

**Kemro**  
**KeTop T10**  
**Project engineering manual V1.02**

**Translation of the original manual**

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# 1 Introduction

## 1.1 Purpose of the document

This document describes the hand-held terminal KeTop T10.

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

### **Information**

*This manual is not addressed 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: <ul style="list-style-type: none"> <li>● the method of operation of a PLC,</li> <li>● safety regulations,</li> <li>● the application.</li> </ul>
Electrician	Specialized training in the electro-technical field (in accordance with industrial training guidelines). Knowledge in: <ul style="list-style-type: none"> <li>● safety regulations,</li> <li>● wiring guidelines,</li> <li>● circuit diagrams,</li> <li>● correct installation of electrical connections.</li> </ul>

Target group	Prerequisite knowledge and ability
Start-up technician	Technical basic education (advanced technical education, engineering degree or corresponding professional experience), Knowledge about: <ul style="list-style-type: none"> <li>• safety regulations,</li> <li>• the method of operation of the machine or system,</li> <li>• fundamental functions of the application,</li> <li>• system analysis and troubleshooting,</li> <li>• the setting options at the operating devices.</li> </ul>
Service technician	Technical basic education (advanced technical education, engineering degree or corresponding professional experience), Knowledge about: <ul style="list-style-type: none"> <li>• the method of operation of a PLC,</li> <li>• safety regulations,</li> <li>• the method of operation of the machine or system,</li> <li>• diagnosis possibilities,</li> <li>• systematic error analysis and troubleshooting</li> </ul>

### 1.3 Intended Use of the Handheld Terminal

The intended use of the KeTop T10 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 safety features.

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 safety functions are realized with two circuits in order to meet the requirements of category 4 PL e in accordance with EN ISO 13849-1 considering the  $B_{10d}$  values of the safety 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 customer variants of the KeTop T10.*

*Because of the fact that customer 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 customer 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

### 1.4.2 Not contained in this document

- Mask description of the application
- Software

## 1.5 Documentation for further reading

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-button and enabling control device (Enabling 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.

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 <sub>10d</sub>	-	Number of cycles until 10% of the components fail dangerously (per channel)
MTTF <sub>d</sub>	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

## 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 accordance 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.

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.



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### 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!

---

### CAUTION

- The KeTop housing must not be opened. Otherwise safety and tightness of the housing can no longer be ensured.
  - 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.
  - If you do not use the device, hang it into the wall bracket provided for storage.
  - 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.
-

## 2.3 Personnel safety instructions



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### 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.
- 



---

### 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. 0,5 A must be used.
- 



---

### WARNING!

- For the right projecting of the Handheld Terminal the manufacturer 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.

## 3 System overview

The following chapters provide a brief overview of the functions, integration and use of the KeTop T10.

### In general

The KeTop T10 is a machine operating device that is intended for jogging robots in an intuitive way with "DirectMove". DirectMove is the name for operating a robot or a machine on the basis of position detection in or parallel to the pointing direction.

Compared to a conventional KeTop the KeTop T10 is equipped with a firmware for calculation the orientation of the device and for communication with the control, since it has a limited graphical interface.

The key benefit of the KeTop T10 is the knowledge about it's own orientation in space. This way the KeTop T10 can be used for selecting desired directions of movements. Similar to show a direction to a human operator using ones finger. Although the KeTop T10 is designed for jogging robots, it can be used for any application, where it is useful to show directions or orientation in space by using the device itself.

An integrated emergency stop and an enabling control switch make it the perfect operating device for any machine requiring save manual operation. The new, intuitive way of operation together with its compact size allows the operator to concentrate on the operated machine instead of paying attention to the operating device.

The display of the KeTop T10 is used to display the status and shows the icons setted by the application on the control. An exception are the error codes or internal icons (e.g. compass for referencing) which are displayed directly by the KeTop T10.

The following chapters offer an overview of the following topics:

- KeTop T10 functions
- Connecting the KeTop T10 to an OEM control
- Using the KeTop T10 for robot jogging

### 3.1 Functions of KeTop T10

In principle the KeTop T10 is a operating device with keyboard, joystick and a small color LCD display for showing operating modes and status. But in addition to that the device has knowledge about its own orientation in space. This information is used by the robot control to handle the robot. The KeTop T10 itself has no built-in logic for robot jogging and no specific information about it. This way it is up to the controller to implement the best way of using the device in a special context.

The display is quite reduced in function: It only allows the selection of predefined icons representing mode and state information. There are several icon sets available which are stored in the KeTop T10 itself.

The KeTop T10 has an Ethernet interface which allows exchanging information with the control. The following information is exchanged between controller and the device:

- state of keyboard and joystick
- current orientation of the device
- current selected icons for display

As a communication protocol KVC (KEBA Virtual Channel) based on UDP/IP designed by KEBA is used. The protocol also implements a transfer of parameters. Parts of the data exchange are handled cyclically like a live check to detect connection errors between KeTop T10 is active.

The communication protocol is integrated into the firmware of the KeTop T10. The firmware also contains all (inertial) sensor evaluation to derive the orientation of the device.. Furthermore a small web server on the device allows basic diagnosis and network settings.

### **Inertial sensor processing**

The KeTop T10 contains a 6D IMU (inertial measurement unit), consisting of 3 accelerometers and 3 gyroscopes, which measure the motion of the device in space. The sensor software contains all necessary sensor processing and state control to provide the robot control with the current orientation of the device and filter undesired vibrations like e.g. from tremor of the hand of the operator.

To get reliable orientation results from the sensors, the sensors have to be calibrated at the beginning of operation. This is done automatically after power-up as soon as the device is in rest position. Due to the inertial sensors the KeTop T10 only can calculate the orientation relative to the starting orientation. Therefore before operation the KeTop T10 has to be put in a defined orientation relative to the robot. The automatically calculated orientation is stored as reference direction via the reference button.

Sensor errors lead to a growing deviation of the orientation in horizontal direction. To keep the quality of the orientation at a high level the KeTop T10 has to be referenced about every 10 minutes. The user can check the accuracy of the current orientation at any time by activating device's own orientation button.

The used gyro sensors (measuring angular speed), have a measurement range of 2000°/s. If this range is exceeded it is necessary to restore the original orientation by re-referencing.

## **3.2 Integration of the KeTop T10 into robot control**

The KeTop T10 is equipped with an Ethernet interface for exchanging I/O data between device and control. The hardware interface is compatible with the

standard devices of the KeTop product line. So KeTop T10 may be used alternating with another KeTop device on one control without hardware change.

### Software structure

KVC is used as a communication protocol for exchanging data between device and control and provides means of:

- I/O data exchange (keyboard, joystick, orientation and display information)
- Connection live check
- Parameterization of KeTop T10

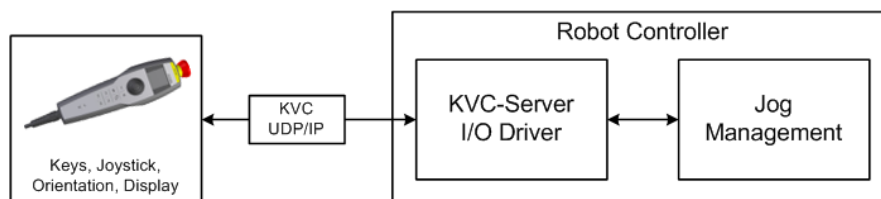


Fig.3-1: KeTop T10 integration; Software structure

For connecting KeTop T10 to a robot control additionally to the required I/O device driver implementing KVC protocol the integration to the jog management has to be using (the jog management evaluates the user interactions with the controls of the KeTop T10 and derives mode, direction and speed for robot jogging).

### KVC Server Development Kit

The KVC SDK (Server Development Kit) supports a quick implementation of the driver software for the control. The KVC SDK contains a reference server implementation for Windows delivered as source code in the programming language C and a KeTop T10 emulation that can be used for testing a KVC driver implementation.

The reference implementation is containing all operating system dependent functions in a module to make porting to different operating systems an easy task. Furthermore the reference server is integrated in a test program. This dialog based application provides all functions of the KVC communication for interactive test.

## 3.3 Using KeTop T10 for jogging a robot

Robot jogging usually is performed using predefined coordinate systems as world coordinates or tool coordinates. Usually the robot is moved in a desired direction by pressing a button or deflecting a joystick.

Using KeTop T10 for jogging a robot is quite similar. But instead of selecting a desired axis with a special button, the axis is shown in space with the device itself (e.g. for selecting the vertical axis the KeTop T10 is held in vertical direction, for jogging horizontal the KeTop T10 is held horizontal, and so on). For

adjusting jog speed and positive or negative direction the joystick is used. So the direction and movement of the thumb always directly corresponds to the robot movement, which is the most intuitive way. The joystick can also be moved toward the operator to make intuitively a movement of the robot towards the operator.

The buttons on the KeTop T10 can be used for selecting different jog modes and coordinate systems. The display can be used for showing selected modes and additional information, such as error status. The following chapter gives a suggestion, how to use a KeTop T10 for jogging a robot.

### 3.3.1 Suggestion for jog functions

As the robot control is in charge of the jog functions, any modifications are possible. The suggested function set is a typical implementation which has proved useful in field tests by KEBA.

The KeTop T10 provides a joystick with a button function which is used for jogging or moving the robot. The jog operation can be switched between Cartesian coordinates and robot joints. Furthermore the KeTop T10 provides a new motion mode for the alignment of the Tool Center Point (TCP) without changing the position, called "virtual handle mode".

#### Jogging in Cartesian space

One of the following Cartesian modes can be chosen:

- Free mode (free movement)
- Coordinate mode - movement of the robot is aligned to coordinates ("snap-to-grid")

In free mode the direction of the KeTop T10 directly gives the direction of movement without aligning to a coordinate system.

In coordinate mode the directions are defined by a selected coordinate system (*world/object/tool*). Also several tool coordinate systems can be defined and selected. The axis of movement is selected by the direction of the KeTop T10 itself and corresponds to the axis of the coordinate system which is closest to the axis defined by the length dimension of the KeTop T10. Coordinate mode can be seen as a kind of "snap-to-grid" variant of the free motion mode.

Advantage of the free mode is that any arbitrary direction of robot motion can be achieved. Coordinate mode is useful for jogging very precisely when fine adjusting robot position.

The joystick is used to control the jog speed and in either translation or rotation. Deflecting the joystick forward and backward activates translation along the selected (= pointed with the device) axis. Deflecting left and right activates rotation around the selected axis. This way position and rotation of the robot can be changed in alternation very easy without any operation mode switching. Thus the movement of the thumb directly corresponds to the produced movement of the robot. A simultaneous translation and rotation is locked by the firmware. Therefore an oblique diagonal deflection of the joystick results in the

activation of the movement (translation/rotation) which is interpreted by the device.

The direction of the KeTop T10 can be changed during active jogging at any time. This results in a continuously changing motion direction in free mode and a direction jumping from one axis of the coordinate system to the next in aligned mode (= integrated tracking functionality).

### **Jogging robot joints**

The keypad is used for toggling jog mode between Cartesian mode and joint mode. In joint mode the joystick is used for jogging the active joint. The active joint can be selected by the keypad (keys "Plus" and "Minus").

### **Virtual handle mode ("grabbing")**

When the joystick is pressed, the Tool Center Point (TCP) follows directly any orientation change of the KeTop T10. This gives the impression of grabbing the TCP directly and changing the orientation manually. So the KeTop T10 serves as a virtual handle of the TCP. The position of the Tool Center Point itself is unchanged. Due to safety standards the rotation speed of the robot is limited in virtual handle mode. When the KeTop T10 is rotated nearly in the allowed speed limit in grab operation, a warning is displayed, and if the speed is too high, the robot movement will be stopped.

All motion functions (translation, rotation, grab) are locked against each another to prevent unexpected behavior of the robot.

## 4 Description of the product

The handheld terminal KeTop is a portable operating and display device with rugged design without an operating system. Using Ethernet, the KeTop is ideal for a great variety of applications.

### 4.1 Front view



Fig.4-1: Front side of the device

<b>1</b> ... Emergency stop switch (twin circuit) or stop switch (option)	<b>2</b> ... TFT display
<b>3</b> ... Joystick	<b>4</b> ... Membrane keypad
<b>5</b> ... Strain relief and bend protection for connection cable	

## 4.2 Rear view



Fig.4-2: Back side of the device

<b>1</b>	... Type plate
<b>2</b>	... Enabling control device

## 4.3 Side view

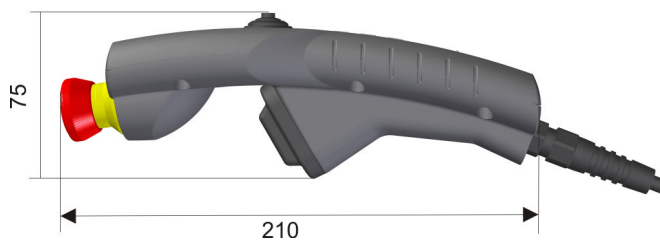


Fig.4-3: Side view of the device

## 4.4 Ergonomic Features

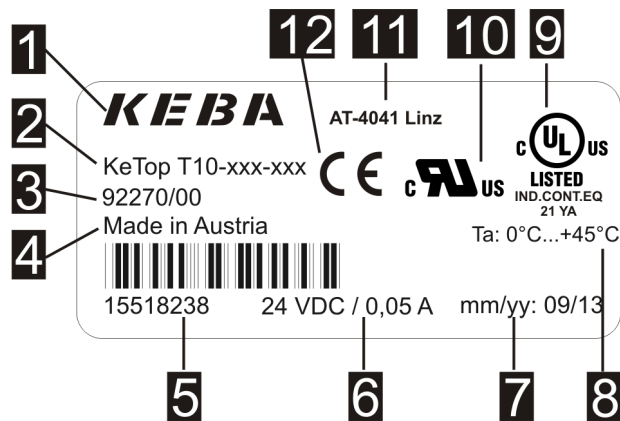
- Operation by right-handed and left-handed people
- Easily readable display

- Operation with one hand possible (low weight, optimal handle situation)

## 4.5 Housing

- Vibration- and shock resistance
- Housing made of non-flammable material (UL 94-V0), impact-resistant, withstands water, cleaning agents (alcohol and tensides), oil, drilling oils, grease and lubricants
- Extremely sturdy housing. Drop-tested on industrial flooring from a height of 1.5 m (59 in).

## 4.6 Type Plate



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

## 5 Display and operating elements

- Membrane keys with mechanical pressure point
- Backlighting LC color display, 1,45", 65,000 colors, 128 x 128 pixels

### 5.1 Membrane keypad

The KeTop T10 is equipped with a membrane keypad with 10 keys, the two bottom keys have predefined functions. For the keypad assignment see "Ke-Top KVC programming manual". The keypad operation is carried out exclusively with the fingers.

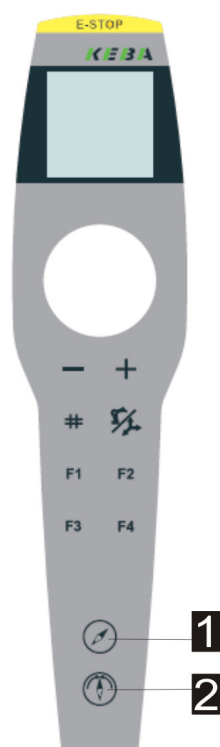


Fig.5-1: Membrane keypad for KeTop T10

By pressing the key ( **1** ) the direction of the KeTop T10 gets controlled and displayed (orientation button).

To re-reference the KeTop T10 it has to be held in the desired direction, then the key ( **2** ) has to be pressed (reference button).

#### 5.1.1 Key assignment

The keys are numbered from left to right and from top to bottom.

0	
1	2

3	4
5	6
7	8
9	
10	

The order corresponds to the position in the bit string and the KVC code, i.e. 0 for the leftmost bit, etc. The joystick button therefore is in the KVC bit pattern on the leftmost and has the KVC code 0.

## 5.2 Joystick

The KeTop is equipped with a 2-axis joystick inclusive joystick button. This is evaluated by the software and can be read via the KVC server.

To avoid that the joystick is damaged when the device falls to ground, a short joystick is used.

- Value range: -128 to +127 per axis (256 increments)

## 5.3 Display

All information is represented by symbols, there is no text. The display contents are generated by the control and only shown on the display. The only exceptions are the error messages that are displayed directly on the KeTop.

The display has a size of 128 x 128 pixels and provides 13 spaces for the symbols:

1	2	3	4
5	0		6
7			8
9	10	11	12

Fig.5-2: Display spaces

Space	Size of the symbols
0	64 x 64
1-12	32 x 32

The firmware of the KeTop T10 contains three sets of symbols with fixed definitions. In the KVC protocol you can programme which symbols are used and how the individual symbols are arranged on the display. The selection of symbols used in the KVC server cannot be changed during operation of the KeTop T10. The symbols defined for the operation and error indications (see [chapter](#)

19 "*Appendix: Icon sets*" on page 78) are preset and cannot be changed or deleted.

## 6 Connection and wiring

### 6.1 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 (0.24mm<sup>2</sup>)
- Material: zinc-coated copper strand
- Line resistance: ≤ 90 Ohm/km (≤ 145 Ohm/mile)

### 6.2 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.



### WARNING!

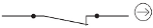
- Not fully functional emergency stop devices may have fatal consequences! Emergency stop switches which are red-yellow marked must be effective under all circumstances in all operating modes of a machine or plant.  
Store handheld terminals with not operational red-yellow emergency stop switches on 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 temporarily 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 buttons 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".

## 6.3 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.

### 6.3.1 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 



**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**

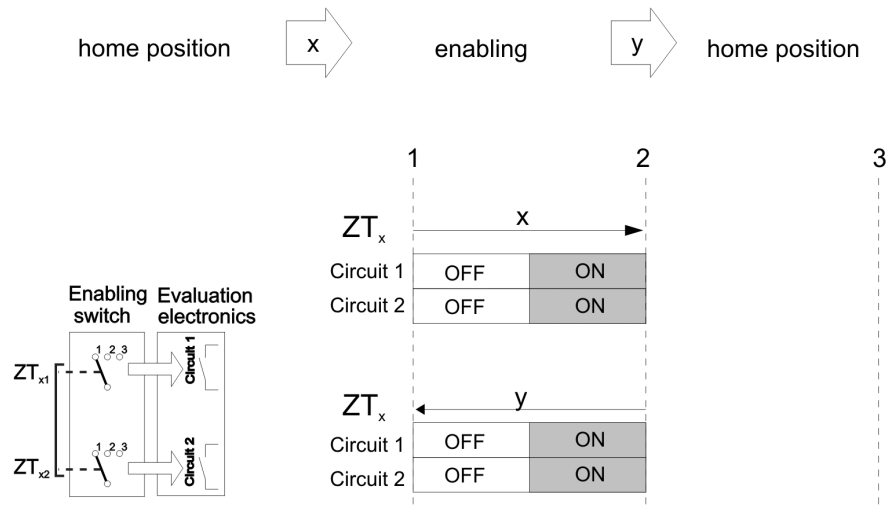


Fig.6-1: Contact travel diagram for enabling

**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.

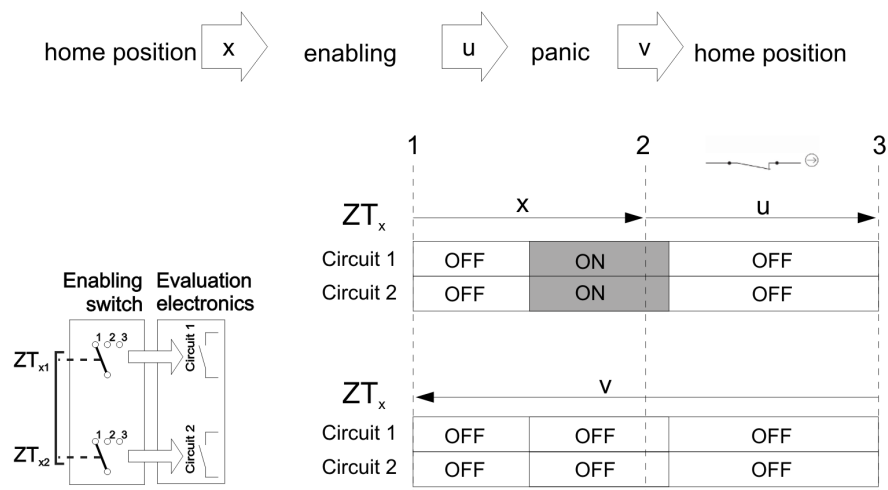


Fig.6-2: Contact travel diagram for panic

**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 must 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 activated) 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 ( $B_{10d}$ -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.

### 6.3.2 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.

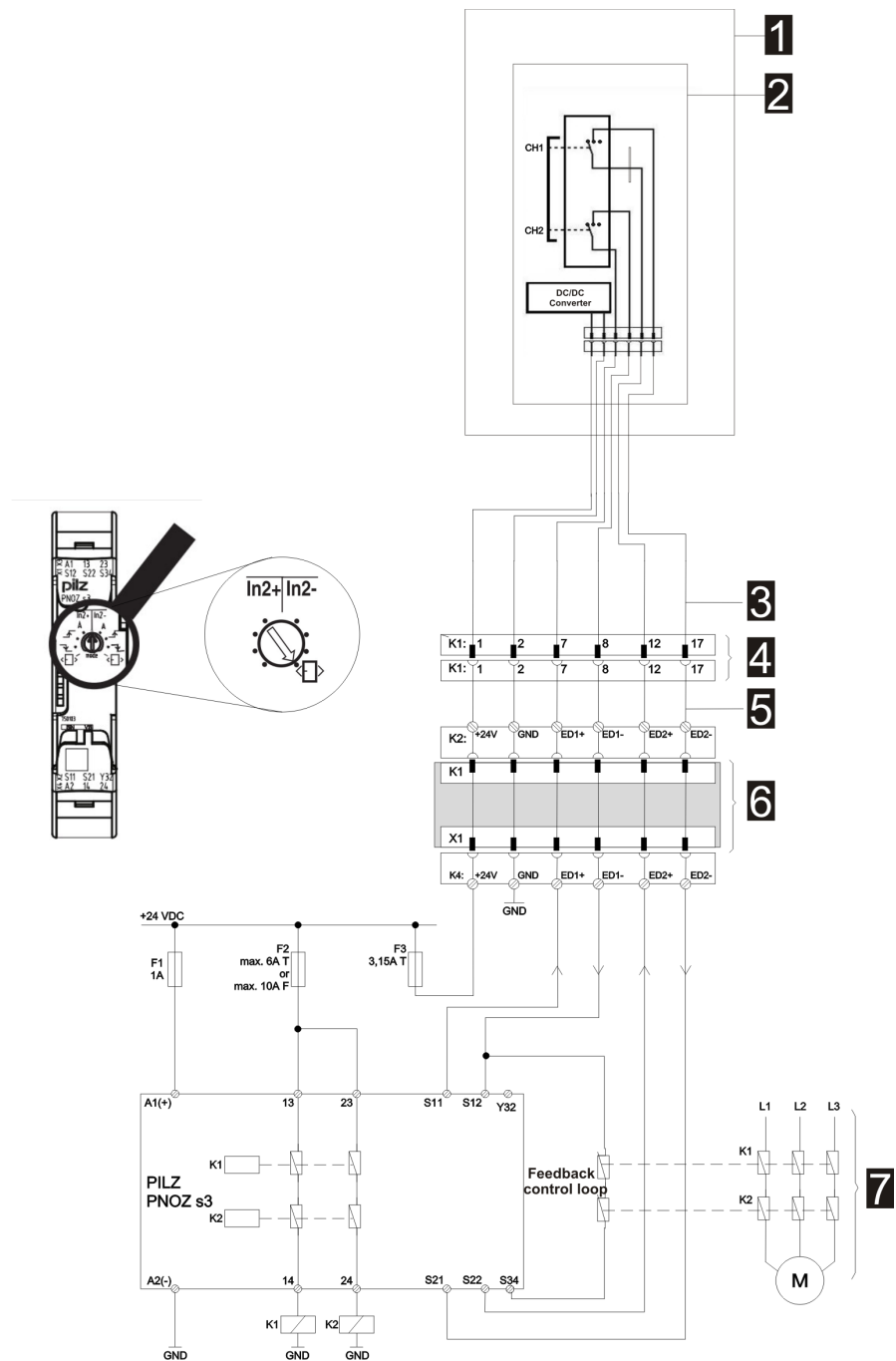


Fig.6-3: Suggested wiring

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

The graphic 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

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

## 6.4 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".**
- 

## 6.5 Ethernet

The standard version of the KeTop is equipped with an Ethernet interface, the signals are transferred by shielded lines in the connection cable.

The following interface parameters are defined and cannot be changed:

- 10 MBit/s
- UDP and TCP/IP protocol

## 6.6 Connector plug

The supply voltage and the signals (emergency stop, Ethernet, KVC signals, ...) of the KeTop T10 are merged in one cable and are plugged via one connector to the control cabinet.

### 6.6.1 Pin assignment

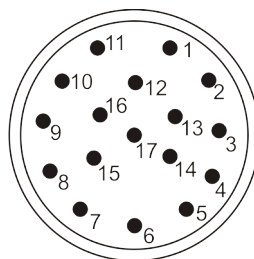


Fig.6-4: Pin assignment connector plug

Pin No.	Signal designation	Description
1	24 V DC	Supply voltage (24 V)
2	GND	Ground
3	E-Stop Circuit 2	Emergency stop (circuit 2)
4	E-Stop Circuit 2 GND	Emergency stop (ground circuit 2)
5	E-Stop Circuit 1	Emergency stop (circuit 1)
6	E-Stop Circuit 1 GND	Emergency stop (ground circuit 1)
7	Enabling Device Circuit 1	Enabling control device (circuit 1)
8	Enabling Device Circuit 1 GND	Enabling control device (ground circuit 1)
9	n.c.	Not connected
10	n.c.	Not connected
11	n.c.	Not connected
12	Enabling Device Circuit 2	Enabling control device (circuit 2)
13	TD+	Ethernet (Transmit +)
14	TD-	Ethernet (Transmit -)
15	RD+	Ethernet (Receive +)
16	RD-	Ethernet (Receive -)
17	Enabling Device Circuit 2 GND	Enabling control device (ground circuit 2)

## 7 Operating behaviour

After being switched on and a short self-test, the KeTop T10 is ready for operation. The device tries to establish a connection to a control system which will be used to exchange data for the keyboard, the joystick, the display and the orientation. Based on the user entries the control system determines the content of the display and the actions of the robot. The device also includes a web server for diagnostics and for the configuration of the network.

### 7.1 Start-up

The start-up of the KeTop begins automatically after connecting the power supply and proceeds in the following order:

- 1) **Starting of the boot loader and loading of the firmware**

The software of the device consists of a boot loader and of the firmware. Firmware updates are provided only by the manufacturer.
- 2) **Self-test**

During this phase the device carries out several self-tests (e.g. validity of EEPROM contents such as symbol data, proper functioning of the sensors, ...) On the display, the splash screen, containing the firmware version number, the company logo and the IP address, is shown.
- 3) **Connecting to server and calibration**

After the self-test the device tries to establish a KVC connection to the control system. As long as no connection has been established, an appropriate symbol is shown on the display.

In parallel, the inertial sensors are calibrated. For this purpose the KeTop must be in a steady position (e.g. on the wall brackets). As long as the device is connected with the control system and the calibration has not been finished, the symbol "waiting for calibration" is shown on the display. If the device is not in a steady position during start-up, the calibration will be carried out later.
- 4) **Referencing**

After the calibration is finished and the connection with the control system has been established, the device has to be referenced which means the orientation of the KeTop will be defined related to the roboter. For this purpose, the KeTop has to be positioned in the desired start orientation and the reference button has to be pressed (see [fig. 5-1 "Membrane keypad for KeTop T10" on page 25](#)). As long as the referencing has not been finished, the symbol "waiting for referencing" is shown on the display.
- 5) **Start-up successful**

If the start-up and the initialization of the device was successful, i.e. the KeTop has been calibrated and referenced correctly and is connected to the control system, the device can be used by the application. The symbols specified by the control system are shown on the display. If no symbol has been set by the application the display stay black.

## 7.2 Referencing during operation

Sensor errors lead to a growing horizontal deviation of the orientation. Therefore the referencing of the KeTop must be repeated from time to time. The user can check the accuracy of the current orientation at any time by activating the orientation button of the KeTop (see [fig. 5-1 "Membrane keypad for KeTop T10" on page 25](#)). The display will show a symbol with a compass indicating the supposed referencing direction. As soon as the orientation of the device matches the supposed referencing direction, the compass needle will change its color from red to green. A necessary reset of orientation is performed by holding the KeTop T10 into the defined direction and pressing the reference button (see [fig. 5-1 "Membrane keypad for KeTop T10" on page 25](#)).

### **Information**

- *Every 10 minutes the referencing of the KeTop T10 become invalid automatically and the icon for "Reference lost" is shown. The operator is forced to re-reference the device.*
- *By a fast position change (e.g. by a fall) which exceeds the measuring range, the reference can become invalid. The exceeding of the measuring range ist detected automatically.*
- *During the heating phase of the device a higher drift of orientation can occur. This phase can last up to 30 minutes.*
- *Long working phases or fast temperature changes can lead to a higher deviation of orientation. This can be improved by placing the KeTop T10 from time to time for approx. 20 seconds into an steady position (e.g. in the wall bracket). Thereby the inertial sensors of the device will be automatically recalibrated.*

## 8 Configuration

The KeTop T10 is configured externally on a PC via web server which is integrated on the KeTop T10. For this the KeTop T10 has to be connected with a PC.

### 8.1 Connection KeTop T10 - PC

The KeTop is connected by way of the junction box JB 001 (siehe [chapter 14.2 "Junction Box JB 001" on page 46](#)) via Ethernet to the PC. There are two connection options:

- Connection via switch
- Direct connection

#### Connection via switch

In this connection option a switch is provided between the junction box and the PC. For the connection a 1:1 standard Ethernet cable is used.

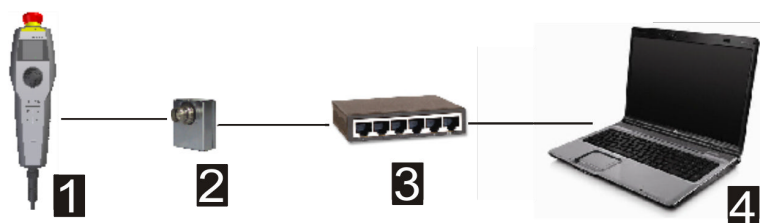


Fig.8-1: Connection KeTop T10 - PC via Switch

<b>1</b> ... KeTop T10	<b>2</b> ... Junction box JB 001
<b>3</b> ... Switch/Hub	<b>4</b> ... PC

#### Direct connection

In this connection option the KeTop T10 is connected directly via the junction box to the PC. For the connection a 1:1 standard Ethernet cable is used.

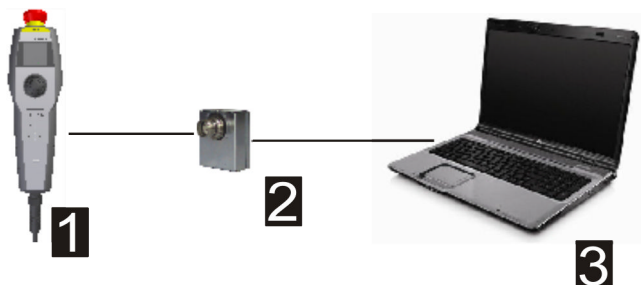


Fig.8-2: Direct connection KeTop T10 - PC

<b>1</b> ... KeTop T10	<b>2</b> ... Junction box JB 001
<b>3</b> ... PC	

**Information**

*If there is no connection, this is indicated by a symbol (see chapter 19 "Appendix: Icon sets" on page 78).*

## 8.2 Configuration of the KeTop T10

After the KeTop has been connected to the PC, you can access the configuration mask on the PC, by opening a web browser with the address <IP address of the KeTop>/settings.shtml. At delivery, the default IP address is set to 192.68.25.11.

The following configurations can be set:

- Device IP-Address: Configuration of the desired IP address of the KeTop
- Server IP-Address: Configuration of the IP address of the desired control
- Netmask: Configuration of the subnet mask

### KeTop: settings

Device IP-Address:	192 168 25 11	set
Server IP-Address:	192 168 25 9	set
Netmask:	255 255 255 0	set

Fig.8-3: Configuration of the addresses

The settings will be active after a restart.

**Information**

*For questions related to the network operation please contact your network administrator.*

## 9 Diagnostics



Current errors or warnings are shown on the display of the KeTop by a symbol (see [chapter 19 "Appendix: Icon sets" on page 78](#)).

The KeTop offers diagnostics information about the firmware version, the current network configuration and the current errors and warnings. There are three ways to show this information:

- on the display of the KeTop T10 (diagnostics screen)
- via the integrated web server
- via KVC

A description of the status codes and errors codes can be found in the appendix.

### Diagnostics screen

Diagnostics information can be shown on the display of the KeTop. This diagnostics screen is opened by pressing  and  (see [fig. 5-1 "Membrane keypad for KeTop T10" on page 25](#)).

### Integrated web server

The information can also be queried via the integrated web server. The web server can be opened on a PC via an internet browser. This requires to connect the KeTop with the PC and to enter the IP address of the device in the browser.

### Status information

Version	KetopT10 v 0.143003 (Thu Sep 5 16:40:08 GMT 2013)
Server-IP	<b>192.168.25.9</b>
Device-IP   MAC	<b>192.168.25.11</b>   00-60-b5-32-00-01
Netmask	<b>255.255.255.0</b>
Uptime	seconds since start: 41
Status	KVC is connected INU is calibrated INU is referenced Active warning codes: no warnings Active error codes: no errors
Selftest result	00000

Fig.9-1: Current settings

Configuration	Description
Version	Firmware version
Server-IP	IP address of the server (control)
Device-IP   MAC	IP and MAC address of the KeTop
Netmask	Subnet mask

Configuration	Description
Uptime	Elapsed time since start up of the KeTop
Status	<p>Information about:</p> <ul style="list-style-type: none"> <li>• KVC connection</li> <li>• Calibrating</li> <li>• Referencing</li> <li>• Warnings</li> <li>• Errors</li> </ul> <p>If warnings or errors occur the corresponding error codes will be written in the respective line. Meanings of the codes see <a href="#">chapter 20 "Appendix: Status and error codes" on page 85</a>.</p>
Selftest result	<p>Status code is displayed.</p> <p>Meaning of the status code see <a href="#">chapter 20 "Appendix: Status and error codes" on page 85</a>.</p>

### KVC

In addition, the status code of the KeTop is transferred via KVC to the control where it can be read out. For further information see "KeTop KVC programming manual".

## 10 Maintenance

The device itself is maintenance-free.

## 11 Disposal

### 11.1 Disposal of the module

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#### 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.

## 12 Technical Data

### 12.1 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 (acc. to EN 61131-2)
Inrush current:	<1A
Power consumption:	1.2 W (50 mA to 24 V DC)
Display:	1,45" TFT-LCD, LED-backlight, 65.000 color, 128 x 128 Pixel 65,000 color
Touchscreen:	No
Keypad:	<ul style="list-style-type: none"> <li>• Membrane keypad with tactile feedback</li> <li>• maximum 10 keys</li> </ul>
Equipment class:	III according to EN 61131-2 and EN 50178
Protection class:	IP54

### 12.2 Environmental conditions

Operating temperature:	0 °C to 45°C (32 °F to 113 °F)
Storage temperature:	-20 °C to +70 °C (-4 °F to 158 °F)
Transport temperature:	-25 °C to +70 °C (-13 °F to 158 °F)
Relative humidity (non-condensing):	5 % to 95 % (EN 61131-2)
Vibration resistance (operation):	<ul style="list-style-type: none"> <li>• 5 Hz ≤ f &lt; 9 Hz with 3,5 mm (0.138 in)</li> <li>• 9 Hz ≤ f &lt; 150 Hz with 1 g (0,035 pounds)</li> </ul>
Shock resistance (operation):	15 g / 11 ms (EN 61131-2)

### 12.3 Interface

Ethernet:	1
• Data transmission rate:	10 MBit/s

### 12.4 Mechanical properties

Construction:	ABS housing withstands grease, oil, lubricants, alcohol, etc.
Flammability class:	UL94-V0
Dimensions:	
• Width:	210 mm
• Height:	62 mm

• Depth:	75 mm
Weight:	ca. 250 g (without cable)
Drop-tested:	1.5 m on industrial floor

## 12.5 E-Stop ratings (respective grey halt-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:	B <sub>10d</sub> : 250 000
Design:	2 circuits, external wiring
Galvanic isolation:	500 V AC to the rest

## 12.6 Enabling control device

Output type:	Solid-state output
Voltage:	24 V DC
Current:	500 mA (max.)
B <sub>10d</sub> :	2 <sup>nd</sup> position: 1 000 000 3 <sup>rd</sup> position: 1 000 000
Actuating force:	from 1 <sup>st</sup> position to 2 <sup>nd</sup> position: 3 N typical from 2 <sup>nd</sup> position to 3 <sup>rd</sup> position: 17 N typical
Galvanic isolation:	500 V AC to the rest

## 13 Options

This chapter describes the options the KeTop is available with.

### 13.1 Grey stop switch

In place of the emergency stop switch a gray stop switch can be used. See [chapter 6.2 "Emergency Stop Button and grey Stop Button" on page 28](#).

## 14 Accessories

### 14.1 Wall bracket KeTop T10

The powder-coated black wall bracket is used for stationary operation, storage or calibration of the KeTop

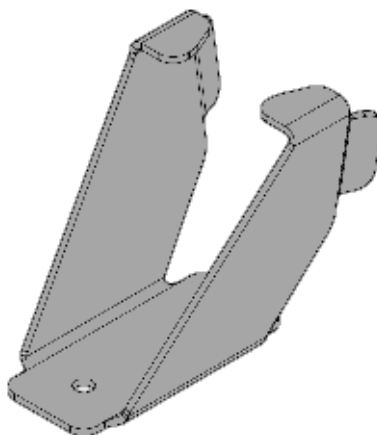


Fig.14-1: Carrier

#### 14.1.1 Dimensions

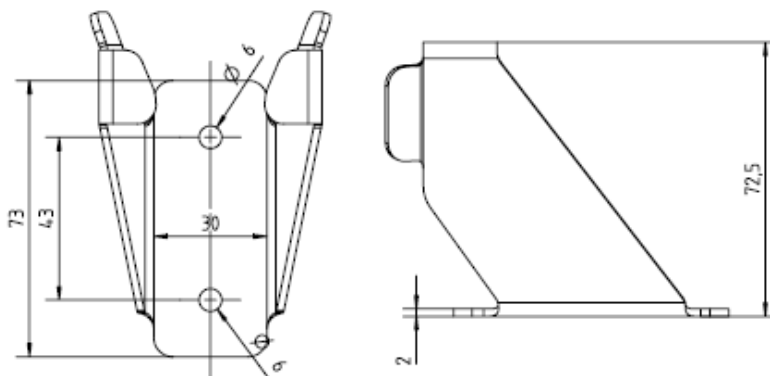


Fig.14-2: Front and side view of the wall bracket (all dimensions in mm)

### 14.2 Junction Box JB 001

This chapter describes the junction box JB 001 which is used to connect a KeTop to a PLC via Ethernet.

## 14.2.1 Views and basic dimensions

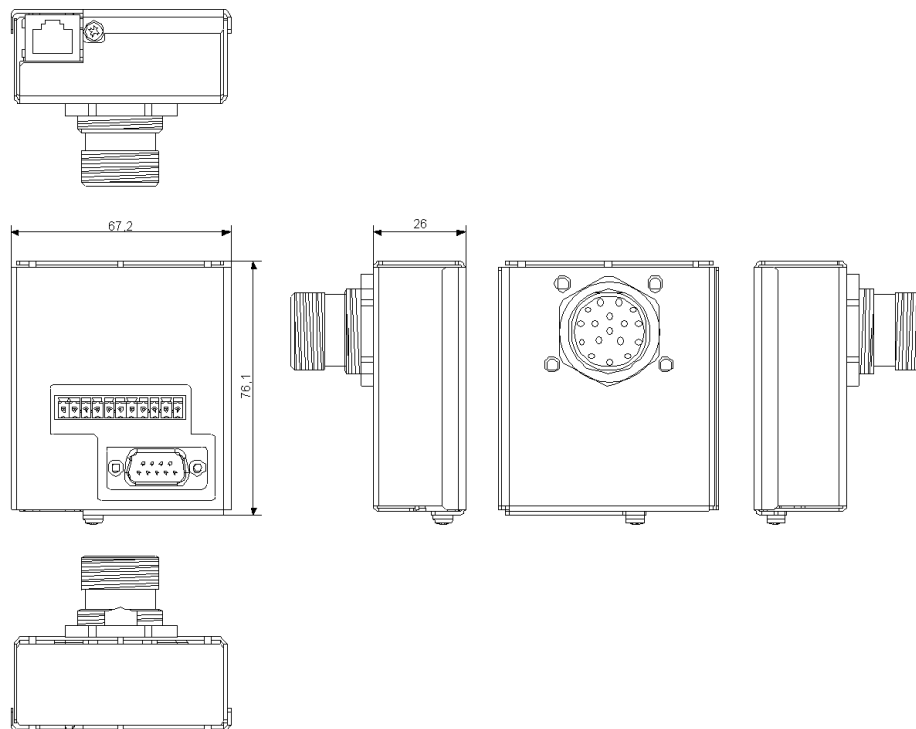


Fig.14-3: View of the JB 001

<b>1</b> ... Mounting nut
---------------------------

### 14.2.2 Connectors

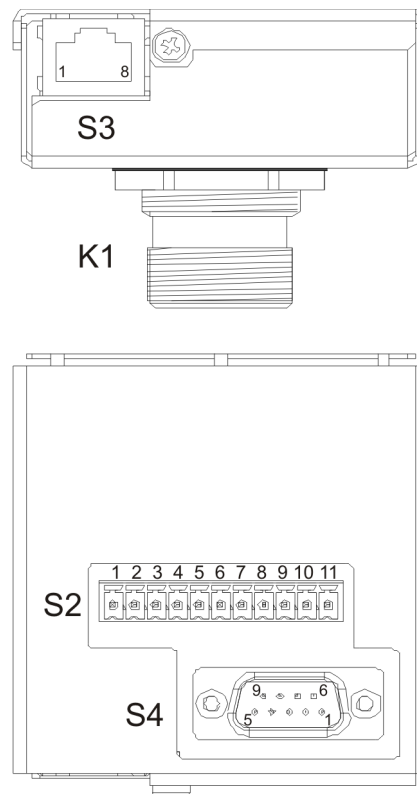


Fig.14-4: Connectors of the JB 001

<b>K1</b> ... 17-pin Coninverse female connector for the KeTop connection cable	<b>S2</b> ... 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. <sup>1)</sup>
<b>S3</b> ... RJ-45 female connector for connection to a PLC <sup>2)</sup>	<b>S4</b> ... 9-pin DSUB male connector for CAN connection

<sup>1)</sup>The required mating plug for terminal block S2 can be ordered from Co. "Phoenix" with material number FMC 1.5/11-ST-3.5.

<sup>2)</sup> via Ethernet

### 14.2.3 Connection diagram

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



**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**

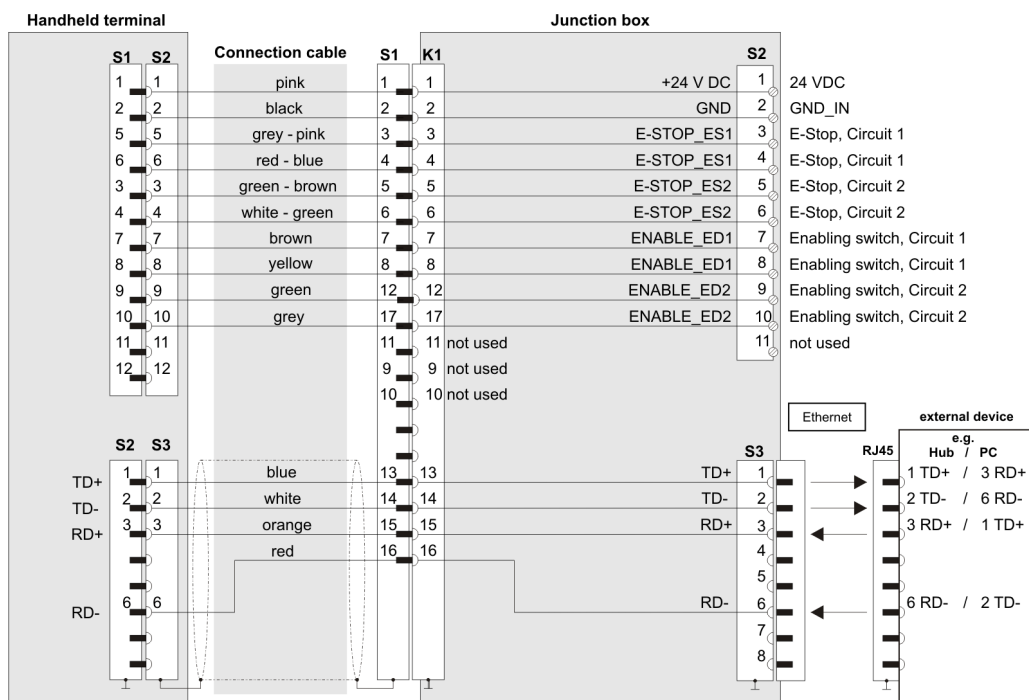


Fig.14-5: Connection diagram for Ethernet: KeTop T10 via junction box JB 001

**Information**

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

**14.2.4 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).

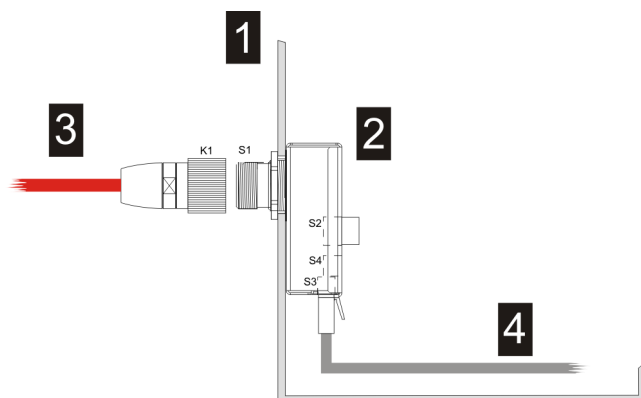


Fig.14-6: Shield connection in the control cabinet

<b>1</b> ... Control cabinet (max. 5 mm wall thickness)	<b>2</b> ... Junction Box JB 001
<b>3</b> ... Connection cable to KeTop	<b>4</b> ... CAN cable to host control

### 14.2.5 Mounting Instructions

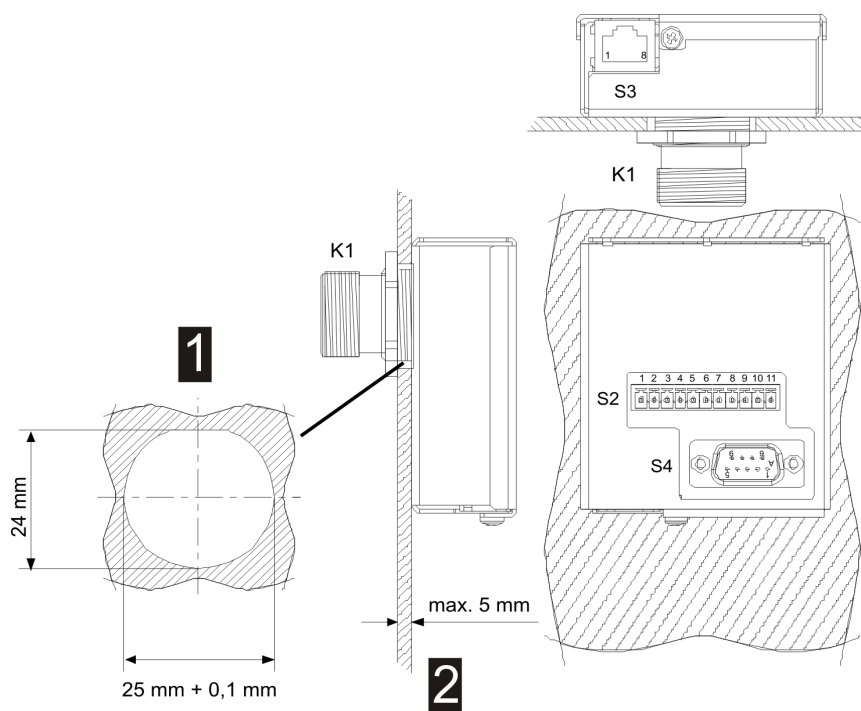


Fig.14-7: Dimension drawing for the mounting opening of the JB 001

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

## 14.2.6 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)
	Without KeTop: none
Power consumption:	With KeTop: see chapter "Technical Data - In general"
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 %
	IEC 60068-2-6:
Vibration resistance (operation):	<ul style="list-style-type: none"> <li>• 5 Hz ≤ f &lt; 9 Hz at 7 mm</li> <li>• 9 Hz ≤ f &lt; 150 Hz at 2 g</li> </ul>
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)

## 14.3 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).

14.3.1 Views and basic dimensions

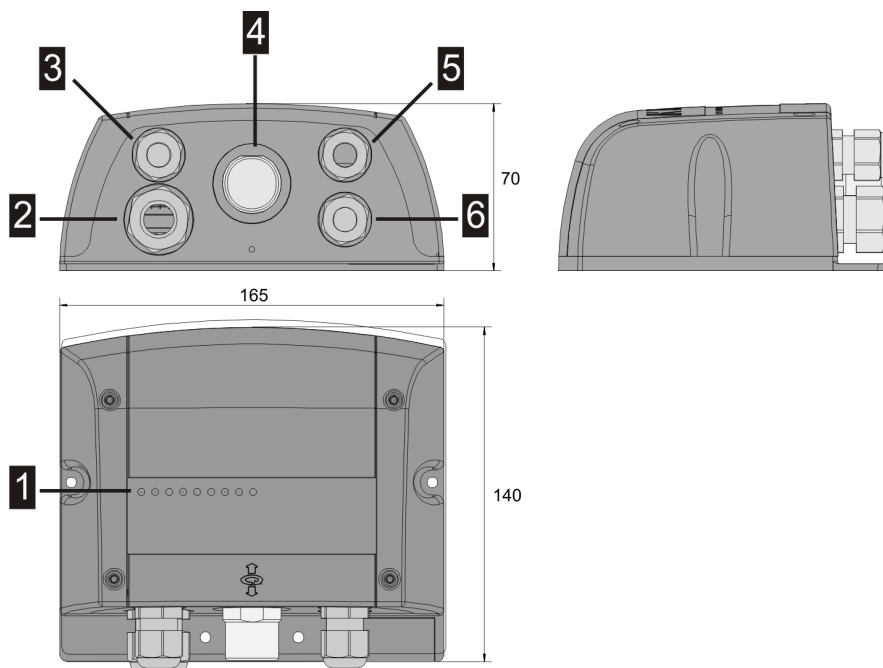


Fig.14-8: View and device description of the Gateway box

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

### 14.3.2 Interior view

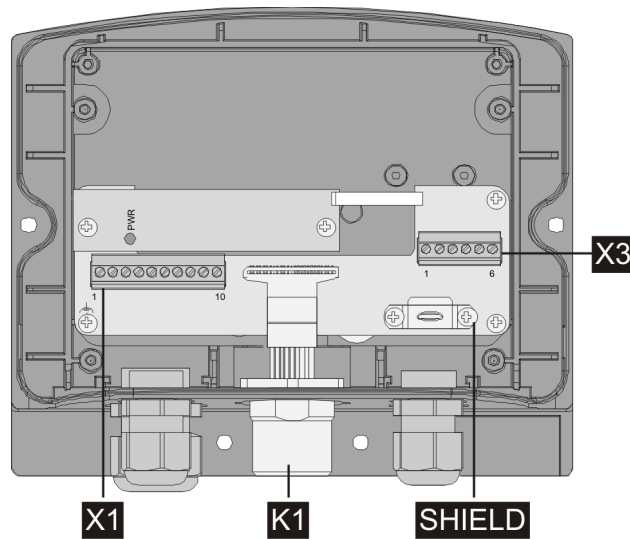


Fig.14-9: Interior view of connection box

<b>K1</b> ... 17-pin female connector (Coninvers) for KeTop connection cable	<b>X1</b> ... Terminal block for power and control lines (enabling control device and emergency stop)
<b>X3</b> ... Terminal block for data lines	<b>SHIELD</b> ... 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".

### 14.3.3 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 mm<sup>2</sup> / 0,14-1,5 mm<sup>2</sup> / 28-16 AWG
- flexible with wire end ferrules without / with plastic sleeve: 0,25-1,5 mm<sup>2</sup> / 0,25-0,5 mm<sup>2</sup>

Grid dimension: 3,81

Insulation length: 7 mm<sup>2</sup>

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

**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.

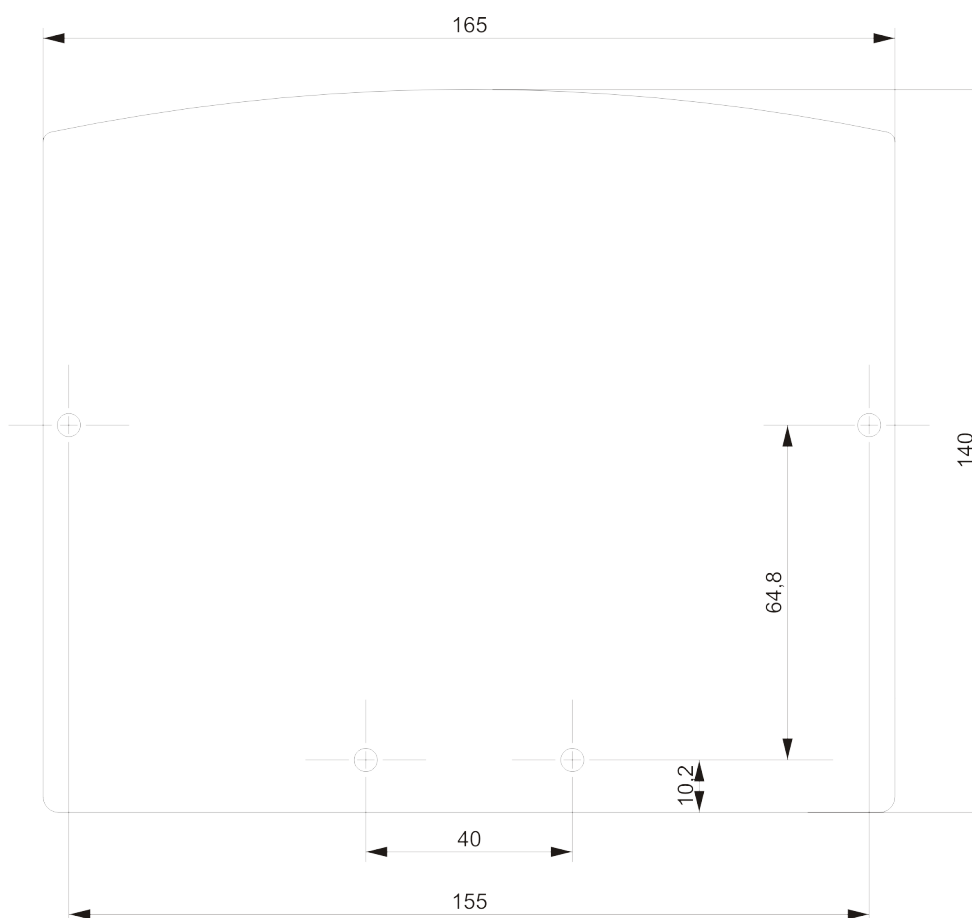
**14.3.4 Drilling template for wall mounting**

Fig.14-10: 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](http://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

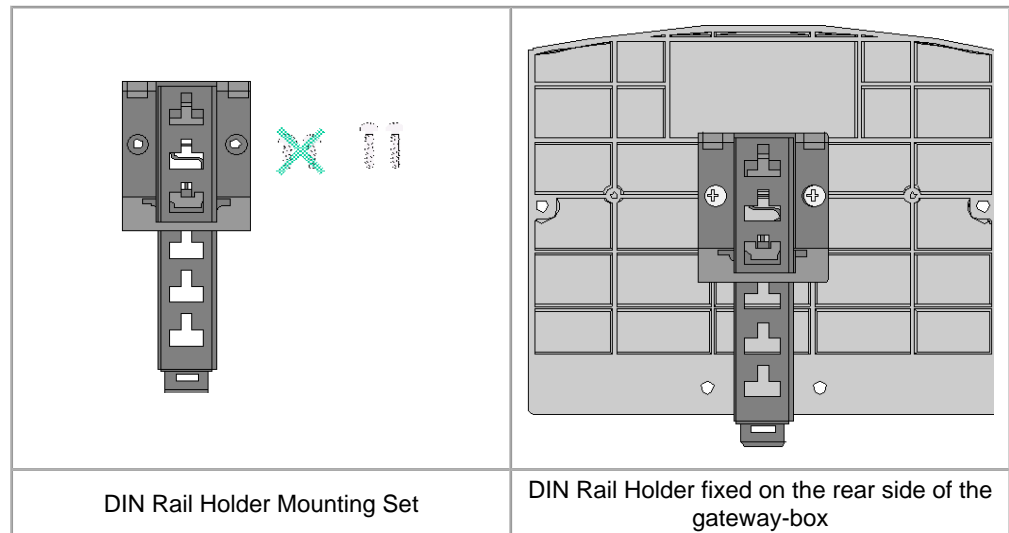
Head form: flat head

Max. head diameter: Ø 9 mm

- Recommended rawlplug: Ø 6 x 30mm

### 14.3.5 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.



Tab.14-11: DIN Rail Holder Mounting Set for connection box

### 14.3.6 Use of Connection Box

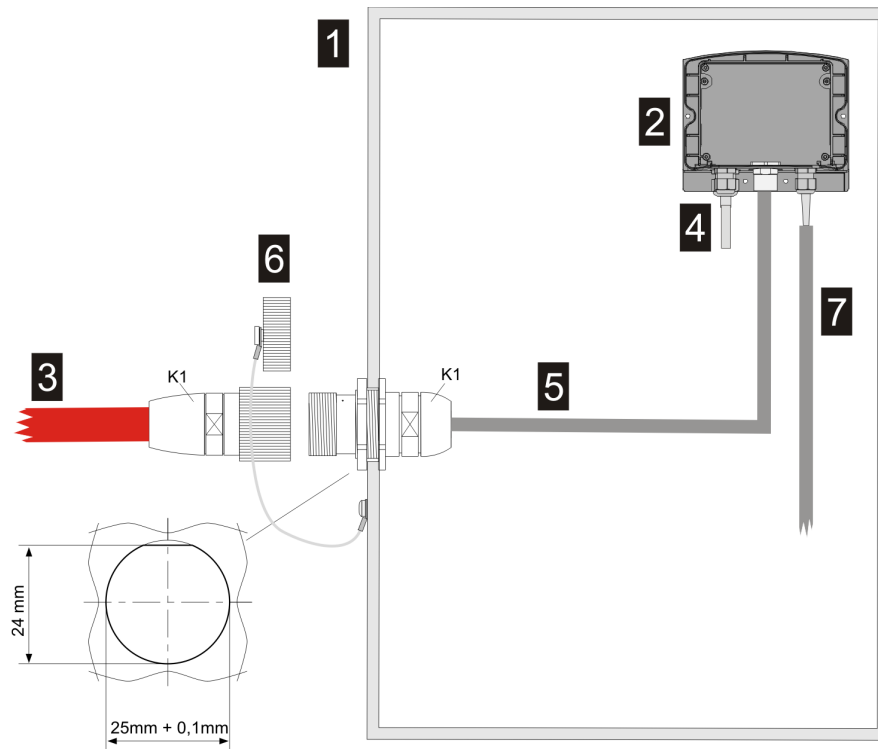


Fig.14-12: Connection box KeTop CB211 in control cabinet

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

### 14.3.7 Minimum Bending Radius of Cable

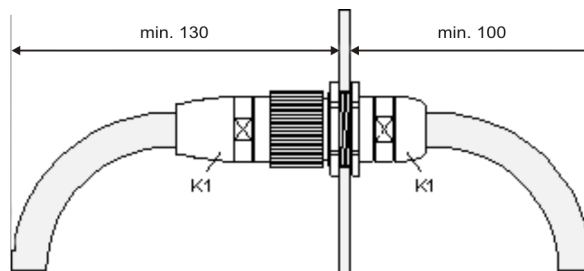


Fig.14-13: Required minimum distance outside and inside the control cabinet

### 14.3.8 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.

### 14.3.9 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

## 15 EC directives and standards

### 15.1 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

### 15.2 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
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#### 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
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#### 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

### 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)
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### UL examination for robotic applications

UL 1740	Industrial Robots and Robotic Equipment E216950 (TETZ2, TETZ8)
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## 16 Declaration of conformity

### 16.1 EC Declaration of Conformity



#### EC Declaration of Conformity



KEBA AG  
Gewerbepark Urfahr  
4041 Linz  
AUSTRIA

Document No.: 92270/CE/1

We declare that the following products

Name of product: KeTop T10  
KeTop C10

Variants: Mat.Nr.:

92270	92541
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are in conformity with the essential requirements of the following European Council Directives:

- EC-Directive relating to machinery 2006/42/EC
- EC-Directive relating to electromagnetic compatibility 2004/108/EC

Conformity to the directive 2006/42/EC is assured by the compliance with the applicable parts of the following harmonized european standards for the emergency stop switch respectively stop switch (if available) as well as the enabling device:

- EN ISO 13850:2006
- EN 60204-1:2006

Conformity to the directive 2004/108/EC is assured by the compliance with the applicable parts of the following harmonized european standard:

- EN 61131-2:2007

#### Important notes:

The emergency stop switch respectively stop switch (if available) and enabling switches 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.

Any modification on the product(s), that is performed without KEBA's consent will render this declaration invalid.

This declaration certifies the conformity with the directives mentioned, but does not imply any warranty of the features of the product(s).

The safety instructions contained in the documentation supplied with the product(s) must implicitly be followed!

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

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## 17 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.

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.

## 17.1 "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"

## 17.2 "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

- 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

### **17.3 "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.

### **17.4 "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.

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.

## 17.5 "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.

## 17.6 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 determined from a hazard and risk analysis. In case of hazards that can cause irreversible injury or death usually a Performance Level not less than PL d is required.

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.

## 17.7 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

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.

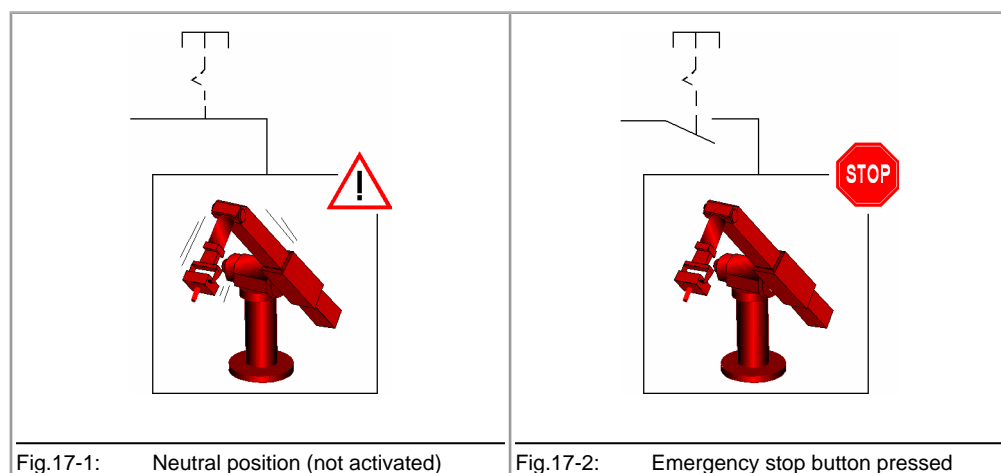
If the machine or equipment is operated with the handheld terminal, care must be taken at this time to ensure that operation can only be controlled by the handheld terminal and cannot be operated from any other point on the equipment. The hazard zone may only be entered by the person who is operating 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.

## 17.8 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.



Tab.17-3: Emergency stop button functions

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 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.

## 17.9 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-

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.

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.

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.

### 17.10 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).

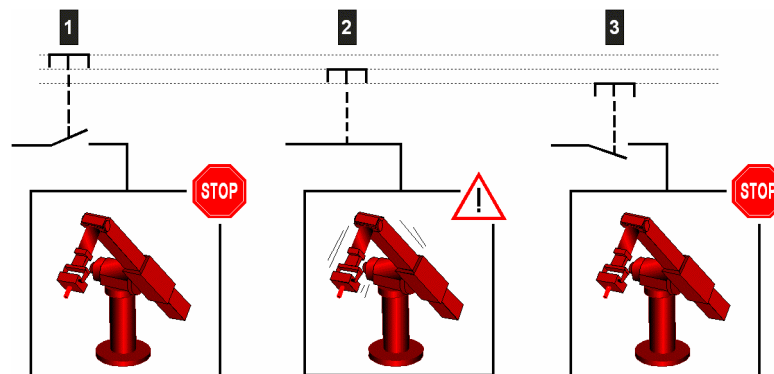


Fig.17-4: Enabling functions

<b>1</b> ... "Neutral position" not activated	<b>2</b> ... "Enabling" pressed
<b>3</b> ... "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

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.

## 18 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.

### 18.1 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.

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

- 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.18-1: 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.

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.

## 18.2 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 control device, 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. All connection cables available from KEBA guarantee correct shielding connection.

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

- 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.

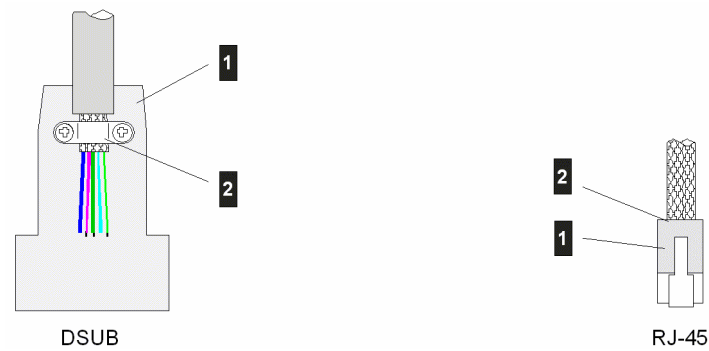


Fig.18-2: Correct shield connection for DSUB and RJ-45 connectors

- |          |  |
|----------|--|
| <b>1</b> | ... Metallised or metallic housing             |
| <b>2</b> | ... 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.

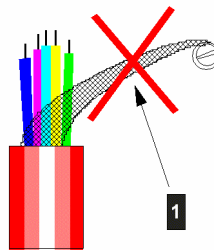


Fig.18-3: Insufficient contacting of a cable shield

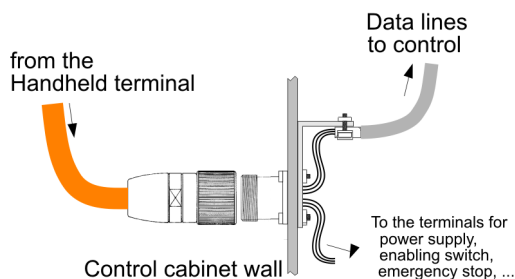
- |          |                  |
|----------|------------------|
| <b>1</b> | ... No pig tails |
|----------|------------------|

### 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 takes place 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 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.

## 19 Appendix: Icon sets

This appendix contains a listing of from KEBA provided icons which can be displayed on the display of the KeTop. The following icons are available:

- Predefined internal icons
- Icons with 64 x 64 pixels for the applicaton (Icon set 2)
- Icons with 32 x 32 pixels for the applicaton (Icon set 3)

### **Information**

*Icon set 1 is not available for the user.*

Additionally the buildup of the following customized icon sets can be requested from KEBA:




- Predefined internal icons
- Customized icons with 64 x 64 pixels (Icon set 4)
- Customized icons with 32 x 32 pixels (Icon set 5)

The following description of the icons for the application are suggestions for use. The final use of the icons depends on the control application.









### 19.1 Predefined internal icons

These icons are included in the firmware and displayed by this. The set contains of three icons with 32 x 32 pixels which are displayed in the top left corner of the display and of eight icons with 64 x 64 pixels which are displayed in the center.

#### **Symbols with 32 x 32 pixels**




Icon	Description
	Information
	Warning
	Error

















## Symbols with 64 x 64 pixels






Icon	Description
	Waiting for host connection or control error
	Calibration successful
	Calibration not successful or not calibrated
	Calibration in progress
	Referencing not successful or reference lost
	Referencing not successful or reference lost
	Referencing successful
	Connected with host

## 19.2 Icons with 64 x 64 pixels for the application (Icon set 2)

These icons contains of 64 x 64 icons for individual use in the application.









ID	Icon	Description
1	Black Display	KeTop T10 ready or empty space
2		Waiting for host connection or control error
3		Calibration successful
4		Calibration not successful or not calibrated

















ID	Icon	Description
5		Calibration in progress
6		Referencing not successful or reference lost
7		Referencing successful
8		Device not active
9		Joint mode active
10		Cartesian tool mode active
11		Cartesian object mode active
12		Cartesian free mode active
13		Internal error
14		Connected with host
15		Grab mode active
16		Emergency stop pressed
17		Information
18		Joint mode not available
19		Drive(s) has/have no power
20		Cartesian tool mode not available
















ID	Icon	Description
21		Cartesian object mode not available
22		Device has been moved too fast during grab mode
23		Warning
24		Moved during jog start
25		Figure null











### 19.3 Symbols with 32 x 32 pixels for the application (Icon set 3)

This iconset consists of icons with 32 x 32 pixels for individual use in the application.

ID	Icon	Description
1	Black Display	Empty space
2		Figure null
3		Figure one
4		Figure two
5		Figure three
6		Figure four
7		Figure five
8		Figure six
9		Figure seven

ID	Icon	Description
10		Figure eight
11		Figure nine
12		Symbol A
13		Symbol B
14		Symbol C
15		Symbol D
16		Symbol E
17		Symbol F
18		Connected with host
19		Joint mode active
20		Cartesian tool mode active
21		Cartesian object mode active
22		Empty bar bottom
23		Full bar below
24		first endposition (lower)
25		second endposition (upper)

ID	Icon	Description
26		Information
27		Error
28		Warning
29		Device not active
30		Device not active
31		Emergency stop pressed
32		Cartesian free mode active
33		Grab mode active
34		Waiting for host connection or control error
35		Joint mode not available
36		Drive(s) has/have no power
37		Cartesian tool mode not available
38		Referencing not successful or reference lost
39		Referencing not successful or reference lost
40		Cartesian object mode not available

ID	Icon	Description
41		Empty bar left
42		Empty bar right
43		Full bar left
44		Full bar right
45		Calibration successful
46		Calibration not successful or not calibrated
47		Calibration in progress
48		Referencing successful
49		Device has been moved too fast during grab mode
50		Moved during jog start

## 20 Appendix: Status and error codes

In this appendix the status and error codes of the KeTop T10 and their meanings are explained.

### 20.1 Status codes

The status code consists of five digits. Each digit delivers information about a certain part of the device:

<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Sensors	KVC	Application	Display	EEPROM

In the following tables the meanings of the digits are explained:

#### Sensors

Code	Diagnosis code	Description
0	INU_OK	No error
1	INU_SENSOR_READ	Measuring value cannot be read
2	INU_SENSOR_RATE	Unexpectedly large number of measuring values
3	INU_SENSOR_VALUE	Implausible measuring value

#### KVC

Code	Diagnosis code	Description
0	KVC_OK	No error
1	KVC_NOT_INIT	KVC cannot be initialized
2	KVC_PROTOCOL_ERR	Protocoll error
3	KVC_CONN_UNSTABLE	Connection unstable (Warning)

#### Application

Code	Diagnosis code	Description
0	APPL_OK	No error
1	APPL_NOT_INIT	Application cannot be initialized
2	APPL_EEPROM	Application cannot read or write to EEPROM
3	APPL_DISPMAN	Display manager cannot write (e. g. icon size mismatch, invalid icon number, etc.)
4	APPL_DEVMON	Error monitoring the devices
5	APPL_DEACTIVATED	Device deactivated (e.g. joystick not available, no keyboard available, etc.)

#### Display

This error code is binary coded and shows incorrect iconsets.

Code	Description
0	No error
1	Error in first two sets (internal icons and 64 x 64)
2	Error in third set (32 x 32)
3	Error in first two sets and in third set
4	Error in fourth set (64 x 64 customized)
5	Error in first two sets and in fourth set
6	Error in third and fourth set
7	Error in first two sets, in third set and in fourth set
8	Error in fifth set (32 x 32 customized)
9	Error in first two sets and in fifth set
A	Error in third and fifth set
B	Error in first two sets, in third set and in fifth set
C	Error in fourth set and in fifth set
D	Error in first two sets, in fourth set and in fifth set
E	Error in third, fourth and fifth set
F	Error in all sets

### EEPROM

No.	Description
0	No error
1	EEPROM cannot be read (bus or storage error)

## 20.2 Codes for errors or warnings

The error code respective the warning code is a more detailed description of the status code and explains occurred errors and warnings. The code consists of a double figure.

### Error

No.	Enum ID	Description	Appendant diagnosis code
00	eKvcErrorNotInitialized	KVC cannot be initialized, start up failed	KVC_NOT_INIT
01	eKvcErrorWrongTelNr	Wrong telegram number	KVC_PROTOCOL_ERR
02	eKvcErrorMsgTooLong	Received KVC message too long	KVC_PROTOCOL_ERR
03	eDevmonErrorMaxListeners	Maximum number of devices reached, receiving device cannot be added	APPL_DEVMON
04	eDevmonErrorNotInitialized	Device monitoring cannot be initialized	APPL_NOT_INIT
05	eDispManErrorNotInitialized	Display manager cannot be initialized	APPL_NOT_INIT

## Warning

No	Enum ID	Description	Error behavior	Appendant diagnosis code
00	eKvcWarningMsgIgnoredCyclic	Incoming cyclic KVC message ignored (message queue full)	Reset of warning after 20 seconds	-
01	eKvcWarningMsgIgnoredAnticyclic	Incoming anticyclic KVC message ignored (message queue full)	Reset of warning after 20 seconds	-
02	eKvcWarning-WrongTelLenReq-State	Wrong telegram length of received request state telegram	Reset of warning after 20 seconds	KVC_PROTOCOL_ERR
03	eKvcWarning-WrongTelLenParam-Read	Wrong telegram length of received parameter read telegram	Reset of warning after 20 seconds	KVC_PROTOCOL_ERR
04	eKvcWarning-WrongTelLenParam-Write	Wrong telegram length of received parameter write telegram	Reset of warning after 20 seconds	KVC_PROTOCOL_ERR
05	eKvcWarningRecv-SafetyTel	Received safety telegram, although not supported on KeTop T10	Reset of warning after 20 seconds	KVC_PROTOCOL_ERR
06	eKvcWarningConnAbort	KVC connection lost (detected by timeout)	Reset of warning on reconnecting.	-
07	eKvcWarningManyIgnoredMsg	Warning when more than 4 messages will be ignored within 20 seconds	Reset of warning if less than 5 messages are ignored within the next 20 seconds	KVC_CONN_UNSTABLE
08	eKvcWarningRepeatingConnAbort	Warning when more than 4 messages will be ignored within 10 seconds	Reset of warning if less than 5 messages are ignored within the next 10 seconds.	KVC_CONN_UNSTABLE
09	eKvcWarningEepromReadingFail	Reading device info from EEPROM failed	-	APPL_EEPROM
10	eKvcWarningEepromDataInvalid	(Parts of) EEPROM data not initialized or invalid	-	APPL_EEPROM
11	eKvcWarningNot-SupportedParam	KVC parameter not supported on KeTop T10	-	KVC_PROTOCOL_ERR
12	eKvcWarningInvalidParNr	KVC parameter number does not exist	-	KVC_PROTOCOL_ERR
13	eKvcWarning-WrongParLen	Wrong length of KVC parameter value (quoted length and real length differ)	-	KVC_PROTOCOL_ERR
14	eDevmonWarning-DefaultValueJoy	Failed to read number of joystick axes from EEPROM	Taking default value	APPL_DEVMON
15	eDevmonWarning-DefaultValueKeys	Failed to read number of keys from EEPROM	Taking default value	APPL_DEVMON

No	Enum ID	Description	Error behavior	Appendant diagnosis code
16	eDevmonWarning-DefaultValueOri	Failed to read information from EEPROM if orientation data is available at all or whether it shall be interpreted or not	Taking default: supposing orientation data is available and it shall be used	APPL_DEVMON
17	eDevmonWarning-DefaultValueDevPin	Failed to read device pin from EEPROM	Taking default value	APPL_DEVMON
18	eDevmonWarningOriDeactivated	Stopped to interpret orientation because INU is defect	-	APPL_DEACTIVATED
19	eDevmonWarningKeysDeactivated	Deactivated keys because of a hardware problem	-	APPL_DEACTIVATED
20	eDevmonWarningJoystickDeactivated	Deactivated joystick because of a hardware problem	-	APPL_DEACTIVATED
21	eDevmonWarningEepromRWFail	Failed to read from EEPROM – hardware or resources problem	-	APPL_EEPROM
22	eDevmonWarningInvalidBaseUCT	Too large base update cycle time (UCT) – base UCT must be less than the UCT of the other devices and more than zero	Setting base UCT to its default (i.e. 5ms)	APPL_DEVMON
23	eDevmonWarningInvalidJoyUCT	Too small UCT for joystick – joystick UCT must be at least the base UCT	Setting joystick to its default (i.e. 25ms)	APPL_DEVMON
24	eDevmonWarningInvalidKeysUCT	Too small UCT for the key image – key UCT must be at least the base UCT	Setting key UCT to its default (i.e. 5ms)	APPL_DEVMON
25	eDevmonWarningInvalidOriUCT	Too small UCT for orientation interpretation – orientation UCT must be at least the base UCT	Setting orientation UCT to its default (i.e. 100ms)	APPL_DEVMON
26	eDispManWarningDrawIconFailed	Failed to draw system icon in the upper left corner	-	APPL_DISPMAN
27	eDispManWarningInvalidTileId	Given tile-id is higher than the number of tiles	-	APPL_DISPMAN
28	eDispManWarningInvalidIconSetFull	Given set-id contains full screen icons, which cannot be set by the user	-	APPL_DISPMAN
29	eDispManWarningInvalidIconSetBig	Given set-id contains big icons, but tile-id is for small icons	-	APPL_DISPMAN

No.	Enum ID	Description	Error behavior	Appendant diagnosis code
30	eDispManWarningInvalidIconSetSmall	Given set-id contains small icons, but tile-id is for big icons	-	APPL_DISPMAN
31	eDispManWarningScreensaverDefaultVal	Failed to read screensaver timeout from EEPROM	Screensaver timeout will be set to zero, that means the screensaver is turned off.	APPL_EEPROM
32	eKeySeqWarningFactoryResetFailed	Factory reset failed – failed to read default values from EEPROM	-	APPL_EEPROM
33	eKeySeqWarningFailedSaveJoyCalibVal	Failed to read joystick calibration flags from EEPROM	-	APPL_EEPROM

## 21 Appendix: KVC telegrams on KeTop T10

This appendix explains how the KeTop T10 executes the KVC telegrams. Furthermore the parameter provided on the KeTop T10 are listed and example values for them are shown.

### Concurrency of KVC telegrams

According to the protocol definition state requests will be transmitted cyclically which means the executing is always one after another.

Parameter requests are carried out as necessary and have to be serialized on the server: The server can only send another request after the acknowledge of the previous request has been received. This ensures that each parameter request is executed correctly.

A synchronization between status requests and inquiries parameter is not necessary, since they are handled in several buffers. So state requests and parameter requests can be handled in parallel.

### KVC parameter on the KeTop T10

#### Parameters for changing and returning the configuration on the KeTop T10

Parameter	Example content
ScreenSaverTime	20000 [ms]
ScreenSaverState	activated
DevHWInfoData	1, 4, 0, 2549, 15308652, 86839, 15308652, 0, 23388
CpuInfoData	frequ 50000000, ram 98304
DevTypeInfo	KeTop T10, FreeRTOS
FirmwareVersion	1.4, KeTop T10 v 1.004 (Wed Nov 6 15:42:55 GMT 2013)
BootSystemVersion	1.6, KEBA Bootloader v1.06
NetConfig	192.168.137.151, 255.255.255.0, 192.168.137.1, 192.168.137.234, 0
DiagnosisDataLength	5
ClientDiagnosis	20000
DisplayTileCount	13
DisplayData	Representation of syntax <Tile#: [Set-Id/Icon-Id]> 0:[2/12] 1:[3/1] 2:[3/1] 3:[3/1] 4:[3/1] 5:[3/1] 6:[3/1] 7:[3/1] 8:[3/1] 9:[3/3] 10:[3/4] 11:[3/5] 12:[3/1]
MonitorCycleTime	5 (ms)

#### Parameter as commands for KeTop T10

Parameter	Process
Reset	Reset
Calibrate	Kalibration of the sensor
OrientationReset	Referencing = Reset of the orientation

For more information see "KeTop KVC Programmierhandbuch".