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Operating Manual

Pressure Measurement Set CoboSafe-Tek

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This operating manual describes the pressure measurement procedure CoboSafe-Tek and its handling. The measuring method is part of a system and can only be used in conjunction with the following components:

- Software CoboSafe-Vision
- Force gauge from the CoboSafe-CBSF product series



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

Pay special attention to the associated document "CoboSafe – General Safety Instructions" as well as the safety instructions and warnings in this document in order to prevent injuries and product damage. Keep this documentation handy for future reference. Share this documentation with future users of the product.

Associated with this manual is the document:

- CoboSafe – General Safety Instructions

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1 About this Manual


This operating manual describes the pressure measurement procedure CoboSafe-Tek and its handling. The measuring method is part of a system and may be used only in conjunction with the following components:

:

- CoboSafe-Vision
- CoboSafe-CBSF and variants

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 "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">■ 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 readily accessible to personnel at all times.■ Operating personnel must read the entire manual and be familiar with the product before beginning any work.■ 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 associated CoboSafe manuals.■ In addition, the local accident prevention regulations and general safety regulations apply to the area of application of the measuring system.
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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.

Warnings	
	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 injuries 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 which 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:

Symbol	Explanation
	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.

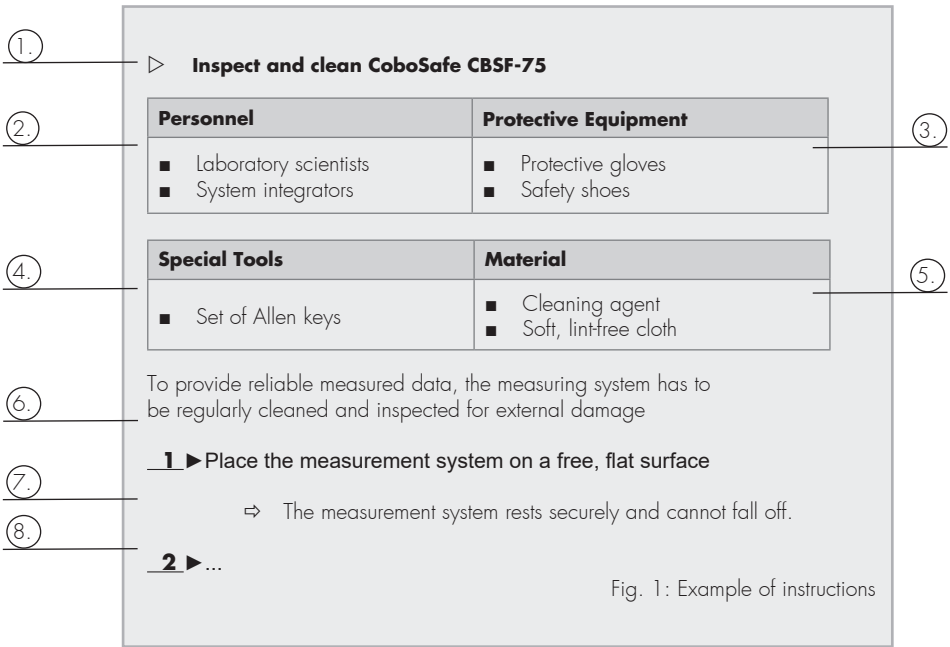


Fig. 1: Example of instructions

Explanations to the figure "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 "Qualification Required of Personnel" in the document "CoboSafe – 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 document "CoboSafe – 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-Tek is a pressure measurement method used to determine the pressure forces and pressure distribution in collisions with collaborating robots. The pressure values are calculated using the CoboSafe-Vision software on the basis of the underlying standards and publications (Read the related document 'CoboSafe – General Safety Instructions', ➤ chapter 'Underlying Standards and Information Material'). CoboSafe-Tek 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.

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 Risks

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

3 Brief Description

The pressure measurement system consists of hardware components and the software CoboSafe-Vision. Using hardware components, the pressure signals of the film sensor are recorded and transmitted to the software. The pressure measurement takes place simultaneously with the force measurement. The software synchronizes the force measurement with the pressure measurement and calculates the force and pressure values. It visualizes the pressure distribution in different colors and creates a pressure illustration over the course of the pressure effect. The application-oriented evaluation is realized by our software CoboSafe-Vision.

4 Scope of Delivery



Fig. 2: Scope of delivery

- Transport case
- USB stick with equilibration files and user manual
- CAT5 network cable and RJ45 connector
- Versa Tek Sensor Handle
- USB transfer cable
- Versa Tek 8-Port Hub
- Film sensors with different resolutions, Type 5051 or 5027

5 Hardware Components

5.1 Safety Information

NOTICE

Property damage by incorrect connection to the PC

- The VersaTek Handle must only be inserted in the VersaTek Hub.
- Only high-quality USB cables approved by the manufacturer may be used.

Incorrectly connecting the VersaTek handle to the PC can cause property damage.

NOTICE

Material damage caused by external influences on the VersaTek handle.

- Avoid impacts, falls and high loads.
- Avoid liquids, dirt, or dust from entering the VersaTek Handle.

Improper use of the VersaTek Handle may cause damage to the hardware component.

5.2 Overview VersaTek Handle



The VersaTek Handle captures the pressure sensor data and transmits it to the VersaTek Hub. The VersaTek Handle cable is a shielded CAT5E cable with RJ45 connector. If required, it can be easily extended to a maximum of 30 m with an RJ45 extension cable of the same quality without sacrificing performance.

The VersaTek Handle has a lug on the front, with which the handle is opened. In the 'open' position it retracts the contact pins and thus enables the insertion of the pressure measuring film. When the lug is closed, the contact pins are pressed against the contact points of the sensor.

Fig. 3: Overview handle

5.3 Overview VersaTek 8-Port Hub

The VersaTek Hub is used to convert the VersaTek Handle communication protocol to USB.

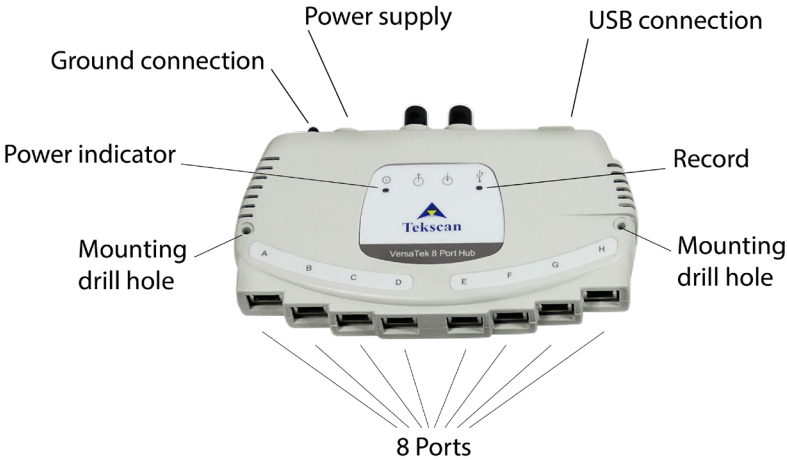


Fig. 4: Overview hub

5.4 Installing and connecting the components

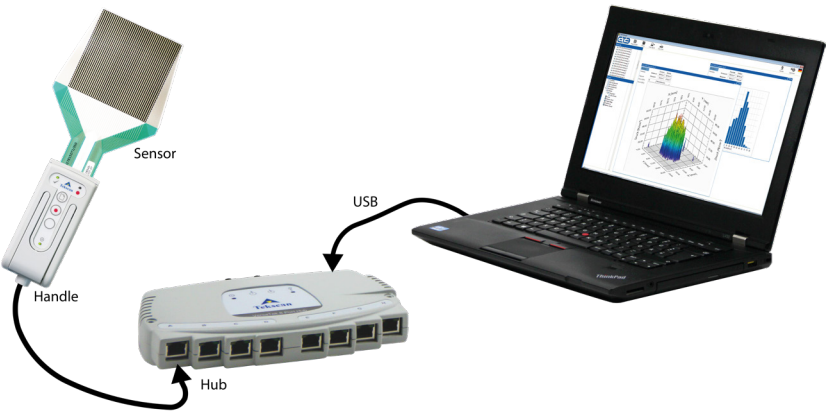


Fig. 5: Connecting the components

6 Updates and Upgrades

The updating and further development of peripherals and software is necessary due to normative adaptations. The changes are provided by the manufacturer in the form of upgrades and updates. In order to maintain full functionality, updating to the latest version is necessary and must be ensured.

Information about important changes can be obtained using the CoboSafe-Vision software. When the PC software CoboSafe-Vision is started, the version status is automatically queried online. The information window also informs about changes to the CoboSafe-Tek system.

After updating the current status, the current instructions for use are also available. The operating instructions must be available in printed form (Read the related document 'General Safety Instructions'). If hardware components are required, please contact the service cobosafe@gte.



An update may require adjustment of the pressure measurement system. An update and upgrade must then be carried out to ensure correct evaluation via the software.

7 Information about the Pressure Measuring Film

The pressure measuring films are available in different pressure ranges and resolutions. Types 5051 and 5027 are used for measurements with CoboSafe-CBSF.

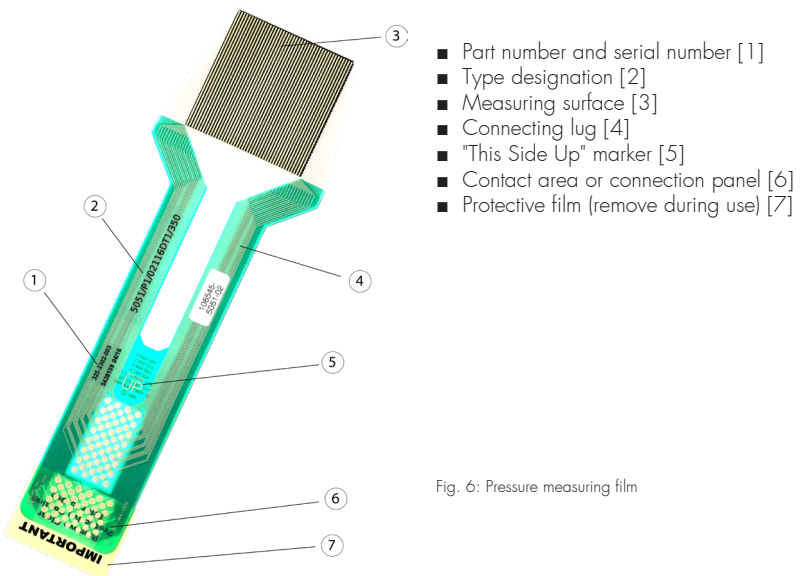


Fig. 6: Pressure measuring film

7.1 Functionality of the Pressure Measuring Film

The film sensor is an ultra-thin, flexible circuit board. The measuring surface consists of pressure-sensitive points which are also referred to as 'sensor elements', 'sensels' or 'cells'. Each sensor cell behaves in the circuit like a variable electrical resistance. In the unloaded state, the resistance is high and decreases under load. The output value is converted into a digital value via the handle and assigned to a scale of 0-255 RAW (raw data value).

The sensor cells are arranged in rows and columns. Conductor tracks connect the sensor cells to the contact points in the connection panel via the terminal lug.

The top of the pressure sensor is marked 'This Side Up' near the connection panel. The connecting lug must be inserted into the handle in such a way that the marking is on the upper side of the lever, i.e. on the side of the lug.

7.2 Safety Information when handling the pressure measuring film

NOTICE

Defect of the pressure measuring film

Improper handling of the pressure measuring film may cause damage to property.

- Do not force the pressure measuring film into the handle
- Avoid drawing on the inserted pressure measuring film.
- Act free of load when handling the pressure measuring film.
- Avoid sharp objects.
- Avoid slipping or sliding collisions.
- If necessary, use Teflon foil with a thickness of 0.05 mm on the measuring surface.
- Use an equilibration file that corresponds to the current state of the pressure measuring film.



For strong visible kinks, the pressure measuring film should be re-equilibrated. However, equilibration should take place once a year. Replace heavily damaged pressure measuring films.



The correct specification of the types used is required for the evaluation. An incorrect type specification will generate incorrect measured values.

⚠ WARNING

Personal injury due to incorrectly classified robots

- Make sure that there is no surface change of the pressure sensor.
 - Make sure the correct equilibration file has been used.
- Wrongly classified robots can cause serious injuries to collaborating personnel.

7.3 Durability

Tekscan pressure films have an unlimited shelf life. The shelf life is affected by use and traces of use.



Regular equilibration extends the durability of the pressure measurement film.

7.4 Storage

After use, return the pressure sensors to a protective container. Protect the packaging unit from moisture.

7.5 About the Measurement Data

The pressure measurement is carried out in combination with the force measurement. The measured values are directly transmitted and evaluated. The pressure curve is synchronized to the force curve. This makes it possible to display both the force and the pressure value and the pressure distribution at the same time of the measurement. The pressure measurement method thus enables the quasi-static pressure to be determined.

The significance of the measurement results is limited exclusively to the respective contact situation.

7.6 Equilibration

The individual sensors of the pressure measuring film can produce different values under the same load. In order to generate a relevant measurement result, the values of the individual cells must be compared with each other using scaling factors. This is achieved by the process of equilibration. The result is a data set that contains a scaling factor for each cell. This data record is used for the evaluation.

A typical application for equilibration is also when the sensor is repeatedly loaded at the same physical location. Typically, the unloaded region of the pressure sensor retains its original sensitivity. The region that receives constant load changes, on the other hand, will change its sensitivity. This circumstance can be compensated with the aid of equilibration.

Further information on the process can be found in the CoboSafe-Vision user manual.

7.7 Calibration

The calibration of the pressure sensor is not necessary because only the pressure distribution has to be determined. The time course of the pressure measurement is calibrated to the force curve. This allows the pressure distribution and the application of force to be determined for the same point in time. The compression force is then calculated using the recorded force of the calibrated force sensor.

7.8 Datasheets Sensor

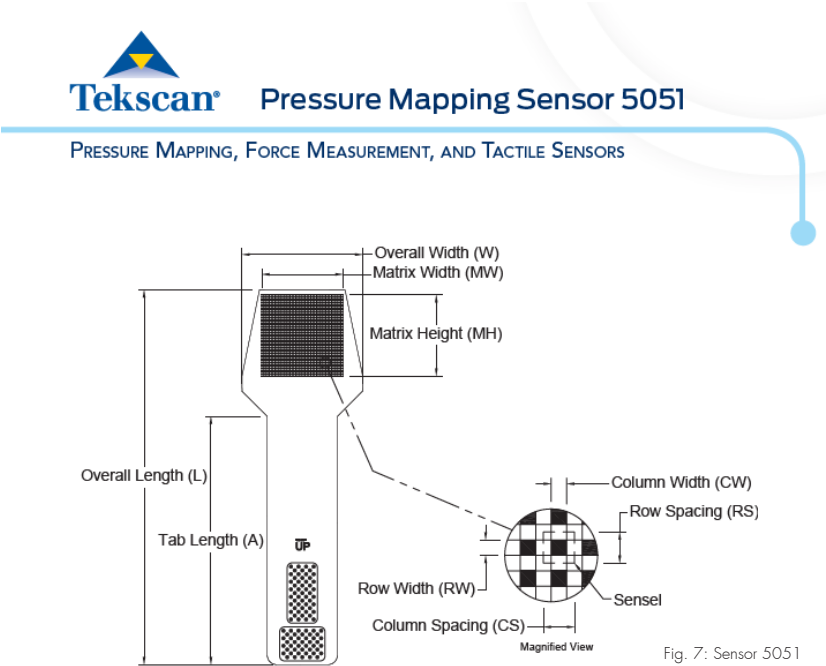


Fig. 7: Sensor 5051

General Dimensions					Sensing Region Dimensions						Summary	
Overall Length L	Overall Width W	Tab Length A	Matrix Width MW	Matrix Height MH	Columns Pitch		Qty.	Rows Pitch		Qty.	Total No. of Sensesl	Sensesl Spatial Resolution (sensesl per sq-cm)
(mm)	(mm)	(mm)	(mm)	(mm)	CW	CS		RW	RS			
252.5	81.3	166.2	55.9	55.9	0.8	1.3	44	0.8	1.3	44	1,936	62.0
(in)	(in)	(in)	(in)	(in)	(in)	(in)		(in)	(in)			(sensesl per sq-in)
9.94	3.20	6.54	2.20	2.20	0.030	0.050	44	0.030	0.050	44	1,936	400.0

Pressure Ranges									
kPa	48	345	1,034	2,413	3,448	8,274	17,238	34,475	172,375
psi	7	50	150	350	500	1,200	2,500	5,000	25,000

Tekscan® Pressure Mapping Sensor 5027

PRESSURE MAPPING, FORCE MEASUREMENT, AND TACTILE SENSORS

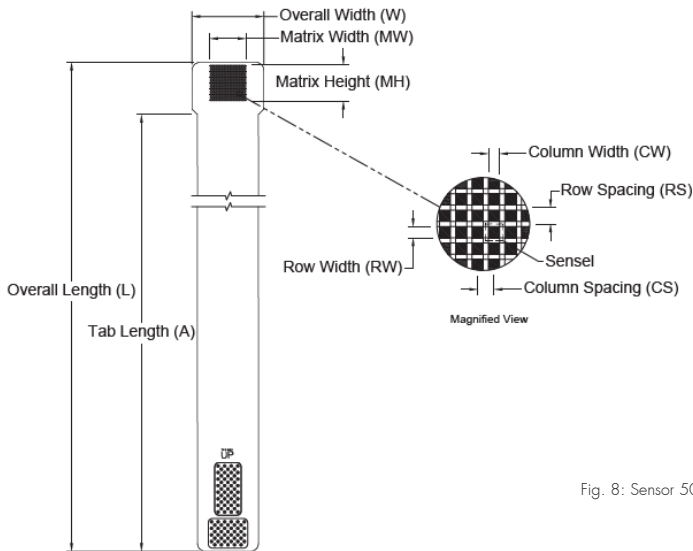


Fig. 8: Sensor 5027

General Dimensions					Sensing Region Dimensions							Summary	
Overall Length L	Overall Width W	Tab Length A	Matrix Width MW	Matrix Height MH	Columns			Rows			Total No. of Senses	Sensel Spatial Resolution	
(mm)	(mm)	(mm)	(mm)	(mm)	CW	Pitch CS	Qty.	RW	Pitch RS	Qty.			
508.0	55.7	467.6	27.9	27.9	(mm)	(mm)	44	(mm)	(mm)	44	1,936	(sensels per sq cm)	
20.00	2.19	18.41	1.10	1.10	0.008	0.025	44	0.008	0.025	44	1,936	(sensels per sq in)	

Pressure Ranges		
kPa	345	3,448
psi	50	500

8 Preparing the Measurement

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

8.1 Selecting Suitable Pressure Measuring film

If several pressure measuring films are available for selection, the selection of the sensor type depends on the expected pressure area and the expected maximum pressure. Generally, the pressure area should be at least one third of the sensor area.

In the case of objects with too sharp edges, the resolution of the sensor may not be sufficient, as only a few sensors are hit. The sensor can be hit differently during repeated measurements. This can lead to larger differences in the measurement results. The resolution of the sensor is then too low. If even the smallest film cannot address enough sensors, it may be more sensible to measure with the CoboSafe-Scan measuring system.

8.2 Testing and Cleaning

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 a reliable measurement and must therefore be replaced.

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

8.2.1 Checking pressure measuring film

- Damaged pressure sensors must not be used for the measurement. Check the pressure sensor for external damage (e.g., cracks, kinks).
- The areas to be used must be free of damage.
- Check whether a current equilibration file exists (CoboSafe-Vision).

8.2.2 Checking and Cleaning the Collision Surface of the Robot

Clean the collision surface of the robot (e.g., gripper) with a clean cloth. In particular, remove coarse particles (e.g., grains of sand or metal chips).

8.3 Inserting the Pressure Sensor

Personell

- Laboratory scientist
- System integrator

- 1 ►** Remove the protective foil from the pressure sensor.
- 2 ►** Open the lug of the handle.
- 3 ►** Align the mark 'This Side Up' of the pressure sensor with the handle.
- 4 ►** Insert the pressure sensor slowly and in a controlled manner without force into the opening slot until the stop can be felt.
- 5 ►** Close the lever.
- 6 ►** Control lamp 'Sensor ok' on the handle must light green.

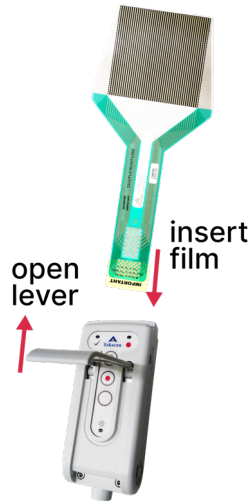


Fig. 9: Inserting pressure sensor in handle

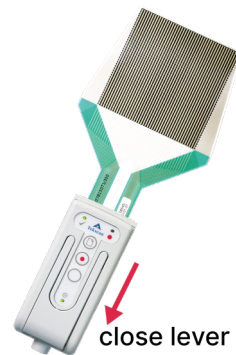


Fig. 10: Closing lug

⇒ You have correctly inserted the pressure measurement foil into the handle.

8.4 Positioning Pressure Sensor

After inserting the pressure sensor, the measuring surface is placed on the force measuring device CBSF.

Example CoboSafe-CBSF:

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

▷ Place the pressure measuring film on the force gauge CoboSafe-CBSF.

- 1 ▶** The specified compression element is displayed in CoboSafe-Vision in the measurement plan.
Position the specified compression element (Fig. 10/1) on the measuring surface of the CBSF force sensor.
- 2 ▶** Place the measuring surface of the pressure sensor (Fig. 10/2) on the compression element.
- 3 ▶** Carefully fix the applied film to the edges of the measuring surface, e.g., with adhesive tape.
- 4 ▶** If intended: Carefully cover the measuring unit with a microfibre cloth.



Fig. 11: Positioning the pressure sensor

⇒ The measuring unit is ready combined.

9 Perform Measurement

WARNING

Risk of injury due to collision between robot and measuring unit

- Do not intervene in the collision area during the measurement and keep distance to the collision area.
- Perform collisions only with the prepared measuring unit. If body parts get between the robot and the measuring unit, bruising and impact injuries can result.

▷ Perform a controlled measurement.

- 1 ▶** Start robot movement. The robot moves in the intended vector and collides centrally with the measuring unit.
- 2 ▶** Wait until a message on the force gauge display indicates that the measurement has been carried out.
- 3 ▶** End the contact situation according to the instructions in the robot manual. The measuring unit can be removed.
- 4 ▶** If used: Carefully remove the microfibre cloth. Carefully loosen the fixing adhesive tape. Remove pressure sensor.

⇒ The measurement was successfully performed.

10 Transferring Measurement Data

After the measurement time has elapsed, the force and pressure measurement data are automatically transferred to CoboSafe-Vision. The evaluation takes place via CoboSafe-Vision.

10.1 Temperature and Humidity

CoboSafe- CBSF devices have an integrated measurement and automatically transmit data for ambient temperature and humidity.

CBSF-Basic instruments require measurement by an external thermo-hygrometer.

11 Detectingand Remedying Malfunctions

Error description	Cause	Remedy
No data transmission	Pressure sensor has no contact	Insert the pressure sensor into the handle again. The green LED must light up.
	Pressure sensor in-correctly inserted	Insert pressure sensor correctly (see chapter 8.3)
	Cable not correctly plugged into the hub.	Check cable connections
	No mains voltage	Check power supply
Pressure measurement shows the maximum pressure over the whole surface	Unsuitable pressure sensor (measuring range too small)	Use a suitable pressure sensor.
	Collision forces too high	Reduce collision forces by changing the robot parameters
Pressure measurement exceeds limit values at certain points	Measuring surface of the CBSF force sensor dirty	Clean measuring surface
	Collision surface of the robot dirty	Cleaning the collision surface of the robot
Measuring surface has bends	Collisions with sharp-edged surfaces	Equilibrate pressure sensor or replace pressure sensor

12 Technical Data

Dimensions:

Device	Dimensions
VersaTek Handle	140 mm x 55 mm x 45 mm
VersaTek Hub	195 mm x 125 mm x 30 mm

Performance data:

Technical information	Value	Unit
Mains voltage	100 ... 240	VAC
Frequency	50 ... 60	Hz
Current consumption	1,2	A
Cable Handle – Hub	4,57	M
Cable Hub – PC	3	M
Connection Type	USB 2.0	
Transfer rate	Bis 20	KHz
VersaTek Hub Inputs	8	
Temperature range	-10 bis +55	°C
Relative humidity (non-condensing)	0 ... 90	%rF

12.1 Storage Conditions

12.1.1 Storage conditions pressure measurement film

Technical information	Value	Unit
Relative humidity (non-condensing)	35 ... 80	%rF
Temperature, recommended	<15	°C



Pressure sensors should be stored in a protected container. The size should be dimensioned so that no creases or wrinkles can occur.

12.1.2 Storage conditions for components

After use, the system components should be stored in the supplied transport case.

12.2 Requirements for Temperature and Humidity Measurement

Temperature measurement:

Technical information	Value	Unit
Measurement inaccuracy	$\pm 0,5$	°C

Humidity measurement:

Technical information	Value	Unit
Measurement inaccuracy	± 3	%rF

13 Customer Service

Scope of customer service	<ul style="list-style-type: none">■ Mediation of authorized contact persons for the calibration■ Spare part orders■ Assistance with problems with the measuring system
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

14 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.

14.1 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.

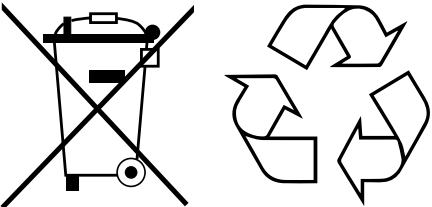


Fig. 12: Disposal

