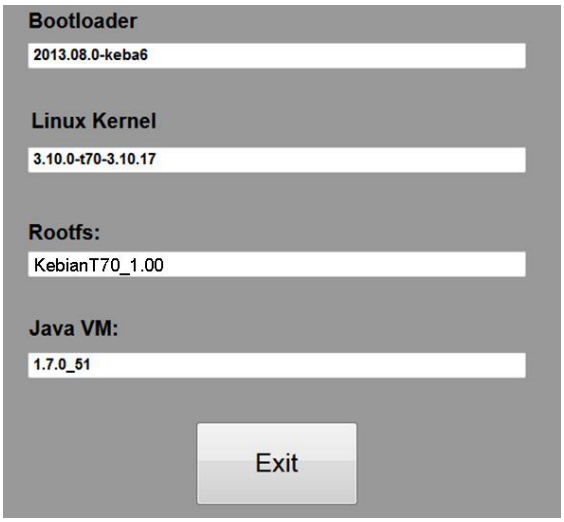

Fig.7-8: Software version

Via ***Exit*** the mask will be closed.

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8 Maintenance

8.1 Cleaning the touch screen

CAUTION

Never clean the touch screen with solvents, scouring agent or scrubbing sponges. Otherwise the touch surface could be damaged!

For cleaning the device, use a soft cloth and a bit of water or a mild cleaning agent. The cleaning agent should be sprayed onto the cloth and not directly onto the surface.

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9 Disposal

9.1 Disposal of the module

CAUTION

Please observe the regulations regarding disposal of electric appliances and electronic devices!

- The symbol with the crossed-out waste container means that electrical and electronic devices including their accessories must not be disposed of in the household garbage.
- The materials are recyclable in accordance with their labeling. You can make an important contribution to protecting our environment by reusing, renewing and recycling materials and old appliances.

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10 Technical Data

10.1 In general

Rated supply voltage:	24 V DC (rated voltage tolerance 19,2 V DC to 30 V DC according to EN 61131-2)
Maximum interruption time of supply voltage:	≤ 10 ms (lt. EN 61131-2)
Inrush current:	max. 5,6 A (with limitation of current)
Power consumption:	12 W (500mA to 24 V DC)
Display:	7" TFT-LCD, LED-backlight, 1024 x 600 pixels (WSVGA)
Touchscreen:	Yes, analog-resistive
Keypad:	• Membrane keypad with tactile feedback • Keypad at the rear side possible • Maximum 21 keys at the front + 12 keys at the rear side • 4 status LEDs
Equipment class:	III according to EN 61131-2 and EN 50178
Protection class:	IP65

10.2 Environmental conditions

Operating temperature:	For Single Core processor: 0 °C to 45°C (32 °F to 113 °F) For Dual Core processor: 0 °C to 40°C (32 °F to 104 °F)
Storage temperature:	-20 °C to +70 °C (-4 °F to 158 °F)
Relative humidity (non-condensing):	5 % to 95 % (not condensing)
Vibration resistance (operation):	(IEC 60068-2-6) • 5 Hz ≤ f < 8,4 Hz with 3,5 mm • 8,4 Hz ≤ f < 150 Hz with 1 g (0.0022 pounds)
Shock resistance (operation):	15 g (0.033 pound) / 11 ms (EN 61131-2)
Altitude (operation):	Max. 2,000 m sea level (6,560 ft)

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10.3 Processor

Processor:	Freescale i.MX6 Single Core 1 GHz (Optional: Freescale i.MX6 Dual Core 1 GHz)
Memory:	RAM: ● Single Core: 1 GB ● Dual Core: 2 GB FLASH: 4 GB
Operating system:	Linux

10.4 Interfaces

Debug-Schnittstelle:	1
● Type:	RS-232-C
Ethernet:	1
● Data transmission rate:	100 MBit/s
USB:	1
● Type:	USB 2.0; high speed

10.5 Mechanical properties

Construction:	ABS/PC housing withstands grease, oil, lubricants, alcohol, etc.
Flammability class:	UL94-V0
Dimensions:	
● Width:	212 mm
● Height:	251 mm
● Depth:	73 mm (with E-Stop)
Weight:	ca. 950 g (with E-Stop)
Drop-tested:	1,5 m (with E-Stop), afterwards at least IP54

10.6 E-Stop or grey stop button

Rated voltage:	24 V DC
Minimum current:	10 mA (each contact)
Maximum current:	1000 mA (each contact)
Utilization category:	DC-13 (in accordance with IEC 60947-5-1)
Schlegel FRVKOO:	B_{10d}: 250 000
Design:	2 circuits, external wiring
Galvanic isolation:	500 V AC to the rest

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10.7 Enabling control device

Output type:	Solid-state output
Rated voltage:	24 V DC (rated voltage tolerance 19.2 V DC to 30 V DC according to EN 61131-2)
Rated current:	500 mA (max.)
B_{10d}:	2nd position: 1 000 000 3nd position: 1 000 000
Actuating force:	from 1st position to 2nd position: 3 N typical from 2nd position to 3rd position: 17 N typical
Galvanic isolation:	500 V AC to the rest

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11 Options

This chapter describes the options the KeTop is available with.

11.1 Rotary Encoder Switch with 16 positions

The KeTop T70 can be equipped with an Rotary Encoder Switch (16 positions, 4 bit gray code) by default evaluated by Software. For further details about the evaluation see the programming manual.

Information

Optionally this control element can be wired on the connection cable directly. In this case you will need a special kind of connection cable, which can be purchased from KEBA.

11.2 Rotary Encoder Switch with 4 positions

The KeTop T70 can be equipped with an Rotary Encoder Switch with 4 positions (1 out of 4) by default evaluated by Software. For further details about the evaluation see the programming manual.

Information

Optionally this control element can be wired on the connection cable directly. In this case you will need a special kind of connection cable, which can be purchased from KEBA.

11.3 Key Switch

The KeTop T70 can be equipped with a key switch. This can either be evaluated by software or placed directly on the connection cable. When evaluated by software there can be incorrect state evaluations in case of a software error. Therefore the responsibility of the evaluation of the switching elements rests with the user.

Excerpt from the Machinery Directive 2006/42/EC (Annex I, chapter 1.2.5)

If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode.

From this excerpt it is evident that a safety-related switching element, depending on the system / safety concept, may be relevant, but this is not required for

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each machine. On the basis of a risk analysis / risk assessment the customer must define whether a safety-related switching element is required or not.

WARNING!

When evaluated by software there can be incorrect state evaluations in case of a software error. If the position of the key switch is safety-related this electro-mechanical switching element must be wired directly (without electronical evaluation on the KeTop) into the safety logic.

CAUTION

The safety logic must check the position of the key witch on exclusivity to simulaneously detect multiple selected modes.

The key switch is available with 2 or 3 positions.

11.4 Illuminated Push-Button

The KeTop T70 can be equipped with a illuminated push-button, that is evaluated by the software.

The illuminated push-buttons are available with impulse or click-stop function.

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12 Accessories

12.1 Connection cable for KeTop TTxxx-eaa

The standard KeTop handheld terminals are available with the following cables:

- KeTop TT025-eaa: 2,5 m
- KeTop TT050-eaa: 5 m
- KeTop TT070-eaa: 7 m
- KeTop TT100-eaa: 10 m
- KeTop TT150-eaa: 15 m
- KeTop TT200-eaa: 20 m

The connection cable withstands water, cleaning agents (alcohol and tensides), oil, drilling oils, grease and lubricants.

CAUTION

If KeTop connection cables are equipped with an user specific connector and not with KEBA's proposed connector, reduced electromagnetic immunity is possible. In this case the user has to ensure that the requirements of the EMC-directive 2004/108/EC are met.

Pin assignment

Description of signal	S2, 12-pin female connector	S3, 8-pin RJ-45- jack	Connection cable KeTop TTxxx-eaa, color of wires		S1, 17-pin male connector, pin no.:
24 V DC	1	-	pink	->	1
GND_IN	2	-	black	->	2
E-Stop, circuit 2	3	-	brown-green	->	3
E-Stop, circuit 2	4	-	white-green	->	4
E-Stop, circuit 1	5	-	grey-pink	->	5
E-Stop, circuit 1	6	-	red-blue	->	6
enabling control, circuit 1, pos.	7	-	brown	->	7
enabling control, circuit 1, neg.	8	-	yellow	->	8
enabling control, circuit 2, pos.	9	-	green	->	12
enabling control, circuit 2, neg.	10	-	grey	->	17
not used	11	-	-	-	9
not used	12	-	-	-	10
not used	-	-	-	->	11
TD+ (Ethernet)	-	1	blue	->	13

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Description of signal	S2, 12-pin female connector	S3, 8-pin RJ-45- jack	Connection cable KeTop TTxxx-eaa, color of wires		S1, 17-pin male connector, pin no.:
TD- (Ethernet)	-	2	white	->	14
RD+ (Ethernet)	-	3	orange	->	15
RD- (Ethernet)	-	6	red	->	16

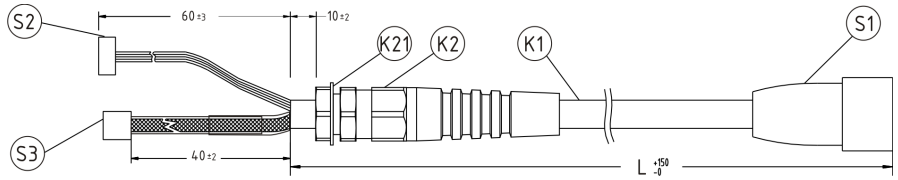

Fig.12-1: Connection cable KeTop TTxxx-eaa

S1	... 17-pin male connector	S2	... 12-pin female connector
S3	... 8-pin RJ-45 jack	K1	... connection cable
K2	... cable bushing	K21	... mounting nut for cable bushing
L	... length (acc. to product variant)		

12.2 Magnet carriers KeTop MC070

The magnet carrier is mounted directly on the KeTop and is used for storage of the device. It consists of two magnet which are mounted with two delivered hexagon bolts of size M4x8 at the mounting bracket of the device (mounting see instruction sheet).

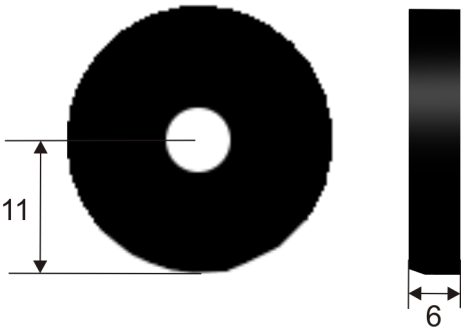

Fig.12-2: Magnet carier (all dimensions in mm)

12.3 Junction Box JB 001

This chapter describes the junction box JB 001 which is used to connect a KeTop to a PLC via Ethernet, RS-422-A or RS-232-C.

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12.3.1 Views and basic dimensions

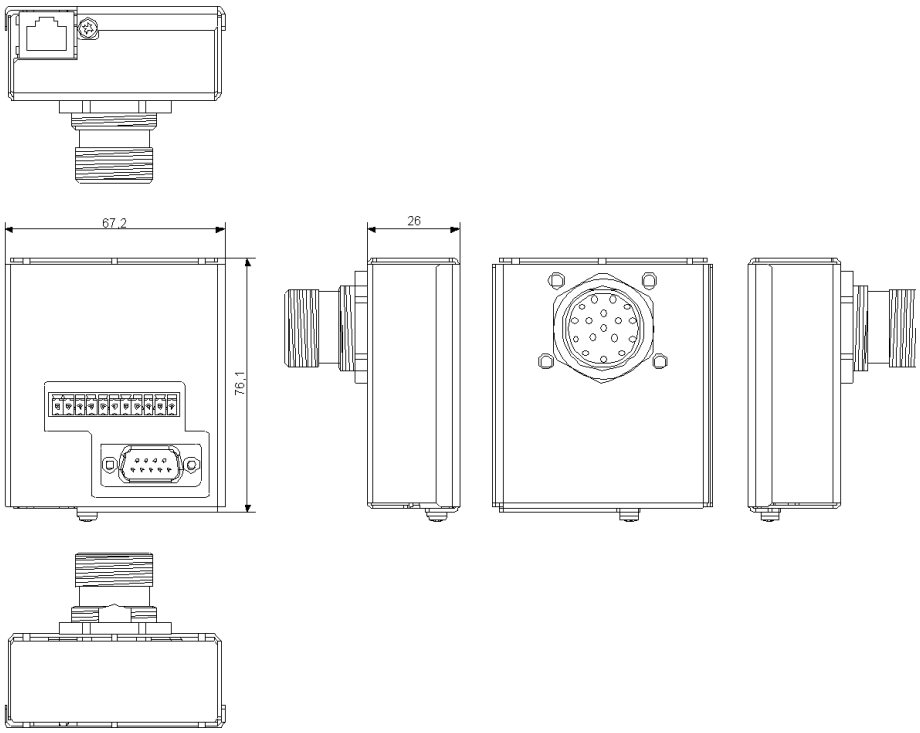

Fig.12-3: View of the JB 001

1	... Mounting nut

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12.3.2 Connectors

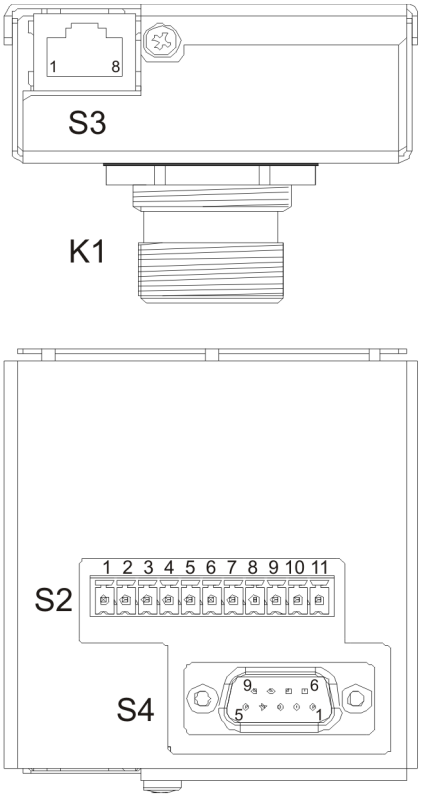

Fig.12-4: Connectors of the JB 001

K1 ... 17-pin Coninverse female connector for the KeTop connection cable	S2 ... 11-pin terminal block for power supply and control line (emergency stop switch, enabling control device). For this terminal block a plug will be needed.[1)]
S3 ... RJ-45 female connector for connection to a PLC [2)]	S4 ... 9-pin DSUB male connector for CAN connection

[1)]The requiered mating plug for terminal block S2 can be orderd from Co. "Phoenix" with material number FMC 1.5/11-ST-3.5.

[2)] via Ethernet, RS-232-C or RS-422-A

12.3.3 Connection diagram

The connection diagramm shows the connection of power supply, control lines (emergency stop switch and enabling control device) and data lines via the junction box.

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WARNING!

Danger to persons by electric shock!

- **Only supply the device with power from voltage sources having protective extra-low voltage (e.g. SELV or PELV acc. to IEC 61131-2)**
- **Only connect voltages and circuits which are safely separated from dangerous voltages (e.g. by means of sufficient insulation) to connections, terminals or interfaces up to a rated voltage of 50 V.**

Ethernet

Information

Point-to-point connections between KeTop and PLC require a crossed cable.

12.3.4 Shielding inside the Control Cabinet

In many cases, several interference sources exist in the control cabinet, such as servo drive modules, transformers, contactors and relays. Therefore it is necessary to continue the cable shield from the connector shell (control cabinet) up to the PLC (continuous connection from handheld terminal up to PLC).

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12.3.5 Mounting Instructions

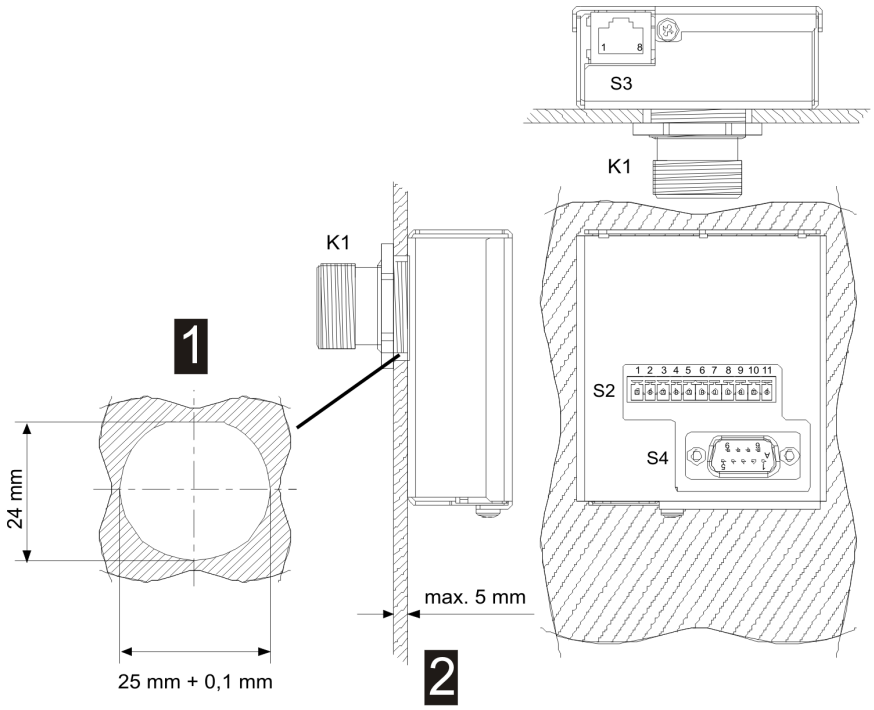

Fig.12-5: Dimension dfrawing for the mounting opening of the JB 001

1	... Zoom view of the mounting opening
2	... Control cabinet wall (max. 5 mm wall thickness)

12.3.6 Technical data of Junction Box JB 001

General data

Rated supply voltage (KeTop):	24 V DC (rated voltage tolerance 19.2 V DC to 30 V DC according to EN 61131-2)
Power consumption:	Without KeTop: none With KeTop: see chapter "Technical Data - In general"l
Inrush current (KeTop):	see chapter "Technical Data - In general"
Safety class:	III in accordance with EN 61131-2 and EN 50178
Protection degree:	IP20

Environmental conditions

Operating temperature:	5 °C to 55 °C (41 °F to 131 °F)
Storage temperature:	-25 °C to +70 °C (-13 °F to 158 °F)
Relative humidity (non-condensing):	5 % to 95 %

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Vibration resistance (operation):	IEC 60068-2-6: • 5 Hz ≤ f < 9 Hz at 7 mm • 9 Hz ≤ f < 150 Hz at 2 g
Shock resistance (operation):	15 g / 11 ms (IEC 60068-2-27)

Mechanical properties

Construction:	Steel panel housing, blue zinc coated, withstands grease, oil, lubricants, alcohol, etc.
Flammability class:	UL94-V0
Dimensions:	
• Width:	67.2 mm (2.6457 in)
• Height:	76.1 mm (2.9961 in)
• Depth:	26 mm (1.0236 in)
Weight:	220 g (0.485 lb)

12.4 KeTop CB211 Connection Box

The KeTop CB211 connection box is used for integration of the KeTop in the machine/system. It is suitable for wall mounting and can also be mounted on a mounting rail through the use of the mounting rail assembly kit (KeTop DR200).

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12.4.1 Views and basic dimensions

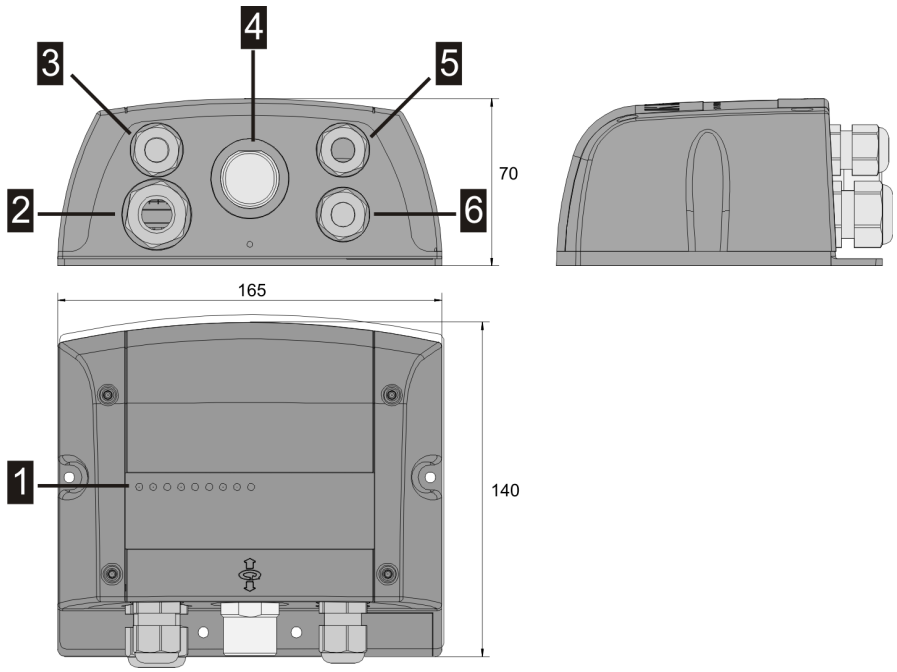

Fig.12-6: View and device description of the Gateway box

1 ... Status and error LEDs	2 ... PG gland (M20) for voltage supply, enabling control device and emergency stop
3 ... PG gland (M16) for separate functional ground (status as supplied with dummy plugs)	4 ... Coninvers female connector for KeTop connection cable
5 ... PG glands (M16) for data lines	6 ... PG glands (M16) for data lines (status as supplied with dummy plugs)

WARNING!

Danger to persons by electric shock!

- **Only supply the device with power from voltage sources having protective extra-low voltage (e.g. SELV or PELV acc. to IEC 61131-2)**
- **Only connect voltages and circuits which are safely separated from dangerous voltages (e.g. by means of sufficient insulation) to connections, terminals or interfaces up to a rated voltage of 50 V.**

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12.4.2 Interior view

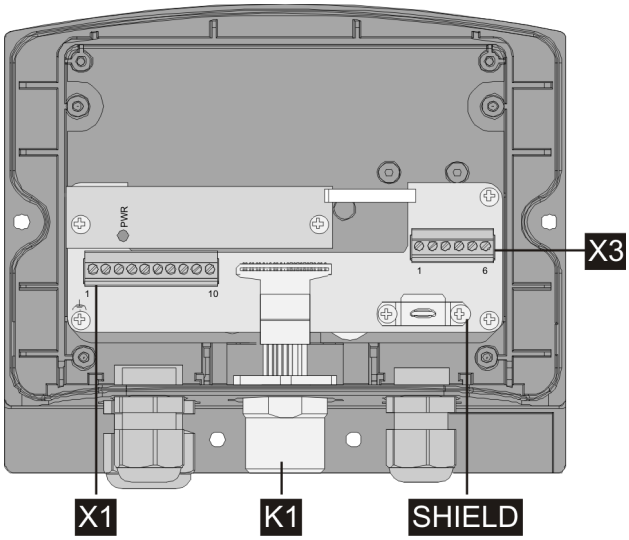

Fig.12-7: Interior view of connection box

K1 ... 17-pin female connector (Coninvers) for KeTop connection cable	X1 ... Terminal block for power and control lines (enabling control device and emergency stop)
X3 ... Terminal block for data lines	SHIELD ... Cable shield clamp with connection surface for cable shield of data lines (not used for strain-relief of the cable!)

Details about connecting the connection box KeTop CB 211 to the KeTop see chapter "Connection and wiring".

12.4.3 Technical data of the connection terminals

The following technical data apply to the X1 and X3 connector terminal blocks already available in the connection box:

Connection capacity:	
• rigid / flexible / wire gages:	0,14-1,5 mm² / 0,14-1,5 mm² / 28-16 AWG
• flexible with wire end ferrules without / with plastic sleeve:	0,25-1,5 mm² / 0,25-0,5 mm²
Grid dimension:	3,81
Insulation length:	7 mm²
Tightening torque:	0,22-0,25 Nm

Order data of Co PHOENIX:

Gateway-terminal block	PHOENIX	
	Type	Part no.
X1	MCVR 1.5/6-ST-3.81	1827169
X3	MCVR 1.5/7-ST-3.81	1827172
X4, X4B	MCVR 1.5/10-ST-3.81	1827208

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Information

- *Consider the connection capacity of the terminal blocks when selecting the connection cable.*
- *Use the following screwdriver to connect the wires to the terminal blocks: Blade: 0.4 x 2.5 x 80 mm, Length: 160 mm*
- *Multi-line connections (2 wires in one terminal) are not allowed. Use the X4B terminal block for continuing the field bus.*

12.4.4 Drilling template for wall mounting

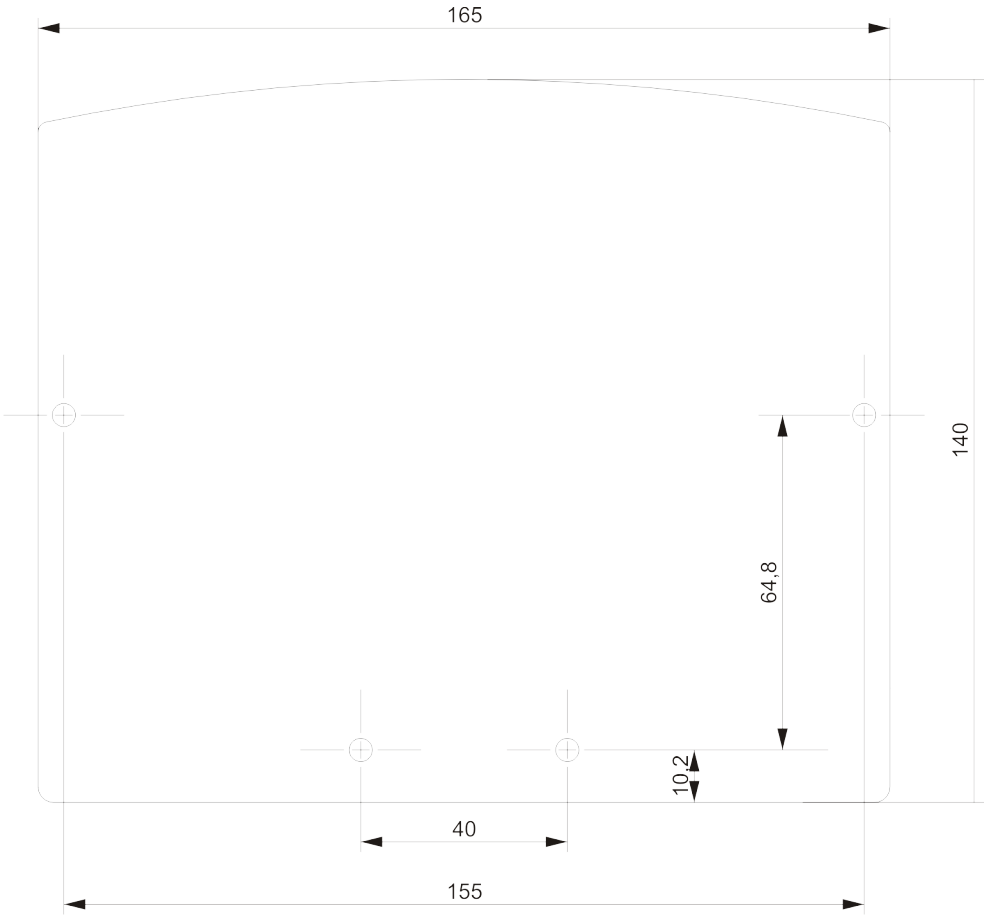

Fig.12-8: Drilling template for the Gateway box (specifications in mm)

Information

A scaled drilling template (scale 1:1) can be downloaded from www.ke-ba.com via ***Login*** ▸ ***Industrial automation*** *(Doc.No.:* ***1007622****).*

For wall mounting, we recommend the following screws and materials:

- Chipboard screw: Ø 4 x 40mm

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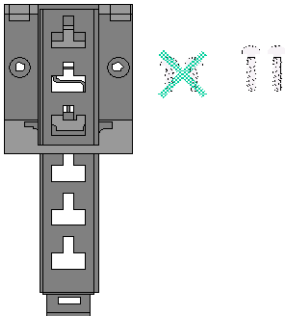
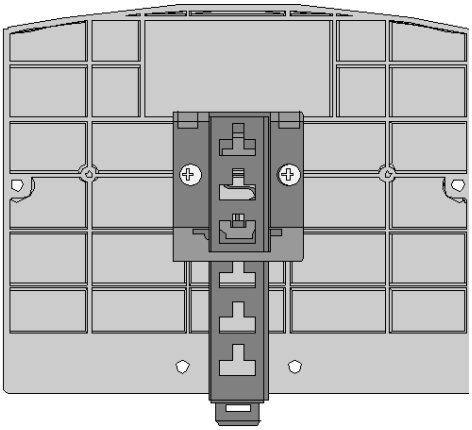
Head form: flat head

Max. head diameter: Ø 9 mm

- Recommended rawlplug: Ø 6 x 30mm

12.4.5 DIN Rail Holder Mounting Set KeTop DR200

The DIN rail holder KeTop DR200 is available as accessory and will be mounted on the rearside of a KeTop CB2xx connection box. So the connection box can be easily snapped onto a DIN rail.

	
DIN Rail Holder Mounting Set	DIN Rail Holder fixed on the rear side of the gateway-box

Tab.12-9: DIN Rail Holder Mounting Set for connection box

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12.4.6 Use of Connection Box

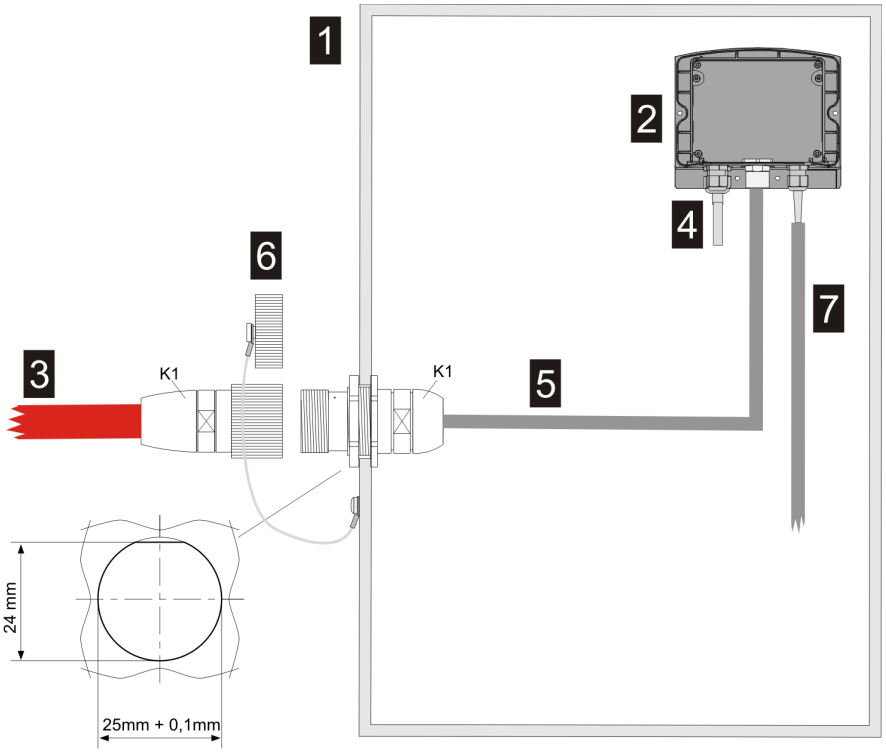

Fig.12-10: Connection box KeTop CB211 in control cabinet

1 ... Control cabinat (max. 5 mm wall thickness)	2 ... Connection Box
3 ... Connection cable to KeTop	4 ... Power supply, emergency stop, enabling control device
5 ... KeTop IC220 or KeTop IC224	6 ... Dust protection cap
7 ... Data line	

12.4.7 Minimum Bending Radius of Cable

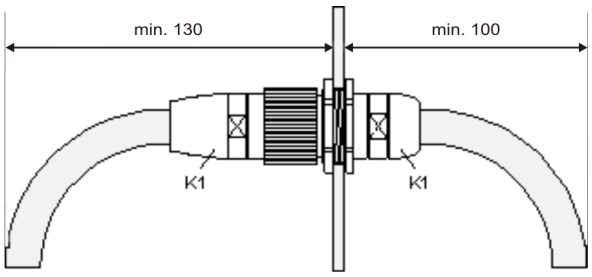

Fig.12-11: Required minimum distance outside and inside the control cabinet

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12.4.8 Accessories

Accessories	Usable for	Description
Intermediate cable	KeTop IC220 (2 m) KeTop IC240 (4 m)	Connection box to connection cable
DIN Rail Holder Mounting Set	KeTop DR100	For mounting on the rearside of a KeTop CB2xx connection box.
Strapping plug	KeTop BC001	Serves for bridging the emergency stop circuits if the KeTop is unplugged.

12.4.9 Technical Data of Connection Box KeTop CB211

General data

Rated supply voltage:	24 V DC (rated voltage tolerance 19.2 V DC to 30 V DC according to EN 61131-2)
Maximum interruption time of supply voltage:	≤ 10 ms (following EN 61131)
Power consumption:	10.8 W (600 mA at 18 V DC, 450 mA at 24 V DC)
Inrush current:	max. 5.6 A (with limitation of current)
Safety class:	III in accordance with EN 61131-2 and EN 50178
Protection degree:	IP65

Environmental conditions

Operating temperature:	0 °C to 50 °C (32 °F to 122 °F)
Storage temperature:	-20 °C to +70 °C (-4 °F to 158 °F)
Relative humidity (non-condensing):	5 % to 95 %
Vibration resistance (operation):	(IEC 60068-2-6)
	5 Hz ≤ f < 9 Hz with 7 mm (0.276 in)
	9 Hz ≤ f < 150 Hz with 2 g (0.0044 pound)
Shock resistance (operation):	15 g (0.033 pound) / 11 ms (IEC 60068-2-27)

Mechanical properties

Construction:	ABS housing, withstands grease, oil, lubricants, alcohol, etc.
Flammability class:	UL94-V0
Dimensions:	
• Width:	160 mm
• Height:	140 mm
• Depth:	70 mm
Weight:	500 g

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13 EC directives and standards

13.1 EC directives

2006/42/EC	Directive for the safety of machinery with the application MD 2006/42/EC
2004/108/EC	EMC directive
2011/65/EC	RoHS directive

13.2 Standards

For examination of the conformity of the KeTop regarding the directives the following legally not bounded european standards has been used:

Examination of the conformity regarding the directive of machinery

EN ISO 13850:2008	Safety of machinery - emergency stop equipment, functional aspects, principles for design
EN 60204-1:2006 chap. 9 and 10	Safety of machinery - Electrical equipment of machines, general requirements

Examination of the conformity regarding the directive of EMC

EN 61131-2:2007 chap. 8, 9 and 10	Programmable Controllers, Part 2: Equipment requirements and test

Other standards

For the design of the safety concept some parts of the following legally not bounded european standards has been used.

General procedure and safety principles

EN ISO 12100:2010	Safety of machinery - Basic concepts - risk evaluation and risk abatement

Enabling control device

EN 60204-1:2006	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN ISO 10218-1:2011	Manipulating Industrial Robots - Safety requirements - Part 1: Robots
EN 60947-5-8:2006	Low-voltage switchgear and controlgear - Part 5-8: Control circuit devices and switching elements - Three-position enabling switches
EN 60947-1:2007	Low-voltage switchgear and controlgear - Part 1: General rules
EN 60947-5-1:2004	Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices

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Stop switch and emergency stop switch

EN ISO 13850:2008	Safety of machinery; emergency stop equipment, functional aspects; principles for design
EN 60204-1:2006 chap. 9 and 10	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

Ergonomics

EN 614-1:2006	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles
EN 614-2:2000	Interaction of the design of machines and the work task
EN 894-3:2008	Safety of machinery – Ergonomics requirements for the design of displays and control actuators – Part 3: Control actuators

Stability and impermeability of casing

EN 60529:1991	Protection degree of casing
EN 61131-2:2007 chap. 12	Programmable controllers - Part 2: Equipment requirements and tests

Electrical safeness and fire protection

EN 61131-2:2007 chap. 11	Programmable controllers - Part 2: Equipment requirements and tests
EN 50178:1997	Electronic equipment for use in power installations

Environmental Conditions

EN 61131-2:2007 chap. 4	Programmable controllers - Part 2: Equipment requirements and tests
EN 50178:1997	Electronic equipment for use in power installations

For the US market these standards had been used furthermore:

UL examination for industrial control equipment

UL 508	Industrial Control Equipment (NRAQ, NRAQ7)

UL examination for robotic applications

UL 1740	Industrial Robots and Robotic Equipment E216950 (TETZ2, TETZ8)

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14 Declaration of conformity

EC Declaration of Conformity

KEBA AG

Gewerbepark Urfahr

4041 Linz

AUSTRIA

We declare that the following product(s) is/are in conformity with the essential requirements of the following European Council Directive(s).

Conformity to the directive(s) is/are assured by the compliance with the applicable parts of the described harmonized european standards.

Product group	Product	RL 2004/108/EC	EN 61131-2:2007	RL 2006/42/EC	EN ISO 13850:2008	EN 60204-1:2006	EN ISO 13849-1:2008	RL 2011/65/EU	IFA [2]	SIBE Schweiz [3]
Teach pendants	T20x/C20x	X	X	X	X	X		X		
	C35E	X	X	X	X	X	X	X		X
	C41x	X	X	X	X	X	X	X		X
	T50x/C50x	X	X	X	X	X	X	X		X
	T55x/C55x	X	X	X	X	X	X	X	X	
	C70 COM	X	X	X	X	X	X			X
	T70x/C70x	X	X	X	X	X				
	C70 STB	X	X	X	X	X				
	T100x	X	X	X	X	X	X			X
	C100x	X	X	X	X	X	X			X

x ... variant suffix

[1] ... only for variants with enabeling device evaluation electronics

[2] ... IFA (Institute für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung – DGUV) – type examination (MD 2006/42/EC)

[3] … SIBE Schweiz (NSBIV AG) – type examination (MD 2006/42/EC)

Important notes:

This document is only an overview and not the original declaration of conformity. The original declarations of conformity can be requested from KEBA.

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Any modification on the product(s), that is performed without KEBA's consent will render this declaration invalid. The safety instructions contained in the documentation supplied with the product(s) must implicitly be followed!

The emergency stop switch respectively stop switch and enabling control devices are part of the safety control circuits of a machine. Therefore the fundamental safety requirements in accordance with Appendix 1 of the Directive for machines can only be met with all safety control circuits.

Authorised person to compile the technical file is Wolfgang Mahr, Keba AG, Gewerbepark Urfahr, A-4041 Linz.

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15 Appendix: Machinery Safety

Guidelines of the European Union

An essential goal of the European Union is the realization of a single European market and thus free trade. This means that quantitative import limitations of goods between the member states are prohibited.

Goods that endanger the safety of persons or the environment are an exemption. Member states can prohibit such products on their country's territory. To ensure free trade for these products, the national safety regulations of the member states are standardized via guidelines set forth by the European Union.

These guidelines apply for a number of product classes, such as for example machines, medical products, as well as toys. However, corresponding guidelines were also developed for additional common safety aspects of products, such as protection against electricity, explosion protection or electro-magnetic compatibility. The guidelines are directed towards member states, who must implement them into the respective national laws. The guidelines therefore have legally binding effects.

With the CE label the manufacturer certifies to have met all obligations of the EC guidelines applicable for the product. The CE symbol, which is affixed to the products by the manufacturer himself, is the "passport" within the EU and intended for the overseeing authorities.

In addition, independent, accredited certification organizations can verify the conformity with the EU guidelines and confirm this with a EU design sample certification.

Both the Electromagnetic Compatibility Directive (EMC 2004/108/EC) and the Machinery Directive (MD 2006/42/EC) are applicable to the handheld terminals.

Machinery Safety

Additional measures must be taken wherever faults arising in the machinery may cause personal injury or significant material damage. These measures must also guarantee a safe operating condition for the whole system in the event of a fault. According to the Machinery Directive (MD) a machine is considered to be "a totality of components or appliances linked together, of which at least one can move". The directive also implies, that " Machinery must be designed and constructed so that it can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen".

Although the handheld terminal is not, strictly speaking, a machine, it does, however, perform important tasks to guarantee the safety functions of a machinery to which it is attached.

The handheld unit has, for example, the “Emergency Stop" safety function and an enabling control device for use in special operating modes. It is, as a result, a “Safety Component" in the sense of the Machinery Directive.

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Safety components, or parts whose failure or faulty operation put the safety of people within the hazard area of the machine in danger, fall expressly within the range of application of the Machinery Directive.

The fundamental requirements that the Machinery Directive places on the manufacturer are as follows:

- To carry out a hazard and risk analysis
- To comply with the integration of safety principles
- To compile and keep a technical construction file
- To provide solutions in accordance with the latest state of the art
- To recognise conformity by means of harmonised Standards
- To apply CE marking

The same basic requirements apply to safety components. In their particular case, it must be proven that failure or malfunction are not possible, or that malfunction does not lead to a hazardous situation.

15.1 "Hazard and Risk Analysis"

The manufacturer of a machine is required to analyse its machine throughout its operating life and in all modes of operation, and to document all hazards that may possibly arise. This has to be done without taking into account possible protection devices.

The next step is to formulate a goal for protection against each identified hazard and subsequently to define one or more protective measures to achieve the protection goal.

Further details about the procedure for carrying out the hazard and risk analysis and lists of commonly occurring hazards can be found in the following Standards:

- EN 12100-1 and EN 12100-2 "Safety for machinery - Basic concepts, general principles for design"
- EN 14121-1 "Safety of machinery - Risk assessment"

15.2 "Principles for the Integration of Safety"

In Appendix I, Chapter 1.1.2 of the Machinery Directive 2006/42/EC there is a clear procedure and sequence for the selection of protective measures:

Eliminating or minimising the hazards

This takes place at the design stage of the machine. These measures include, for example:

- A reduction in the use of energy (power, revolutions, voltages etc.) as far as this is possible
- The avoidance of unnecessary sharp points or edges

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- The avoidance of human errors by means of the ergonomic and logical design of operating devices
- The avoidance of hazardous materials and commodities

Taking protective measures against hazards that cannot be eliminated

These measures include, for example:

- Guards, railings, housings
- Protective devices (light barrier for hazard elimination)
- Protective control equipment (enabling control devices, two-hand controls, speed monitoring etc.)

User information about residual hazards

This last of the three options is used if residual hazards remain after the first two options have been applied. These measures include, for example:

- Warning notices
- Training and organisational measures
- The use of personal protective equipment

15.3 "Technical Construction File"

The technical construction file contains all the documents that are required to prove the safety of the machinery / safety component. These are, for example:

- A complete drawing of the machinery or safety component including control circuit diagrams
- Hazard and risk analysis
- Calculations
- Research and test results
- A list of the basic safety requirements of the Machinery Directive applicable to the machine and a description of the solutions
- Applied Standards
- Operating instructions
- A list of the quality assurance measures in the procedure

The technical construction file must be retained for a minimum of 10 years after the supply of the last product, and must be presented within a period of a few days in the event of a claim for damages.

15.4 "State of the Art"

This means technical possibilities at a certain point of time that are based on certain scientific and technical knowledge. The state of the art also means something that is commercially viable, that is it can be realised by the majority in the industrial sector concerned.

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The state of the art is defined as the state of development of advanced procedures, equipment or operating methods, that makes the practical applicability of the measure appear assured overall in respect of the targeted goals (e.g. the goals of protection of work, protection of the environment, safety of third parties and operating efficiency: namely to achieve a generally high level overall in relation to the aspects under consideration).

The state of the art can develop further irrespective of the Standards.

15.5 "Recognition of Conformity by means of Harmonised Standards"

The European Directives mainly contain general requirements for the safety of products; however they do not contain details of how to carry them out.

The European Standards Institutes are responsible for this. They provide implementation proposals for real safety problems or specific product classes. Standards that are assumed to meet and correctly interpret the requirements of the Directives are known as “Harmonised Standards”. Most of the available Standards, however, are not harmonised.

By applying and implementing harmonised Standards, a manufacturer can claim conformity for the respective product. However, the Standards, in contrast to the Directives, are not legally binding. This means that the manufacturer may also take into consideration other solutions that are not described in the Standards; but these solutions must attain at least the same safety level as the relevant Standards and satisfy the requirements of the appropriate Directives.

15.6 Selection of Performance Level and Safety Categories in accordance with EN ISO 13849-1

The Machinery Directive demands that a fault in control circuit logic, or interference or damage thereto, shall not lead to a hazardous situation.

This general approach is substantiated in EN ISO 13849-1 "Safety of machinery - Safety related parts of control systems", which defines Performance Levels (PL a to e) for control parts that are relevant to safety. The PL depends on the safety category, the $MTTF_d$-value and the degree of coverage of diagnosis (DC_{avg}) of the corresponding safety circuit.

As in the preceding standard EN 954-1, the safety category describes the structure of the safety function. The Performance Level (PL), which describes the conditional probability of failure and the defect discernability of the safety function, has been added.

The selection of the PL has to be done by the manufacturer of a machine depending on the real risk potential. The risk potential will be be determined from a hazard and risk analysis. In case of hazards that can cause irrevisible injury or death usually a Performance Level not less than PL d is required.

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The category of the Performance Level determines if

- the system has been built in single circuit technology, which means that a failure will lead to a loss of safety, although the availability of components and parts is high (category 1)
- the system has been built in single circuit technology, which means that a failure will lead to a loss of safety, but the failure will be detected by the system and will be displayed somehow or other (category 2)
- the system has been built in multiple (2) circuit technology and that a fault will not lead to loss of safety (category 3) or
- the system has been built in multiple (2) circuit technology and a build up of multiple faults will not lead to loss of safety (category 4).

Starting from category 3 it is also important in this context that individual faults are detected in time to avoid a build up of faults, which may finally lead to loss of safety.

Faults that have to be detected in electric and electronic systems are for example short circuits between multiple circuits, interrupts, short circuits or contacts that are stuck together. Special certified safety control devices are often used to detect faults in the individual safety circuits, which have a certain PL. The PL quoted for these devices is only attained, however, if also the whole machine circuit under review lies within the scope of the respective PL and the PL of all components supporting the safety functions has to be considered. The PL must always be considered in relation to a complete safety function and not as applied to individual components or parts.

A guide for easily calculating the PL for a safety function consisting of several individual components can be found in standard EN ISO 13849-1 chapter 6.3 and appendix H and I.

If safety components are being connected in series, the individual component with the least PL determines the PL of the whole safety function. For example a safety function consisting of 3 components, one with category 4 PL e, another one with category 3 PL d and a third component with category 2 PL c will have a PL c for the whole safety function. This means that a fault will lead to loss of safety, although components with category 4 PL e are integrated into the safety function, as one of the components being used has category 2.

When chaining several PLs the overall PL can decrease. For more information read EN 13849-1 chapter 6.3.

The proof of attainment of a safety category can take place with the aid of an FMEA (Failure Mode and Effects Analysis), in which all the faults that could possibly arise are simulated, either theoretically or in practice, and it is demonstrated that the requirements of the category are fulfilled.

15.7 Application of Handheld Terminals in Special Operating Modes

For the manual control of machines in special operating modes, where safety depends on the timely reaction of the operating staff, it is absolutely essential

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that the operator can overlook the operating area. The handheld terminal has the advantage that the operator can get very close to the control panel. At the same time, the danger of misuse increases with mobility since, in remote locations where it is not possible to observe the operating area, machine movements can also be set in motion with the handheld terminal, knowingly or unknowingly. The machine operator, therefore, has to find the right compromise between necessary flexibility and a reasonable limitation of the working range when selecting the corresponding cable length for the handheld terminal's. It is not possible for the working range of radio-operated handheld terminal's to be limited by means of the cable; therefore additional technical solutions are required for these handheld terminal's.

If the machine or equipment is operated with the handheld terminal, care must be taken at this time to ensure that operation can only be controlled by the handheld terminal and cannot be operated from any other point on the equipment. The hazard zone may only be entered by the person who is operating the handheld terminal. If it should be necessary for more than one person to work in the hazard zone at the same time, each person present requires an enabling control device and machinery movement may only be allowed after all the enabling control devices have been activated.

15.8 Information about the Emergency Stop Button

In theory, a perfectly designed machine should not require an emergency stop button, since the Machinery Directive demands that a machine must be safe throughout its lifetime and in all operating modes.

In practice, however, one is aware that unforeseen situations arise, in spite of all precautions. In order to enable fast shutdown of the machine in these cases, or to avert danger, an emergency stop button is provided on most machines.

As can be seen from the following illustration, a machine is permanently in the hazard state from the viewpoint of the emergency stop button, for as long as this is not activated.

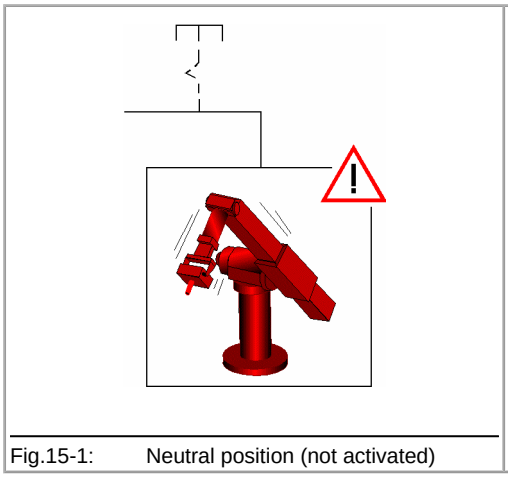

Fig.15-1: Neutral position (not activated)

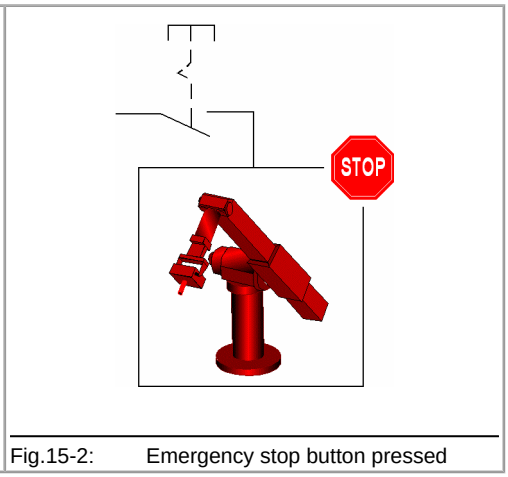

Fig.15-2: Emergency stop button pressed

Tab.15-3: Emergency stop button functions

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The emergency stop button may not, therefore, serve as the primary safety device but is provided exclusively to cover any residual risks.

Instead of this and depending on the mode of operation, other methods should be employed as the primary safety device, for example guards, light barriers and two-hand control devices or enabling control devices.

When the emergency stop button is activated, the entire machine or all of the machines that are switched together in a plant must be lead to a safe state e.g. by stopping and switching off the power to the endangering drive mechanisms (stop categories 0 or 1 in accordance with EN 60204-1).

The release of the emergency stop button must not cause any uncontrolled restart of the machine.

Irrespective of whether a handheld terminal has an emergency stop button or not, permanently installed, universally identifiable and easily accessible emergency stop buttons must be provided at selected points around the machine in every case.

15.9 Application of Emergency Stop Button and Stop Button on the Handheld Terminal

The Machinery Directive does not specify any detailed requirements in respect to the colouring of the operating elements for emergency stop. The requirement states: “The device must have clearly identifiable, clearly visible and quickly accessible controls“.

Emergency stop buttons are usually identified by red/yellow. The specific design should have a signalling function whose effect is that any person, and especially untrained people, can quickly recognise the control as the device to eliminate a hazard in the case of an emergency.

One imperative requirement for equipment identified in this way is, therefore, that it must be possible to trigger a safe state at any time and in any operating mode, without further knowledge of the machine (see also EN ISO 13850).

It is not acceptable for an emergency stop button to be enabled temporarily, since this can lead to faulty operation and life threatening loss of time in panic situations.

If one considers handheld terminals in relation to these requirements it is evident that a differentiation must be made as to whether an emergency stop button on the handheld terminal may be used or not, depending on specific criteria and applications.

Permanently installed handheld terminals: Emergency stop button

Permanently installed handheld terminals are provided with a cable by means of which the handheld terminal is connected to the designated machine. The handheld terminal is usually connected to or disconnected from the machine with the machine switched off. This takes place during the installation or de-

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installation process. The handheld terminal's are not designed to be connected or disconnected whilst the machine is operating.

On many simple machines the handheld terminal is also the only operating option, so that, without the handheld terminal, the machine cannot be put into operation at all. Nonetheless, if the connector is unplugged from the machine during operation the emergency stop circuit is broken and the emergency stop function of the machine is activated, causing the machine to stop.

If a handheld terminal is uninstalled from a machine and is not reinstalled immediately, the equipment must be locked out in order to avoid confusion with a functioning handheld terminal. The machine can only be put back into operation again after a new handheld terminal has been installed.

This procedure must be described in the operating instructions for the machine and is the responsibility of the operator.

Due to the fact that plugging and unplugging takes place only rarely and that the machine is out of operation when unplugged, the risk of an accident as the result of a non-operational emergency stop button is considered to be very low and the use of red/yellow identification is therefore permissible.

The red/yellow emergency stop button must be connected into the emergency stop circuit of the machine in any case and must cause the power supply to the machine or set of machines in a plant to be switched off (stop category 0 or 1 in accordance with EN 60204-1).

Radio controlled handheld terminals: Stop button

Wireless handheld terminal's present a different case. These devices are not normally assigned to a specific machine but can be frequently logged on and off whilst the machine is in operation and can also be switched between different machines. For this reason the stop button is not always operational and the operating status is not clear to everyone.

Therefore, for stop functions in wireless controllers, EN 60204-1:2006 "Safety of Machinery. Electrical Equipment of Machines" (Chapter 9.2.7.3), demands:

"The operating means to initiate this stop function shall not be marked or labelled as an emergency stop device, even though the stop function initiated on the machine can be an emergency stop function."

For this reason, for radio controlled handheld terminal's KEBA uses a stop button that features all the mechanical characteristics of a normal emergency stop button but is of a neutral grey colour.

In contrast to the red/yellow emergency stop button there is no need to switch the stop output signals of the radio receiver into the machine's normal emergency stop circuit. It can also be used to stop individual safety zones of a machine or plant, where functions such as "Safe operational stop" can be triggered. This means that the drive components are safely maintained in controlled shutdown by means of active, powered drives (stop category 2 in accordance with EN 60204-1). This can prevent the loss of reference data and facilitates fast restart of the machines.

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The trained handheld terminal or machine operator is aware of the function assigned to the button and knows the current operating mode in each case as well as the current assignment of the machine. For this reason the colouring is not disadvantageous to the machine operator.

The safety gain is that, in the case of inactive or unassigned equipment, no danger of confusion is presented to third parties in respect of functional emergency stop buttons.

Temporary plug-in handheld terminals: Stop button

Some cabled equipment is provided with a quick-release connector (e.g. bayonet) that makes it possible to plug in and unplug the handheld terminal quickly and ergonomically whilst the machine is in operation. Such handheld terminal's are provided for frequent alternation of operation between one or more machines and are needed there on a temporary basis, for commissioning or setting up purposes.

By means of several measures, such as bridging connectors or relay circuits, the emergency stop circuits of the machine are bridged when the handheld terminal is unplugged so that the machine can also continue to run in normal operation without the handheld terminal. Start-up and operation of the machine can then take place using an independent operating device.

These handheld terminals share the same problems as the radio terminals, since due to frequent plugging and unplugging it cannot be ruled out that disconnected handheld terminal's with ineffective stop buttons may be left lying or hanging temporarily in a machine shop or factory in the neighbourhood of working machines and may be mistaken for functional units in an emergency situation.

This special case is not clearly treated in the corresponding Standards. However, in the Product Standards for presses (EN 692:2004, EN 693:2001, EN 12622:2001, EN 13736:2003) one finds the following clear statement:

"Any disconnectable control station shall not incorporate an emergency stop button if the press can be operated while this controls station is disconnected."

Further Product Standards are currently under review.

In several discussions with external notified bodies and technical committees it was also determined that temporary, plug-in handheld terminals should be treated as radio handheld terminal's.

The approach to constructively eliminate hazards by using clear colour coding, in preference to any organisational measures, also corresponds to the "Principles for the Integration of Safety" of the Machinery Directive and is therefore legally binding.

For this reason, temporary plug-in handheld terminals may likewise only be equipped with a grey stop button.

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Since handheld terminals made by several other manufacturers are on the market with a grey stop button and have been certified by nominated test centres, the state of the art requirement is also met.

15.10 Information about enabling control devices

Many machines have both a normal and special operating modes.

The machine fulfils its primary mission in normal (automatic) operation. In this mode of operation, safety is guaranteed by closed, guards and/or with protective devices.

A machine's special operating modes serve to maintain normal operation. In doing so, safety must be guaranteed in a way that is different to normal operation, since hazardous areas of the machine can now be entered and targeted machine movements have to be possible. The enabling control device plays a primary role here.

This application requires the enabling control device to eliminate the hazards that are to be controlled in a timely manner, before any personal injury occurs. Additional safety measures may be necessary for this purpose, such as safely reducing the speed of drive mechanisms.

In contrast to the emergency stop button respectively the stop button, a machine in special operating mode with an enabling button is in a safe state as long as this enabling button is not activated (see illustration).

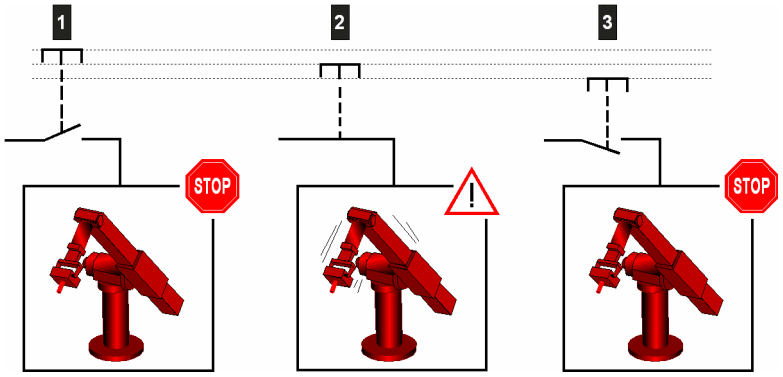

Fig.15-4: Enabling functions

1 ... "Neutral position" not activated	2 ... "Enabling" pressed
3 ... "Panic" pressed heavily	

The enabling function is also described in EN 60204-1:2006 and corresponds to the state of the art.

The panic position on 3 stage enabling control devices was introduced because limbs often become cramped when a person is in a state of shock and

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as a result is not able to release the enabling control device. For this reason, firmly pushing down on the enabling control device also leads to switch off.

The controller must be designed in such a way that machine movement is not initiated directly when the enabling control device is activated but only as a result of the additional activation of a control button. This may be via the handheld terminal's membrane keyboard or graphical software buttons on the touch screen.

An optionally available joystick can also be used to trigger the machine movement signal.

According to EN 60204, only stop categories 0 or 1 are allowed for the enabling function, i.e. stopping the machine with the enabling control device must always be combined with switching off the power supply to the drive mechanisms.

In order to prevent incorrect, permanent activation of the enabling control device by mechanical fixing devices, it is recommended to limit the maximum duration of an accepted enablement. This must be achieved by means of a controller located downstream to the handheld terminal.

An enabling control device is not a replacement for a two-hand control device, which is specified for some machines (e.g. presses) and must therefore not be confused.

In contrast to the enabling control device, the two-hand control device forces the endangered limbs of the operator into a safe position whilst the machine is in motion.

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16 Appendix: Electromagnetic Compatibility

The European Union obligates its member states to harmonise their statutory provisions in respect of electromagnetic compatibility by means of Directive 2004/108/EC. In the following text this Directive is abbreviated to the EMC Directive.

All electrical and electronic device that is put into circulation in Europe must, therefore, conform to the fundamental safety requirements of the EMC Directive. According to this Directive, electromagnetic compatibility is the ability of a device, plant or system to work satisfactorily in the electromagnetic environment, without itself causing electromagnetic interference that would be unacceptable to all devices, plant and systems present in this environment.

In addition to the legal requirements described above, the reliable functioning of an electrical device is also a fundamental quality characteristic of such a device.

As well as basic information concerning electromagnetic compatibility, the following pages describe the implementation of the EMC requirements in respect of the KeTop product range of handheld terminal devices.

16.1 The electromagnetic environment – interference sources, interference sinks and coupling paths

There are a number of artificial and also natural sources of interference in the electromagnetic environment that can affect electrical and electronic device.

The most well-known natural interference phenomenon is atmospheric discharge (lightning discharge).

Artificial sources of interference are, on the one hand, intentional, such as mobile radio, amateur radio, TV and radio transmitters, and, on the other hand, unintentional, such as microwave ovens, arc welding, ignition systems, high voltage device, electric motors, electronic device and also electrostatic discharge.

Atmospheric discharge (lightning)

Atmospheric discharge can take place directly or indirectly on power and communication lines. The consequence of such an impact if there is insufficient protection is the destruction of the electrical device.

Atmospheric discharge is simulated in accordance with the international test standard IEC 61000-4-5 (EN 61000-4-5 for Europe) – "Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test".

The relevant international product standard for control systems, IEC61131-2 (EN61131-2 for Europe), divides the areas of application into zones. Higher or lower levels of interference can be expected depending on the zone in question. All Kemro control systems and also the products of the KeTop range are suitable for application in Zone B.

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The product standard requires the testing of surge immunity in accordance with IEC 61000-4-5.

Electrostatic discharge (ESD)

Materials can be charged by contact followed by subsequent separation. This effect only arises when at least one of the two materials is a non-conductor. As a result, discharge may take place if a charged conductor, or one that is changed by the influence of an electronic field, comes near a metallic object.

After charging, the possible voltages between the charged bodies can reach over 10 kV.

The most frequent occurrence of electrostatic discharge takes place between people and metallic objects. Since one is practically unnoticed of discharges below 3500 V and yet electronic components are destroyed by low voltages, ESD damage to electronic components often goes unnoticed.

The international Standard IEC 61000-4-2 (EN 61000-4-2 for Europe) is used to simulate the measurement of electrostatic discharge. The international product standard IEC 61131-2 (EN 61131-2 in Europe) for programmable controls demands testing to IEC 61000-4-2 and also defines the severity level.

Technical systems as interference sources

Technical systems can act as sources of interference. In doing so, the interference may be intentional or unintentional. Electromechanical energy is often also used for material processing.

Periodically occurring interference:

- Ignition impulses of combustion engines
- Sparking of commutator motors
- Electromagnetic fields of induction furnaces, arc welding device, microwave device etc.
- Pulse currents from frequency converters and switching power supplies
- Electromagnetic fields of radio and telecommunications device

Randomly occurring interference:

- Ignition impulses of fluorescent lamps
- Switching procedures on inductive electrical circuits
- Contact bounces when closing or opening make-and-break contacts
- Voltage fluctuations on heavy load switching procedures

There is a series of test standards for the above listed sources of interference, intentionally or unintentionally caused by technical systems, which simulate this interference:

- IEC 61000-4-3 High Frequency Electromagnetic Field Immunity Test
- IEC 61000-4-4 Electrical Fast Transient / Burst Immunity Test

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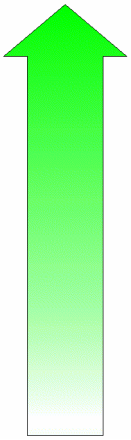
- IEC 61000-4-6 Test of Immunity to Conducted Disturbances, Induced by High Frequency Fields
- IEC 61000-4-8 Power Frequency Magnetic Field Immunity Test
- IEC 61000-4-11 Voltage Dips, Short Interruptions and Voltage Variations Immunity Test

All the international Standards listed here are also available as European Standards. The Product Standard IEC 61131-2 demands testing to these Standards and also defines the severity level.

Technical systems as interference sinks

In the case of functional interference, EMC problems first arise at interference sinks. The following interference sinks can be identified dependent on the degree of immunity to electromagnetic influences:

Immunity		Interference sinks
max		Transformers
		Circuit breakers, contactors
		Relays
		Power transistors
min		Transistor circuits
		Integrated switching circuits

Tab.16-1: Examples for technical systems as interference sinks

Control systems without integrated switching circuits are unthinkable and would therefore not be sufficiently immune without suitable EMC measures.

Coupling paths

The transfer of interference signals from an interference source to an interference sink can take place via various coupling paths.

Coupling paths very often consist of two or more parallel lines running closely together. The coupling is a field coupling that takes place at low frequencies either via the electrical field (capacitive coupling) or via the magnetic field (inductive coupling).

At high frequencies and with corresponding expansion of the parallel running lines one speaks about an electromagnetic coupling due to close linking of both field types.

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Direct coupling can occur when electrical circuits from the interference source and electrical circuits from the interference sink have common line components.

If there is a large distance between an interference source and an interference sink then one speaks of a radiation coupling.

16.2 EMC measures on KeTop

The KeTop is designed for industrial applications. Considerable electromagnetic and electrostatic interference can occur in this environment. For this reason special emphasis was placed on interference immunity and data security in the design of the device. The EMC design implemented and described below considers all the above named sources of interference and the possible coupling paths.

- All shielding and filter measures (filtered power supply) in the KeTop are carried out directly on the printed circuit board.
- The special design of the KeTop cable guarantees interference immunity even for greater connection lengths, i.e. the data lines (communication signals) are shielded and so they are separated from the control lines (power supply, enabling button, emergency off, key-operated switch etc.) inside the KeTop cable.
- Power supply lines in the control cabinet are usually unshielded. They are therefore laid outside the KeTop cable shield in order to prevent a coupling with the sensitive data lines.
- The unshielded control and power supply lines are either filtered on entry into the shielded housing of the KeTop or separated from the electronics in such a way that any interference signals carried by these lines cannot affect the internal electronics of the KeTop.
- It is not necessary to lay the KeTop cable separately.

Shield connections

The cable shield of the KeTop cable can be considered to be an extension of the KeTop shielded housing (=printed circuit board) to the shielded housing of the communication partner (e.g.: PLC). From this it can be deduced that the shielded connections from the cable shield to the device shields make a fundamental contribution to the interference immunity of the KeTop. It is not necessary to wire shielded connections to earth. The shielding connection in the KeTop is made via the RJ-45 connector in the connection slot. Connecting the KeTop via the connection box (e.g. CB211) guarantees safe shielding protection right through to the communication partner. It is therefore urgently recommended to use a suitable KEBA connection box. All connection cables available from KEBA (KeTop TTxxx, KeTop ICxxx, KeTop XD040 and KeTop CD040) guarantee correct shielding connection.

For self-made cables the following conditions must be met for shielding data lines:

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- On every connector design (DSUB or RJ-45) the cable shield must be connected to as large a surface area of the connector housing as possible.

Fig.16-2: Correct shield connection for DSUB and RJ-45 connectors

1	...	Metallised or metallic housing
2	...	Connect the shield to a large surface area

- The use of pig tails for contacting the cable shield via plug pins is unsuitable. The inductivity of such pig tails represents high impedance resistance for higher frequency interference; this means an apparent break in the cable shield. Interference is then no longer diverted and works directly on the inner lines.

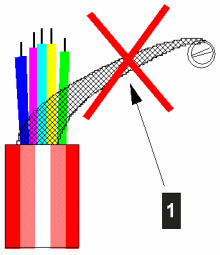

Fig.16-3: Insufficient contacting of a cable shield

1	...	No pig tails

Shielding inside the control cabinet

In many cases a range of interference sources, such as servo drive modules, transformers, contactors and relays, is present in the control cabinet. It is therefore necessary to run the cable shield from the connector housing (control cabinet) to the control (continuous connection from the handheld terminal to the control).

When using the appropriate connection box and a shielded cable for the data line from the connection box to the control, the continuous, high frequency compatible connection of the shield from the KeTop to the control is guaranteed.

If for some reason a connection box cannot be used, the continuous connection of the shielding on less critical interface types such as RS-232-C takes place

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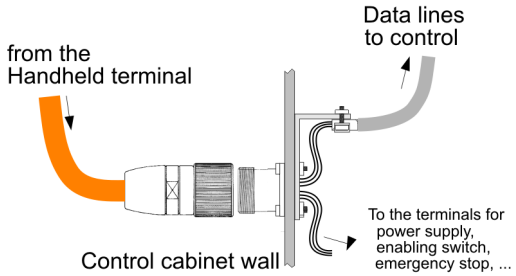
by contacting the connector housing with the control cabinet and inside the control cabinet by contacting the shielding with the control cabinet (using shielding clips). The smaller the distance between the contacting of the connector housing on the control cabinet to the cable clip in the control cabinet, the better the shield damping.



The interference immunity of the device with the connection type presented above is also decisively influenced by the satisfactory separation of the control signals and the data line signals. The better the separation of the two signal types and the shorter the shielding connection, the higher will be the interference immunity of the complete system. If the Ethernet is used as the communications interface (KeTop T100 only) one of the two connection cables provided for the purpose of connecting to a control system must be used (IC020 or IC040). Both cables carry the Ethernet signals to a suitable connector (RJ-45) and thereby produce a continuous shielding connection and also the required characteristic impedance of the cable.

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