

325-2810-012-US-16



**Operating Manual**

## Force Gauges CoboSafe-CBSF

Operating manual: CoboSafe-CBSF  
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This operating manual describes the operation of the CoboSafe-CBSF force measuring devices. The measuring method is part of a system and can only be used in conjunction with the following components:

- CoboSafe-Vision
- CoboSafe-Scan
- CoboSafe-Tek



**Before beginning work of any kind, read this manual and the general safety instructions. Keep for later use!**

Pay particular attention to the associated document "CoboSafe – General Safety Instructions" and the safety instructions and warnings in this document to prevent injuries and product damage.

Keep this documentation at hand so that you can look it up if necessary. Share this documentation with future users of the product.

Associated with this manual is the document:

- CoboSafe – General Safety Instructions

# Table of Contents

- 1 About this Manual . . . . . 6
  - 1.1 Symbols and Warnings in this Manual . . . . . 6
    - 1.1.1 Warnings . . . . . 6
    - 1.1.2 Explanation of Symbols . . . . . 7
  - 1.2 Appearance of Instructions . . . . . 8
- 2 For your Safety . . . . . 9
  - 2.1 Intended Use . . . . . 9
  - 2.2 Qualification Required of Personnel . . . . . 9
  - 2.3 Responsibility of the Operator . . . . . 9
  - 2.4 Residual Risk When Using CoboSafe-CBSF Force Gauges . . . . . 10
- 3 Brief Description . . . . . 11
- 4 Scope of Delivery . . . . . 11
- 5 Signs and Labels . . . . . 12
- 6 Informative Value of the Measurement Results . . . . . 13
- 7 Structure and Function CoboSafe-CBSF . . . . . 15
  - 7.1 CoboSafe-CBSF-Force Sensors . . . . . 15
  - 7.2 Display . . . . . 16
  - 7.3 Menu Navigation . . . . . 16
  - 7.4 Setting the Date and Time . . . . . 18
  - 7.5 Measured Value Display . . . . . 18
- 8 Structure and Function CoboSafe CBSF- Basic . . . . . 19
  - 8.1 CoboSafe CBSF-Basic . . . . . 19
  - 8.2 Menu Navigation CBSF-Basic . . . . . 19
- 9 Damping Element K1 and Spring Rate K2. . . . . 22
- 10 Preparing for Measurement . . . . . 23
  - 10.1 Safety When Preparing a Measurement . . . . . 23
  - 10.2 Defining Measurement Target . . . . . 25
  - 10.3 Preparing the Measurement Environment . . . . . 25
  - 10.4 Robot Parameters . . . . . 27
  - 10.5 Checking the Components . . . . . 28
    - 10.5.1 Testing Proper Functioning of Force Sensor . . . . . 29
    - 10.5.2 Checking and Cleaning the Collision Surface of the Robot . . . . . 30
  - 10.6 Attach CoboSafe CBSF to Contact Surface . . . . . 30
    - 10.6.1 Attaching Mounting Adapter to contact surface . . . . . 30
    - 10.6.2 Attach CoboSafe-CBSF to Mounting Adapter . . . . . 31
  - 10.7 Mounting the K1 Damping Element . . . . . 32
  - 10.8 Applying Pressure Measuring Film . . . . . 33

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11	Performing Measurement . . . . .	33
11.1	Performing a Measurement with the CoboSafe-CBSF . . . . .	34
12	Transmitting Measured Data CoboSafe-CBSF . . . . .	36
12.1	Transmitting Measured Data CoboSafe-CBSF-Basic . . . . .	36
12.2	Wireless Data Transmission . . . . .	36
12.3	Transmission via USB Port . . . . .	36
13	Maintaining Functionality . . . . .	37
13.1	Maintenance Schedule . . . . .	37
13.2	Checking and Cleaning . . . . .	37
13.2.1	Checking and Cleaning CoboSafe-CBSF . . . . .	38
13.2.2	Inspecting and Cleaning Compression Elements K1 . . . . .	38
13.3	Recharging Batteries . . . . .	39
13.4	Replacing Batteries . . . . .	39
13.5	Calibration . . . . .	39
13.5.1	CoboSafe-CBSF Inspection Date . . . . .	39
13.5.2	Calibration by a Certified Laboratory . . . . .	39
13.5.3	Temperature/Humidity . . . . .	40
13.5.4	K1 Damping elements . . . . .	40
13.5.5	Spare Parts . . . . .	40
13.5.6	Firmware Update . . . . .	40
14	Properly Storing CoboSafe-CBSF . . . . .	40
15	Detecting and Remediating Malfunctions . . . . .	41
16	Technical Data . . . . .	42
16.1	Technical Data Force Sensor CoboSafe-CBSF . . . . .	42
16.2	Technical Data CoboSafe CBSF-Basic . . . . .	43
16.3	Technical Data Accessories . . . . .	45
16.4	Requirements for Measurement Setup . . . . .	45
16.5	Requirements for Temperature and Humidity Measurement . . . . .	45
17	Customer Service . . . . .	46
18	Disposal . . . . .	46
18.1	Disposal by the Manufacturer . . . . .	46
19	Appendix: Dimension drawing mounting adapter: . . . . .	47

## 1 About this Manual


This manual describes operation of the CoboSafe-CBSF force measurement device. The measuring method is part of a system and may be used only in conjunction with the following components:

- Software CoboSafe-Vision
- Pressure Measurement Set CoboSafe-Scan
- Pressure Measurement CoboSafe-Tek

Carefully and thoroughly read this document and the documentation for all of the systems to be used to become familiar with the product before using it.

To prevent injury and damage to the product, pay particular attention to the associated document ↗ “CoboSafe – General Safety Instructions” as well as to the safety and warning notes in this document.

Keep this documentation nearby to serve as a reference when needed. Pass the documentation along to later users of the product.

	<ul style="list-style-type: none"><li>■ The operating manual with safety instructions is a component of the measuring system and has to be stored near the measuring system, ensuring that it is accessible to personnel at all times.</li><li>■ Operating personnel must read the entire manual and be familiar with the product before beginning any work.</li><li>■ The fundamental requirement for working safely is consideration of all of the safety and warning notes as well as following the instructions in this and all related CoboSafe manuals.</li><li>■ In addition, the local accident prevention regulations and general safety regulations apply to the area of application of the measuring system.</li></ul>
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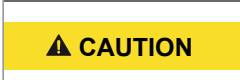

The illustrations in this manual are intended to aid in fundamental understanding of the product. They may deviate from the actual model.

### 1.1 Symbols and Warnings in this Manual

#### 1.1.1 Warnings








Safety and warning notes in this manual are indicated by symbols. The safety and warning notes are preceded by signal words indicating the extent of the hazard.

To prevent accidents, personal injury and property damage, comply with the safety and warning notes and proceed with caution.

<b>Warnings</b>	
	This combination of symbol and signal word indicates an immediately dangerous situation that will lead to death or severe injuries if not avoided.
	This combination of symbol and signal word indicates a possibly dangerous situation that could lead to death or severe injury if not avoided.
	This combination of symbol and signal word indicates a possibly dangerous situation that could lead to minor injuries if not avoided.
	This signal word indicates a possibly dangerous situation that could lead to property damage if not avoided.


### 1.1.2 Explanation of Symbols

The following symbols are used in this manual to emphasize instructions, results, lists, notes and other elements:

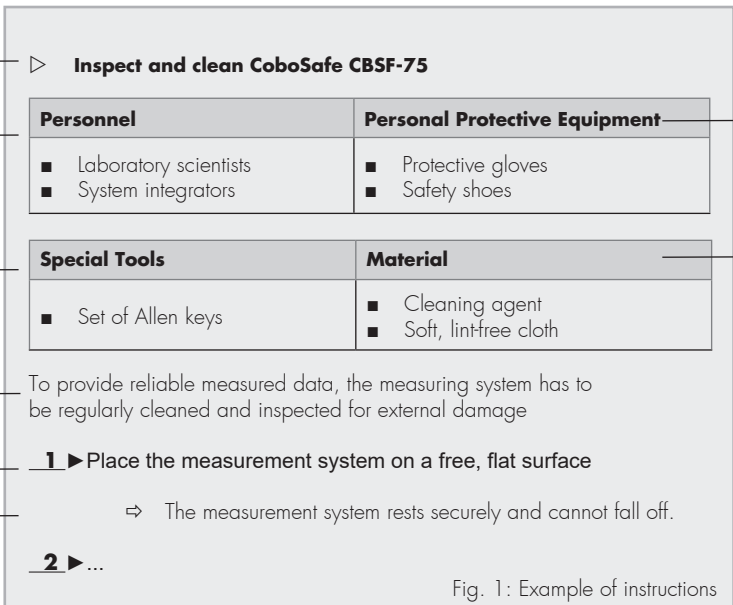
<b>Symbol</b>	<b>Explanation</b>
	Introductory information relevant to safety
	Helpful tips and recommendations as well as information to ensure efficient and uninterrupted use
	Precedes instructions
	Step-by-step instructions. The instructions are numbered in the order of the respective steps.
	Results of steps
	References to sections of this manual and to other applicable documents
	Lists with no specific order

## 1.2 Appearance of Instructions

The initial requirements in regard to personnel qualifications, personal protective equipment (PPE), special tools and materials are different for each step/process.

	It is imperative that the specified requirements for all instructions are met.
---	--

The following illustration shows an example of how a set of instructions is structured.



The diagram illustrates the structure of an instruction. It consists of a main title, two tables for requirements, a descriptive paragraph, and numbered steps. Callouts 1-8 point to specific elements:

- 1. Points to the triangle symbol preceding the title.
- 2. Points to the 'Personnel' table.
- 3. Points to the 'Personal Protective Equipment' table.
- 4. Points to the 'Special Tools' table.
- 5. Points to the 'Material' table.
- 6. Points to the descriptive paragraph.
- 7. Points to the first numbered step.
- 8. Points to the second numbered step.

<b>Inspect and clean CoboSafe CBSF-75</b>	
<b>Personnel</b> <ul style="list-style-type: none"> <li>Laboratory scientists</li> <li>System integrators</li> </ul>	<b>Personal Protective Equipment</b> <ul style="list-style-type: none"> <li>Protective gloves</li> <li>Safety shoes</li> </ul>
<b>Special Tools</b> <ul style="list-style-type: none"> <li>Set of Allen keys</li> </ul>	<b>Material</b> <ul style="list-style-type: none"> <li>Cleaning agent</li> <li>Soft, lint-free cloth</li> </ul>

To provide reliable measured data, the measuring system has to be regularly cleaned and inspected for external damage

**1** ▶ Place the measurement system on a free, flat surface

⇒ The measurement system rests securely and cannot fall off.

**2** ▶ ...

Fig. 1: Example of instructions

### Explanation of illustration "Example of instructions"

1. A triangle precedes the title of instructions or a step to be performed.
2. Indicates the qualification required of personnel to be able to safely perform the action described. In the above example, the person performing the task has to be a laboratory scientist or a system integrator. For a description of the personnel qualifications, refer to chapter "Requirements of Personnel" in the general safety instructions."
3. List of Personal Protective Equipment (PPE) required. In the above example, protective gloves and safety shoes have to be worn; chapter "Personal Protective Equipment" in



- the general safety instructions.
4. If necessary: List of special tools required. A set of Allen keys is needed to check and clean the device.
  5. If necessary: List of consumables required. In the example above, a cleaning agent and a soft, lint-free cloth is needed.
  6. Introductory note on why action is required and what has to be kept in mind.
  7. Step in the set of instructions. Always perform the steps one after the other and as described.
  8. Result of the previous step.

▷ **Always verify that the result is the same as what is described here.**

## 2 For your Safety

The separate document ↗ "CoboSafe – General Safety Instructions" provides users with further information and must also be observed.

### 2.1 Intended Use

CoboSafe-CBSF force gauges (hereinafter also referred to as force sensors) are used to determine the forces occurring in collisions with collaborating robots. The force values are calculated in the device based on the underlying standards and publications. Please observe the instructions for use part 'CoboSafe – General Safety Instructions', ↗ chapter 'Underlying standards and information leaflets'. The CoboSafe-Vision software is used to visualize and archive the stored measurement data. CoboSafe-CBSF may only be used for this purpose.

### 2.2 Qualification Required of Personnel

Only qualified personnel may work with the measuring and test system to avoid serious physical injury or considerable damage to property. Qualified are persons who are familiar with the commissioning and operation of robots. They must have the appropriate qualifications. They must be able to assess the work assigned to them, identify possible sources of danger, and take appropriate safety measures. The separate document ↗ "CoboSafe – General Safety Instructions" must also be observed.

### 2.3 Responsibility of the Operator

Please read the chapter of the same name in the corresponding document ↗ "CoboSafe – General Safety Instructions".

## 2.4 Residual Risk When Using CoboSafe-CBSF Force Gauges

Please read the chapter "Residual risks" in the corresponding document "CoboSafe – General Safety Instructions".



### Attention!

The measurement setup must meet requirements regarding stiffness and at the same time guarantee stability. Therefore, hard and stiff components must be used, which must be firmly connected to each other. Depending on the measurement setup, burrs, corners and edges can cause cut and impact injuries, for example when using aluminum profiles. Falling or tilting components of the measuring setup can cause injuries.

### WARNING

#### Dangerous measurement setup

Risk of injury due to improperly erected measurement setup!

- Establish measurement setup only with deburred components.
- Upholster corners and edges.
- Secure measurement setup against unauthorized access.
- Wear specified protective equipment.
- Secure the measurement setup against tilting.

If the measurement setup is established using sharp edged components or has sharp corners, this can result in cuts and impact injuries. Tilting parts of the measurement setup (e.g., due to low stability) can cause impact and crushing injuries.

### WARNING

#### Falling components


Risk of injury from dropping or dropping components!

- Keep order in the workplace.
- Keep work surfaces free for assembly and storage of components.
- After use, store unused components as described in this manual.
- Handle all components with care.
- Always hold the force sensors at the side for lifting and positioning and make sure that the display and switch are not touched.
- Wear specified personal protective equipment.

Some components of the measuring system are heavy and hard. If force sensors, mounting adapters, transport cases, film rolls or the scanner are dropped, severe injuries up to crushing and bone fractures can result.

### 3 Brief Description

The CoboSafe CBSF force gauges accurately check the permissible load thresholds for workplaces with human-robot collaboration (HRC). The handy devices are characterized by their small design, which allows easy integration of the force sensors into measurement setups - even in confined spaces. The device evaluates the force measurement, and the result is stored with the metadata ID, date and time. A wireless data connection can be established for data transmission. K1 damping elements are automatically detected by the CBSF, it also measures temperature and humidity.

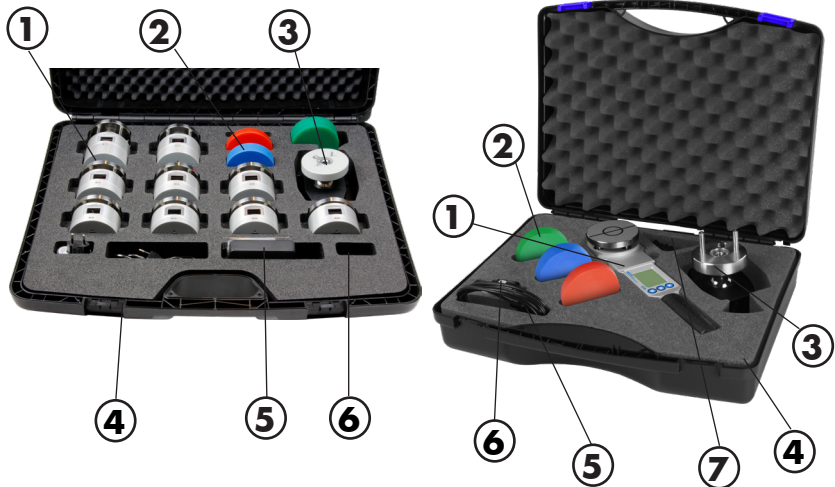
	<p><b>Attention</b> Only the specified measuring equipment may be used to perform a measurement. Measurement may not be performed when a configuration differs.</p>
---	---

### 4 Scope of Delivery

CoboSafe-CBSF

or

CBSF-Basic



The CoboSafe-CBSF system consists of the following components:

- Force sensors from the product series CBSF [1]
- K1 damping elements [2]
- Mounting adapter [3]
- USB charger with power cord [4]
- Transport case [5]
- USB flash drive containing CoboSafe-Vision software [6]
- Thermo-hygrometer (only for CoboSafe CBSF-Basic) [7]

Fig. 2: Scope of delivery

## 5 Signs and Labels

The following markings shall be affixed to the CoboSafe CBSF:

### ⚠ CAUTION

#### Danger of Crushing

The sign indicates a danger of crushing hands and fingers. Never touch the force sensor during measurement.



Fig. 3: danger of crushing

#### Type plate

The type plate is attached to the side of the CoboSafe-CBSF force sensor. The type plate contains the following data:

- Device type
- Spring constant (Spring Rate)
- Maximum Force
- Temperature range (Temp)
- Year of manufacturing (Year of M)
- Article number (Art.-Nr.)
- Serial number (Serial)
- Charging voltage (input)
- CE label

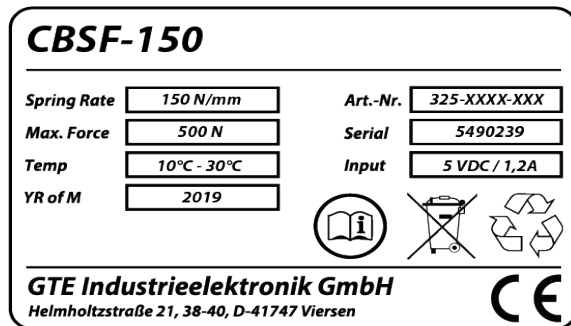


Abb. 4: Type plate



**The numerical appendix for the type designation corresponds to the indication of the spring constant.**

Example: CBSF-150 = Force sensor with 150 N/mm spring constant.

**Inspection Date**

A label on the side of the measuring device indicates when the device has to be inspected and calibrated by the manufacturer. The year printed on the label is the year in which the next inspection is due. The month is indicated by the circle in which a month can be punched out.



Fig. 5: Label "Inspection Date"



This example shows a sticker that requires calibration in February 2018.

## 6 Informative Value of the Measurement Results

The informative value of the results is limited exclusively to the specific contact situation measured. The values shown in the display of the CoboSafe-CBSF are not sufficient for an evaluation alone. The measured values can only be interpreted completely using the software CoboSafe-Vision and a pressure measuring process (CoboSafe-Tek or CoboSafe-Scan).



### **Selection of Measuring Points**

Information on the "Selection of measuring points" can be found in the chapter of the same name in the corresponding document "CoboSafe – General Safety Instructions".

### Qualitative curve of an impact force

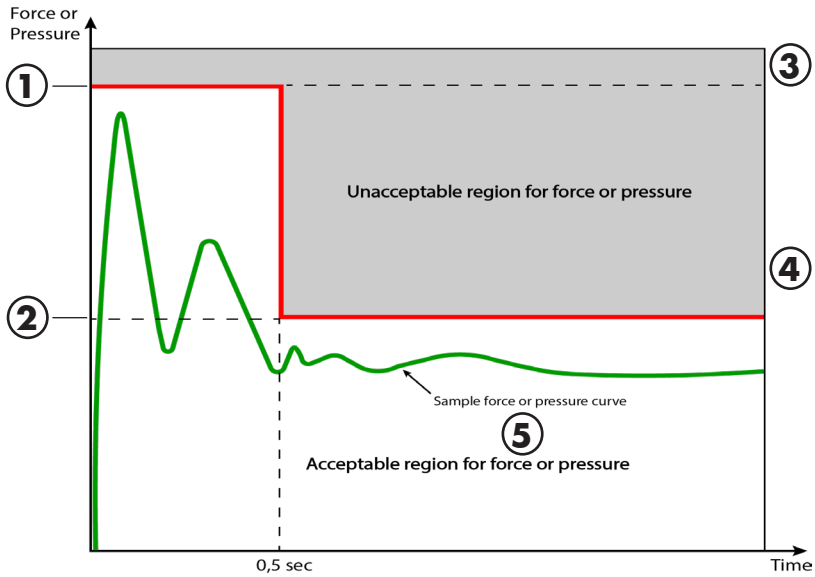


Fig. 6: Curve of an impact force

- Ft maximum transient force [N] [1]
- Fs maximum quasistatic force [N] [2]
- Quasistatic limit for relevant body region [3]
- Transient limit for relevant body region [4]
- Permitted force and pressure range [5]

## 7 Structure and Function CoboSafe-CBSF

### 7.1 CoboSafe-CBSF-Force Sensors

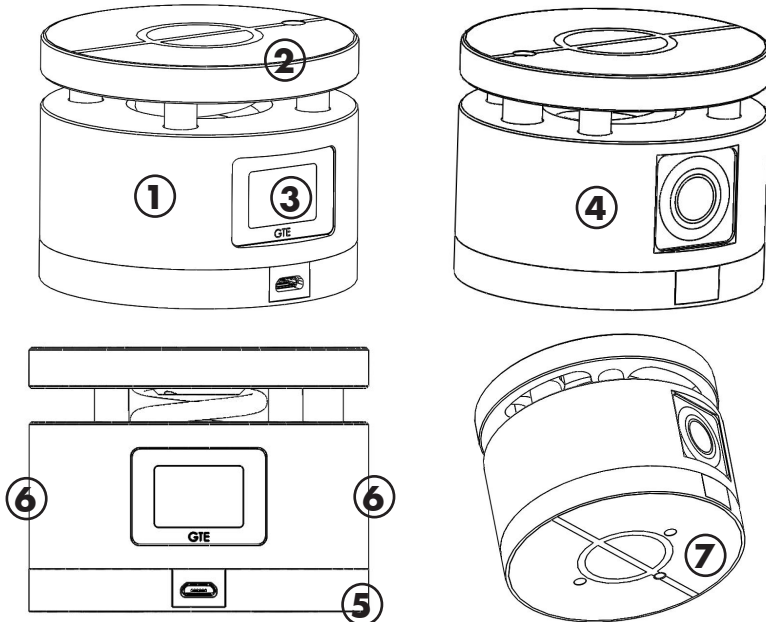


Fig. 7: CoboSafe-CBSF

- Measuring body [1]
- Measuring plate [2]
- Display [3]
- Pushbutton on rear panel [4]
- Base plate [5]
- Handle surfaces [6]
- Holder and mounting option for adapter. Threaded hole M4 x 8 mm. [7]



#### Dimensioned drawing of the base plate

A dimensioned drawing of the base plate can be found in the appendix.

## 7.2 Display

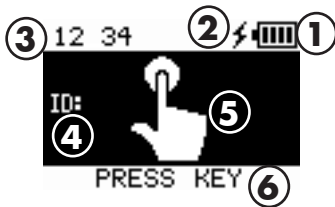


Fig. 8: Starting display

- Charge level [1]
- Charging display [2]
- Time [3]
- Measurement number [4]
- Measured value display [5]
- Command line [6]

## 7.3 Menu Navigation

CBSF is operated by pressing the button on the back of the device briefly or for a longer time.

- Short keypress: Switch between menus and submenus
- Long keypress: Open menu; confirm selection; exit menu.

### Switch on:

- Long keypress: CoboSafe-CBSF starts up when the pushbutton is released.

### Operating mode:

When switched on, the CoboSafe-CBSF is immediately ready for measurement (REC). After the measurement has been completed, the results are displayed.







- Short keypress: Activate next measurement (in 'manual' mode).
- Long keypress: Menu opens in option 'Shutdown'.
- Long keypress: Switch off CoboSafe-CBSF (Device switches off after 45 minutes automatically)

### Open menu:

- Long keypress: Switch on CoboSafe-CBSF.
- Long keypress: Menu opens in option 'Shutdown'.
- Short keypress: Move to the next menu.
- Long keypress: Switch to the submenu.
- Short keypress: Switch between the options in the submenu.
- Long keypress: Select the option and exit the submenu.



**Menu list and functions**

Menu	Submenu	Function
		Switches off CoboSafe-CBSF
	Manual	Press the button to activate measurement. Measurement begins when force reaches $F > 20\text{ N}$
	Auto	Measurement begins automatically when force reaches $F > 20\text{ N}$
	On	Switches on the wireless transmission
	Off	Switches off wireless transfer transmission
	Cancel	Cancels deleting
	All Data	Deletes all stored measurements
	SVN: S/N: WL:	Firmware Version Serial number of CoboSafe-CBSF Wireless ID
	Temp.: Humidity:	Temperature display Humidity display
	Bat. V: Bat. A:	Battery voltage in Volt Battery consumption in mA
	Capacity: Free: Used: Last ID:	Capacity of the memory (quantity of measurements) Number of measurements still possible Number of measurements performed Last measurement number (ID)
		Exits menu and switch to operating mode

## 7.4 Setting the Date and Time

The date and time are set using the CoboSafe-Vision software. Before first use, connect the CBSF devices to the PC and start the software. Use the 'CBSF Sync.' function to program and update. Follow the instructions in CoboSafe-Vision to synchronize the date and time.

## 7.5 Measured Value Display

The CoboSafe-CBSF force sensor outputs the measured values in the display after the measurement has been completed:

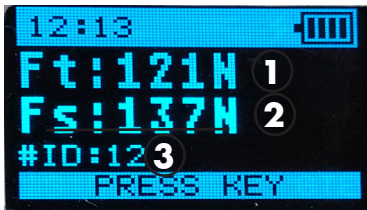


Fig. 9: Measured value display

- Ft = maximum transient force [1]
- Fs= maximum quasistatic force [2]
- Number of the current measurement [3]

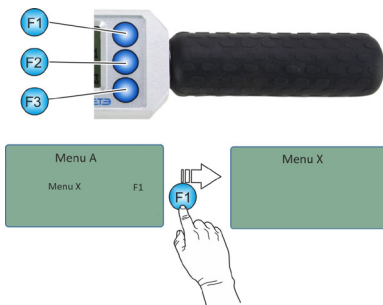
## 8 Structure and Function CoboSafe CBSF- Basic

### 8.1 CoboSafe CBSF-Basic



Fig. 10: CBSF-Basic

### 8.2 Menu Navigation CBSF-Basic

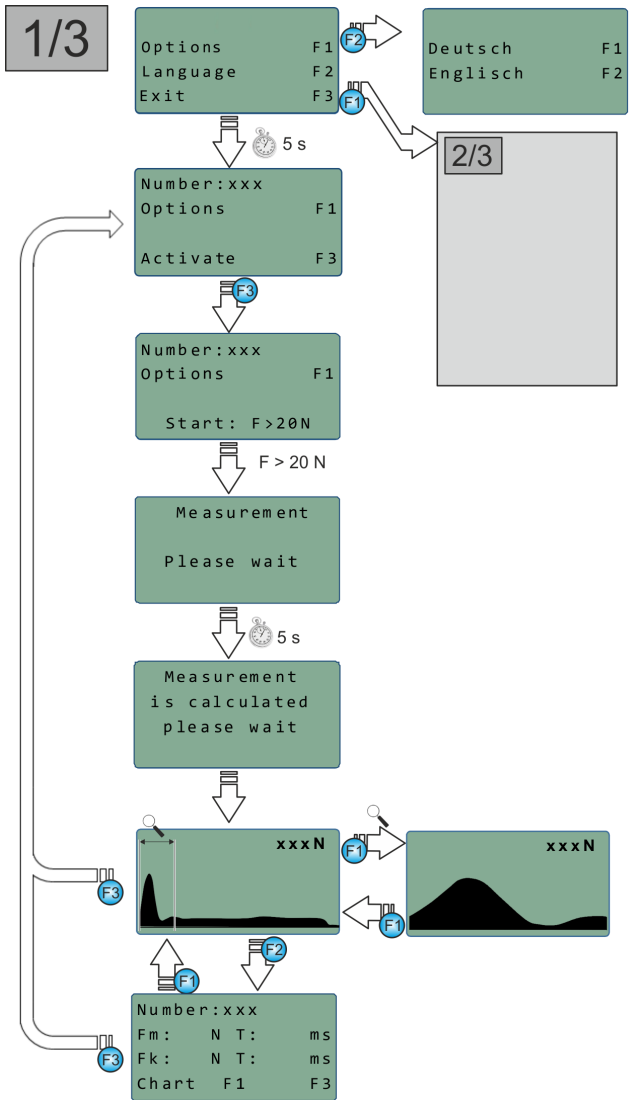


The force sensor is operated via 3 softkeys each, which can be assigned different functions in each menu.

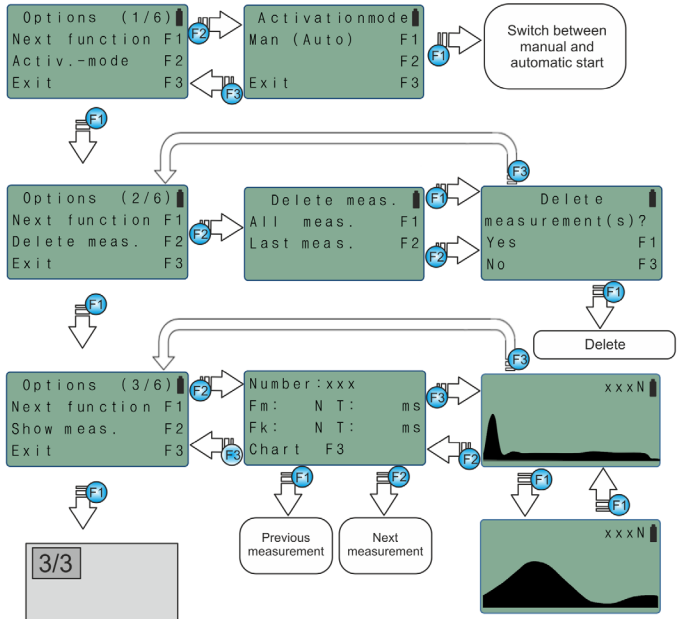
In the following menu trees, the softkeys are labeled F1, F2 and F3.

Pressing the designated softkey executes a function, switches between setting options or navigates in menus.

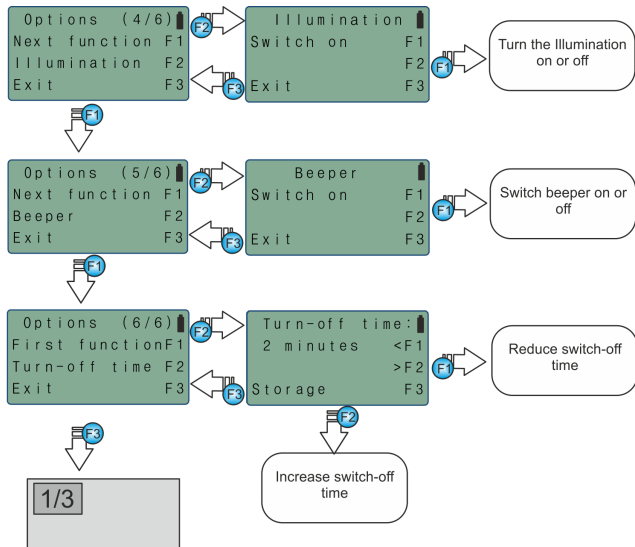
Fig. 11: Menu Navigation CBSF-Basic



2/3



3/3



## 9 Damping Element K1 and Spring Rate K2

The compression properties of, for example, muscle tissue to fat tissue or to surfaces of the body less covered such as fingers differ. Also, the biofidel property related to the pain sensation and the injury risk is different. The body resistance must also be taken into account.



### **Biofidel setup**

To create a biomechanical or biofidelic setup, specified compression elements K1 and K2 have to be used.

- The damping elements K1 simulate the biomechanical property of body surfaces.
- The spring rate K2 simulates the biofidelic body resistance.

The K1 damping elements are classified by Shore hardness. Colors are assigned to the different Shore hardness. The correct damping element is determined by the color:

Color	Shore-hardness
Green	10° Shore A +/- 7
Blue	30° Shore A +/- 5
Red	70° Shore A +/- 5

The Shore hardness of the K1 damping elements can change with aging. The manufacturer recommends replacement after one year as part of the calibration service. If the K1 damping elements are exposed to special conditions such as high ambient temperatures or contact with solvent containing liquids, it may be necessary to replace them earlier.



### **Spring rate K2**

The K2 spring rates are special springs built into the CoboSafe CBSF force sensors. They enable a correct simulation of the biofidelic body resistance. The springs (K2) of the manufacturer are all tested for suitability and are subject to strict selection criteria.

## 10 Preparing for Measurement

The force sensors CoboSafe-CBSF are the fundamental device for force and pressure measurements. The measuring device is positioned at the collision points determined for the application. The additional damping element K1 is placed on the measuring surface, when this is defined in the test specification and included in the configuration of the measurement plan.

Depending on the measuring plan, a pressure measuring film from the CoboSafe-Scan or CoboSafe-Tek system is placed on the damping element K1 or directly on the measuring plate (Fig. 9). The collision measurement is carried out with this setup.

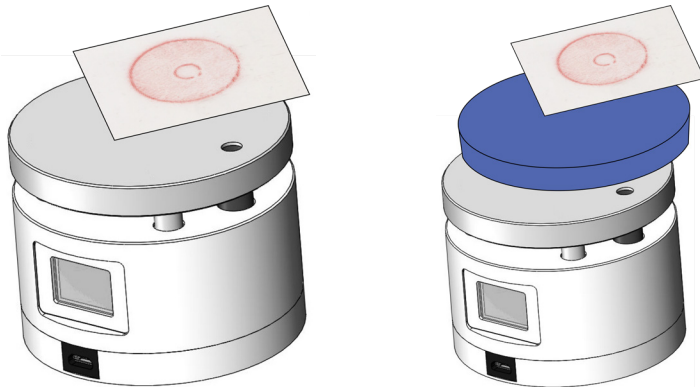


Fig. 12: Measurement setup without and with K1 damping element



Keep in mind that CoboSafe-CBSF has to acclimate to the surroundings for at least two hours before beginning the operation.

### 10.1 Safety When Preparing a Measurement

#### **⚠ CAUTION**

#### **Sharp edges**

Risk of cuts due to sharp edges!

- Only establish the measuring setup with completely deburred components.
- Wear personal protective equipment.

There is a risk of cutting injuries on edges that have not been deburred.

**⚠ WARNING**

**Tilting and falling components**

Risk of injury due to tilting and falling components of the measurement setup!

- Construct the measuring setup with care.
- If the setup with one person is not safely possible, get a second person to help.
- Wear personal protective equipment.

Hard and heavy components (e.g., aluminum profiles) are often handled and joined while the measurement setup is being established. Until these components are firmly connected, they can tilt or fall, causing severe crushing and impact injuries.

**⚠ CAUTION**

**Clamping point**

The clamping point is located in the red area between measuring surface and measuring body.

- The force sensor must be held in position during the measurement by means of a mounting adapter.

The force sensor must not be fixed manually during the measuring process, otherwise there is a risk of crushing. During the measurement, e.g., fingers can be squeezed in this area.

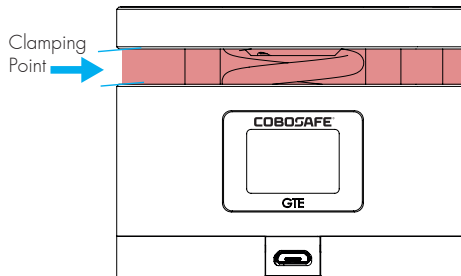


Fig. 13: Clamping point



## 10.2 Defining Measurement Target

The collision scenarios have to be defined before measurement begins. Body zones where potential collisions between robot work site personnel and robots have to be identified. The collision positions and collision vectors result from the determined scenarios for which collision measurement has to be performed.

The definition of possible collisions and the choice of force and pressure sensor must be taken into account when preparing the measurement environment and selecting the measurement points within CoboSafe Vision. The collision positions determine the body localizations and, if necessary, the specific localizations.

When selecting the measurement points, it must be considered that only the respective contact situations can be measured and evaluated.

## 10.3 Preparing the Measurement Environment

### WARNING

#### Requirements for the scaffold

Risk of injury from tilting scaffold!

- Ensure firm stand of the scaffold.
- Exclude the possibility of collision with other equipment (e.g., forklift).

If the scaffold is not anchored sufficiently and tilts, crushing and impact injuries may result.

We recommend that the measurement setup and the support surface is constructed from aluminum system rails from reputable manufacturers and that profiles with a cross-section of at least 40 x 40 mm be used.

The specific structure depends on the defined objective of the measurement.

**⚠ WARNING**

**Dangerous situations when handling the scaffold**

Ensure the following points when erecting the scaffolding:

- The contact surface for the force sensor must have a minimum spring constant of 2000 N/mm in the direction of the collision vector.
- The pre-set position of the measuring point is guaranteed.
- Sufficient stability is ensured (e.g., by anchoring in the foundation or support struts) to prevent tilting due to collisions and/or weight forces of the force sensor.
- Sufficient firmness is ensured to absorb the total weight of the measuring unit and the force resulting from the collision.
- To erect the scaffolding, always work in accordance with the according regulations on site.
- Wear personal protective equipment according to the instructions: Protective clothing, safety shoes, protective gloves and industrial safety helmet are necessary.
- Properly handle heavy and bulky parts with two persons or with lifting equipment.

Serious injuries from falling components are possible.



**Use safety factor 3 for firmness calculations.**

**Requirements for the contact surface**

The contact surface for the CoboSafe-CBSF force sensor must ensure a secure hold. If the measuring setup is manufactured as recommended using aluminum profile rails, the following minimum requirements for the contact surface are generally met:

- The normal vector (Fig. 14/2) of the contact surface (Fig. 14/3) forms a line with the collision vector (Fig. 14/1).
- The contact surface is flat. Do not use obviously curved surfaces.
- The minimum contact area is 80 mm x 80 mm.

If the mounting adapter is to be mounted in a groove of the aluminum profile rail, e.g., using sliding blocks, an additional free groove of at least 140 mm must be available.

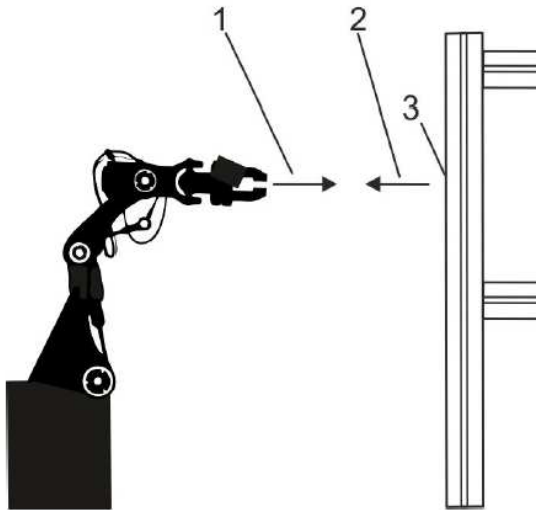


Fig. 14: Example: Robot with rail framework for mounting the assembly adapter

## 10.4 Robot Parameters

### NOTICE

#### Set robot parameters

Material damage due to high collision speeds, forces and pressures!

- Only combine measurement units as described in this manual.
- Carefully plan collisions and document the planning.
- Design collision kinematics carefully and iteratively.
- Always test at greatly reduced speeds first.
- Then slowly increase the speeds.
- Finally, achieve the intended operating conditions at the collaboration workstation.

If the robot exceeds the application limits of the force and pressure sensors during the collision, material damage to the measuring system can result.



**Consider robot operation safety settings from ISO/TS 15066.**

**Guide travel path collision:**

Personnel	Personal Protective Equipment
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ System integrator</li> <li>■ Robot operator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective equipment required by the robot manufacturer</li> </ul>

The collision kinematics on the robot are determined by defining the robot parameters. The determination must be made according to the objective of the measurement.

- ▶ Carefully plan the adaptation of the robot parameters. Consider the following:
  - The vector of the robot movement is normal to the measuring surface of the sensor.
  - Vector of the robot movement hits the measuring surface centrally
- ▶ Test collision movement without mounted force sensor.
- ▶ Begin with strongly reduced speeds and slowly approach the realistic collision conditions.

<b><i>i</i></b>	<p><b>Test measurement of the parameters</b></p> <p>The specified parameters must be checked in the course of the measurement with a test measurement and, if necessary, repeatedly adjusted.</p>
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**10.5 Checking the Components**

The smallest unevenness on the measuring surface can have an influence on the measuring result. Therefore, clean the measuring surfaces before a collision measurement. Please observe the instructions in the ↗ chapter 'Checking and cleaning CoboSafe-CBSF'.

Personnel	Personal Protective Equipment	Material
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ System integrator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective clothing</li> <li>■ Protective gloves</li> <li>■ Safety footwear</li> </ul>	<ul style="list-style-type: none"> <li>■ Soft, lint-free cloth</li> <li>■ Detergents</li> <li>■ Reference weight</li> </ul>

Impurities (e.g. sand grains or metal chips) in the measurement setup can lead to considerable exceedances of the limit value during pressure measurement. All contact surfaces must therefore be cleaned before measurement. Damaged components of the measuring system prevent reliable measurement and must be replaced.

### 10.5.1 Testing Proper Functioning of Force Sensor

- ▷ Check the force sensor with a reference weight.

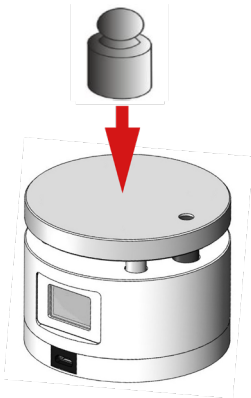


Fig. 12: Reference weight

- 1 ▶ Place CoboSafe-CBSF on a flat surface. The measuring surface must face up.
- 2 ▶ Carefully lower the reference weight onto the measuring surface and wait until the measurement begins.



#### Measurement start

Measurement starts at 20 N!

The measurement is running. After 5 seconds, the measurement result can be transferred to CoboSafe-Vision and displayed. If the measured force corresponds to the weight force of the reference weight applied, the force sensor functions as intended. If the measured value deviates, the force sensor is damaged.

- ⇒ The CoboSafe CBSF has been tested to confirm proper functioning.



#### Damaged force sensor

A damaged force sensor must not be used for measurement and must be replaced.

### 10.5.2 Checking and Cleaning the Collision Surface of the Robot

▷ Check and clean the collision surface of the robot.

- 1** ▶ Use a clean cloth.
- 2** ▶ Clean the collision surface of the robot. In particular remove coarse particles e.g. grains of sand or metal chips.
- 3** ▶ Ensure that the scaffolding and the contact surface meet the requirements of the measuring setup

⇒ All components have been tested and cleaned as described.

## 10.6 Attach CoboSafe CBSF to Contact Surface

### 10.6.1 Attaching Mounting Adapter to contact surface

▷ Attaching mounting adapter to contact surface

Personnel	Personal Protective Equipment
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ System integrator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective clothing</li> <li>■ Protective gloves</li> <li>■ Safety footwear</li> <li>■ Industrial safety helmet</li> </ul>

- 1** ▶ Prepare the measurement as described
- 2** ▶ Connect the mounting adapter to the contact surface, e.g., screw it into the aluminum profile rails using slot nuts.



Fig. 16: Mounting adapter

⇒ The mounting adapter is firmly connected to the contact surface.

### 10.6.2 Attach CoboSafe-CBSF to Mounting Adapter

▷ Attach the CoboSafe-CBSF to mounting adapter

Personnel	Personal Protective Equipment
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ System integrator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective clothing</li> <li>■ Protective gloves</li> <li>■ Safety footwear</li> </ul>

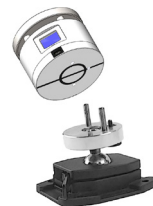
**1** ▶ Release the locking mechanism of the mounting adapter

Fig. 17: Release mounting adapter



**2** ▶ Attach the force sensor to the bolts of the mounting adapter

Fig. 18: Attach CBSF



- 3 ▶** Fix the force sensor to the mounting adapter using the thumbscrew.



Fig. 19: Fix CBSF

- 4 ▶** Align the force sensor. Consider collision vector.

- 5 ▶** Close locking mechanism.



Fig. 20: Locking

⇒ The CoboSafe-CBSF is firmly connected to the contact surface.

The mounting adapter is firmly connected to the contact surface. The force sensor is fixed in its position and firmly connected to the mounting adapter. The surface normal of the measuring surface lies on a line with the collision vector. The measuring unit can be established.

### 10.7 Mounting the K1 Damping Element

The measurement plan from the CoboSafe-Vision evaluation software specifies whether and which K1 damping element is to be used. The damping elements are recognizable by their color. Remove the K1 damping element from the case and place it on the measuring surface of the CoboSafe-CBSF.

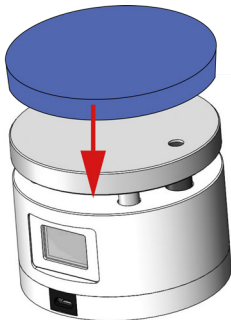


Fig. 21: CoboSafe-CBSF with damping element K1



## 10.8 Applying Pressure Measuring Film

When the damping element K1 has been correctly mounted on the force sensor - if required according to the measuring plan - the pressure measuring sensor (pressure measuring film) is positioned on the measuring surface. The pressure sensor must be securely positioned. Simple aids may have to be used for this purpose.

For detailed information, please refer to the separate product instruction manual for the respective pressure measurement method.

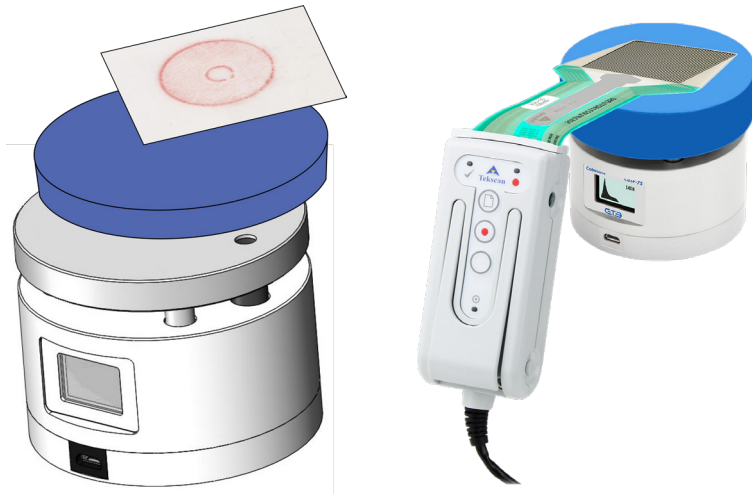


Fig. 22: Measuring setup with CoboSafe-Scan and CoboSafe-Tek

## 11 Performing Measurement

Once the measuring device is positioned properly, measurement can begin.

After completion of the first measurement, the results can be assessed in CoboSafe-Vision. If the permissible limit values are exceeded, measures must be taken to reduce the effects of force and pressure. Possible measures are for example changes of the robot parameters (e.g., the speed). If these measures are not sufficient, additional measures may have to be taken, such as buffers on sharp edges.

A new measurement is then performed at this collision point. The measurement is repeated until the corrective measures take effect and the results are below the limit values.

<b><i>i</i></b>	<p><b>Test measurements</b></p> <p>The initial test measurements can be performed without pressure measurement to save consumables. The results of force measurement appear on the CBSF-XS display. If the application is such that the forces are below the threshold values, pressure measurement can be added.</p>
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<b><i>i</i></b>	<p><b>Measurement numbers</b></p> <p>Each measurement is assigned a number. It is advisable to note the number of a completed force and pressure measurement on the CoboSafe-Scan pressure image. This enables it to be later correlated to the force measurement.</p>
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**⚠ WARNING**

**Dangerous robot motion**

Risk of crush and collision between robot and measuring device!  
 The collision situation to be measured can be dangerous.

- Do not reach into the collision range during measurement and keep a safe distance away from collision range.
- Perform collisions only with the properly prepared measuring device.

Body parts between the robot and the measuring device can be pinched or bumped.

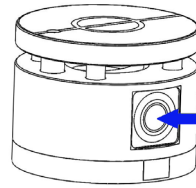
**11.1 Performing a Measurement with the CoboSafe-CBSF**

Personnel	Protective equipment
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ Robot operator</li> <li>■ System integrator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective clothing</li> <li>■ Protective gloves</li> <li>■ Safety footwear</li> <li>■ Industrial safety helmet</li> <li>■ Protective equipment required by the robot manufacturer</li> </ul>

**1** ▶ Make sure that the measurement is prepared as described (see chapter "Preparing the measurement").

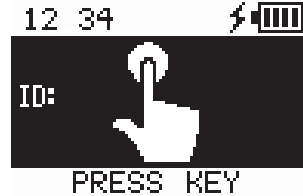
- 2 ▶** Switch on the force sensor by pressing the pushbutton

Fig.23: Pushbutton



- 3 ▶** Read and note the displayed measurement number.

Fig.24: Measurement number



- 4 ▶** Start robot movement.  
The robot moves in the intended vector and collides centrally with the measuring unit.
- 5 ▶** Wait until the CoboSafe-CBSF displays a message on the display indicating that the measurement has been performed.  
The measurement data of the force measurement are stored in the internal memory.
- 6 ▶** End the contact situation according to the instructions in the robot's manual.
- 7 ▶** Remove and separate the measuring unit.
- 8 ▶** Carefully remove the microfibre cloth
- 9 ▶** Carefully loosen fixing aids such as adhesive tape
- 10 ▶** Carefully remove the pressure measuring film.
- 11 ▶** Remove the K1 damping element and stow it in the transport case.



**When using the measuring system CoboSafe-Scan: Scan films promptly!**

The film "C" of the pressure measuring system CoboSafe-Scan is reddish in the area of the contact. Film "C" must now be scanned promptly to quantify the measurement data. Please read the operating manual of CoboSafe-Scan.

## 12 Transmitting Measured Data CoboSafe-CBSF

The force measurements performed are stored and indexed in the CoboSafe-CBSF. The record receives the following information:

- Date
- Time
- Measurement number
- Device type
- Damping element K1 used
- Ambient temperature during measurement
- Humidity during measurement

The data can be transferred wirelessly to CoboSafe-Vision or via USB cable. For more information, please refer to the „CoboSafe-Vision Operating Manual “.

### 12.1 Transmitting Measured Data CoboSafe-CBSF-Basic

The data set stored by CBSF-Basic contains only the measurement number and no additional data. Supplementary parameters are defined when importing into the CoboSafe-Vision software.

### 12.2 Wireless Data Transmission

To be able to transmit data wirelessly, wire transmission has to be activated by selecting “ON” in the wireless menu. Read to chapter “Menu Navigation” to learn about this. The range of wireless transmission is about 20 meters under normal conditions. It may be restricted by external factors. If transmission is restricted or not possible at all, use a USB cable for transmission.

Not with CoboSafe-CBSF-Basic!

### 12.3 Transmission via USB Port

Use the included USB cable to transfer the data. Plug the cable into the Micro-USB connection socket of the CoboSafe-CBSF and into the USB socket of the PC. For more information on data transmission, refer to the „CoboSafe-Vision Operating Manual “.

<b><i>i</i></b>	Only a shielded USB cable approved by the manufacturer may be used to connect the CBSF to the PC.
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### 13 Maintaining Functionality

The CoboSafe-CBSF force measuring devices should be inspected before and after measurement to ensure proper functioning. Look for apparent damage and excessive pollution. Never use a damaged device.

If there is any uncertainty regarding proper functioning or precision, e.g., because the device has been dropped or shows damage, the CoboSafe-CBSF should be sent to the manufacturer to be inspected.

#### 13.1 Maintenance Schedule

Inspection Interval	Maintenance Tasks	Personnel
Before each measurement	Inspection and cleaning	Laboratory scientist, System integrator
After each measurement	Inspection and cleaning	Laboratory scientist, System integrator
After approx. 20 operating hours or when indicated	Charging batteries	Laboratory scientist, System integrator
Annually	Calibration of CoboSafe-CBSF	Manufacturer or certified service personnel
	Replacement of damping elements K1	Laboratory scientist, System integrator
Every 2 years	Replacing batteries	Manufacturer
After updating standards or in case of wear	If necessary, replace damping elements K1, firmware update	Manufacturer

#### 13.2 Checking and Cleaning

Instructions for checking and cleaning CoboSafe-CBSF force sensors and K1 damping elements.

Personnel	Personal Protective Equipment	Materials
<ul style="list-style-type: none"> <li>■ Laboratory scientist</li> <li>■ System integrator</li> </ul>	<ul style="list-style-type: none"> <li>■ Protective clothing</li> <li>■ Protective gloves</li> <li>■ Safety footwear</li> </ul>	<ul style="list-style-type: none"> <li>■ Soft, lint-free cloth</li> </ul>

### 13.2.1 Checking and Cleaning CoboSafe-CBSF

▷ Checking and cleaning CoboSafe-CBSF

- 1** ▶ Wipe the measuring surface and housing with a clean cloth.  
In particular, remove coarse particles (e.g., grains of sand or metal chips).  
If present: Remove adhesive residue.
- 2** ▶ Use a soft cloth to clean the display on the device as well. Verify that the screen is clearly legible.
- 3** ▶ Check measuring surface for external damage.



#### **Damage to CoboSafe-CBSF**

If there is no damage apparent on the housing or the measuring surface, inspection is completed. Please contact the manufacturer in the event of damage.

⇒ Inspection and cleaning of the device are completed.

### 13.2.2 Inspecting and Cleaning Compression Elements K1

▷ Regularly check your K1 damping elements

- 1** ▶ Check the surfaces of the compression elements K1 for external damage.
- 2** ▶ Clean the K1 damping elements, if necessary.
- 3** ▶ Bend the damping element slightly and check for porosity.  
Porous damping elements show lasting cracking when bent. A porous damping element K1 may not be used and must be replaced.
- 4** ▶ Carefully wipe the surfaces of the compression elements with a cloth:
  - SH 10 and SH 30: Use a dry cloth.
  - SH 70: Use a damp cloth.

⇒ The damping element is free of impurities and ready for use.

### 13.3 Recharging Batteries

The specifications of the charger can be found in the manufacturer's documents and on the type plate. If the specification does not correspond to the country-specific specifications and designs, the charger must be replaced. The technical data for charging voltage and maximum charging current must be observed.

Battery charging can be performed using the following options:

- Charging by charger. The specifications can be found in the technical data.
- Charging via the USB port of the PC.



#### **Cyclic Charging**

Charge the device at regular intervals, especially during prolonged periods of inactivity!

### 13.4 Replacing Batteries

The battery cannot be replaced by the operator. In the course of annual calibration by the manufacturer, the batteries and their charging cycles are checked and replaced if necessary. Batteries are replaced at the latest every two years.

### 13.5 Calibration

Calibration of the force sensors is necessary to ensure the measuring capability of the system. To have the measuring system calibrated, contact customer service. Customer service can name a contact person for you or coordinate the next steps. The measuring system can be mailed to the manufacturer to have it calibrated.

#### 13.5.1 CoboSafe-CBSF Inspection Date

A label on the device indicates when the force measuring device has to be inspected and calibrated by the manufacturer; refer to  chapter "Signs and Labels" (inspection date).

#### 13.5.2 Calibration by a Certified Laboratory

The force measuring device can be calibrated by a lab accredited according to DIN EN ISO/IEC 17025.

We recommend having calibration performed by the manufacturer.

The calibration of the measuring unit for temperature and humidity is not possible.

### **13.5.3 Temperature/Humidity**

The integrated thermometer and hygrometer are calibrated along with the CBSF measuring devices.

If calibration is not possible for various reasons, an external suitable measuring instrument must be used to determine the parameters.

### **13.5.4 K1 Damping elements**

The damping elements K1 are checked by the manufacturer for compliance with their specification during calibration of the CBSF-XS.

Otherwise, the damping elements K1 should be replaced when worn or at the latest once a year.

### **13.5.5 Spare Parts**

Use only original spare parts or parts approved by the manufacturer. Spare parts can be obtained from GTE Industrieelektronik GmbH. Please contact customer service for assistance.

### **13.5.6 Firmware Update**

Firmware is updated via the CoboSafe-Vision software (this does not apply to CBSF-Basic).

## **14 Properly Storing CoboSafe-CBSF**

- Ensure prescribed storage conditions (Refer to chapter "Technical Data")
- Always store CBSF-XS devices in the included transport cases.
- Store CBSF-XS devices such that they are not exposed to shaking or vibrations.



## 15 Detecting and Remedying Malfunctions

Error description	Cause	Remedy	Personnel
Force measurement repeatedly exceeds limit values	Wrong selection of robot parameters.	Adjust robot parameters	Laboratory scientist, System integrator
	CoboSafe-CBSF incorrectly calibrated	Have CoboSafe-CBSF calibrated	Manufacturer
	CoboSafe-CBSF defective	Check CoboSafe-CBSF and have it repaired. Contact customer service	Manufacturer
Display on CoboSafe-CBSF is blank when device is switched on.	Batteries empty	Charge batteries,	Laboratory scientist, System integrator
	Batteries defective	Have CBSF checked and repaired. To do this, contact customer service	Manufacturer
No wireless data transmission.	Wireless deactivated.	Activate wireless	Laboratory scientist, System integrator
	Too much distance between CoboSafe CBSF and laptop.	Use USB cable to transfer data.	Laboratory scientist, System integrator
#1	Device not started successfully. Internal error	Restart device	Laboratory scientist, System integrator
		Send device to manufacturer to be checked	Manufacturer
#2	Module defective	Device must be sent to the manufacturer to be repaired	Manufacturer
#3	Weight on device before started	Restart the device	Laboratory scientist, System integrator
#4	Memory full	Delete stored measured values	Laboratory scientist, System integrator

## 16 Technical Data

### 16.1 Technical Data Force Sensor CoboSafe-CBSF

#### Weight and dimensions (mm):

Specification	Value	Unit
Weight	<> 790	g
Diameter	80	mm
Height	60 ... 107	mm
Measuring surface Diameter	80	mm
Measuring surface Height	60 ... 107	mm

#### Performance data:

Specification	Value	Unit
Measuring range CoboSafe-CBSF-10	20 ... 300	N
Measuring range CoboSafe-CBSF-25	20 ... 500	N
Measuring range CoboSafe-CBSF-30	20 ... 400	N
Measuring range CoboSafe-CBSF-35	20 ... 500	N
Measuring range CoboSafe-CBSF-40	20 ... 500	N
Measuring range CoboSafe-CBSF-50	20 ... 500	N
Measuring range CoboSafe-CBSF-60	20 ... 500	N
Measuring range CoboSafe-CBSF-75	20 ... 500	N
Measuring range CoboSafe-CBSF-150	20 ... 500	N
Maximum pressure on measuring surface	1 500	N/cm <sup>2</sup>
Measurement inaccuracy, typical	±1	%
Measuring error maximum, in measuring range (from end value)	±3	%
Sampling rate	≥ 1	kHz
Voltage supply	3,7	V (DC)
Power consumption	500	mA
Capacity of internal memory (single measurements)	>100	piece

Specification	Value	Unit
Interface, Type	USB/Wireless	
Spring constant CoboSafe-CBSF-10	10	N/mm
Spring constant CoboSafe-CBSF-25	25	N/mm
Spring constant CoboSafe-CBSF-30	30	N/mm
Spring constant CoboSafe-CBSF-35	35	N/mm
Spring constant CoboSafe-CBSF-40	40	N/mm
Spring constant CoboSafe-CBSF-50	50	N/mm
Spring constant CoboSafe-CBSF-60	60	N/mm
Spring constant CoboSafe-CBSF-75	75	N/mm
Spring constant CoboSafe-CBSF-150	150	N/mm

**Operating conditions:**

Specification	Value	Unit
Relative humidity, non-condensing	20 ... 90	% RH
Temperature	+10 ... +30	°C

**Storage conditions:**

Specification	Value	Unit
Relative humidity, non-condensing	20 ... 90	% RH
Temperature	+10 ... +30	°C

**16.2 Technical Data CoboSafe CBSF-Basic****Weight and dimensions (mm):**

Specification	Value	Unit
Weight	1400	g
Measuring surface diameter	80	mm
Measuring surface height	70	mm
Length incl. handle	310	mm
Width	80	mm

**Performance Data:**

Specification	Value	Unit
Voltage supply	2,4	V
Measured curve memory	100	pieces
Measuring range	20 ... 500	N
Maximum pressure, on measuring surface	1500	N/cm <sup>2</sup>
Measuring inaccuracy, typical value	± 1	%
Measuring error, maximum ( in measurement range	± 3	%
Spring rate (SI)	75	N/mm
Spring rate (SAE)	428,26	lb/in
Sampling rate	≥ 1	kHz
Port, type	USB-mini	-
Charging batterie	2	hour
Battery life	8	hour
Charging current	500	mA

**Operating conditions:**

Specification	Value	Unit
Relative humidity, non-condensing	20 ... 90	% RH
Temperature	+10 ... +30	°C

**Storage conditions:**

Specification	Value	Unit
Relative humidity, non-condensing	20 ... 90	% RH
Temperature	+10 ... +30	°C

### 16.3 Technical Data Accessories

Specification	Value	Unit
Nominal voltage, primary side	100 ... 230	V (AC)
Nominal voltage, secondary side	5	V
Charging current	0,7 ... 1,2	A

### 16.4 Requirements for Measurement Setup

#### Mechanical requirements contact surface:

Specification	Value	Unit
Stiffness measuring points	> 2000	N/mm
Contact surface	80 x 80	mm



#### Requirements bearing surface

The stated values represent recommendations of the manufacturer.

### 16.5 Requirements for Temperature and Humidity Measurement

#### Temperature measurement:

Specification	Value	Unit
Measurement inaccuracy	$\pm 5$	$^{\circ}\text{C}$

#### Humidity measurement:

Specification	Value	Unit
Measurement inaccuracy	$\pm 3$	% RH

## 17 Customer Service

Scope of customer service	<ul style="list-style-type: none"> <li>■ Mediation of authorized contact persons for the calibration</li> <li>■ Spare part orders</li> <li>■ Assistance with problems with the measuring system</li> </ul>
Phone	Customer service is available from Mo - Thu from 8:00 to 16:00 (08 AM – 04 PM) Fridays from 8:00 to 14:30 (08 AM – 02:30 PM) +49 2162 3703-0
E-mail	cobosafe@gte.de
Postal address	GTE Industrieelektronik GmbH Customer Service Helmholtzstraße 21 41747 Viersen, Germany
Further information	www.cobosafe.com

## 18 Disposal

### NOTICE

#### Improper disposal

Environmental damage due to improper disposal!

- Do not dispose of the measuring system in residual waste.
- Dispose of all components according to regulations at the place of use.

The measuring system contains components that can damage the environment if disposed of improperly.

### 18.1 Disposal by the Manufacturer

The measuring device can be returned for disposal by the manufacturer at the end of its service life. Contact customer service before sending the device.

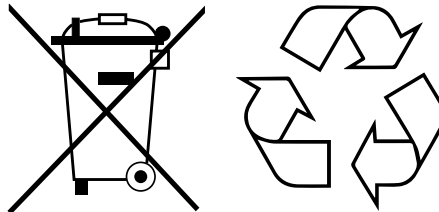


Fig. 24: Disposal

## 19 Appendix: Dimension drawing mounting adapter:

Dimension drawing of mounting options on the CoboSafe-CBSF for holding auxiliary tools  
(Drawing not to scale)

