



## Operating Instructions capa**NCDT** 6222

CS005  
CS02  
CSH02  
CSH02FL  
CS05  
CSE05  
CSE05/M8

CSH05  
CSH05FL  
CS08  
CS1  
CSE1  
CSE1,25/M12  
CSH1

CSH1FL  
CS1HP  
CSH1.2  
CSH1.2FL  
CSH2FL  
CSH3FL  
CS2

CSH2  
CSE2  
CSE2/M16  
CS3  
CSE3/M24  
CS5  
CS10

CSG0.50  
CSG1.00

Non-contact Capacitive Displacement Measuring

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## 1. Safety

System operation assumes knowledge of the operating instructions.

### 1.1 Symbols Used

The following symbols are used in these operating instructions:



Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.



Indicates a situation that may result in property damage if not avoided.



Indicates a user action.



Indicates a tip for users.

Measure

Indicates hardware or a software button/menu.

### 1.2 Warnings



Disconnect the power supply before touching the sensor surface.

- > Danger of injury
- > Static discharge

Connect the power supply and the display/output device according to the safety regulations for electrical equipment.

- > Risk of injury
- > Damage to or destruction of the sensor and/or controller



Avoid shocks and impacts to the sensor and controller.

- > Damage to or destruction of the sensor and/or controller

The supply voltage must not exceed the specified limits.

- > Damage to or destruction of the sensor and/or controller

Protect the sensor cable against damage.

> Destruction of the sensor

> Failure of the measuring device

### **1.3 Notes on CE Marking**

The following apply to the capaNCDT 6222:

- EU directive 2004/108/EU
- EU directive 2011/65/EU, "RoHS" Category 9

Products which carry the CE mark satisfy the requirements of the EU directives cited and the European harmonized standards (EN) listed therein. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, article 10, at:

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The measuring system is designed for use in industrial environments and meets the requirements.

## 1.4 Intended Use

- The capaNCDT 6222 measuring system is designed for use in industrial areas. It is used for
  - displacement, distance, thickness and movement measurement
  - position measuring of parts or machine components
- The system must only be operated within the limits specified in the technical data, [see 2.3](#).
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the system
- Take additional precautions for safety and damage prevention in case of safety-related applications.

## 1.5 Proper Environment

- Protection class: IP 40
- Temperature range:
  - Operation
    - Sensor: -50 ... +200 °C (-58 to +392 °F) <sup>1</sup>
    - Sensor cable: -100 ... +200 °C (-148 to +392 °F) (CCmx and CCmx/90)  
-20 ... +80 °C (-4 to +176 °F) (CCgx and CCgx/90 - permanently)  
-20 ... +100 °C (-4 to +212 °F) (CCgx and CCgx/90 - 10,000 h)
    - Controller: +10 ... +60 °C (+50 to +140 °F)
  - Storage
    - Sensor: -50 ... +200 °C (-58 to +392 °F) <sup>2</sup>
    - Sensor cable: -50 ... +200 °C (-58 to +392 °F) (CCmx and CCmx/90)  
-50 ... +80 °C (-58 to +176 °F) (CCgx and CCgx/90)
    - Controller: -10 ... +75 °C (+14 to +167 °F)
- Humidity: 5 - 95 % (non-condensing)
- Ambient pressure: Atmospheric pressure
- The space between the sensor surface and the target must have an unvarying dielectric constant.
- The space between the sensor surface and the target may not be contaminated (for example water, rubbed-off parts, dust, etc)

1) An operating temperature of -50 ... +100 °C (-58 to +212 °F) applies for the sensors CSG0.50-CA and CSG1.00-CA -50

2) A storage temperature of -50 ... +100 °C (-58 to +212 °F) applies for the sensors CSG0.50-CA and CSG1.00-CA -50

## 2. Functional Principle, Technical Data

### 2.1 Measuring Principle

The principle of capacitive distance measurement with the capaNCDT system is based on the principle of the parallel plate capacitor. For conductive targets, the sensor and the target opposite form the two plate electrodes.

If a constant AC current flows through the sensor capacitor, the amplitude of the AC voltage at the sensor is proportional to the distance between the capacitor electrodes. The AC voltage is demodulated, amplified and output as an analog signal.

The capaNCDT system evaluates the reactance  $X_C$  of the plate capacitor which changes strictly in proportion to the distance.

$$X_C = \frac{1}{j\omega C}; \quad \text{capacitance } C = \epsilon_r * \epsilon_o * \frac{\text{area}}{\text{distance}}$$

• **i** A small target and bent (uneven) surfaces cause a non-linear characteristic.

This theoretical relationship is realized almost ideally in practice by designing the sensors as guard ring capacitors.

The linear characteristic of the measuring signal is achieved for electrically conductive target materials (metals) without any additional electronic linearization. Slight changes in the conductivity or magnetic properties do not affect the sensitivity or linearity.

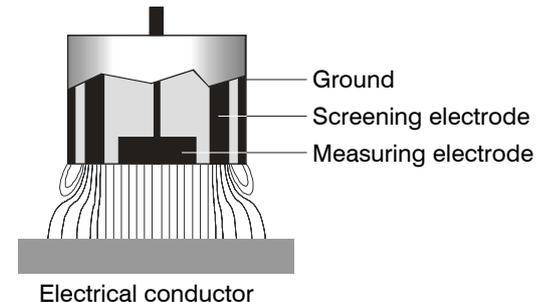


Fig. 1 Functional principle of the guard ring capacitor

## 2.2 Structure

The non-contact, multi-channel measuring system, installed in an aluminum housing, consists of:

- A basic module DT6222
- A demodulator module DL6222x with integrated preamplifier per sensor
- Sensor
- Sensor cable
- Power supply cable
- Ethernet cable
- Signal output cable

The modular assembly allows to join up to 4 channels (module system).

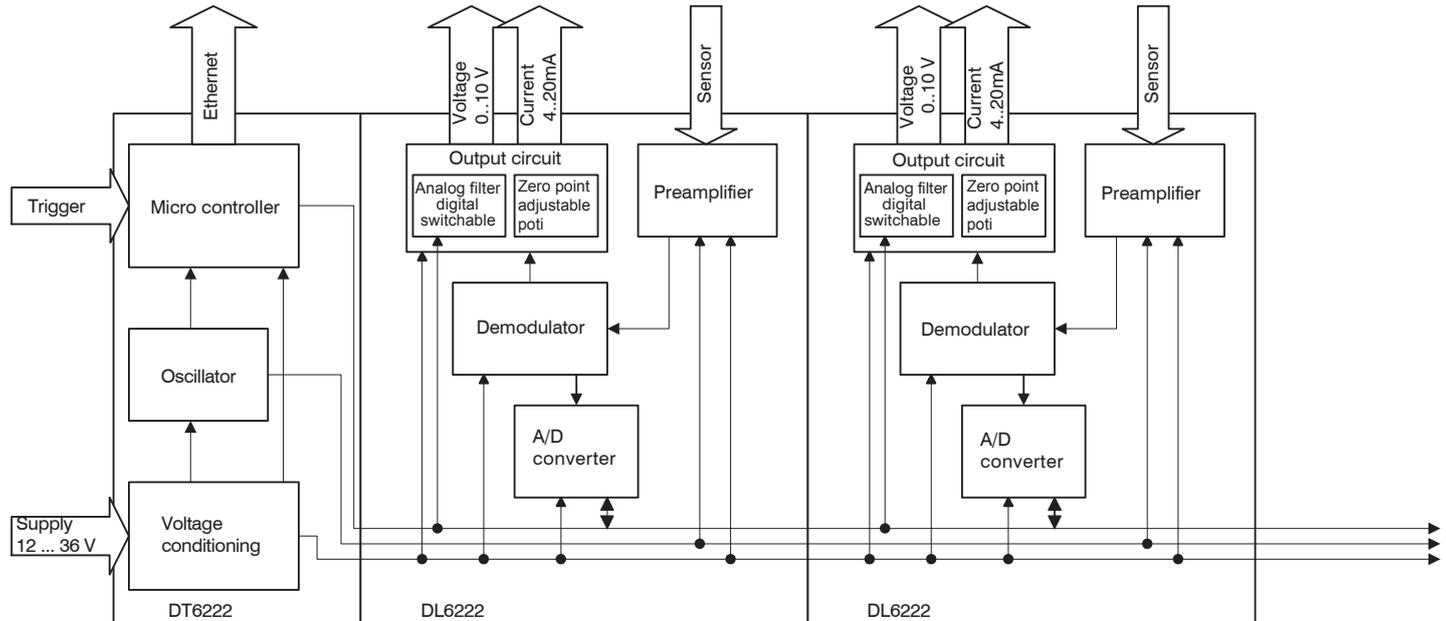


Fig. 2 Block diagram capaNCDT 6222

### 2.2.1 Sensors

For this measurement system, several sensors can be used.

➡ In order to obtain accurate measuring results, keep the surface of the sensor clean and free from damage.

The capacitive measuring process is area-related. A minimum area (see table) is required depending on the sensor model and measuring range. In the case of insulators the dielectric constant and the target thickness also play an important role.

#### Sensors for electrical conducting targets (metals)

Sensor model	Measuring range	Min. target diameter
CS005	0.05 mm	3 mm
CS02	0.2 mm	5 mm
CSH02	0.2 mm	7 mm
CSH02FL	0.2 mm	7 mm
CS05	0.5 mm	7 mm
CSE05	0.5 mm	6 mm
CSE05/M8	0,5 mm	6 mm
CSH05	0.5 mm	7 mm
CSH05FL	0.5 mm	7 mm
CS08	0.8 mm	9 mm
CS1	1 mm	9 mm
CSE1	1 mm	8 mm
CSE1,25/M12	1,25 mm	10 mm
CSH1	1 mm	11 mm
CSH1FL	1 mm	11 mm
CS1HP	1 mm	9 mm

<b>Sensor model</b>	<b>Measuring range</b>	<b>Min. target diameter</b>
CSH1,2	1.2 mm	11 mm
CSH1.FL	1.2 mm	11 mm
CSH2FL	2 mm	17 mm
CS2	2 mm	17 mm
CSH2	2 mm	17 mm
CSE2	2 mm	14 mm
CSE2/M16	2 mm	14 mm
CS3	3 mm	27 mm
CSE3/M24	3 mm	20 mm
CSH3FL	3 mm	24 mm
CS5	5 mm	37 mm
CS10	10 mm	57 mm
CSG0.50	0.5 mm	appr. 7 x 8 mm
CSG1.00	1.00 mm	appr. 8 x 9 mm

### 2.2.2 Sensor Cable

Sensor and controller are connected by a special, double screened sensor cable.

Do not shorten or lengthen these special cables.

Usually, a damaged cable can not be repaired.

**NOTICE**

Switch off the device when plugging and removing connectors.

Do not crush the sensor cable.

Do not modify to the sensor cable.

> Lost of functionality

Model	Cable length	Cable ø	2 axial connector	1x axial + 1x 90°	For sensors	Min. bending radius	
						once	permanently
CCgxC	2/4 m	3.1 mm	•		0.05 - 0.8 mm	10 mm	22 mm
CCgxC/90	2/4 m	3.1 mm		•	0.05 - 0.8 mm		
CCgxB	2/4 m	3.1 mm	•		1 ... 10 mm		
CCgxB/90	2/4 m	3.1 mm		•	1 ... 10 mm		
CCmxC	1.4/2.8 m	2.1 mm	•		0.05 - 0.8 mm	7 mm	15 mm
CCmxC/90	1.4/2.8 m	2.1 mm		•	0.05 - 0.8 mm		
CCmxB	1.4/2.8 m	2.1 mm	•		1 ... 10 mm		
CCmxB/90	1.4/2.8 m	2.1 mm		•	1 ... 10 mm		

The sensors of type CSH have integrated a 1.4 long sensor cable. Cable lengths of 2.8 m are available too if required.

Other cable lengths are also available on request.

The sensor model CSE1 (measuring range 1 mm) has the connector type C.

### 2.2.3 Controller

The capaNCDT 6222 Multi-channel measuring system consists of a basic module DT62xx and one up to four demodulator modules DL62xx, according to requirements. The components are stored in aluminum housings.



Fig. 3 Front view basic module DT6222 with 4 demodulator modules DL6222

### **Basic module DT6222**

The basic module DL62xx consists of the units voltage conditioning, oscillator and digital unit.

The voltage conditioning generates all required internal voltages from the supply voltage, both for the basic module as well as the connected demodulator modules. The oscillator supplies the demodulator modules with constant frequency and amplitude-stable alternating current. The frequency is 62 kHz. The digital unit controls the A/D converter of the demodulator modules and measures the actual measuring values. The measuring values can be read out via the Ethernet interface in digital form, [see 6](#).

### **Demodulator module DL6222**

The demodulator module DL62xx consists of an internal preamplifier, demodulator, output stage and A/D converter. The internal preamplifier generates the distance dependent measuring signal and amplifies it. Demodulator and output stage convert the measuring signal in a standardized voltage and current signal. The measuring values can be processed digitally with the help of the A/D converter.

The trim potentiometer zero allows a special zero adjustment of the analog output signals, [see Fig. 3](#).

<b>NOTICE</b>
---------------

- **i** Output voltage can achieve up to 15 VDC, if the sensor is disconnected respectively exceedance of measuring range.

## 2.3 Technical Data

Controller type		DL6222	DL6222/ECL2
Resolution dynamic		0.05 % FSO (20 kHz)	0.1 % FSO (20 kHz)
Bandwidth		20 kHz (-3dB)	20 kHz (-3dB)
Bandwidth adjustable		to 20 Hz	to 20 Hz
Data rate output digital		max. 3.906 kSa/s	max. 3.906 kSa/s
Linearity (typical)		$\leq \pm 0,1$ % d.M.	$\leq \pm 0,2$ % d.M.
Max. sensitivity deviation		$\leq \pm 0.1$ % FSO	$\leq \pm 0.1$ % FSO
Long term stability		$\leq 0.02$ % FSO/month	$\leq 0.02$ % FSO/month
Synchronous operation supported (multiple control units)		no	no
Isolator measurement		no	no
Temperature stability		200 ppm	200 ppm
Temperature range	Operation	Sensor <sup>1</sup> -50 ... +200 °C (-4 ... +392 °F)	-50 ... +200 °C (-4 ... +392 °F)
		Controller +10 ... +60 °C (+50 ... +140 °F)	+10 ... +60 °C (+50 ... +140 °F)
	Storage	-10 ... +75 °C (+14 ... +167 °F)	-10 ... +75 °C (+14 ... +167 °F)
Supply		24 VDC (12 ... 36 VDC)	24 VDC (15 ... 36 VDC)
Power consumption at 24 VDC		DT6222 per DL6222	2.8 W (typical) 1.2 W (typical); 1.4 W (max.)
Output	0 ... 10 V (short-circuit proof)		0 ... 10 V (short-circuit proof)
	4 ... 20 mA (load max. 500 Ohm)		4 ... 20 mA (load max. 500 Ohm)
	Ethernet		Ethernet
Sensors		all sensors suitable	all sensors suitable
Sensor cable standard		CCm1.4x; CCg2.0x	CCm2.8x; CCg4.0x
Sensor cable (matched)		$\leq 2.8$ m (mit CCmxx) $\leq 4.0$ m (mit CCgxx)	$\leq 2.8$ m (mit CCmxx) $\leq 4.0$ m (mit CCgxx)
Trigger		TTL, 5 V	TTL, 5 V

FSO = Full Scale Output

1) A storage temperature of -50 ... +100 °C (-58 to +212 °F) applies for the sensors CSG0.50-CA and CSG1.00-CA -50

## 2.4 Options

Article number	Designation	Description	Suitable for articles		
			2303035 DL6222	2303036 DL6222/ECL2	2303038 DL6222/LC
2982045	LC DL62x0 analog	Special calibration of linearity on analog output	○	○	•
2982059	ECL2 DL6222	Special set-up for 2-way sensor cable length	-	•	•
2982061	EMR2 DL6222	Extended measuring range (factor: 2)	○	○	•
2982062	RMR1/2 DL6222	Shortened measuring range (factor: 1/2)	○	○	•

- Articles already contain the option
- Option available
- No option available

### 3. Delivery

#### 3.1 Unpacking, Included in Delivery

1 Basic module DT62x0 with 1 - 4 demodulator modules DL62x0

1 Power supply and trigger cable PC6200-3/4, 3 m long, [see A 1.2](#)

1 Ethernet cable, 3 m long

1 Conversion kit (Springs for mounting on DIN-rail, mounting plates for wall fastening, threaded rods in different lengths), [see A 1.1](#).

Optional accessories:

1 Sensor

1 Sensor cable with connector

1 Signal output cable, [see A 1.3](#)

-  Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.
-  Check the delivery for completeness and shipping damage immediately after unpacking.
-  If there is damage or parts are missing, immediately contact the manufacturer or supplier.

#### 3.2 Storage

- Temperature range storage:

- Sensor: -50 ... +200 °C (-58 to +392 °F) <sup>1</sup>
  - Sensor cable: -50 ... +200 °C (-58 to +392 °F) (CCmx and CCmx/90)  
-50 ... +80 °C (-58 to +176 °F) (CCgx and CCgx/90)
  - Controller: -10 ... +75 °C (+14 to +167 °F)
- Humidity: 5 - 95 % RH (non-condensing)

1) A storage temperature of -50 ... +100 °C (-58 to +212 °F) applies for the sensors CSG0.50-CA and CSG1.00-CA -50

## 4. Installation and Assembly

### 4.1 Precautionary Measures

No sharp-edged or heavy objects may get into contact with the sensor cable sheath.

- Protect the cable against pressure loads in pressurised rooms.
- Avoid kinks in any case.
- Check the connections for tight fit.

**i** A damaged cable cannot be repaired.

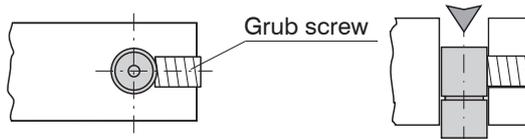
### 4.2 Sensor

The sensors may be mounted free-standing or flush.

When assembling, make sure that the polished sensor surface is not scratched.

#### 4.2.1 Radial Point Clamping with Grub Screw, Cylindric Sensors

This simple type of fixture is only recommended for a force and vibration-free installation position. The grub screw must be made of plastic so that it cannot damage or deform the sensor housing.



*Fig. 4 Radial point clamping with grub screw*

#### **NOTICE**

Do not use metal grub screws!

> Danger of damaging the sensor

### 4.2.2 Circumferential Clamping, Cylindric Sensors

This sensor mounting option offers maximum reliability because the sensor is clamped around its cylindrical housing. It is absolutely necessary in difficult installation environments, for example on machines, production plants, etc.

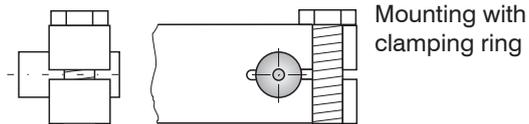


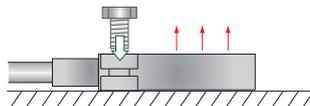
Fig. 5 Circumferential clamping

**i** Tension at the cable is inadmissible!

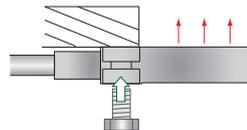
### 4.2.3 Flat Sensors

Flat sensors are mounted by means of a tap hole for M2 (in case of sensors 0.2 and 0.5 mm) or by a through hole for M2 screws. The sensors can be bolted on top or below.

**Screwing from above**

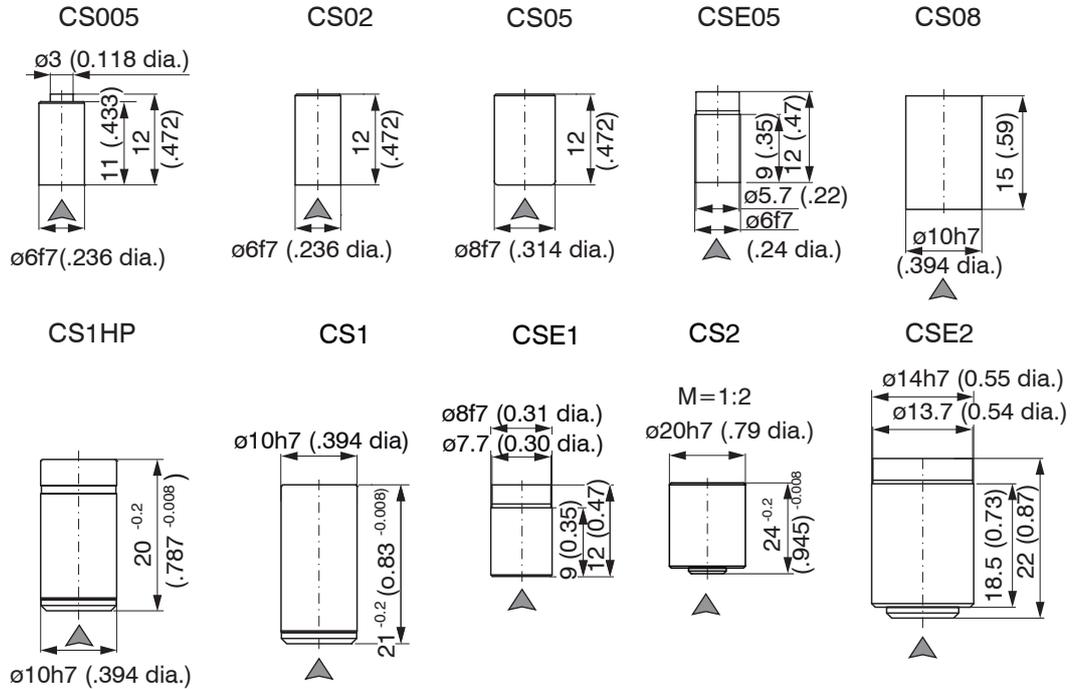


**Screwing from bottom**



### 4.2.4 Dimensional Drawings Sensors

#### Cylindric sensors



▲ Connector side

Dimensions in mm (inches)

Circumferential clamping possible from 3 mm behind the front face.

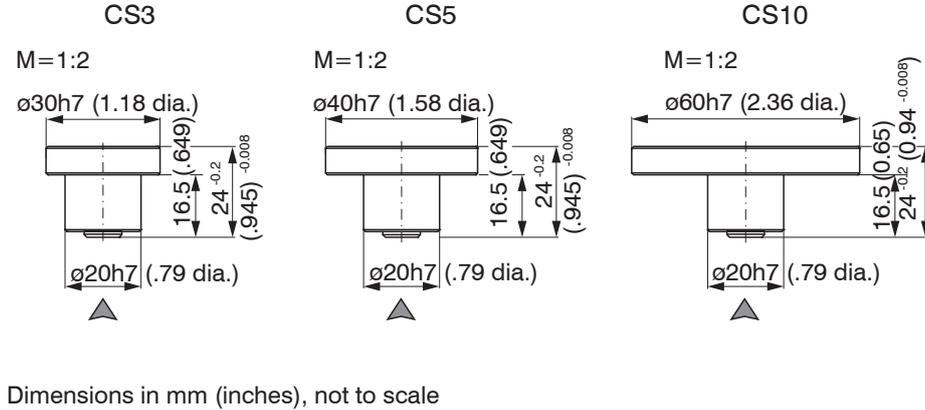
Dimensional drawings of other sensors are available on request.

▲ Connector side

Dimensions in mm  
(inches)

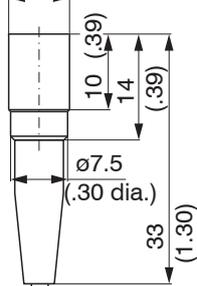
Circumferential clamping possible from 3 mm behind the front face.

Dimensional drawings of other sensors are available on request.

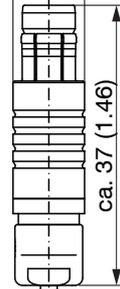


CSH02-CAMx,  
CSH05-CAMx

ø8g6 (.315 dia.)



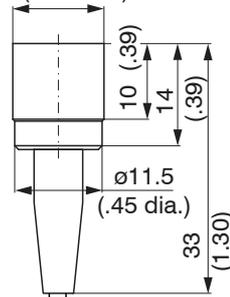
ca. 9.4 (.37)



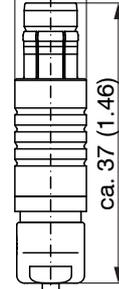
ø2.2 (.09 dia.)

CSH1-CAMx,  
CSH1.2-CAMx

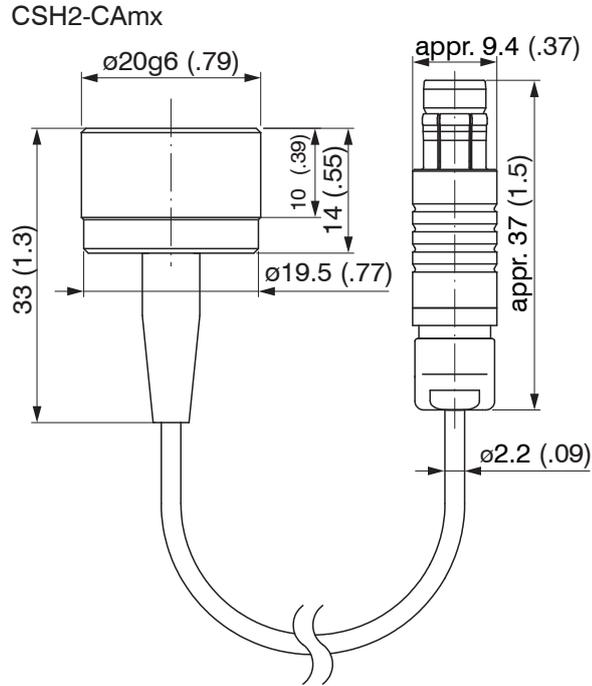
ø12g6 (.473 dia.)



ca. 9.4 (.37)

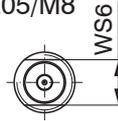


ø2.2 (.09 dia.)

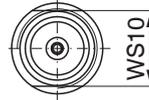


**Cylindrical sensors with thread**

CSE05/M8



CSE1,25/M12

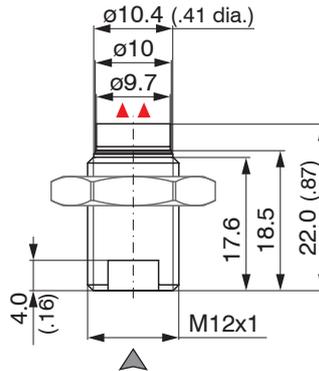
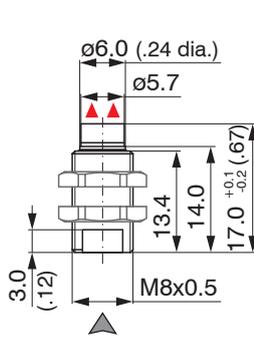


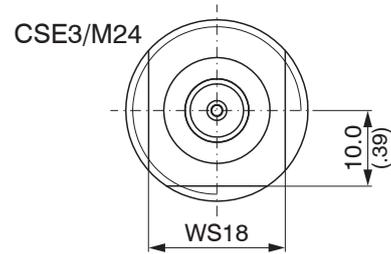
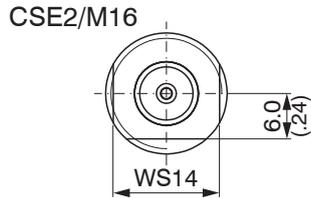
▲ Connector side

Dimensions in mm  
(inches)

▲▲ Active measuring  
surface sensor

Dimensional drawings  
of other sensors are  
available on request.



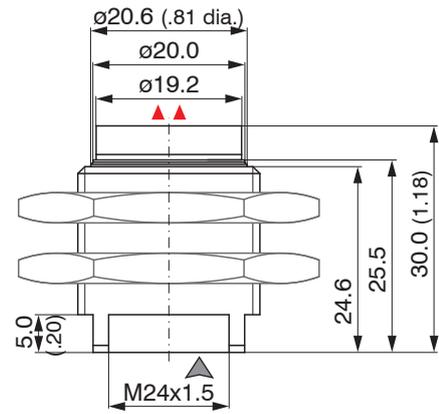
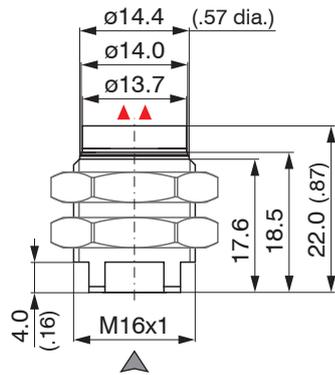


▲ Connector side

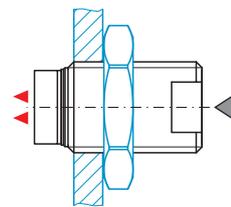
Dimensions in mm  
(inches)

▲▲ Active measuring  
surface sensor

Dimensional drawings  
of other sensors are  
available on request.



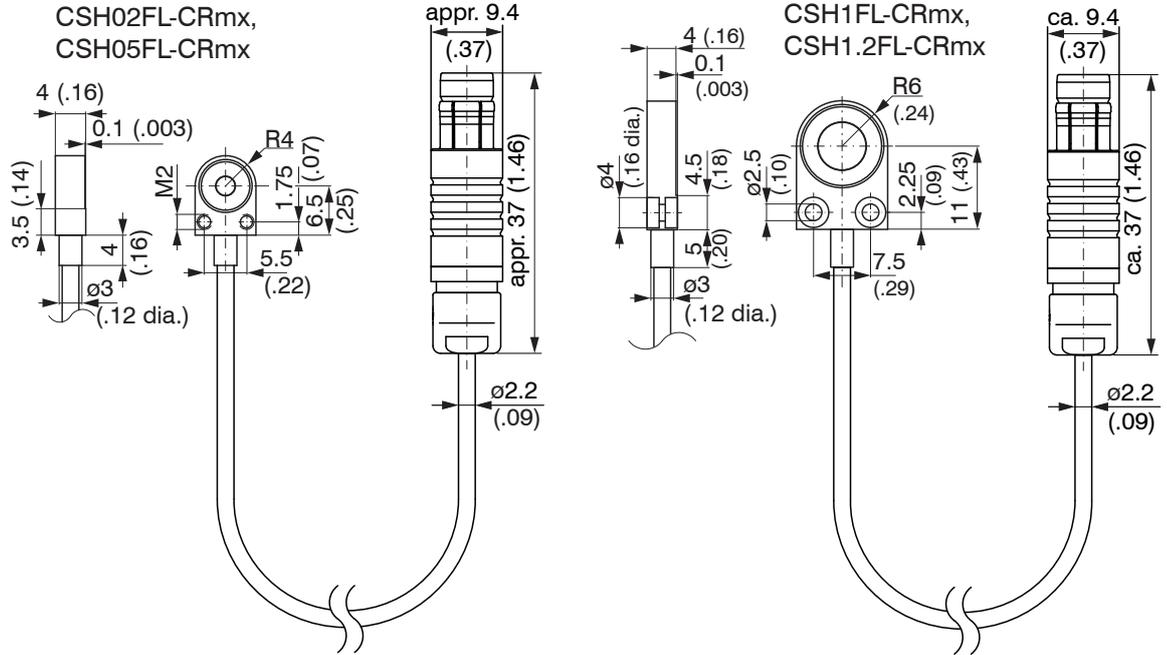
Sensor	Torque
CSE05/M8	2.5 Nm max.
CSE1,5/M12	10 Nm max.
CSE2/M16	20 Nm max.
CSE3/M24	70 Nm max.



Preferred mounting:

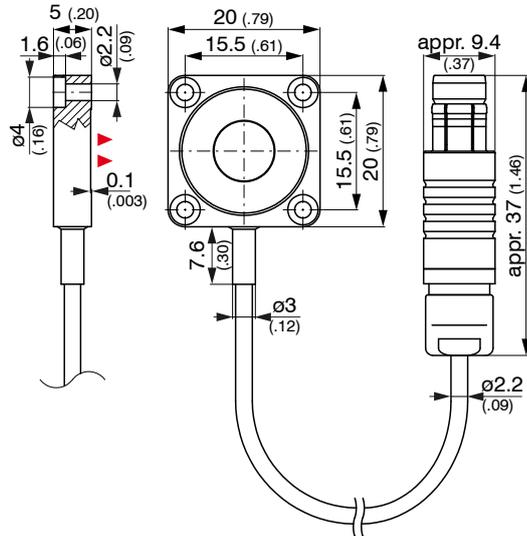
- ➡ Screw the sensor into the sensor holder.
- ➡ Turn the mounting nut on. Do not exceed torques.

**Flat sensors**

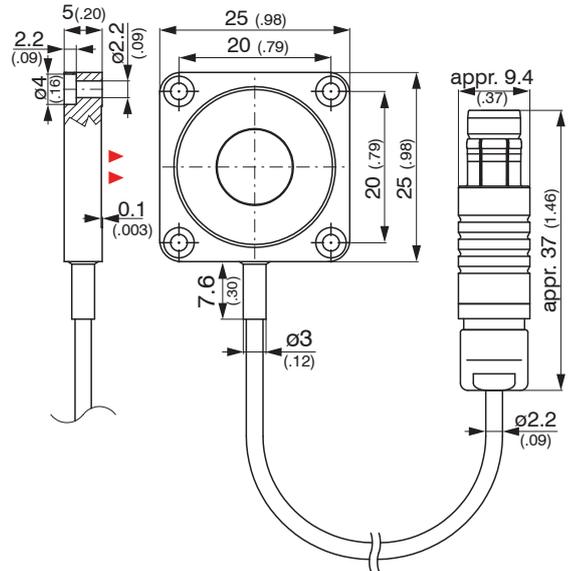


Dimensions in mm (inches), not to scale

CSH2FL-CRmx

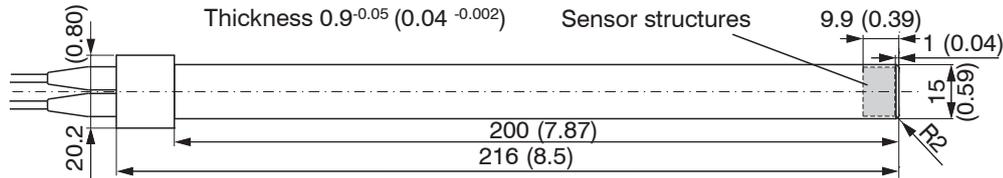


CSH3FL-CRmx

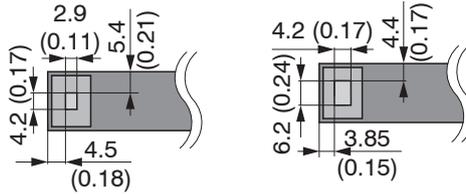


Dimensions in mm (inches), not to scale

CSG0.50-CAm2.0 and CSG1.00-CAm2.0



Sensor structures



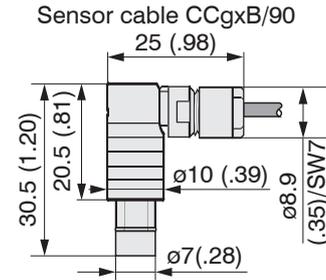
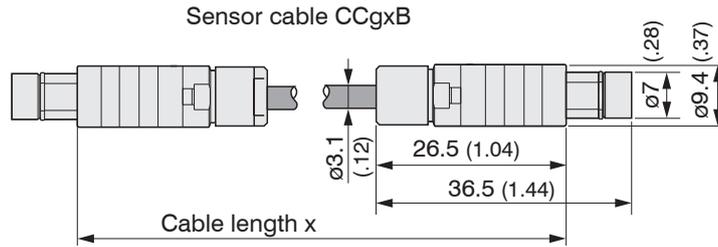
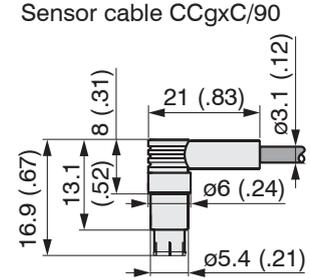
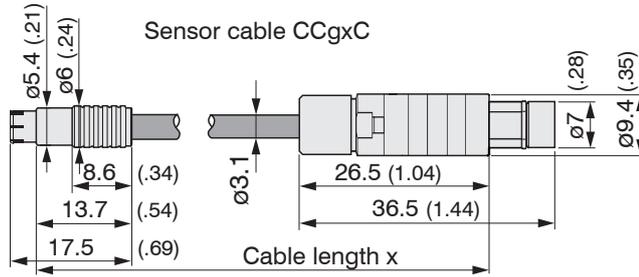
CSG0,50-CAm2,0

CSG1,00-CAm2,0

Dimensions in mm (inches), not to scale

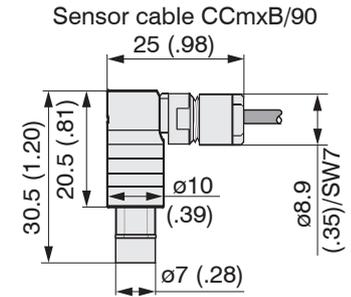
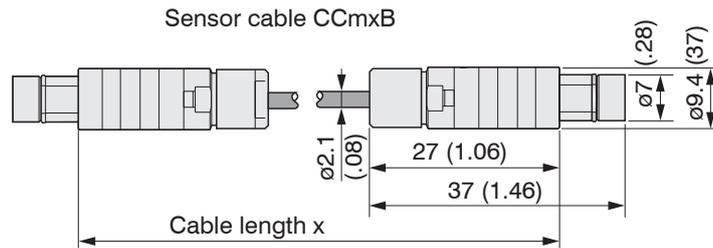
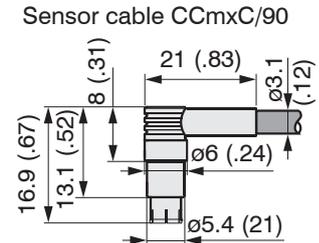
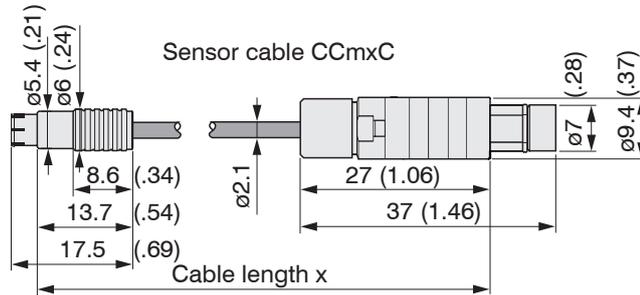
4.3 Sensor Cable

The sensor is connected to the controller by the sensor cable. The connection is made by simple plugging. The connector locks automatically. The tight fit can be checked by pulling the connector housing (cable bushing). The lock can be released and the connector can be opened by pulling the knurled housing sleeve of the cable bushing.



Dimensions in mm (inches), not to scale

Model	Cable length	Cable $\phi$	2 axial connector	1x axial + 1x 90°	For sensors	Min. bending radius	
CCgxC	2 or 4 m	3.1 mm	•		0.05 - 0.8 mm	10 mm (once)	22 mm (permanently)
CCgxC/90	2 or 4 m	3.1 mm		•	0.05 - 0.8 mm		
CCgxB	2 or 4 m	3.1 mm	•		1 ... 10 mm		
CCgxB/90	2 or 4 m	3.1 mm		•	1 ... 10 mm		

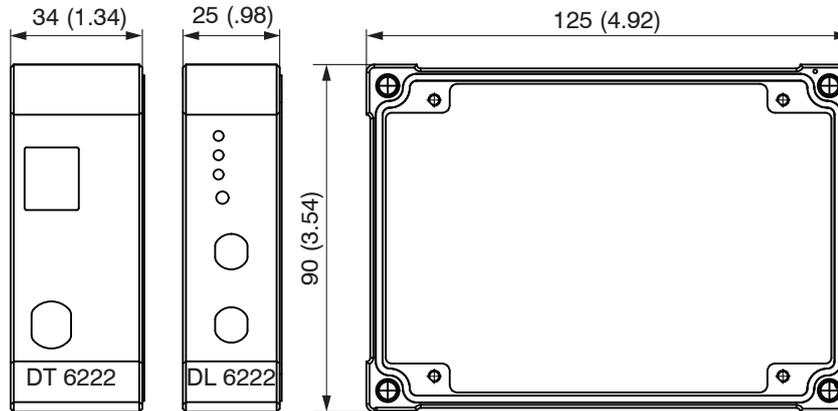


Dimensions in mm (inches), not to scale

Model	Cable length	Cable $\phi$	2 axial connector	1x axial + 1x 90°	For sensors	Min. bending radius	
CCmxC	1.4 or 2.8 m	2.1 mm	•		0.05 - 0.8 mm	7 mm (once)	15 mm (permanently)
CCmxC/90	1.4 or 2.8 m	2.1 mm		•	0.05 - 0.8 mm		
CCmxB	1.4 or 2.8 m	2.1 mm	•		1 ... 10 mm		
CCmxB/90	1.4 or 2.8 m	2.1 mm		•	1 ... 10 mm		

## 4.4 Controller

### 4.4.1 Basic Unit, Demodulator Module



*Fig. 6 Dimensional drawing controller*

Dimensions in mm (inches), not to scale

### 4.4.2 Housing Cover

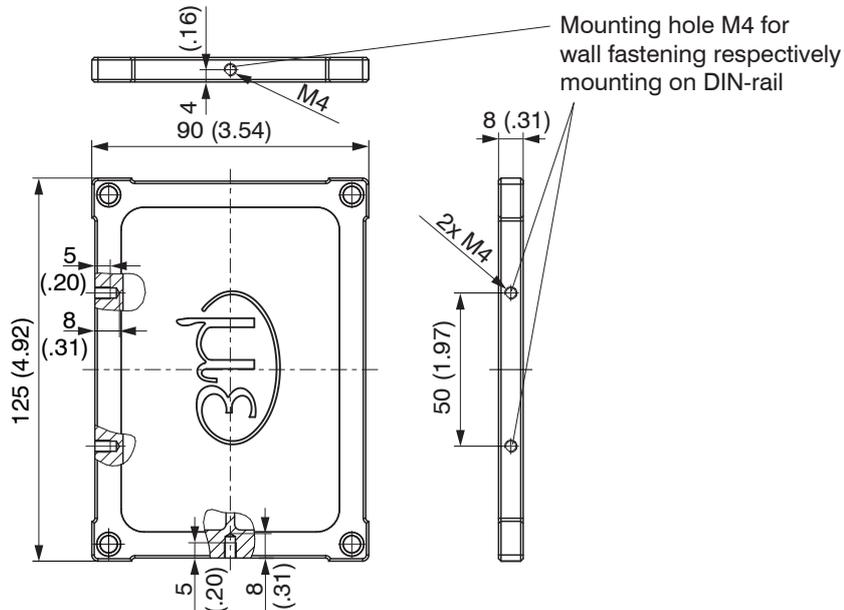


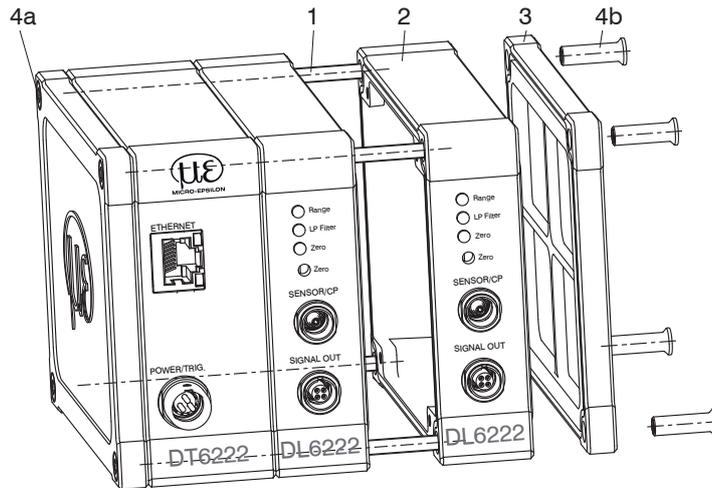
Fig. 7 Dimensional drawing housing cover

Dimensions in mm (inches), not to scale

The controller is mounted using mounting plates or holding clamps for a mounting on DIN-rail which are included with the conversion kit supplied, [see A 1.1](#).

### 4.5 Insert Demodulator Module

- ➡ Unscrew the sleeve nuts (4b) on the right side of the controller, remove the right housing cover (3).
  - ➡ Remove a sleeve nut (4a) with threaded rod (1).
  - ➡ Successively replace the threaded rod (1) by a threaded rod next longer from the supplied conversion kit. Move the new threaded rod with the sleeve nut (4a) through the modules.
  - ➡ Exchange the remaining 3 threaded rods in such a way.
- i** Touch the demodulator modules only at the housing, not at the electronics. This will prevent electro-static discharges on the electronics.
- ➡ Attach the additional demodulator module.



Number demodulator modules	Length threaded rod M4
1	59 mm
2	84 mm
3	109 mm
4	134 mm

Fig. 8 Mechanical components controller

- ➡ Connect both flat flexible cables (5) of the preceding demodulator module with the new demodulator module (6).



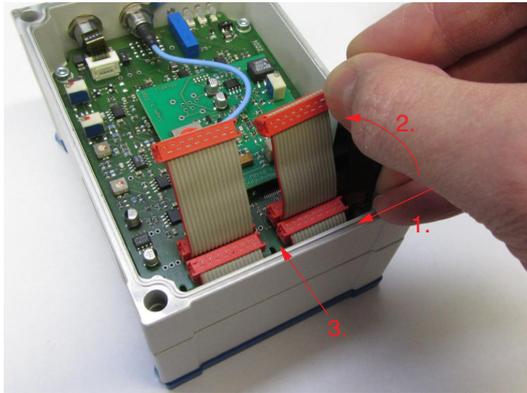
- 5 Wiring preceding demodulator module
- 6 Wiring following demodulator module

*Fig. 9 Wiring demodulator modules*

- ➡ Put on the right housing cover (3).
- ➡ Screw the sleeve nuts (4b) on the threaded rods on the right side of the controller and tighten the sleeve nuts.

The wiring to the preceding demodulator module (5) can be solved using the supplied plugging off assistance as follows:

- ▶ 1. Press the plugging off assistance with the recess laterally to the connector (5).
- ▶ 2. Loosen the connector with a lever movement.
- ▶ 3. Loosen the other side of the connector in the same way.



*Fig. 10 Use of the plugging off assistance for the wiring of the demodulator elements*

## 4.6 Ground Connection, Earthing

- ➡ Make sure you have a sufficient grounding of the measuring object, for example connect it with the sensor or the supply ground.

### Non-contact target earthing

In several applications, the target earthing is difficult or even impossible.

Different to other systems, with capaNCDT systems is no target earthing necessary

The drawing below shows two synchronized capaNCDT sensors, measuring against a mill, see Fig. 11. Due to the unique synchronizing technique of MICRO-EPSILON a special target earthing is not needed in most cases.

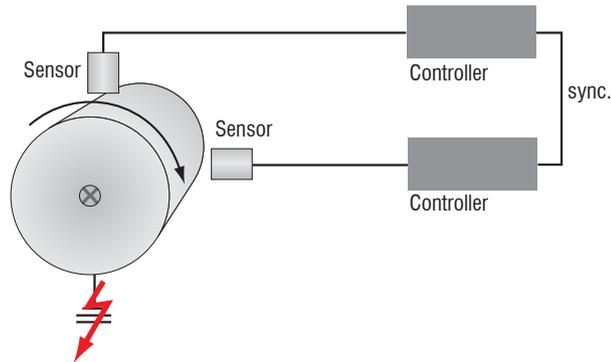


Fig. 11 Position and unbalance measuring with two measuring systems



Fig. 12 Ground connection on the housing cover

No target grounding required with two synchronized capaNCDT sensors.

If necessary use the ground connection on the housing cover. The ground connection is included with the conversion kit supplied, see A 1.1.

## 4.7 Electrical Connections

### 4.7.1 Connectivity Options

The power supply and the signal output are located at the front side of the controller.

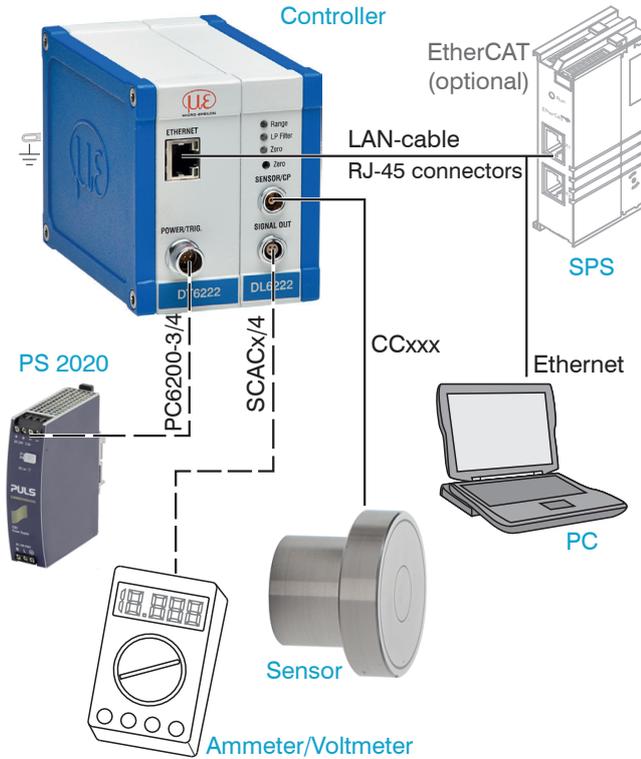
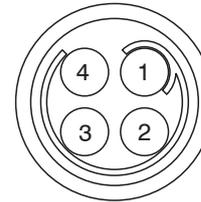


Fig. 13 Measuring system assembly

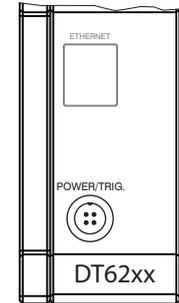
### 4.7.2 Pin Assignment Supply, Trigger

PIN	Color PC6200-3/4	Signal	Description
1	brown	+24VIN	+24 VDC Supply
2	white	Zero VIN	GND Supply
3	yellow	TRI_IN+	Trigger IN+, TTL level
4	green	TRI_IN-	Trigger IN-
Shield			

PC6000-3/4 is a 3 m (13.12 ft) long, pre-assembled power supply and trigger cable.



View on solder pin side, 4-pole ODU female cable connector

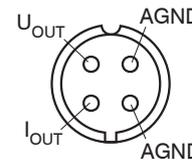


Power supply input on controller, 4-pole male cable connector

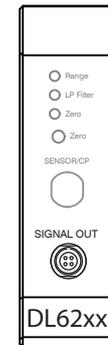
### 4.7.3 Pin Assignment Analog Output

Pin	Color SCACx/4	Signal	Description
1	brown	U-out	$U_{OUT}$ (Load min. 10 kOhm)
2	yellow	I-out	$I_{OUT}$ (Load max. 500 Ohm)
3	grey	AGND	Analog ground
4	white	AGND	Analog ground
Shield			

Analog grounds are connected internally. SCACx/4 is a 3 m (13.12 ft) long, 4-wire output cable. It is supplied as an optional accessory.



View on solder pin side, 4-pole male cable connector



Signal output on controller, 4-pole male cable connector

## 5. Operation

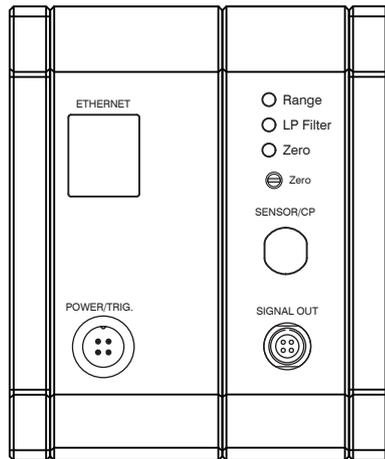
### 5.1 Starting Up

➡ Connect the the display/output devices through the signal output socket, [see 4.7](#), [see 4.7.2](#), [see 4.7.3](#), before connecting the device to the power supply and switching on the power supply.

**i** Allow the measuring system to warm up before the first measurement or calibration for approximately 15 min.

### 5.2 Operating or Display Elements

#### 5.2.1 LED's



1) LP Filter only switchable via Ethernet.

LED	Color	Function
Range	☀	green Target in measuring range
	☀	red Measuring range exceeded
LP Filter <sup>1</sup>	○	off Standard bandwidth active
	☀	red 20 Hz Low-pass filter on the analog outputs enabled
Zero	○	off Zero poti in basic position (right stop)
	☀	red Zero poti adjusted

### 5.2.2 Poti

The zero-poti on the demodulator modules is used for zero adjustment of the analog outputs.

End positions on the left or right stop are marked by a slight click.

The electrical zero point can be set across the whole measuring range with the “zero” potentiometer. The start of the measuring range (= mechanical zero point) is on the front face of the sensor.

A tilted sensor or measuring object results in a reduced measuring range and zero point shifting according to the tilting.

The potentiometer is ex factory set at the right stop (maximum level).

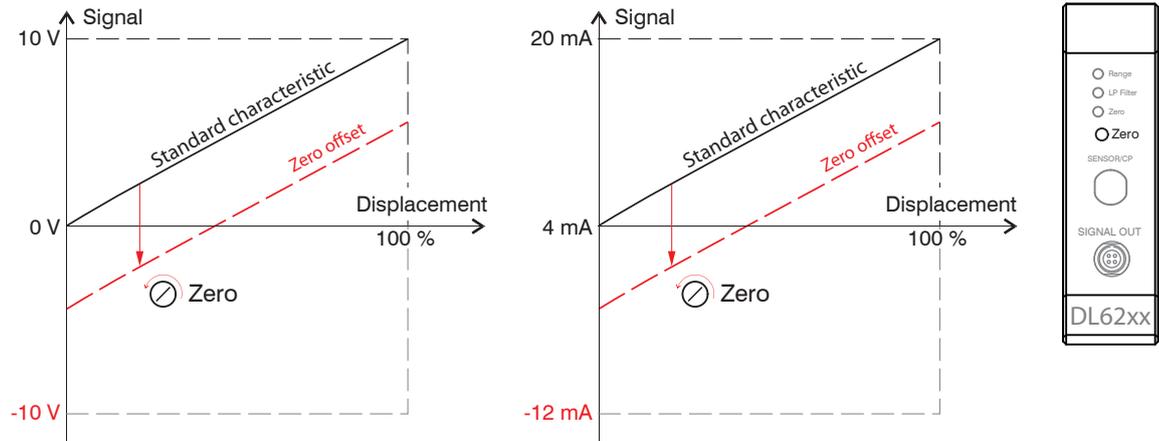


Fig. 14 Zero point shifting with zero-poti

### 5.3 Changing Limit Frequency

The controller operates with a limit frequency of 20 kHz (factory setting). In case that the limit frequency is reduced to 20 Hz, the output signal is filtered more efficiently and the resolution is therefore improved; at the same time the dynamic of the system is reduced. The limit frequency can only be changed via the Ethernet interface.

### 5.4 Triggering

The measuring value output on capaNCDT 6222 is controllable by an external electrical trigger signal or command. Here, only the digital output is affected.

Triggering release by:

- Trigger input (pin 3 and pin 4 on 4-pole power supply connector, [see 4.7.2](#) or
- Software command \$GMD, [see 6.4.3](#)
- $U_{IN}$ , HIGH  $\geq 2,0$  V
- $U_{IN}$ , LOW  $\leq 0,8$  V

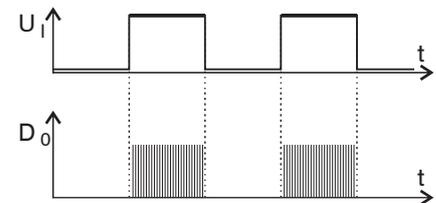
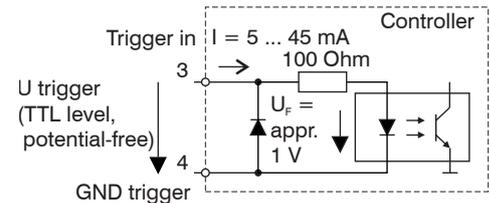
Fig. 15 Trigger Input

The trigger type is determined by the command \$TRGn, [see 6.4.2](#) or

- the web interface, [see 6.7](#)

Level triggering (high level). Continuous measurement output with adjusted data rate, as long as the selected level is active. After that the controller stops the output of the measuring values.

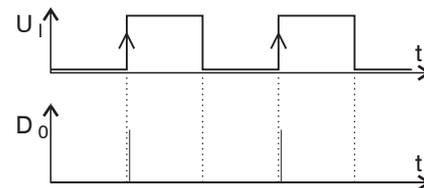
Fig. 16 Active high level trigger ( $U_i$ ), relevant digital signal ( $D_o$ )



Edge triggering. Starts measuring value output, as soon as the rising edge on the trigger input is active. If trigger conditions are met, the controller outputs a measuring value. The set data rate must be greater than the maximum trigger frequency. If triggering is faster than the set data rate, individual measuring values are transmitted twice, because internally no new measuring values of the AD converter are active.

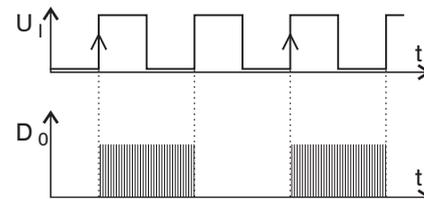
The duration of the pulse must be at least  $5 \mu\text{s}$ .

*Fig. 17 Rising edge trigger ( $U_i$ ), relevant digital signal ( $D_o$ )*



Gate rising edge. Starts measuring value output with set data rate, as soon as the rising edge on the trigger input is active. Another rising edge stops the measuring value output respectively switches it on again.

*Fig. 18 Rising edge trigger ( $U_i$ ), relevant digital signal ( $D_o$ )*



Software triggering (\$GMD). A measuring value is output per channel, as soon as a command is sent. The point of time is not defined as accurately.

No trigger is set ex factory. The controller starts the data transfer immediately after the switching on.

## 5.5 Measurement Averaging

### 5.5.1 Introduction

Measurement averaging is performed before the output of measuring values via the Ethernet interfaces. Measurement averaging improves the resolution, allows masking individual interference points or “smoothes” the reading.

**i** Linearity is not affected by averaging. Averaging has no effect on measuring frequency and output rate.

The controller is delivered ex factory without measurement averaging.

### 5.5.2 Moving Average

The definable number N for successive measurements (window width) is used to calculate the arithmetic average  $M_{mov}$  according to the following formula:

$$M_{mov} = \frac{\sum_{k=1}^N MV(k)}{N}$$

MV = Measuring value  
 N = Number  
 k = Continuous index  
 $M_{mov}$  = Average value

Fig. 19 Formula for the moving average

#### Method

Each new measured value is added, and the first (oldest) value is removed from the averaging.

Example with N = 7:

.... 0 1 2 3 4 5 6 7 8 gets to  $\frac{2+3+4+5+6+7+8}{7}$  Average value n

.... 1 2 3 4 5 6 7 8 9 gets to  $\frac{3+4+5+6+7+8+9}{7}$  Average value n + 1

### 5.5.3 Arithmetic Average Value

The arithmetic average value  $M$  is set and output over the selected number  $N$  of successive measuring values.

#### Method

Measuring values are collected and the average value is calculated consequently. This method leads to a reduction of the amount of data, because an average value is output only after every  $N$ th measuring value.

Example with  $N = 3$ :

... 0 1 2 3 4 ... gets to  $\frac{2+3+4}{3}$  Average value  $n$

... 3 4 5 6 7 ... gets to  $\frac{5+6+7}{3}$  Average value  $n + 1$

### 5.5.4 Median

A median value is formed from a preselected number of measurements. For this, the incoming values are sorted after each measurement. Then, the average value is provided as the median value.

If a even value is selected for the average number  $N$ , middle both measuring values are added and divided by two.

Example with  $N = 7$ :

... 2 4 0 1 2 4 5 1 3 Sorted measuring value 0 1 1 2 3 4 5 Median  $_n = 2$

... 4 0 1 2 4 5 1 3 4 Sorted measuring value 1 1 2 3 4 4 5 Median  $_{n+1} = 3$

### 5.5.5 Dynamic Noise Rejection

This filter removes the noise of the measurement signal completely, but keeps the original bandwidth of the measurement signal.

For that purpose the signal noise is calculated dynamically and measurement changes are only transferred, if they exceed this calculated noise. Thereby at a change in direction of the measurement signal small hysteresis effects in the size of the calculated noise can occur.

## 6. Ethernet Interface

You will achieve especially high resolutions if you readout the measurements in digital form via the Ethernet interface.

For that purpose, use the web interface or a special program. MICRO-EPSILON supports you by the driver MEDAQLib, containing all commands for capaNCDT 6222.

You can find the current driver routine including documents at:

[www.micro-epsilon.com/download](http://www.micro-epsilon.com/download)

[www.micro-epsilon.com/download/software/MEDAQLib.zip](http://www.micro-epsilon.com/download/software/MEDAQLib.zip)

### 6.1 Hardware, Interface

The data logging of all channels is synchronous.

➡ Connect the capaNCDT 6222 to an available Ethernet interface at the PC. Use a crossover cable.

For a connection with the capaNCDT 6222 you will require a defined IP address of the network interface card inside the PC. Go to `Control Panel\Network Connections`. Set up, if applicable, a new LAN connection. For more information, contact your network administrator.

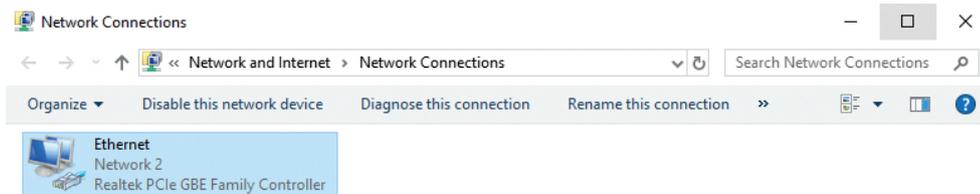
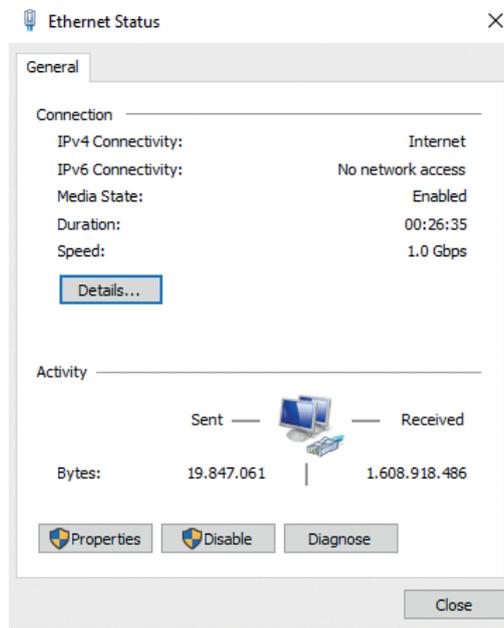


Fig. 20 LAN connection of a PC

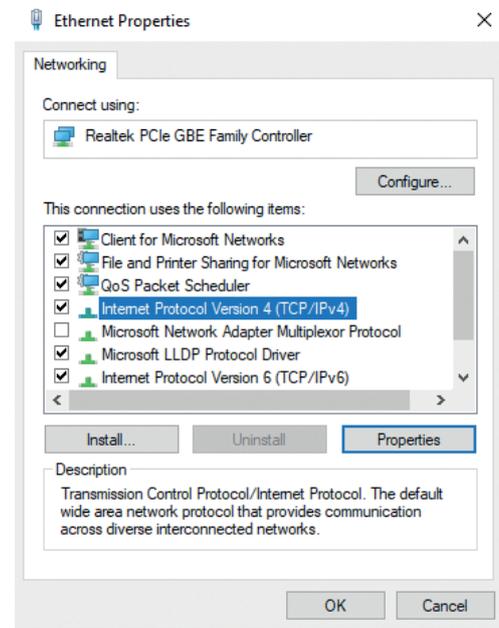
➔ Define the following address in the properties of the LAN connection:

IP address: 169.254.168.1

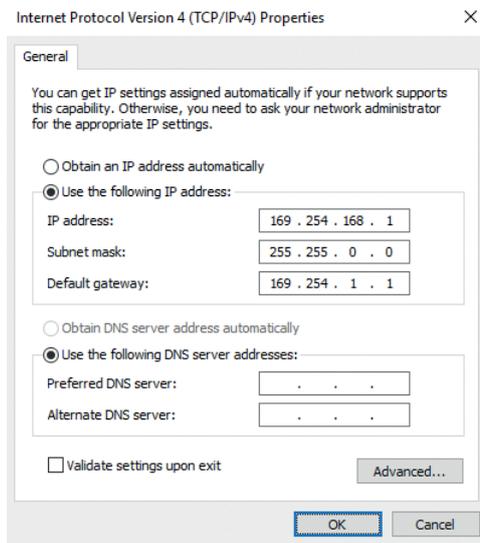
Subnet mask: 255.255.0.0



➔ Select Properties.



➔ Select Internet Protocol (TCP/IP) > Properties.



By default, the IP address of the controller is set to 169.254.168.150. Communication with the controller is done on the data port 10001 for measurement transmission. A command port (Telnet, port 23) is used for sensor commands.

The IP settings and the data port can be changed at any time:

- by using the web browser. Enter the current IP address into the address bar. Go to the menu `Settings > Digital Interfaces > Ethernet settings` to set a new IP address, activate DHCP or change the data port.
- by using software commands, [see 6.4](#).
- by using the `sensorTOOL` software.

If you activate DHCP, access to the controller via a DHCP host name is possible. The host name contains the device name and serial number. Structure: NAME\_SN e. g. DT6222\_1001.

The controller supports UPnP. If you use an operational system with activated UPnP client e. g. standard with Windows 7, the controller is listed in the explorer as a device automatically. This is helpful, if you do not know the IP address of the controller.

## 6.2 Data Format of Measuring Values

All measuring values, recorded at a time, are combined into a measuring value frame (One measuring value per channel).

Several measuring value frames are combined to a measuring value block and then transmitted together with a header as a TCP packet.

All measuring values and the header are transmitted in little-endian format.

Contents	Size	Description
Preamble	32 bit	„MEAS“ as an ASCII text
Order number	32 bit	Order number of sensor as int
Serial number	32 bit	Serial number of sensor as int
Channels (Bit field)	64 bit	Bit field, which channel available. Two bits per channel are used: „00“ = Channel is not available; „01“ = channel available. The lowest channel is on the most low-order bit -> Thereby determining the number of channels N possible.
Status	32 bit	Is not used.
Frame number M / bytes per frame	16 bit / 16 bit	One frame = one measuring value per channel
Measuring value counter	32 bit	Measuring value counter (of 1st frame)
Measuring value frame 1 [number channels N]	N * 32 bit	Measuring values all channels, starting with the lowest channel number
Measuring value frame 2 [number channels N]	N * 32 bit	„
....	...	...
Measuring value frame M [number channels N]	N * 32 bit	„

All measuring values are transmitted as Int32. The measuring value resolution is 24 bits i.e only the most low-order 24 bits of integer number are used. Hexadecimal range: 0 ... FFFFFFFF<sub>16</sub>. Exception is the mathematics function, because the result can also be greater than 24 bits.

Scaling of measuring values:

$$\text{Measurement in } \mu\text{m} = \frac{\text{Digital value (Int)}}{0xFFFFFFFF} * \text{Measuring range in } \mu\text{m}$$

Example: Measuring range sensor CS2 = 2000  $\mu\text{m}$ ; digital value = 7FFFFFFF<sub>16</sub>

Measurement = 999.99  $\mu\text{m}$

By default, the measuring values are continuously output with the set data rate via the data port.

However, there is also a trigger mode, which can be used to get the individual measuring values, see Chap. 6.4.2.

## 6.3 Settings

### Operating modes:

- Continuous transmission with fixed data frequency
- Trigger mode (recall hardware trigger input or individual measuring values, see 5.4).

### Data rate:

It is possible to adjust different data rates between 2.5 Sa/s and 3.9 kSa/s. The data rate applies to all channels.

### Filter/Measuring value averaging:

The following filters are selectable:

- Moving average
- Arithmetic average (only each n<sup>th</sup> value will be output)
- Median
- Dynamic Noise Rejection

The setting for the averaging applies to all channels.

**Linearization Options:**

- Offset correction
- 2-point-linearization
- 3-point-linearization
- 5-point-linearization
- 10-point-linearization

Up to 10 linearization points can be measured for each channel. These are at 10 %, 20 %, 30 %, 40 %, 50 %, 60 %, 70 %, 80 %, 90 % and 100 % of the measurement range. That means, for example, that the sensor is adjusted to 10 % of the measurement range. This linearization point (= actual measurement at this point) is then measured and a correction curve is calculated so that the linearized measured value corresponds to the target measurement value.

Only the measurement value at 10 % of the measurement range is used for the correction of the start of the measurement range.

The correction curve for the 2-point-linearization uses data points at 10 % and 90 % of the measurement range.

The two correction curves for the 3-point-linearization use restart points at 10 % and 50 %, 50 % and 90 % of the measurement range.

The four correction curves for the 5-point-linearization use data points at 10 % and 30 %, 30 % and 50 %, 50 % and 70 %, 70 % and 90 % of the measurement range.

The nine correction curves for the 10-point-linearization use data points at 10 %, 20 %, 30 %, 40 %, 50 %, 60 %, 70 %, 80 %, 90 % and 100 % of the measurement range.

The linearization function allows an individual adjustment

- of the start of the measurement range,
- slope of the characteristic curve (Gain) and
- linearity.

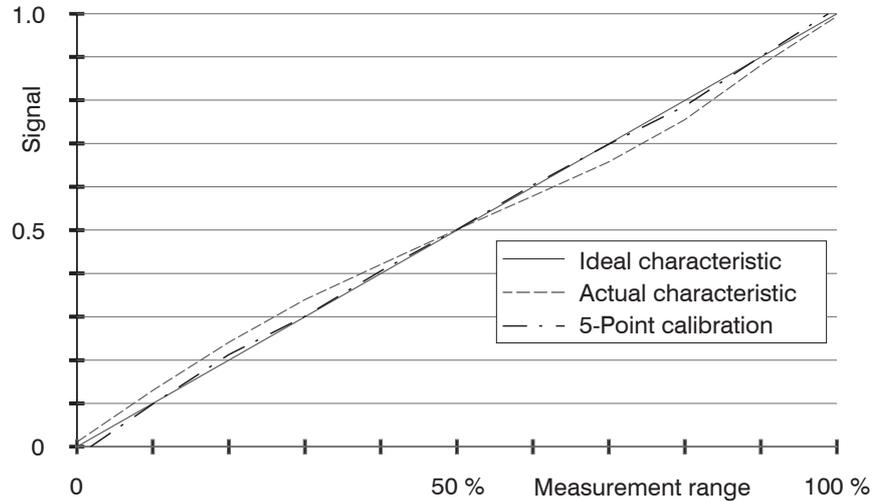


Fig. 21 Output characteristic for the measurement

**i** The software linearization affects only the values (averaging also), which are output via the Ethernet interface.

**Mathematic functions:**

For Calculation of several channels.

## 6.4 Commands

All commands are transmitted via port 23 (Telnet). Each command starts with a \$ character.

The controller ignores all characters, which are transmitted before the \$ character.

The controller immediately returns all transmitted characters back as echo.

After the response has been sent, the controller starts to send measurement values gain (applies to the operating mode "continuous transmission").

Commands are transmitted in ASCII format.

Except for the linearization types and points, the respective settings are the same for all eight channels.

A time out is reached approximately 10 seconds after the last character input.

Channel numbers are separated by a comma, channel number and a parameter belonging to the channel by a colon.

Several successive different parameters (for the command STS and VER) are separated by a semicolon.

Commands always have to end with <CR> or <CRLF>.

### 6.4.1 Data Rate (STI)

Changes the sample time in  $\mu\text{s}$  (respectively sample rate) for all channels, which are used to transmit the measuring values. The requested sample time in  $\mu\text{s}$  is sent to the controller. Because any sample time is not possible, the controller replies with the next available sampletime in  $\mu\text{s}$ . This is active from then.

	STI = Set Sample Time
Command	\$STIn<CR> Example: \$STI1200<CR>
Response	\$STIn,mOK<CRLF> Example: \$STI1200,960OK<CRLF>
Index	n = designated new sample time in $\mu\text{s}$ (TARGET)
	m = new sample time in $\mu\text{s}$ (ACTUAL)

Possible sample times	
n (in $\mu\text{s}$ )	corresponds to data rate
384000	2.6 Sa/s
192000	5.2 Sa/s
96000	10.4 Sa/s
64000	15.6 Sa/s
38400	26 Sa/s
32000	31.3 Sa/s
19200	52.1 Sa/s
16000	62.5 Sa/s
9600	104.2 Sa/s
1920	520.8 Sa/s
960	1041.7 Sa/s
480	2083.3 Sa/s
256	3906.3 Sa/s
Request sample time	
Command	<code>\$STI?&lt;CR&gt;</code>
Response	<code>\$STI?nOK&lt;CRLF&gt;</code>

### 6.4.2 Trigger Mode (TRG)

There are three possible settings regarding the trigger input, [see 5.4](#).

Irrespective of the trigger mode set, a single measured value per channel can be called up by means of a software command, [see 5.5.3](#). If the trigger mode is turned off, the capaNCDT 6222 will send the measurement values without interruption and with the adjusted data rate.

	TRG
Command	\$TRGn<CR>
Response	\$TRGnOK<CRLF>
Index	n = 0: Continuous transmission (default setting) n = 1: Triggermode 1 (rising edge) n = 2: Triggermode 2 (high level) n = 3: Triggermode 3 (gate rising edge) ? = Request trigger mode
Request Trigger mode	
Command	\$TRG?<CR>
Response	\$TRG?nOK<CRLF>

### 6.4.3 Get Measured Data (GMD)

In the trigger mode, one measuring value is transmitted per channel.

	GMD
Command	\$GMD<CR>
Response	\$GMDOK<CRLF> + Measuring value in binary mode (format as in operating mode “continuous transmission”) via data port

#### 6.4.4 Filter, Averaging Type (AVT)

Mode of measurement averaging

	AVT
Command	\$AVTn<CR>
Response	\$AVTnOK<CRLF>
Index	n = 0: No averaging (Default setting) n = 1: Moving average n = 2: Arithmetic average (outputs only each nth measuring value) n = 3: Median n = 4: Dynamic noise rejection ? = Request averaging type
Request averaging type	
Command	\$AVT?<CR>
Response	\$AVT?nOK<CRLF>

#### 6.4.5 Filter, Averaging Number (AVN)

Number of measuring values used to calculate the average (adjustable from 2 ... 8)

	AVN
Command	\$AVNn<CR>
Response	\$AVNnOK<CRLF>
Index	n = 2 ... 8 ? = Request averaging number
Request averaging number	
Command	\$AVN?<CR>
Response	\$AVN?nOK<CRLF>

### 6.4.6 Channel Status (CHS)

Specifies in increasing order in which channels there is a module. (0 = no channel available, 1 = channel available, 2 = math function is output on this channel)

	CHS
Command	\$CHS<CR>
Response	\$CHS1,0,2,1OK<CRLF> (Example: Channel 1,3,4 available, channel 3 with math function)

### 6.4.7 Mode of Linearization (LIN)

Specifies the linearization type for each channel.

The linearization type can be set for each channel. The index m stands for channel number, the index n for the linearization type.

	LIN
Command	\$LINm:n<CR> (for example: \$LIN4:2<CR> = 2-point-linearization for channel 4)
Response	\$LINm:nOK<CRLF>
Index m (Channel number)	1 ... 4
Index n (linearization mode)	0 = no linearization (default setting) 1 = Start of measuring range 2 = 2-point-linearization 3 = 3-point-linearization 4 = 5-point-linearization 5 = 10-point-linearization
Request linearization mode	
Command	\$LIN?<CR>
Response	\$LIN?n,n,n,nOK<CRLF> (n stands for the linearization type)

### 6.4.8 Set Linearization Point (SLP)

Sets a linearization point.

Place the sensor or the target in the corresponding position. After the command has been received, the current measuring value will be recorded at this position as a linearization point and thus the constants are recalculated for the linearization.

	SLP
Command	\$SLPm:n<CR> (for example: \$LIN4:3<CR> = linearization point at 30 % of channel 4)
Response	\$SLPm:nOK<CRLF>
Index m (channel number)	1 ... 4
Index n (linearization point)	n (linearization point): 1 = linearization point at 10 % of the measuring range 2 = linearization point at 20 % of the measuring range 3 = linearization point at 30 % of the measuring range 4 = linearization point at 40 % of the measuring range 5 = linearization point at 50 % of the measuring range 6 = linearization point at 60 % of the measuring range 7 = linearization point at 70 % of the measuring range 8 = linearization point at 80 % of the measuring range 9 = linearization point at 90 % of the measuring range 10 = linearization point at 100 % of the measuring range

### 6.4.9 Get Linearization Point (GLP)

Reads out the linearization point.

The value is output hex format.

	GLP
Command	\$GLPm:n<CR> (for example: \$GLP4:3<CR> = linearization point at 30 % of channel 4)
Response	\$GLPm:n,.....OK<CRLF> (for example \$GLP5:3,A034C9OK<CRLF>)
Index	<p>m (channel number): 1...4</p> <p>n (linearization point):</p> <p>1 = linearization point at 10 % of measuring range</p> <p>2 = linearization point at 20 % of measuring range</p> <p>3 = linearization point at 30 % of measuring range</p> <p>4 = linearization point at 40 % of measuring range</p> <p>5 = linearization point at 50 % of measuring range</p> <p>6 = linearization point at 60 % of measuring range</p> <p>7 = linearization point at 70 % of measuring range</p> <p>8 = linearization point at 80 % of measuring range</p> <p>9 = linearization point at 90 % of measuring range</p> <p>10 = linearization point at 100 % of measuring range</p>

### 6.4.10 Status (STS)

Reads all settings at once.

The individual parameters are separated by a semicolon. The structure of the respective responses corresponds to those of the individual requests.

	STS
Command	\$STS<CR>
Response	\$STSSTIn;AVTn;AVNn;CHS...;TRG.OK<CRLF>

### 6.4.11 Version (VER)

Requesting the current software version including date.

	VER
Command	\$VER<CR>
Response	\$VERDT6200;V1.2a;8010079<CRLF>

### 6.4.12 Set Mathematic Function (SMF)

Sets a math function on a certain channel.

	SMF	
Command	\$SMFm:Offset,Factor1,Factor2,Factor3,Factor4<CR>	
Response	\$SMFm:Offset,Factor1,Factor2,Factor3,Factor4,OK<CRLF>	
Index	m: 1...4 (Channel number)	If a channel is selected, which is already reserved by electronics, the result of the math function is now transmitted instead of the measured value.
	Offset	24 bit offset value with prefix in hex format, at which 21 bit comply with 100 % measured value.  Numbers exceeding 21 bit are therefore greater (for example +3FFFF = complies with 200 % of the measured value).
	Factor1, ..., Factor4	Multiplication factors (including prefix), with which the measured values of channel 1 up to 8 are multiplied. The range of values of -9.9 up to +9.9 with a decimal place. Structure of factors: Prefix and a one-digit number with a decimal place, example +3.4

Example: \$SMF2:+1FFFFFF,+1.0,+0.0,+0.0,-0.3<CR>

On channel 2 the sequent math function is output:

100 % Offset + 1 \* channel 1 - 0.3 \* channel 4

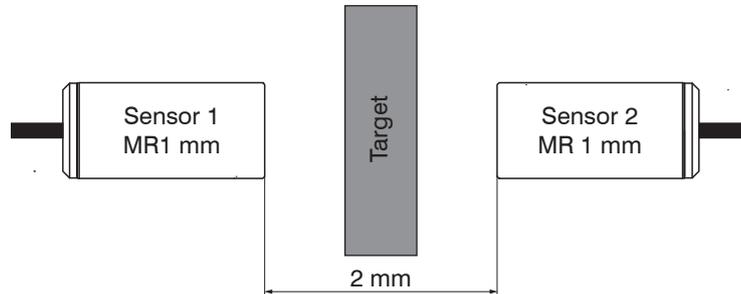


Fig. 22 Example for thickness measurement of a target with two capacitive sensors

Following math function is required for the above adjustment for thickness measurement of the target.

Target thickness = +200 % offset (equates to 2 mm) - 1 \* channel 1 - 1 \* channel 2

Required command:

\$SMF3:+3FFFFFF,-1.0,-1.0,+0.0,+0.0<CR>

**i** 3 measured values can be allocated together at most, the different factors have to be +0.0 each.

If a math function is set on a channel, the channel status changes onto 2.

### 6.4.13 Get Mathematic Function (GMF)

Reads out the math function of a channel.

	GMF	
Command	\$GMFm<CR>	
Response	\$GMFm:Offset,Factor1,Factor2,Factor3,Factor4OK<CRLF>	
Index	m: 1...4 (Channel number)	If a channel is selected, which is already reserved by electronics, the result of the math function is now transmitted instead of the measured value.
	Offset	24 bit offset value with prefix in hex format, at which 21 bit comply with 100 % measured value. Numbers exceeding 21 bit are therefore greater (for example +3FFFF = complies with 200 % of the measured value).
	Factor1, ..., Factor4	Multiplication factors (including prefix), with which the measured values of channel 1 up to 4 are multiplied. The range of values of -9.9 up to +9.9 with a decimal place. Structure of factors: Prefix and a one-digit number with a decimal place. Example +3.4.

### 6.4.14 Clear Mathematic Function (CMF)

Deletes the math function on a channel.

	CMF	
Command	\$CMFm<CR>	
Response	\$CMFmOK<CRLF>	
Index	m: 1...4 (Channel number)	

### 6.4.15 Ethernet Settings (IPS)

Changes the IP settings of the controller.

	IPS
Command	\$IPSm,<IPAddress>,<SubnetAddress>,<GatewayAddress> <CR>
Example	\$IPSO,169.254.168.150,255.255.0.0,169.254.168.1<CR>
Response	\$IPSm,<IPAddress>,<SubnetAddress>,<GatewayAddress>OK<CRLF>
Index	m = 0: static IP address m = 1: activates DHCP* * If DHCP is active, no IP subnet- and gateway address has to be transmitted.
Request settings	
Command	\$IPS?
Response	\$IPS? m,<IPAddress>,<SubnetAddress>,<GatewayAddress>OK<CRLF>

### 6.4.16 Query Data Port (GDP)

Queries the port number of the data port.

Command	\$GDP<CR>
Response	\$GDP<Port number>OK<CRLF> Example: \$GDP10001OK<CRLF>

### 6.4.17 Set Data Port (SDP)

Sets the port number of the data port. Range: 1024 ...65535.

Command	\$SDP<Portnumber> <CR> Example: \$SDP10001OK<CR>
Response	\$SDP<Portnumber>OK<CRLF>

#### 6.4.18 Access Channel Information (CHI)

Reads channel-specific information (e.g. serial number of the display board).

Command	\$CHIm<CR>
Response	\$CHIm:ANO...,NAM...,SNO...,OFS...,RNG...,UNT...,DTY...OK<CRLF>
Index	<p>m (Channel number): 1 - 4            ANO = Article number            NAM = Name            SNO = Serial number            OFS = Measuring range offset            RNG = Measuring range            UNT = Unit of measuring range (e.g. <math>\mu\text{m}</math>)            DTY = Data type of measuring value (1 = measuring value as INT,            0 = no measuring value)</p>

#### 6.4.19 Access Controller Information (COI)

Reads information of the controller (e.g. serial number).

Command	\$COI<CR>
Response	\$COIANO...,NAM...,SNO...,OPT...,VER...OK<CRLF>
Index	<p>ANO = Article number            NAM = Name            SNO = Serial number            OPT = Option            VER = Firmware version</p>

#### 6.4.20 Login for Web Interface (LGI)

Changes the user level for the web interface on `professional`.

Command	\$LGI<Password> <CR>
Response	\$LGI<Password> <OK>CRLF
Index	Password = Password of the device. When delivered, no password is assigned. The field can remain empty.

#### 6.4.21 Logout for Web Interface (LGO)

Changes the user level for the web interface on `user`.

Command	\$LGO<CR>
Response	\$LGOOK<CRLF>

#### 6.4.22 Change Password (PWD)

Changes the password of the device (required for the web interface and the `sensorTOOL`).

Command	\$PWD<oldpassword>,<newpassword>,<newpassword> <CR>
Response	\$PWD<oldpassword>,<newpassword>,<newpassword>OK<CRLF> A password can be from 0-16 characters and must contain only letters and numbers. When delivered, no password is assigned. The field can remain empty/blank.

### 6.4.23 Change Language for the Web Interface (LNG)

Changes the language of the web interface.

Command	\$LNGn<CR>
Response	\$LNGnOK<CRLF>
Index	0 = System 1 = English 2 = German

### 6.4.24 Write Measuring Range Information in Channel (MRA)

Changes the measuring range information of a channel (e.g. in case of a sensor change). This information is e.g. required for the correct scaling of the measuring values in the web interface. The value is specified in  $\mu\text{m}$ .

This is only an information value, what means, the actual measuring range of a sensor is not changed by changing the value.

Command	\$MRAm:<Range in $\mu\text{m}$ ><CR> (Example: \$MRA2:2000<CR> sets the measuring range of channel 2 to 2000 $\mu\text{m}$ )
Response	\$MRAm:<Range in $\mu\text{m}$ >OK<CRLF>
Index	m (Channel number): 1 - 4

### 6.4.25 Set Analog Filter (ALP)

Enables/Disables a low pass filter with 20 Hz limit frequency on analog output

Command	\$ALPn<CR>
Response	\$ALPnOK<CRLF>
Index	0 = Low pass filter not active 1 = Low pass filter is active
Request	\$ALP?
Response	\$ALP?nOK<CRLF>

#### 6.4.26 Default Messages

- Unknown command: (ECHO) + \$UNKNOWN COMMAND<CRLF>
- Wrong parameter after command: (ECHO) + \$WRONG PARAMETER<CRLF>
- Timeout (approximately 15 s after last input) (ECHO) + \$TIMEOUT<CRLF>
- Wrong password: \$WRONG PASSWORD<CRLF>

### 6.5 Operation Using Ethernet

Dynamic web pages are generated in the controller which contain the current settings of the controller and the peripherals. Operation is only possible while there is an Ethernet connection to the controller.

#### 6.5.1 Requirements

You need a web browser with HTML5 support (e.g. Mozilla Firefox  $\geq 3.5$  or Internet Explorer  $\geq 10$ ) on a PC with a network connection. To support a basic first commissioning of the controller, the controller is set to a direct connection.

If you have configured your browser to access the internet via a proxy server, in the browser settings you will need to add the IP address of the controller to the list of addresses which should not be routed through the proxy server. The MAC address of the unit can be found on the nameplate of the controller.

“Javascript” must be enabled in the browser so that measurement results can be displayed graphically.

Direct connection to PC, controller with static IP (Factory setting)		Network
PC with static IP	PC with DHCP	Controller with dynamic IP, PC with DHCP
<p>➡ Connect the controller to a PC using a direct Ethernet connection (LAN). Use a LAN cable with RJ-45 connectors for this.</p>		<p>➡ Connect the controller to a switch using a direct Ethernet connection (LAN). Use a LAN cable with RJ-45 connectors for this.</p>
<p>➡ Now start the <code>sensorTOOL</code> program.</p> <p>➡ Click the button . Select the designated controller from the list. In order to change the address settings, click the button <code>Change IP...</code></p> <ul style="list-style-type: none"> <li>• Address type: static IP address</li> <li>• IP address: 169.254.168.150 <sup>1</sup></li> <li>• Subnet mask: 255.255.0.0</li> </ul> <p>➡ Click the button <code>Apply</code> to transmit the changes to the controller.</p> <p>➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.</p> <p>1) Requires that the LAN connection on the PC uses, for example, the following IP address: 169.254.168.1.</p>	<p>Wait until Windows has established a network connection (Connection with limited connectivity).</p> <p>➡ Now start the <code>sensor-TOOL</code> program.</p> <p>➡ Click the button . Select the designated controller from the list.</p> <p>➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.</p>	<p>➡ Enter the controller in the DHCP / register the controller in your IT department.</p> <p>The controller gets assigned an IP address from your DHCP server. You can check this IP address with the <code>sensorTOOL</code> program.</p> <p>➡ Now start the <code>sensorTOOL</code> program.</p> <p>➡ Click the button . Select the designated controller from the list.</p> <p>➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.</p> <p>Alternatively: If DHCP is used and the DHCP server is linked to the DNS server, access to the controller via a host name of the structure “DT6222_&lt;serial_number&gt;” is possible.</p> <p>➡ Start a web browser on your PC. To achieve a controller with the serial number “01234567”, type in the address bar on your browser “DT6222_01234567”.</p>
<p>Interactive web pages for setting the controller and peripherals are now shown in the web browser.</p>		

The `sensorTOOL` program is available online at <https://www.micro-epsilon.com/download/software/sensorTool.exe>.

## Access via Web Interface

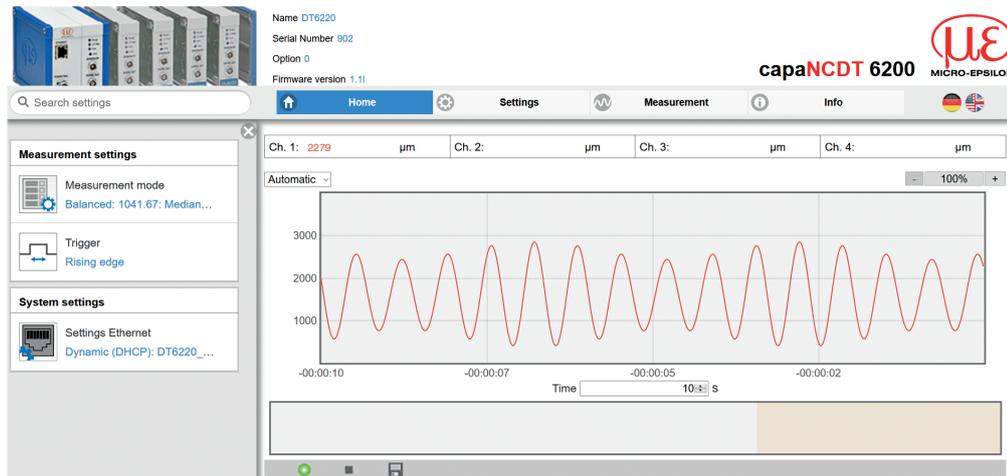


Fig. 23 First interactive web page after calling the IP address

Use the upper navigation bar to access additional features (e. g. Settings etc.).

All settings on the web page are applied immediately in the controller.

Parallel operation with web interface and Telnet commands is possible; the last setting applies.

The appearance of the web pages may vary depending on functions and peripherals. Each page contains parameter descriptions and tips on completing the controller.

### 6.5.2 Operating Menu, Set Controller Parameter

You can program the capaNCDT 6222 at the same time in two different kinds:

- Using a web browser via the sensor web interface
- With ASCII command set and terminal program via Ethernet (Telnet)

## 6.6 Channel n

### 6.6.1 Channel Information, Measuring Range

➡ Menu `Settings > Channel n > Channel information`.

The measuring ranges of the connected sensors must be entered manually. Do not forget to enter the new range after changing a sensor.

Data channel	1 / 2 / 3 / 4	Value	Value range 0 ... 1000000 $\mu\text{m}$
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### 6.6.2 Linearization

A linearization of a measuring channel (physical demodulator module) may be necessary, if, for example, the target geometry is changed. Selection of a linearization type depends on how many data points the correction curve should use.

**i** The measuring device requires a run-in period of approximately 15 minutes.

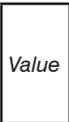
Measuring channel	1 / 2 / 3 / 4	Linearization type	No linearization / Offset / 2-point / 3-point / 5-point / 10-point
-------------------	---------------	--------------------	--

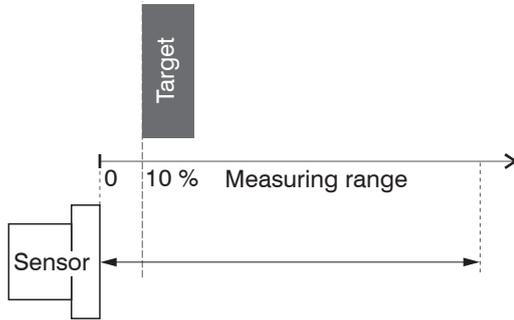
The sequence, with that the linearization points are measured, doesn't play a role.

#### Example: Procedure for a 3 point linearization:

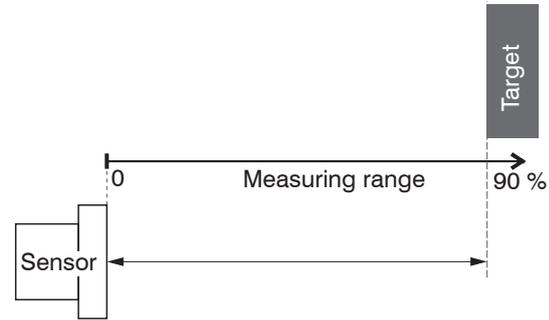
- ➡ Select the designated measuring channel.
- ➡ Select a 3-point linearization type.
- ➡ Adjust the target to 10 % of the measuring range to the sensor.

 Grey shaded fields require a selection.

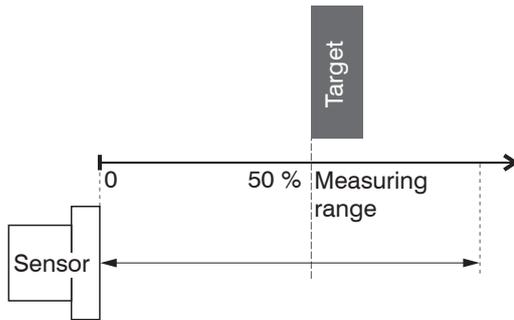
 Dark-bordered fields require you to specify a value.



- ➔ Click on the `Reset` button in web interface in the line 10 %.
- ➔ Adjust the target to 50 % of the measuring range to the sensor.



- ➔ Click on the `Reset` button in web interface in the line 90 %.
- The program will calculate the correction curve from the three data points.



- ➔ Click on the `Reset` button in web interface in the line 50 %.
- ➔ Adjust the target to 90 % of the measuring range to the sensor.

### 6.6.3 Math Function

? **Math function**

Offset (µm)

+ Measurement channel 1 ×

+ Measurement channel 2 ×

+ Measurement channel 3 ×

+ Measurement channel 4 ×

Set math function

Clear math function

This function enables the scaling of a measuring channel and the mathematical combination of individual channels.

**Formula:** Data channel = Offset + factor measurement channel 1 + factor measurement channel 2 + factor measurement channel 3 + factor measurement channel 4.

Data channel = digital values

Measuring channel = analog value of a demodulator module

Data channel	1 / 2 / 3 / 4	Offset	<i>Value</i>	Value range ±8-point MR max.
		Factor measuring channel	<i>Value</i>	Value range -9,9 ... +9,9

Grey shaded fields require a selection.

*Value* Dark-bordered fields require you to specify a value.

## 6.7 Measurement settings

### 6.7.1 Measurement mode

➤ Menu Settings > Measurement settings > Measurement mode

 **Measurement mode**

Measurement mode

**Low noise** ▼

Data rate (Hz)

**104.17** ▼

Filter type

**Median** ▼

Filter width

**7** ▼

Analog low pass filter

**Active** ▼

High speed	<i>data rate: 3906.25 Hz, filter type: Off, analog low pass: inactive</i>
Balanced	<i>data rate: 1041.67 Hz, filter type: Median, filter width: 3, analog low pass: inactive</i>
Low noise	<i>data rate: 104.17 Hz, filter type: Median, filter width: 7, analog low pass: active</i>
User defined	

#### 6.7.1.1 Data Rate

Data Rate	2.6 / 5.21 / 10.42 / 15.63 / 26.04 / 31.25 / 52.08 / 62.5 / 104.17 / 520.83 / 1041.67 / 2083.33 / 3906.25 Sa/s	Instructs the sensor about the frequency, with which data are output via the Ethernet interface.
-----------	--	--

Grey shaded fields require a selection.

Value Dark-bordered fields require you to specify a value.

### 6.7.1.2 Filter type / Averaging

Filter type	No Averaging		
	Moving average	<i>Value</i>	Filter width 2 / 3 / 4 / 5 / 6 / 7 / 8
	Arithmetic mean	<i>Value</i>	
	Median	<i>Value</i>	
	Dynamic noise rejection		
<i>Designation of averaging type. Averaging number indicates, about how many current measuring values should be averaged in the controller, before a new measuring value is output.</i>			

It is recommended, to use averaging for statical measuring or slowly changing measuring values. An averaging reduces noise or suppresses distortions in measuring values.

### 6.7.1.3 Analog Low Pass Filter

Filter	active / inactive	<i>Switches the deep pass filter with 20 Hz limit frequency on analog output</i>
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### 6.7.2 Trigger Mode

➡ Menu Settings > Measurement settings > Trigger

This menu item determines the trigger behavior. The triggering is released by an external electrical signal, [see 4.7.2](#) or by the command \$ GMD, [see 6.4.3](#).

If the trigger mode is turned off, the capaNCDT 6222 will send the measuring values without interruption and with the adjusted data rate.

Trigger mode	Rising edge	<i>A measuring value is output per edge.</i>
	Level high	<i>Level triggering. Measuring value output, as long as the level is active.</i>
	Rising edge (gate)	<i>Starts resp. stops the measuring value output alternatively.</i>
	No trigger	<i>Controller sends measuring values continuously.</i>

Grey shaded fields require a selection.

*Value* Dark-bordered fields require you to specify a value.

## 6.8 System Settings

### 6.8.1 Language Selection

The web interface promotes the units millimeter (mm) when displaying measuring results. You can choose German, English, Chinese, Japanese, Korean or the preset browser language in the web interface. You can also change the language in the menu bar.

### 6.8.2 Login, Change of the User Level

➡ Menu Settings > System settings > Switch user.

Change to the User level by clicking the Logout button. Enter the password into the Password field, and confirm with Login in order to switch to the Expert user level. In Professional mode, you can use the system settings to assign a user-defined password, see 6.8.3.

Fig. 24 Change in the professional user level

The current user level remains after leaving the web interface or restarting the controller.

The following functions are accessible for the user:

	User	Professional
Password required	no	yes
View settings	yes	yes
Change settings, linearization, analog output, change password	no	yes
Start measuring	yes	yes
Scaling diagrams	yes	yes

Fig. 25 Permissions within the user hierarchy

### 6.8.3 Password

Assigning passwords prevents unauthorized changes to controller settings. In the delivery state, no password is deposited in the controller.

- A firmware update will not change the custom password.

After the controller has been configured, you should enable password protection.

➔ Change to the menu `Settings > System settings > Change password`

Password	Value	<i>All passwords are case-sensitive. Letters and numbers are allowed, but special characters are not permitted. A password consists of max. 16 characters.</i>
----------	-------	--

With the first-time assignment of a password the `Old Password` field remains free.

### 6.8.4 Ethernet Settings

➔ Menu `Settings > System settings > Settings Ethernet`.

The IP address of the controller is factory-set to 169.254.168.150. Communication with the controller is performed via a data port (factory-set 10001) for measurement data transmission.

You can change the IP settings and the data port at any time:

- using the web browser,
- using the `sensorTOOL` Software.

Address type	Static IP address / Dynamic (DHCP)	<i>When using a static IP address it is necessary to enter the values for the IP address, netmask and gateway; this is not required when DHCP is used. When DHCP is activated, the controller is accessible in the network under its DHCP Host name. It contains the name and serial number and is unchangeable, see 6.5.1. With DHCP it may be necessary to enable the controller MAC address.</i>
IP address	Value	
Netmask	Value	
Gateway	Value	
MAC address	Value	
UUID	Value	
Data port	Value	

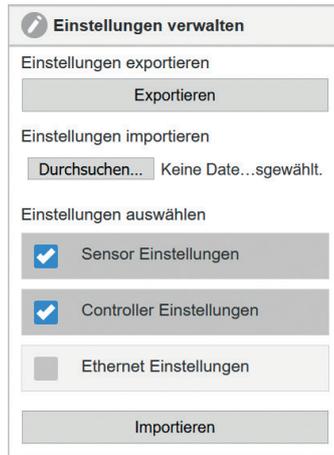
Grey shaded fields require a selection.

Dark-bordered fields require you to specify a value.

### 6.8.5 Import, Export

➤ Menu Settings > System Settings > Manage settings.

Here you can export all controller settings in a file or reimport them from a file.



The Export feature generates a text file which you can either store or display with an editor.

**Sensor settings** e.g. Measuring range, linearization settings

**Controller settings** e.g. Measurement settings, math function, system settings (e. g. language)

**Ethernet settings** e.g. Address type (static, DHCP), IP address, operating mode after start

When importing settings, consider if you want to replace the current controller and/or Ethernet settings.

➤ Choose the desired import option in the settings section.

## 6.9 Firmware Update

The controller has a firmware update function. We recommend to always use the latest firmware version. You can find the latest firmware version on our website and it can be installed with the attached Firmware Update Tool.

## 7. Measurement

With the capaNCDT either the deflection or the compensation method of measurement can be applied.

- **Deflection method** for fast events and tolerance monitoring:

Put the zero point in the centre of the measuring range, the output signal is then in proportion to the distance. Fast events are displayed on a suitable external recorder (oscilloscope, recorder, transient recorder).

- **Compensation method** for constant or slowly changing distances.

Compensation is carried out with the “zero” potentiometer until the output signal is 0 Volt. Sensitivity is not affected by doing this.

## 8. Operation and Maintenance

Please take care of the following:

- ➡ Make sure that the sensor surface is always clean.
- ➡ Switch off the power supply before cleaning.
- ➡ Clean with a damp cloth; then rub the sensor surface dry.

Changing the target or very long operating times can lead to slight reductions in the operating quality (long term errors). These can be eliminated by recalibration.



- ➡ Disconnect the power supply before touching the sensor surface.

- > Static discharge
- > Danger of injury

In the event of a defect in the controller, the sensor or the sensor cable, the parts concerned must be sent back for repair or replacement. In the case of faults the cause of which is not clearly identifiable, the whole measuring system must be sent back for repair or replacement to

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## 9. Liability for Material Defects

All components of the device have been checked and tested for functionality at the factory. However, if defects occur despite our careful quality control, MICRO-EPSILON or your dealer must be notified immediately. The liability for material defects is 12 months from delivery.

Within this period, defective parts, except for wearing parts, will be repaired or replaced free of charge, if the device is returned to MICRO-EPSILON with shipping costs prepaid. Any damage that is caused by improper handling, the use of force or by repairs or modifications by third parties is not covered by the liability for material defects. Repairs are carried out exclusively by MICRO-EPSILON.

Further claims can not be made. Claims arising from the purchase contract remain unaffected. In particular, MICRO-EPSILON shall not be liable for any consequential, special, indirect or incidental damage. In the interest of further development, MICRO-EPSILON reserves the right to make design changes without notification. For translations into other languages, the German version shall prevail.

## 10. Decommissioning, Disposal

➡ Remove the cable for electrical power and output signal on the controller.

Incorrect disposal may cause harm to the environment.

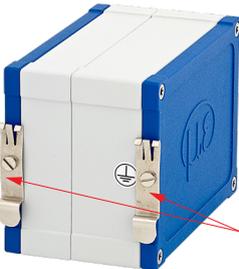
➡ Dispose of the device, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.

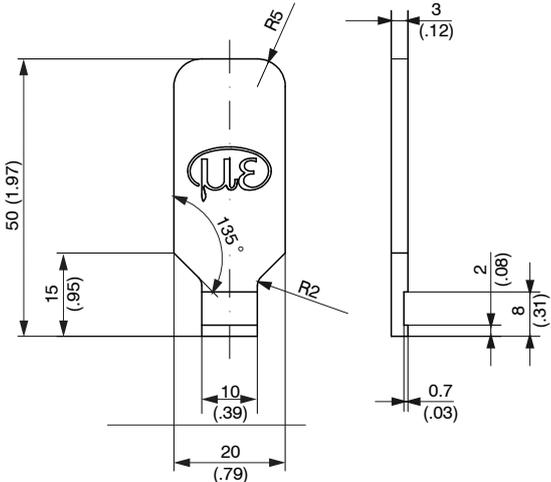
## Appendix

### A 1 Accessories, Service

#### A 1.1 Conversion Kit

The conversion kit is contained in the scope of supply, [see 3.1](#).

Ground terminal	 <p>Ground connection</p>	$\varnothing$ 4,3 mm (.173 dia.)
Mounting clamps for mounting on DIN-rail	 <p>Mounting clamps for mounting on DIN-rail</p>	20 x 0.8 mm/ CK75G hardened/ plated

<p>Mounting plate</p>		<p>Aluminum / powder-coated</p>
<p>Plugging off assistance for connector</p>		

Dimensions in mm (inches), not to scale

Further more, the conversion kit contains sleeve nuts, threaded rods in different lengths and screws.

**A 1.2 PC6200-3/4**

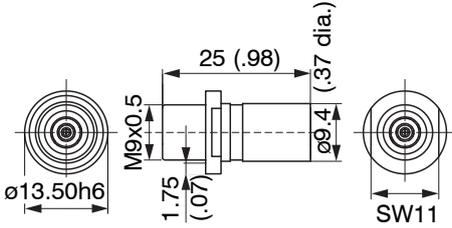
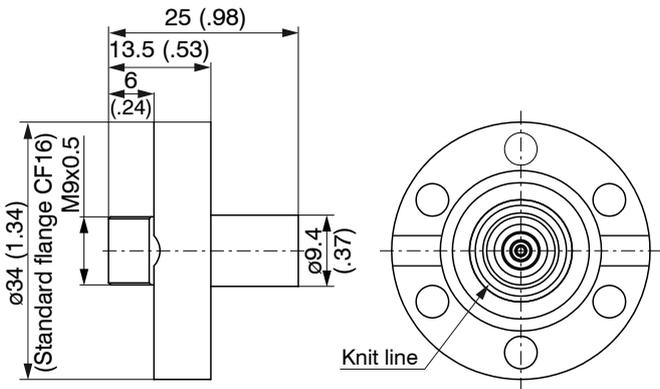
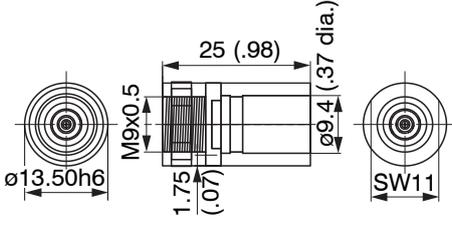
The PC6200-3/4 is contained in the scope of supply, [see 3.1](#).

PC6200-3/4		Power supply and trigger cable, 3 m long
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**A 1.3 Optional Accessories**

MC2.5		Micrometer calibration fixture, setting range 0 - 2.5 mm, reading 0.1 $\mu\text{m}$ , for sensors CS005 to CS2
MC25D		Digital micrometer calibration fixture, setting range 0 - 25 mm, adjustable zero point for all sensors

<p>SWH.OS.650.CTMSV</p>		<p>Vacuum feed through,              Max. leak rate <math>1 \times 10^{-7}</math> mbar · l s<sup>-1</sup>              Compatible with connector type B</p>
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<p>UHV/B</p>		<p>Vacuum feed through triax weldable              Max. leak rate <math>1 \times 10^{-9}</math> mbar · l s<sup>-1</sup>              Compatible with connector type B</p>
		<p>Vacuum feed through triax with CF16 flange              Max. leak rate <math>1 \times 10^{-9}</math> mbar · l s<sup>-1</sup>              Compatible with connector type B</p>
		<p>Vacuum feed through triax screwable              Max. leak rate <math>1 \times 10^{-9}</math> mbar · l s<sup>-1</sup>              Compatible with connector type B</p>

All vacuum feed throughs are compatible to the connectors type B, see 4.3.

SCACx/4		Signal output cable analog, x m long (necessarily for multi-channel operation)
PS2020		Power supply for mounting on DIN-rail input 230 VAC (115 VAC) output 24 VDC / 2.5 A; L/W/H 120 x 120 x 40 mm

#### A 1.4 Service

Function and linearity check-out, inclusive 11-point protocol with graphic and post-calibration.

## A 2 Factory Setting

### Analog:

- Zero-poti = Off (right-stop)
- LP filter 20 Hz = Off

### Digital:

- Data rate = 3906 Sa/s
- Filter = Off
- Linearization = Off
- Trigger mode = Off
- Math functions = Off
- IP address = Static IP  
(169.254.168.150)
- Data port = 10001

### A 3 Tilt Angle Influence on the Capacitive Sensor

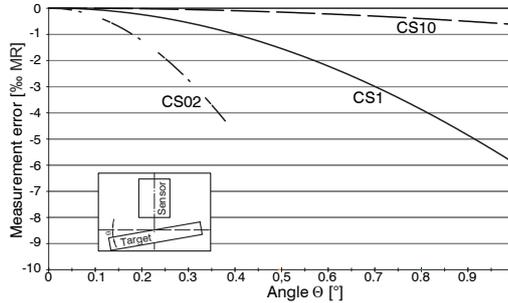


Fig. 26 Example of measuring range deviation in the case of a sensor distance of 10 % of the measuring range

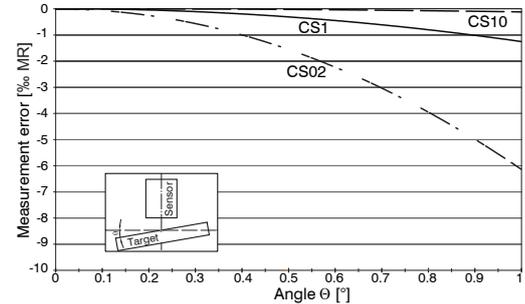


Fig. 27 Example of measuring range deviation in the case of a sensor distance of 50 % of the measuring range

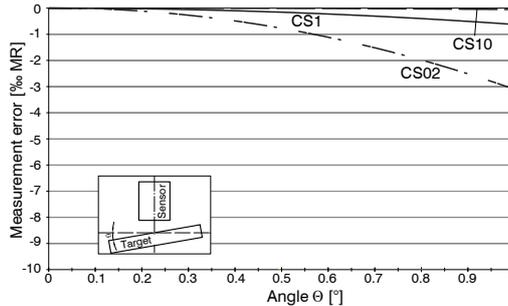


Fig. 28 Example of measuring range deviation in the case of a sensor distance of 100 % of the measuring range

**i** Figures give an influence example shown on the sensors CS02/CS1 and CS10 in the case of different sensor distances to the target. As this results from internal simulations and calculations, please request for detailed information.

### A 4 Measurement on Narrow Targets

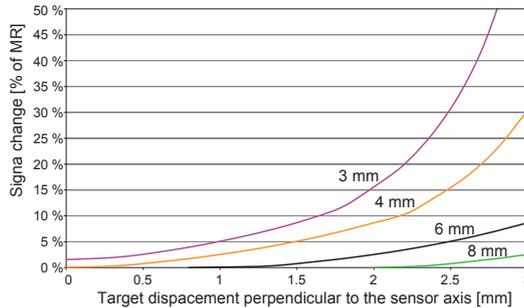


Fig. 29 Example of measuring range deviation in the case of a sensor distance of 10 % of the measuring range

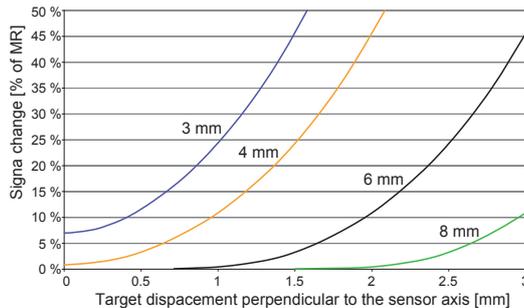


Fig. 31 Example of measuring range deviation in the case of a sensor distance of 100 % of the measuring range

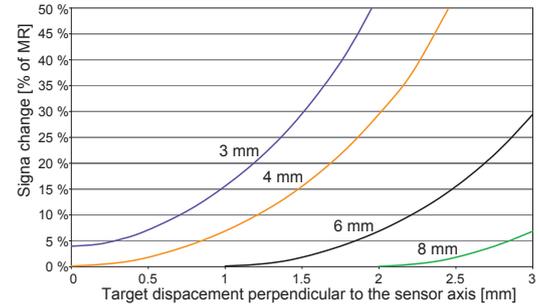


Fig. 30 Example of measuring range deviation in the case of a sensor distance of 50 % of the measuring range

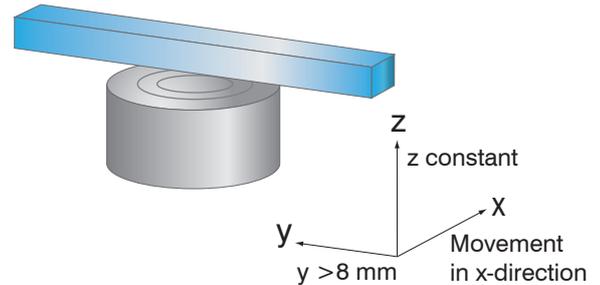


Fig. 32 Signal change in the case of displacement of thin targets in the opposite direction to the measurement direction

Figures give an influence example shown on the sensors CS05 in the case of different sensor distances to the target as well as target widths. As this results from internal simulations and calculations, please request for detailed information.

## A 5 Measurements on Balls and Shafts

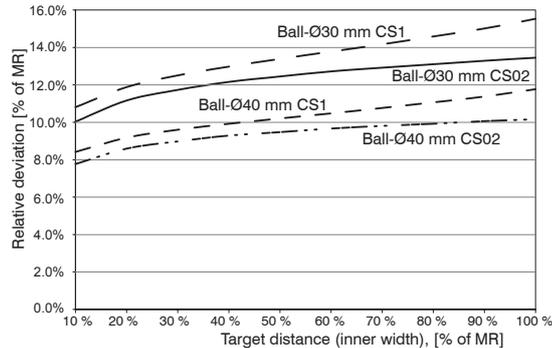


Fig. 33 Measuring value deviation in the case of measurement on ball-shaped targets

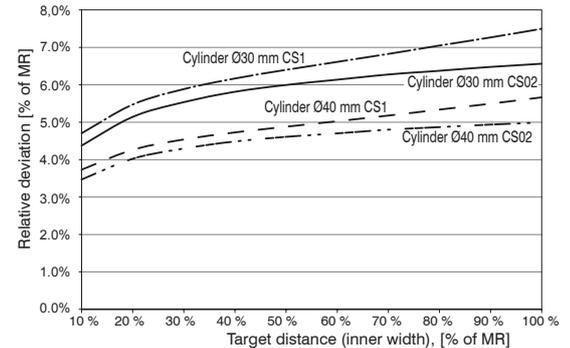


Fig. 34 Measuring value deviation in the case of measurement on cylindrical targets

Figures give an influence example shown on the sensors CS02 and CS1 in the case of different sensor distances to the target as well as target diameters. As this results from internal simulations and calculations, please request for detailed information.



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