Operating Instructions

capaNCDT 6235

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Contents

1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

The following symbols are used in these operating instructions:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation that may result in property damage if not avoided.
➡	Indicates a user action.
i	Indicates a tip for users.
`Measure`	Indicates hardware or a software button/menu.

1.2 Warnings

⚠ CAUTION

Disconnect the power supply before touching the sensor surface.
> Risk 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

NOTICE

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

NOTICE

Protect the sensor cable against damage
> Destruction of the sensor

> Failure of the measuring device

Protect the sensor cable against damage
> Destruction of the sensor

> Failure of the measuring device

1.3 Notes on Product Labeling

1.3.1 Notes on CE Marking

The following apply to the measuring system:
- Directive 2014/30/EU (“EMC)
- Directive 2014/35/EU (“Low Voltage”)
- Directive 2011/65/EU (“RoHS“), category 9

Products which carry the CE marking satisfy the requirements of the EU Directives cited and the relevant applicable harmonized European standards (EN). The product is designed for use in industrial and laboratory environments.

The EU Declaration of Conformity and the technical documentation are available to the responsible authorities according to the EU Directives.

1.3.2 UKCA Marking

The following applies to the product:
- SI 2016 No. 1091 (“EMC“)
- SI 2016 No. 1101 (“Low Voltage“)
- SI 2012 No. 3032 (“RoHS“)

Products which carry the UKCA marking satisfy the requirements of the directives cited and the relevant applicable harmonized standards. The product is designed for use in industrial and laboratory environments.

The UKCA Declaration of Conformity and the technical documentation are available to the responsible authorities according to the UKCA Directives.

1.4 Intended Use

- The capaNCDT 6200 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) [1]
    - Sensor cable: -100 ... +200 C (-58 to +392 °F) (CCmx and CCmx/90)
      -20 ... +80 °C (-58 to +392 °F) (CCgx and CCgx/90 - permanently)
      -20 ... +100 °C (-58 to +392 °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) [2]
    - 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.

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

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.

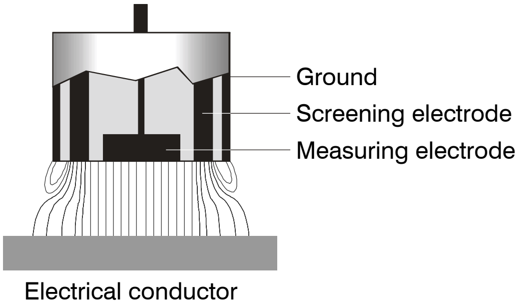


Fig. 1 Functional principle of the guard ring capacitor

2.2 Structure

The non-contact, multi-channel measuring system, installed in an aluminum housing, consists of:
- A basic module DT 6235
- A demodulator module DL 6225, each with integrated preamplifier per sensor
- Sensor
- Sensor cable
- Power supply cable
- Ethernet cable
- Signal output cable

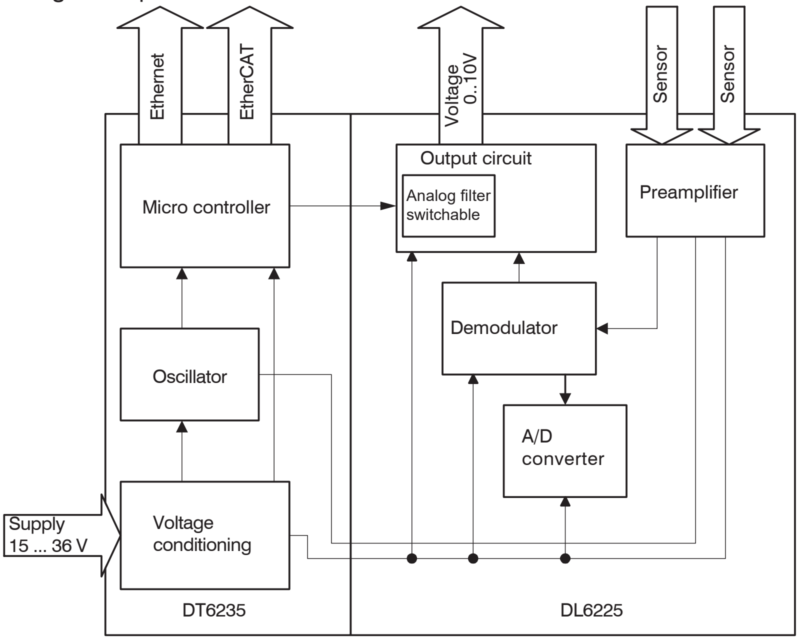


Fig. 2 Block diagram capaNCDT 6235

2.2.1 Sensors

For this measurement system, several sensors can be used. In order to obtain accurate measuring results, the surface of the sensor must be kept 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 metal targets

Model	Measuring range	Min. target diameter
CS005	0.05 mm	Ø 3 mm
CS02	0.2 mm	Ø 5 mm
CS08	0.8 mm	Ø 9 mm
CS1HP	1 mm	Ø 9 mm
CS-025	0.2 mm	Ø 5 mm
CS-05	0.5 mm	Ø 7 mm
CS-1	1 mm	Ø 9 mm
CS-2	2 mm	Ø 17 mm
CS-3	3 mm	Ø 27 mm
CS-5	5 mm	Ø 37 mm
CS-10	10 mm	Ø 57 mm
CSE01	0.1 mm	Ø 3 mm
CSE025	0.25 mm	Ø 4 mm
CSE05	0.5 mm	Ø 6 mm
CSE1	1 mm	Ø 8 mm
CSE1,25	1.25 mm	Ø 10 mm
CSE2	2 mm	Ø 14 mm
CSE3	3 mm	Ø 20 mm

Model	Measuring range	Min. target diameter
CSE05/M8	0.5 mm	Ø 6 mm
CSE1/M12	1 mm	Ø 10 mm
CSE2/M16	2 mm	Ø 14 mm
CSE3/M24	3 mm	Ø 20 mm
CSH02-CAm1,4	0.2 mm	Ø 7 mm
CSH05-CAm1,4	0.5 mm	Ø 7 mm
CSH1-CAm1,4	1 mm	Ø 11 mm
CSH1,2 -CAm1,4	1.2 mm	Ø 11 mm
CSH2-CAm1,4	2 mm	Ø 17 mm
CSH02FL-CRm1,4	0.2 mm	Ø 7 mm
CSH05FL-CRm1,4	0.5 mm	Ø 7 mm
CSH1FL-CRm1,4	1 mm	Ø 11 mm
CSH1,2FL-CRm1,4	1.2 mm	Ø 11 mm
CSH2FL-CRm1,4	2 mm	Ø 17 mm
CSH3FL-CRm1,4	3 mm	Ø 24 mm
CSF2 / CSF2-CRg4,0	2 mm	appr. 50.5 x 14 mm
CSF4 / CSF4-CRg4,0	4 mm	appr. 90.5 x 17.5 mm
CSF6 / CSF6-CRg4,0	6 mm	appr. 127.31 x 25 mm
CSF-0,5/01/Crg	0.5 mm	Ø 3.92 mm
CSF-1/01/CRg	1 mm	appr. 13.5 x 9.5 mm
CSG0,50-CAm2,0	0.5 mm	appr. 7 x 8 mm
CSG1,00-CAm2,0	1 mm	appr. 8 x 9 mm

Model	Measuring range	Min. target diameter
CSG0,5-CRg2,0/KB	0.5 mm	appr. 4.2 x 2.9 mm
CSG1-CRg4,0B/ET	1 mm	appr. 4.12 x 6.65 mm
CSG-1/MAT/CRx-2,0	1 mm	appr. 4.98 x 4.98 mm

2.2.2 Sensor Cable

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

NOTICE

Do not modify the sensor cable. Do not shorten or lengthen the special sensor cables. Do not crush the sensor cable. A damaged cable cannot be repaired. Turn off the device before disconnecting or modifying the cable connection.
> Loss of functionality

<table>
<tr><th rowspan="2">Model</th><th rowspan="2">Cable length</th><th rowspan="2">Cable ø</th><th rowspan="2">2 axial connector</th><th rowspan="2">1x axial + 1x 90 °</th><th rowspan="2">For sensors</th><th colspan="2">Min. bending radius</th></tr>
<tr><th>once</th><th>permanently</th></tr>
<tr><td>CCgxC</td><td>2 or 4 m</td><td>3.1 mm</td><td>•</td><td></td><td>0.05 - 0.8 mm</td><td rowspan="4">10 mm</td><td rowspan="4">22 mm</td></tr>
<tr><td>CCgxC/90</td><td>2 or 4 m</td><td>3.1 mm</td><td></td><td>•</td><td>0.05 - 0.8 mm</td></tr>
<tr><td>CCgxB</td><td>2 or 4 m</td><td>3.1 mm</td><td>•</td><td></td><td>1 ... 10 mm</td></tr>
<tr><td>CCgxB/90</td><td>2 or 4 m</td><td>3.1 mm</td><td></td><td>•</td><td>1 ... 10 mm</td></tr>
<tr><td>CCmxC</td><td>1.4 or 2.8 m</td><td>2.1 mm</td><td>•</td><td></td><td>0.05 - 0.8 mm</td><td rowspan="4">7 mm</td><td rowspan="4">15 mm</td></tr>
<tr><td>CCmxC/90</td><td>1.4 or 2.8 m</td><td>2.1 mm</td><td></td><td>•</td><td>0.05 - 0.8 mm</td></tr>
<tr><td>CCmxB</td><td>1.4 or 2.8 m</td><td>2.1 mm</td><td>•</td><td></td><td>1 ... 10 mm</td></tr>
<tr><td>CCmxB/90</td><td>1.4 or 2.8 m</td><td>2.1 mm</td><td></td><td>•</td><td>1 ... 10 mm</td></tr>
</table>

The sensor and controller are connected with a special, double-shielded sensor cable. These special sensor cables may not be shortened or extended by the user. A damaged cable cannot be repaired.

i Turn off the device when you disconnect or change the cable connection.

2.2.3 Controller

The capaNCDT 6235 two channel measuring system consists of a basic module DT6235 and a demodulator module DL6225. The components are stored in aluminum housings.

Fig. 3 Basic module DT6235 with demodulator modul DL6225

Basic module DT6235

The basic module DT6235 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 250 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 DL6225

The demodulator module DL6225 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.

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

2.3 Technical Data

Controller		**DT6235**	**DT6235/ECL2**	**DT6235/EMR2**	**DT6235/EMR2/ECL2**
Demodulator		**DL6225**			
Resolution	dynamic (50 kHz)	0.05 % RMS	0.07 % RMS	0.08 % RMS	0.11 % RMS
Frequency response		50 kHz (-3 dB), switchable to 70 Hz			
Measuring rate		62.5 kSa/s (Ethernet) > 200 µs (EtherCAT)			
Linearity		≤ ±0.05 %	±0.1 %	±0.1 %	≤ ±0.2 %
Sensitivity Deviation		≤ ±0.1 %		≤ ±0.2 %	
Long-term stability		< 0.02 % FSO / month			
Synchronization		yes			
Isolator measurrment		no			
Temperature stability		100 ppm	100 ppm	200 ppm (MMR), 800 ppm (EMR)	200 ppm (MMR), 800 ppm (EMR)
Supply voltage		15 … 36 VDC			
Power consumption		5.7 W (24 VDC)			
Digital interface		Ethernet / EtherCAT			
Analog output		0 … 10 V			
Temperature range	Storage	-50 ... +200 °C Sensor +10 ... +60 °C Controller			
	Operation	-10 … +75 °C			
Sensors		all sensors suitable			
Sensor cable		CCm1,4x; CCg2,0x	CCm2,8x; CCg4,0x	CCm1,4x; CCg2,0x	CCm2,8x; CCg4,0x

FSO = Full scale output

3. Delivery

3.1 Unpacking, Included in Delivery

- 1 Basic module DT6235
- 1 Demodulator modul DL6225
- 1 Power supply and trigger cable PC6200-3/4, 3 m long, see A 1.3
- 1 Conversion kit (Mounting clamps for DIN rail mounting, mounting plate for wall mounting),), see A 1.1.

Optional accessories:

- 1 Sensor
- 1 Sensor cable with connector
- Signal output cable, synchronization cable, see A 1.4

➡ 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 for completeness and shipping damages immediately after unpacking.

➡ If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Return of packaging

Micro-Epsilon Messtechnik GmbH & Co. KG offers customers the opportunity to return the packaging of products purchased from Micro-Epsilon by prior arrangement so that it can be reused or recycled.
To arrange the return of packaging, for questions about the costs and / or the exact return procedure, please

contact us directly at info@micro-epsilon.com

3.2 Storage

- Temperature range storage:
  - Sensor: -50 ... +200 °C (-58 to +392 °F) [1]
  - Sensor cable: -50 ... +200 °C (-58 to +392 °F) (CCmx and CCmx/90)
    -50 ... +80 °C (-57 to +176 °F) (CCgx and CCgx/90)
  - Controller: -10 ... +75 °C (+14 to +167 °F)
- Humidity: 5 - 95 % RH (non-condensing)

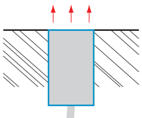
1) A storage temperature of -50 ... +100 °C (-58 to +212 °F) applies for the sensors CSG0.50-CA and CSG1.00-CA -50

4. Installation and Assembly

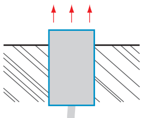
4.1 Sensor

No sharp or heavy objects should be allowed to affect the cable sheath.

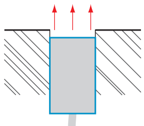
A damaged cable cannot be repaired. Tension on the cable is not permitted!



Flush installation



Protruding installation



Recessed installation, not for sensors in the CSE series

NOTICE During installation, take care that the sensor front face is not scratched.

4.1.1 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.

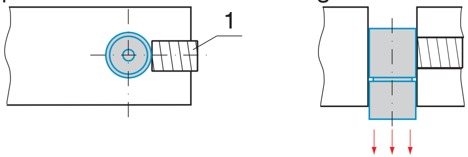


Fig. 4 Radial point clamping with grub screw

NOTICE Danger of damaging the sensor.

> Do not use metal grub screws!

4.1.2 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 et cetera.

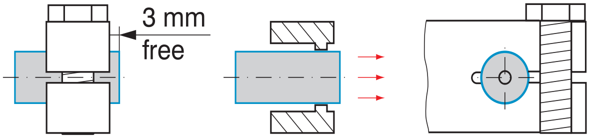
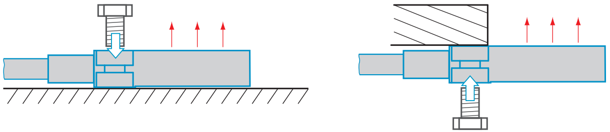


Fig. 5 Circumferential clamping

4.1.3 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.



Screw connection from top   Screw connection from Bottom

Fig. 6 Flat sensor screw connection top / bottom

4.1.4 Dimensional Drawing Sensors and Sensor cable

The dimensional drawings for the standard sensors and the sensor cables are summarized in a separate document. This can be found online at:

https://www.micro-epsilon.de/download-file/set--capaNCDT-Sensoren--en.pdf

4.2 Controller

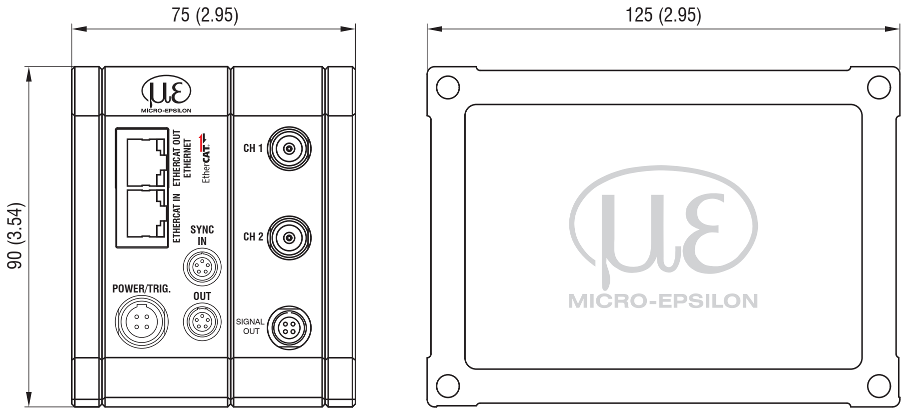


Fig. 7 Maßzeichnung Controller

Dimensions in mm, not to scale

The controller is mounted using mounting plates or retaining clips for a DIN rail mounting, which are included in an optional conversion kit, see A 1.1.

4.3 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. 88. Due to the unique synchronizing technique of Micro-Epsilon a special target earthing is not needed in most cases.

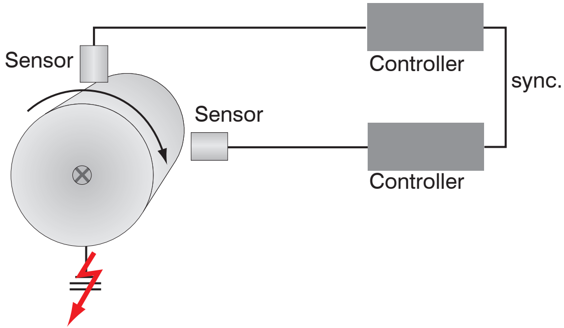


Fig. 8 Position and unbalance measuring with two measuring systems

Fig. 9 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.

4.4 Electrical Connections

4.4.1 Connectivity Options

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

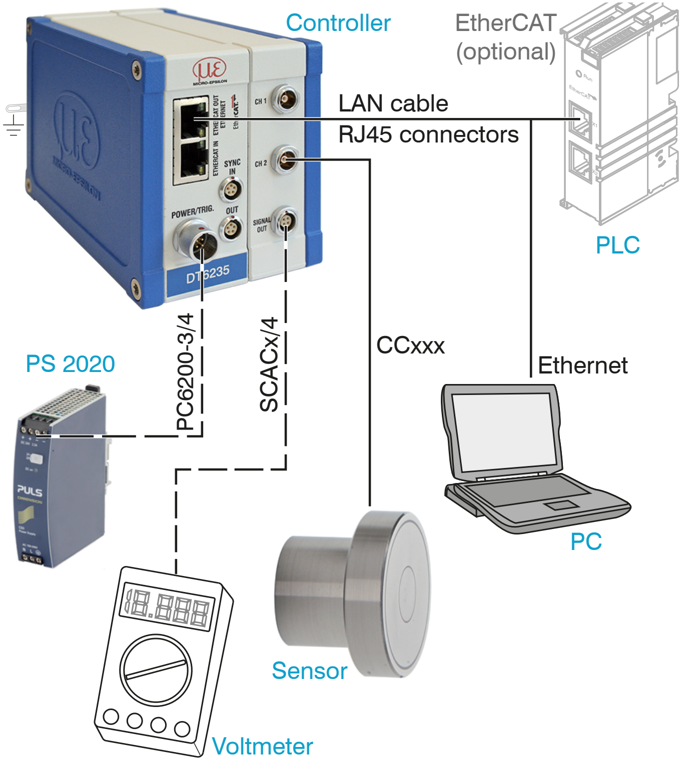
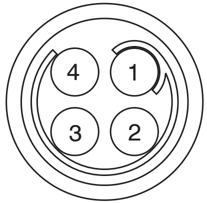


Fig. 10 Measuring system assembly

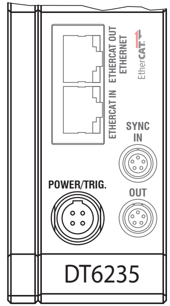
4.4.2 Pin Assignment Supply, Trigger

PIN	Color PC6200-3/4	Signal	Description
1	brown	+24VIN	+24 VDC Supply
2	white	Zero VIN	GND Supply
3	yellow	---	
4	green	---	
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

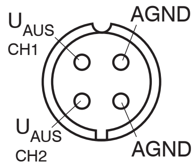


Power supply input on controller, 4-pole male cable connector

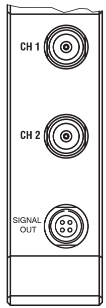
4.4.3 Pin Assignment Analog Output

Pin	Color SCACx/4	Signal	Description
1	brown	U_{OUT} CH1	Voltage output, Load min. 10 kOhm
2	yellow	U_{OUT} CH2	
3	gray	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

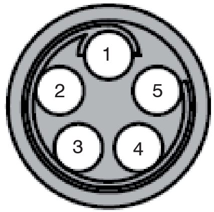


Signal output on controller, 4-pole male cable connector

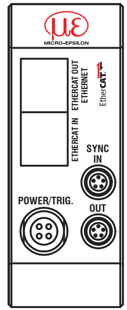
4.4.4 Pin Assignment Synchronization

PIN	Assignment	Insulation	Color
1	n.c	-	-
2	Twisted Pair 1	1	white 1
3	Twisted Pair 1	blue	blue
4	Twisted Pair 2	2	white 2
5	Twisted Pair 2	orange	orange

SC6000-x is a 0,3 or 1 m long, preassembled synchronization cable



View on solder pin side,
5-pin ODU male cable connector



Sync IN/OUT on controller, 5-pin female cable connector

Several measuring systems series capaNCDT 6235 can simultaneously be used as multi-channel system. With the synchronization of the systems, a mutual influence of the sensors is avoided.

- Plug the synchronization cable SC6000-x, see A 1.4, into the female connector SYNC OUT (Synchronisation output) at the controller 1.
- Plug the connector of SC6000-x into the female connector SYNC IN (synchronization input) at controller 2.

The oscillator of controller 2 switches automatically into synchronization, this means, depending on the oscillator 1 of Controller 1.

An influence of poor earthed target is excepted.

Synchronize possibly several measuring systems with a SC6000-x.

i Automatic synchronization. Every controller can be master.

Fig. 11 Synchronization of a second controller

5. Operation

5.1 Starting Up

➡ Connect the the display/output devices through the signal output socket, see 4.4, see 4.4.2, see 4.4.3, 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 Change Ethernet / EtherCAT

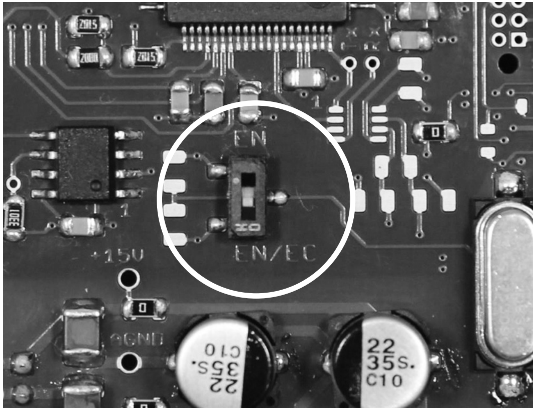


Fig. 12 Change Ethernet/EtherCAT

A switch between Ethernet and EtherCAT, is possible via a hardware switch or via software on the basic unit DT6235, see 7.2.

If the switch is in position `EN` (Ethernet), always the Ethernet interface is active independent of the software setting. If the switch is in position `EN/EC` (Ethernet/EtherCAT), then the active interface depends on the software setting. To change the interface it is necessary to restart the controller.

5.3 Change cutoff Frequency

The controller operates with a factory-set cutoff frequency of 50 kHz. Increasing the cutoff frequency to 70 kHz increases the dynamic range of the system. The cutoff frequency can only be changed using the switch in the demodulator module.

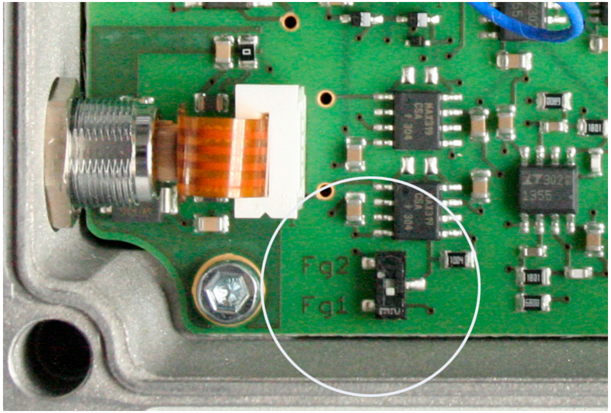


Fig. 13 Cutoff frequency switch on the demodulator module

Switch position	Cutoff frequency
Fg 2	70 kHz
Fg 1	50 kHz

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 6200.

You can find the current driver routine including documents at:
www.micro-epsilon.com/download
www.micro-epsilon.com/download/software/MEDAQLib.zip

6.1 Hardware, Interface

The data logging of all channels is synchronous.

➡ Connect the capaNCDT 6200 to an available Ethernet interface at the PC. Use a crossover cable.

For a connection with the capaNCDT 6200 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.

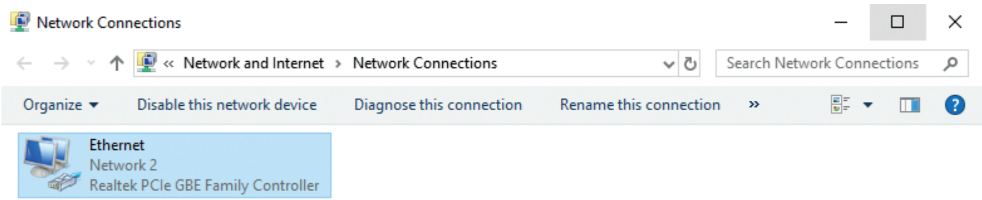
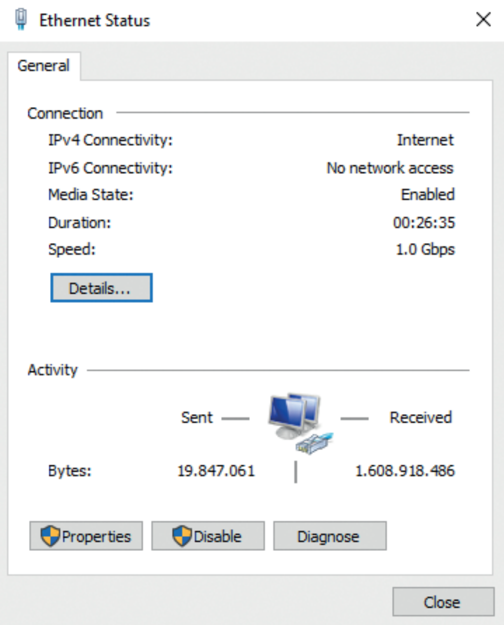


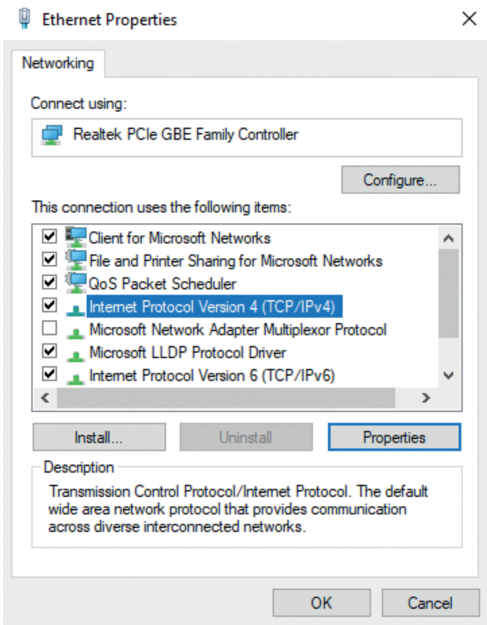
Fig. 14 LAN connection of a PC

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

IP address: 169.254.168.1

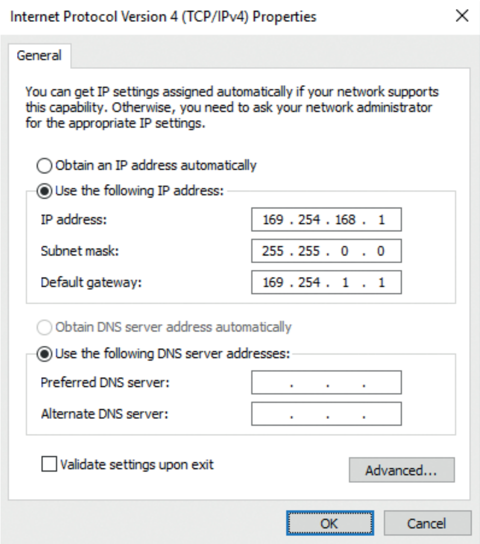
Subnet mask: 255.255.0.0





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 6.33.
- 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. DT6220_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 16 bits i.e only the lowest 16 bits of the integer number are used. Hexadecimal range: 0 ... 5900

Scaling of measuring values:

$$\text{Measurement} = \frac{\text{Digital value (Int)}}{59000} * \text{Measuring range}$$

Example: Measuring range sensor CS2 = 2000 µm; digital value = 29000 (dez)

Measurement = 983,05 µm

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

6.3 Commands

6.3.1 General

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>.

6.3.2 Channal Status (CHS = Channel Status)

Indicates, in ascending order, the channels in which a slot is located. (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)

6.3.3 Status (STS)

Reads all settings at once.
The individual parameters are separated by a semicolon. The structure of the respective responses corresponds to that of the individual queries.

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

6.3.4 Version (VER)

Query the current software version with date.

	VER
Command	$VER<CR>
Response	$VERDT6235;V1.2a;8010079<CRLF>

6.3.5 Ethernet settings (IPS = IP-Settings)

Changes the IP settings of the controller.

	IPS
Command	$IPSm,<IP adress>,<Subnet adress>,<Gateway adress> <CR>
Example	$IPS0,169.254.168.150,255.255.0.0,169.254.168.1<CR>
Response	$IPSm,<IP adress>,<Subnet adress>,<Gateway adress>OK<CRLF>
Index	m = 0: static IP- adress m = 1: activated DHCP* * If DHCP is enabled, no IP Subnet and Gateway address needs to be trans-mitted.
Query Settings	
Command	$IPS?
Response	$IPS? m,<IP adress>,<Subnet- adress>,<Gateway adress>OK<CRLF>

6.3.6 Switch between Ethernet and EtherCAT (IFC=Interface)

This command switches between the Ethernet and EtherCAT interfaces. This only works if the Ethernet/EtherCAT switch is set to ECAT/Auto. Otherwise, the Ethernet interface is always enabled. The new interface is only active after the controller is restarted.

	IFC
Command	$IFCm<CR> Bsp: $IFC1<CR>
Response	$IFCmOK<CRLF>
Index	m = 0: Ethernet m = 1: EtherCAT
Query	
Command	$IFC?
Response	$IFC?mOK<CRLF>

6.3.7 Get Dataport (GDP)

Queries the port number of the data port.

Command	$GDP<CR>
Response	$GDP<Portnummer>OK<CRLF> Bsp: $GDP10001OK<CRLF>

6.3.8 Set Dataport (SDP)

Sets the port number of the data port. Value range: 1024 ... 65535.

Command	$SDP<Portnummer><CR> Bsp: $SDP10001OK<CR>
Response	$SDP<Portnummer>OK<CRLF>

6.3.9 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	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. μm) DTY = Data type of measuring value (1 = measuring value as INT, 0 = no measuring value)

6.3.10 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	ANO = Article number NAM = Name SNO = Serial number OPT = Option VER = Firmware version

6.3.11 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.

6.3.12 Logout for Web Interface (LGO)

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

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

6.3.13 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.

6.3.14 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

6.3.15 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 µm.

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

6.3.16 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>

6.4 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.

6.4.1 Requirements

You need a web browser with HTML5 support (e.g. Mozilla Firefox ≥ 3.5 or Internet Explorer ≥ 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.

<table>
<tr><th colspan="2">Direct connection to PC, controller with static IP (Factory setting)</th><th>Network</th></tr>
<tr><td>PC with static IP</td><td>PC with DHCP</td><td>Controller with dynamic IP, PC with DHCP</td></tr>
<tr><td colspan="2">➡ Connect the controller to a PC using a direct Ethernet connection (LAN). Use a LAN cable with RJ-45 connectors for this.</td><td>➡ Connect the controller to a switch using a direct Ethernet connection (LAN). Use a LAN cable with RJ-45 connectors for this.</td></tr>
<tr><td>➡ Now start the <code>sensorTOOL</code> program.
➡ Click the button . Select the designated controller from the list. In order to change the address settings, click the button <code>Change IP...</code>
• Address type: static IP address
• IP address: 169.254.168.150 [1]
• Subnet mask: 255.255.0.0
➡ Click the button <code>Apply</code> to transmit the changes to the controller.
➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.

1) Requires that the LAN connection on the PC uses, for example, the following IP address: 169.254.168.1.</td><td>Wait until Windows has established a network connection (Connection with limited connectivity).
➡ Now start the <code>sensorTOOL</code> program.
➡ Click the button . Select the designated controller from the list.
➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.</td><td>➡ Enter the controller in the DHCP / register the controller in your IT department.
The controller gets assigned an IP address from your DHCP server. You can check this IP address with the <code>sensorTOOL</code> program.
➡ Now start the <code>sensorTOOL</code> program.
➡ Click the button . Select the designated controller from the list.
➡ Click the button <code>Open WebPage</code> to connect the controller with your default browser.
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 “DT6230_<serial_number>” is possible.
➡ Start a web browser on your PC. To achieve a controller with the serial number “01234567”, type in the address bar on your browser “DT6230_01234567”.</td></tr>
<tr><td colspan="3">Interactive web pages for setting the controller and peripherals are now shown in the web browser.</td></tr>
</table>

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

6.4.2 Access via Web Interface

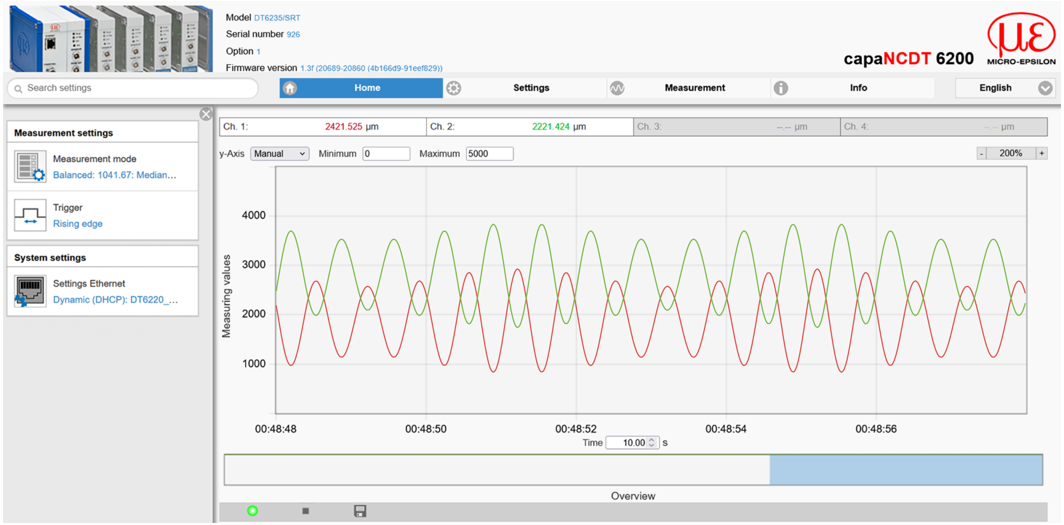


Fig. 15 First interactive web page after calling the IP address

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.

6.4.3 Operating Menu, Set Controller Parameter

You can program the capaNCDT 6200 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)

6.5 Channel n

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	*Value*	Value range 0 ... 1000000 µm

6.6 System Settings

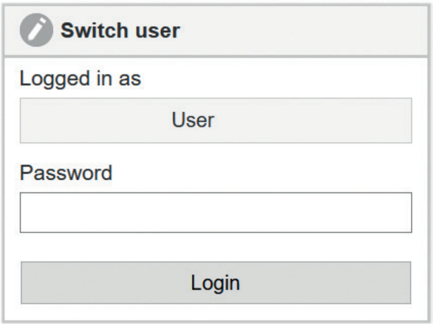
6.6.1 Language Selection

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.

6.6.2 Login, Changing User Level

➡ Menu `Settings > System settings > Switch user`

In the delivery state, the controller is set to Expert level.



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 6.6.3.

Fig. 16 Changing to professional level

The current user level remains after leaving the web interface of 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, password	no	yes
Start measuring	yes	yes
Scaling diagrams	yes	yes

Fig. 17 Permissions within the user hierarchy

6.6.3 Password

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

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

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

6.6.4 Ethernet Settings

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

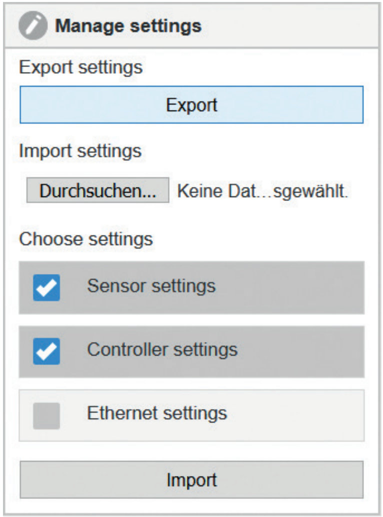
The IP address of the controller is factory-set to 169.254.168.150. Communication with the controller is performed via a data port (factory-set 10001) for measurement data transmission.
You can change the IP settings and the data port at any time:
- using the web browser,
- using the `sensorTOOL` Software.

<table>
<tr><td>Address type</td><td>static IP address / Dynamic (DHCP)</td><td rowspan="6">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 Chap. 6.4.1.
With DHCP it may be necessary to enable the controller MAC address.</td></tr>
<tr><td>IP address</td><td>Value ##</td></tr>
<tr><td>Netmask</td><td>Value ##</td></tr>
<tr><td>Gateway</td><td>Value ##</td></tr>
<tr><td>MAC address</td><td>Value ##</td></tr>
<tr><td>UUID</td><td>Value ##</td></tr>
<tr><td>Data port</td><td>Value ##</td><td>Setting the port on the measurement value server</td></tr>
</table>

6.6.5 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`.

6.7 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. EtherCAT Interface

7.1 Introduction

The EtherCAT interface allows a fast transfer of measured values. The controller supports CANopen over EtherCAT (CoE).

Service Data Objects SDO: All parameters of the controller can thus be read or modified.

Process Data Objects PDO: A PDO telegram is used for real-time transmission of measured values. Individual objects are not addressed. The content of the previously selected data is transmitted.

The displacement values are transmitted as 32 bit Float values.

7.2 Change Interface

You can not change directly to the EtherCAT interface through the web interface or command. Restart your controller to do this. Keep in mind also that the setting of the EtherCAT switch is in the correct position, see Fig. 1818

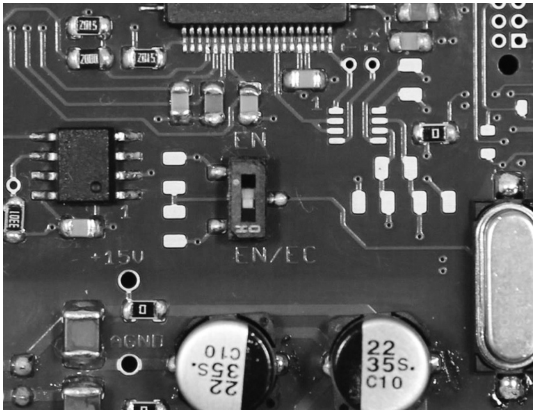


Fig. 18 Switch to change the interface

Switch position	Meaning
`EN` (Ethernet)	Regardless to the software setting always the Ethernet interface is active.
`EN/EC` (Ethernet/EtherCAT)	Active interface, which is set via the web interface or command.

A change from the EtherCAT interface back to the Ethernet interface is possible with the hardware switch on the DT6230 basic unit or via the corresponding CoE Object. In both cases, then a restart of the controller is required.
To integrate the EtherCAT interface e.g. within TwinCAT an ESI-file is supplied.

You will find further instructions in the appendix, see A 6.

8. 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.

9. Operation and Maintenance

Disconnect the power supply before touching the sensor surface.

> Static discharge

> Danger of injury

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

10. Service, Repair

If the sensor or sensor cable is defective:

- If possible, save the current sensor settings in a parameter set, in order to load the settings back again into the sensor after the repair.
- Please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

MICRO-EPSILON MESSTECHNIK
GmbH & Co. KG
Koenigbacher Str. 15
94496 Ortenburg / Germany

Tel: +49 (0) 8542 / 168-0
Fax: +49 (0) 8542 / 168-90
info@micro-epsilon.com
https://www.micro-epsilon.com

11. Disclaimer

All components of the device have been checked and tested for functionality in the factory. However, should any defects occur despite careful quality control, these shall be reported immediately to Micro-Epsilon or to your distributor / retailer.

Micro-Epsilon undertakes no liability whatsoever for damage, loss or costs caused by or related in any way to the product, in particular consequential damage,
e.g., due to

- non-observance of these instructions/this manual,
- improper use or improper handling (in particular due to improper installation, commissioning, operation and maintenance) of the product,
- repairs or modifications by third parties,
- the use of force or other handling by unqualified persons.

This limitation of liability also applies to defects resulting from normal wear and tear (e.g., to wearing parts) and in the event of non-compliance with the specified maintenance intervals (if applicable).

Micro-Epsilon is exclusively responsible for repairs. It is not permitted to make unauthorized structural and / or technical modifications or alterations to the product. In the interest of further development, Micro-Epsilon reserves the right to modify the design.

In addition, the General Terms of Business of Micro-Epsilon shall apply, which can be accessed under Legal details | Micro-Epsilon https://www.micro-epsilon.com/impressum/

12. Decommissioning, Disposal

In order to avoid the release of environmentally harmful substances and to ensure the reuse of valuable raw materials, we draw your attention to the following regulations and obligations:

- Remove all cables from the sensor and/or controller.
- Dispose of the sensor and/or the controller, 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.
- You are obliged to comply with all relevant national laws and regulations.

For Germany / the EU, the following (disposal) instructions apply in particular:

- Waste equipment marked with a crossed garbage can must not be disposed of with normal industrial waste (e.g. residual waste can or the yellow recycling bin) and must be disposed of separately. This avoids hazards to the environment due to incorrect disposal and ensures proper recycling of the old appliances.

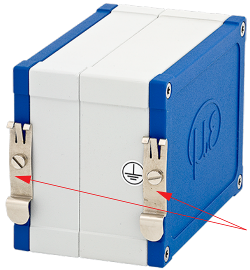
- A list of national laws and contacts in the EU member states can be found at https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en. Here you can inform yourself about the respective national collection and return points.
- Old devices can also be returned for disposal to Micro-Epsilon at the address given in the imprint at https://www.micro-epsilon.de/impressum/.
- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.
- Under the registration number WEEE-Reg.-Nr. DE28605721, we are registered at the foundation Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg, as a manufacturer of electrical and/or electronic equipment.

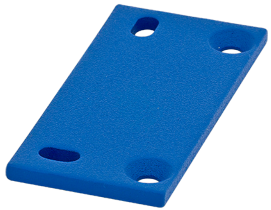
Appendix

A 1 Accessories, Service

A 1.1 Conversion Kit

The conversion kit is contained in the scope of supply, see 3.1.

Ground terminal		ø 4,3 mm (.17.3 dia.)
Mounting clamps for mounting on DIN-rail		20 x 0.8 mm/ CK75G hardened/ plated

Mounting plate		Aluminum / powder-coated

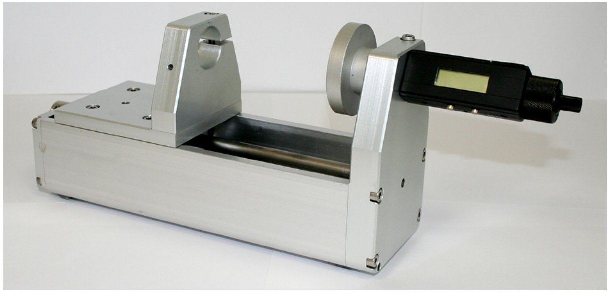
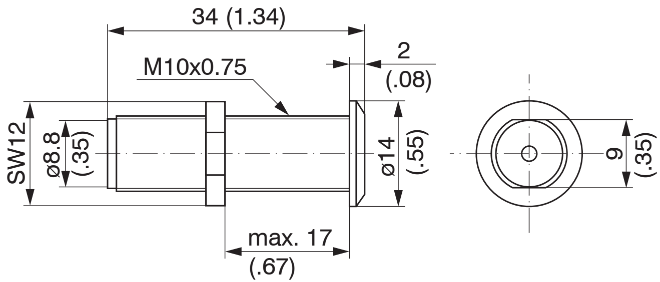
Further more, the conversion kit contains sleeve nuts, threaded rods in different lengths and screws.

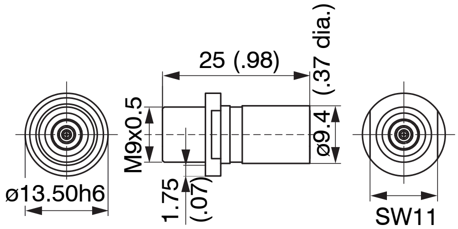
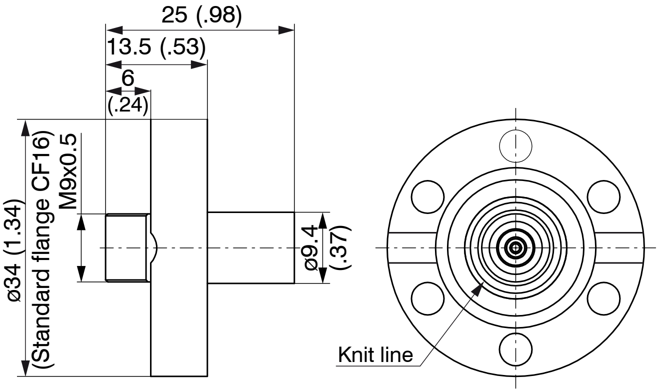
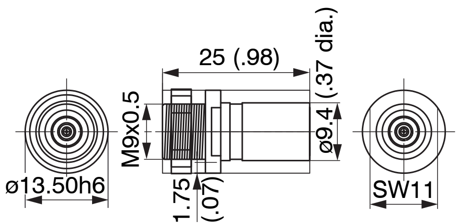
A 1.2 PC6200-3/4

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

A 1.3 Optional Accessories

MC2.5		Micrometer calibration fixture, setting range 0 - 2.5 mm, reading 0.1 μm, for sensors CS005 to CS2
MC25D		Digital micrometer calibration fixture, setting range 0 - 25 mm, adjustable zero point for all sensors
SWH.OS.650.CTMSV		Vacuum feed through, Max. leak rate 1x10e-^{7} mbar · l s^{-1} Compatible with connector type B

<table>
<tr>
<td rowspan="3">UHV/B</td>
<td>
</td>
<td>Vacuum feed through triax weldable
Max. leak rate 1x10e-^{9} mbar · l s^{-1}
Compatible with connector type B</td>
</tr>
<tr>
<td>
</td>
<td>Vacuum feed through triax with CF16 flange
Max. leak rate 1x10e-9 mbar · l s^{-1}
Compatible with connector type B</td>
</tr>
<tr>
<td>
</td>
<td>Vacuum feed through triax screwable
Max. leak rate 1x10e-9 mbar · l s^{-1}
Compatible with connector type B</td>
</tr>
<tr>
<td colspan="3">All vacuum feed throughs are compatible to the connectors type B.</td>
</tr>
</table>

SCACx/4		Signal output cable analog, x m long (necessarily for multi-channel operation)
SC6000-x		Synchronization cable
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 grafic and post-calibration.

A 2 Factory Setting

Analog:

Cutoff frequenzy 50 kHz (Fg 1)

Digital:

- IP- adress = Static IP (169.254.168.150)
- Dataport = 10001

A 3 Tilt Angle Influence on the Capacitive Sensor

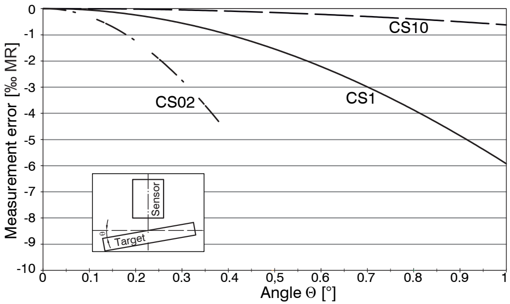


Fig. 19 Example of measuring range deviation in the case of a sensor distance of 10 % of the measuring range

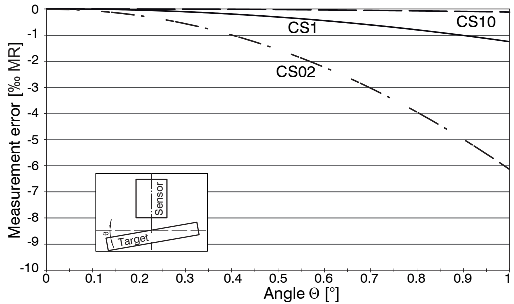


Fig. 20 Example of measuring range deviation in the case of a sensor distance of 50 % of the measuring range

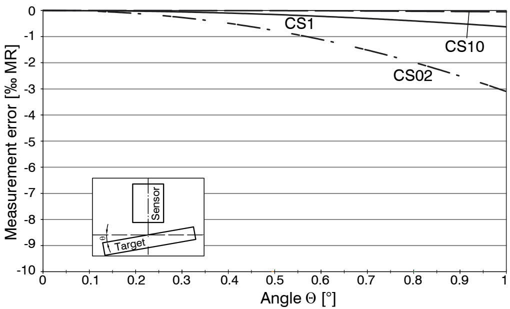


Fig. 21 Example of measuring range deviation in the case of a sensor distance of 100 % of the measuring range

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

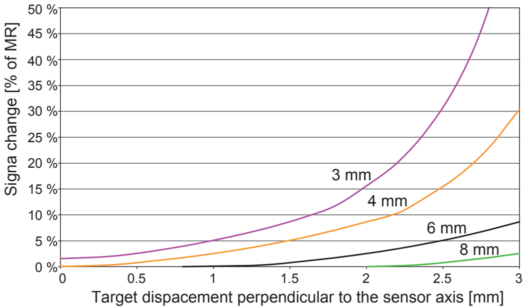


Fig. 22 Example of measuring range deviation in the case of a sensor distance of 10 % of the measuring range

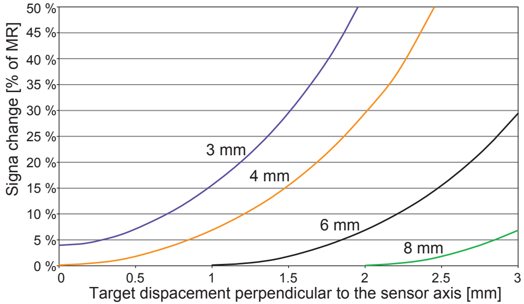


Fig. 23 Example of measuring range deviation in the case of a sensor distance of 50 % of the measuring range

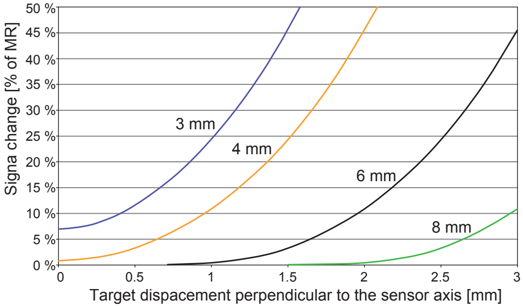


Fig. 24 Example of measuring range deviation in the case of a sensor distance of 100 % of the measuring range

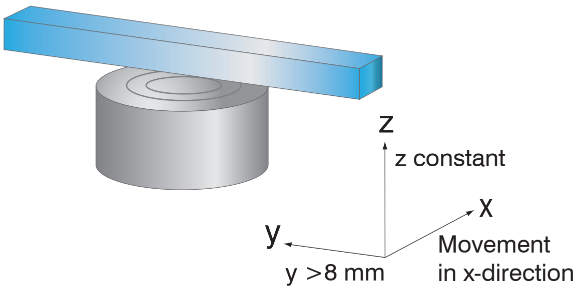


Fig. 25 Signal change in the case of displacement of thin targets in the opposite direction to the measurement direction

i 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

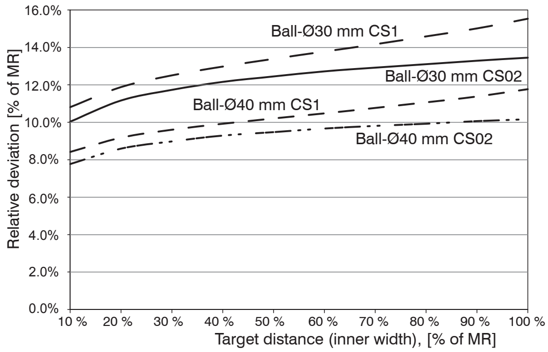


Fig. 26 Measuring value deviation in the case of measurement on ball-shaped targets

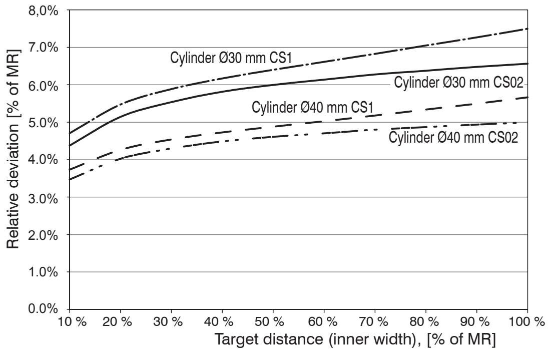


Fig. 27 Measuring value deviation in the case of measurement on cylindrical targets

i 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.

A 6 EtherCAT Documentation

EtherCAT® is, from the Ethernet viewpoint, a single, large Ethernet station that transmits and receives Ethernet telegrams. Such an EtherCAT system consists of an EtherCAT master and up to 65535 EtherCAT slaves.

Master and slaves communicate via a standard Ethernet wiring. On-the-fly processing hardware is used in each slave. The incoming Ethernet frames are directly processed by the hardware. Relevant data are extracted or added from the frame. The frame is subsequently forwarded to the next EtherCAT® slave device. The completely processed frame is sent back from the last slave device. Various protocols can be used in the application level. CANopen over EtherCAT technology (CoE) is supported here. In the CANopen protocol, an object tree with Service Data Objects (SDO) and Process Data Objects (PDO) is used to manage the data.

Further information can be obtained from ® Technology Group (www.ethercat.org) or Beckhoff GmbH, (www.beckhoff.com).

A 6.1 Preamble

A 6.1.1 Structure of EtherCAT®-Frames

The transfer of data occurs in Ethernet frames with a special Ether type (0x88A4). Such an EtherCAT® frame consists of one or several EtherCAT® telegrams, each of which is addressed to individual slaves / storage areas. The telegrams are either transmitted directly in the data area of the Ethernet frame or in the data area of the UDP datagram. An EtherCAT® telegram consists of an EtherCAT® header, the data area and the work counter (WC). The work counter is incremented by each addressed EtherCAT® slave that exchanged the corresponding data.

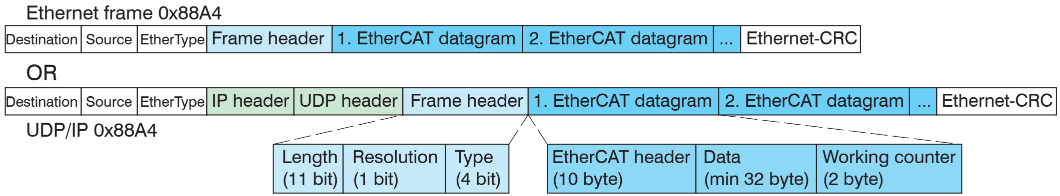


Fig. 28 Setup of EtherCAT frames

A 6.1.2 EtherCAT® Services

In EtherCAT® services for the reading and writing of data are specified in the physical memory of the slave hardware. The following EtherCAT® services are supported by the slave hardware:

- APRD (Autoincrement physical read, Reading of a physical area with auto-increment addressing)
- APWR (Autoincrement physical write, Writing of a physical area with auto-increment addressing)
- APRW (Autoincrement physical read write, Reading and writing of a physical area with auto-increment addressing)
- FPRD (Configured address read, Reading of a physical area with fixed addressing)
- FPWR (Configured address write, Writing of a physical area with fixed addressing)
- FPRW (Configured address read write, Reading and writing of a physical area with fixed addressing)
- BRD (Broadcast Read, Broadcast Reading of a physical area for all slaves)
- BWR (Broadcast Write, Broadcast Writing of a physical area for all slaves)
- LRD (Logical read, Reading of a logical storage area)
- LWR (Logical write, Writing of a logical storage area)
- LRW (Logical read write, Reading and writing of a logical storage area)
- ARMW (Auto increment physical read multiple write, Reading of a physical area with auto-increment addressing, multiple writing)
- FRMW (Configured address read multiple write, Reading of a physical area with fixed addressing, multiple writing)

A 6.1.3 Addressing and FMMUs

In order to address a slave in the EtherCAT® system, various methods from the master can be used. The DT6235 supports as full slave:

- Position addressing
  The slave device is addressed via its physical position in the EtherCAT® segment.
  The services used for this are APRD, APWR, APRW.
- Node addressing
  The slave device is addressed via a configured node address, which was assigned by the master during the commissioning phase.
  The services used for this are FPRD, FPWR and FPRW.
- Logical addressing
  The slaves are not addressed individually; instead, a segment of the segment-wide logical 4-GB address is addressed. This segment can be used by a number of slaves.
  The services used for this are LRD, LWR and LRW.

The local assignment of physical slave memory addresses and logical segment-wide addresses is implemented via the field bus Memory Management Units (FMMUs). The configuration of the slave FMMUs is implemented by the master. The FMMU configuration contains a start address of the physical memory in the slave, a logical start address in the global address space, length and type of the data, as well as the direction (input or output) of the process data.

A 6.1.4 Sync Manager

Sync Managers serve the data consistency during the data exchange between EtherCAT® master and slaves. Each Sync Manager channel defines an area of the application memory. The DT6230 has four channels:

- Sync-Manager-Channel 0: Sync Manager 0 is used for mailbox write transfers (mailbox from master to slave).
- Sync-Manager-Channel 1: Sync Manager 1 is used for mailbox read transfers (mailbox from slave to master).
- Sync-Manager-Channel 2: Sync Manager 2 is usually used for process output data. Not used in the sensor.
- Sync-Manager-Channel 3: Sync Manager 3 is used for process input data. It contains the Tx PDOs that are specified by the PDO assignment object 0x1C13 (hex.).

A 6.1.5 EtherCAT State Machine

The EtherCAT® state machine is implemented in each EtherCAT®. Directly after switching on the controller, the state machine is in the “Initialization“ state. In this state, the master has access to the DLL information register of the slave hardware. The mailbox is not yet initialized, i.e. communication with the application (sensor software) is not yet possible. During the transition to the pre-operational state, the Sync Manager channels are configured for the mailbox communication. In the „Pre-Operational“ state, communication via the mailbox is possible, and it can access the object directory and its objects. In this state, no process data communication occurs. During the transition to the „Safe-Operational“ state, the process-data mapping, the Sync Manager channel of the process inputs and the corresponding FMMU are configured by the master. Mailbox communication continues to be possible in the „Safe-Operational“ state. The process data communication runs for the inputs. The outputs are in the „safe“ state. In the „Operational“ state, process data communication runs for the inputs as well as the outputs.

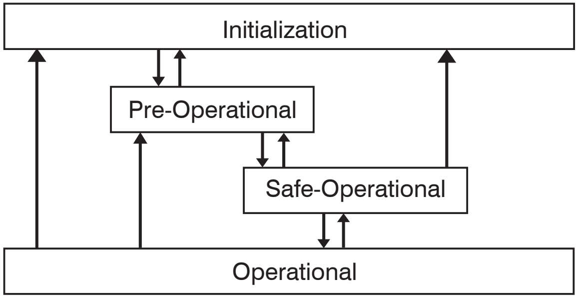


Fig. 29 EtherCAT State Machine

A 6.1.6 CANopen over EtherCAT

The application level communication protocol in EtherCAT is based on the communication profile CANopen DS 301 and is designated either as “CANopen over EtherCAT” or CoE. The protocol specifies the object directory in the sensor, as well as the communication objects for the exchange of process data and acyclic messages. The sensor uses the following message types:

- Process Data Object (PDO). The PDO is used for the cyclic I/O communication, therefore for process data.
- Service Data Object (SDO). The SDO is used for acyclic data transmission.

The object directory is described in the chapter CoE Object Directory.

A 6.1.7 Process Data PDO Mapping

Process Data Objects (PDOs) are used for the exchange of time-critical process data between master and slaves. Tx PDOs are used for the transmission of data from the slaves to the master (inputs), Rx PDOs are used to transmit data from the master to the slaves (outputs); not used in the capaNCDT 6200. The PDO mapping defines which application objects (measurement data) are transmitted into a PDO. The capaNCDT 62xx has a Tx PDO for the measuring data. The following measurements are available as process data:

- Counter Measurement counter (32 Bit)
- Channel 1 Displacement Channel 1
- Channel 2 Displacement Channel 2
- Channel 3 Displacement Channel 3
- Channel 4 Displacement Channel 4

A 6.1.8 Service Data SDO Service

Service Data Objects (SDOs) are primarily used for the transmission of data that are not time critical, e.g. parameter values. EtherCAT specifies the SDO services as well as the SDO information services: SDO services make possible the read/write access to entries in the CoE object directory of the device. SDO information services make it possible to read the object directory itself and to access the properties of the objects. All parameters of the measuring device can be read or changed in this way, or measurements can be transmitted. A desired parameter is addressed via index and subindex within the object directory.

A 6.2 CoE – Object Directory

The CoE object directory (CANopen over EtherCAT) contains all the configuration data of the sensor. The objects in CoE object directory can be accessed using the SDO services. Each object is addressed using a 16-bit index.

A 6.2.1 Communication Specific Standard Objects (CiA DS-301)

Overview		
Index (h)	Name	Description
1000	Device type	Device type
1001	Error register	Error register
1008	Device name	Manufacturer device name
1009	Hardware version	Hardware version
100A	Software version	Software version
1018	Identity	Device identification
1A00	TxPDO Mapping	TxPDO Mapping
1C00	Sync. manager type	Sync. manager type
1C13	TxPDO assign	TxPDO assign

Object 1000h: Device type

1000	VAR	Device type	0x00200000	Unsigned32	ro

Provides information about the used device profile and the device type.

Object 1001h: Error register

1001	VAR	Error register	0x00	Unsigned8	ro

Object 1008h: Manufacturer device name

1008	VAR	Device name	DT6235	Visible String	ro

Object 1009h: Hardware version

1009	VAR	Hardware version	V x.xxx	Visible String	ro

Object 100Ah: Software version

100A	VAR	Software version	V x.xxx	Visible String	ro

Object 1018h: Device identification

1018	RECORD	Identity			

Subindices

0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Vendor ID	0x0000065E	Unsigned32	ro
2	VAR	Product code	0x003EDE73	Unsigned32	ro
3	VAR	Revision	0x00010000	Unsigned32	ro
4	VAR	Serial number	0x009A4435	Unsigned32	ro

The article number is deposit in the product code, the serial number of the sensor in serial number.

Object 1A00h: TxPDO Mapping

1A00	RECORD	TxPDO Mapping			
Subindices					
0	VAR	Number of entries	6	Unsigned8	ro
1	VAR	Subindex 001	0x0000:00	Unsigned32	ro
2	VAR	Subindex 002	0x6020:03	Unsigned32	ro
3	VAR	Subindex 003	0x6020:08	Unsigned32	ro
3	VAR	Subindex 004	0x6020:09	Unsigned32	ro
4	VAR	Subindex 005	0x6020:0A	Unsigned32	ro
6	VAR	Subindex 006	0x6020:0B	Unsigned32	ro

Object 1C13h: TxPDO assign

1C13	RECORD	TxPDO assign			
Subindices					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Subindex 001	0x1A00	Unsigned16	ro

A 6.2.2 Manufacturer Specific Objects

Overview

Index (h)	Name	Description
2010	Controller info	Controller information
2020	Channel 1 Info	Information and settings of channel 1
2021	Channel 2 Info	Information and settings of channel 2
2022	Channel 3 Info	Information and settings of channel 3
2023	Channel 4 Info	Information and settings of channel 4
2060	Controller Settings	Controller settings
2100	Controller Interface	Ethernet/EtherCAT settings
2200	Commands	Commands
6020	Measuring values	Measuring values

Object 2010h: Controller information

2010	RECORD	Controller info			ro

Subindices

0	VAR	Number of entries	5	Unsigned8	ro
1	VAR	Name	DT6235	Visible String	ro
2	VAR	Serial No	xxxxxxxx	Unsigned32	ro
3	VAR	Article No	xxxxxxx	Unsigned32	ro
4	VAR	Option No	xxx	Unsigned32	ro
5	VAR	Firmware version	xxx	Visible String	ro

Object 2020h: Channel information

2020	RECORD	Channel 1 info			ro

Subindices

0	VAR	Number of entries	16	Unsigned8	ro
1	VAR	Name	DL6225	Visible String	ro
2	VAR	Serial No	xxxxxxxx	Unsigned32	ro
5	VAR	Status	Active	Enum	ro
7	VAR	Range	100	Unsigned32	rw
8	VAR	Unit	µm	Enum	ro
16	VAR	Linearization	Off	Enum	ro

The structure of objects 2021h to 2027h corresponds to the object 2020h.

Object 2060h: Controller settings

2060	RECORD	Controller Settings			ro

Subindices

0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Sample rate	62500 Hz	Enum	rw
2	VAR	Averaging type	Off	Enum	rw
3	VAR	Averaging number	2	Enum	rw
4	VAR	Trigger	Off	Enum	rw
5	VAR	Analog Lowpass	Inactive	Enum	rw

Object 2100h: Controller interface

2100	RECORD	Controller Interface			ro

Subindices

0	VAR	Number of entries	7	Unsigned8	ro
1	VAR	Ethernet/EtherCAT	EtherCAT	Enum	rw
3	VAR	Ethernet Adress type	Static	Enum	rw
4	VAR	Ethernet IPAddress	169.254.168.150	Visible String	rw
5	VAR	Ethernet Subnet	255.255.0.0	Visible String	rw
6	VAR	Ethernet Gateway	169.254.168.1	Visible String	rw
7	VAR	Ethernet Dataport	10001	Unsigned16	rw

Object 2200h: Commands

2200	RECORD	Commands			ro

Subindices

0	VAR	Number of entries	2	Unsigned8	ro
1	VAR	Command	AVT1	Visible String	rw
2	VAR	Command Response	AVT1OK	Visible String	ro

Any commands can be sent to the controller with the object 2200h, for example, the math functions as these are not defined in the COE objects.

Object 6020h: Measuring values

6020	RECORD	Measuring values			ro

Subindices

0	VAR	Number of entries	11	Unsigned8	ro
3	VAR	Counter	xxxx	Unsigned32	ro
8	VAR	Channel 1	xxxx	Float	ro
9	VAR	Channel 2	xxxx	Float	ro
10	VAR	Channel 3	xxxx	Float	ro
11	VAR	Channel 4	xxxx	Float	ro

A 6.3 Measurement Data Format

The measuring values are transmitted as Float.

The unit can be read from the channel info objects 2020h to 2023h (unit).

A 6.4 EtherCAT Configuration with the Beckhoff TwinCAT©-Manager

For example the Beckhoff TwinCAT Manager can be used as EtherCAT Master.

- Copy the device description file (EtherCAT®-Slave Information) `Micro-Epsilon.xml` in the directory \\TwinCAT\IO\EtherCAT (for TwinCATV2.xx) or \\TwinCAT\3.1\Config\IO\EtherCAT (for TwinCAT V3.xx), before the measuring device can be configured via EtherCAT®.

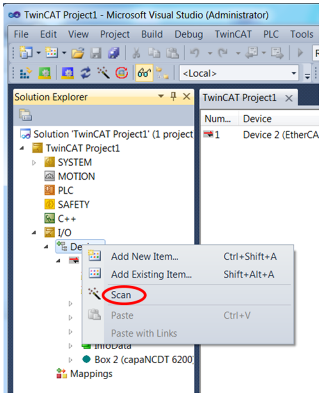
The file is available online at:
https://www.micro-epsilon.com/download/software/Micro-Epsilon_EtherCAT_ESI-File.zip

EtherCAT®-Slave information files are XML files, which specify the characteristics of the Slave device for the EtherCAT® Master and contain information to the supported communication objects.

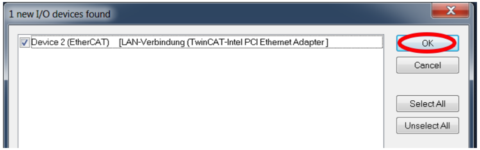
- Restart the TwinCAT Manager after copying.

Searching for a device:

- Select the tab `I/O Devices,` then `Scan`.
- Confirm with `Yes`.

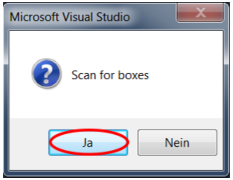


- Select a network card, where EtherCAT®–Slaves should be searching for.



Confirm with `OK`.

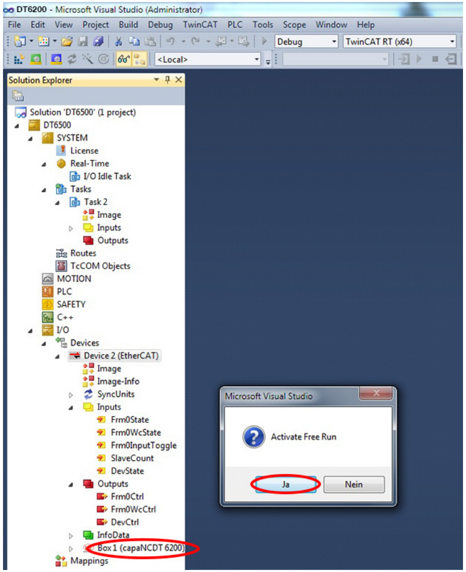
The window `Scan for boxes` (EtherCAT®-Slaves) appears.



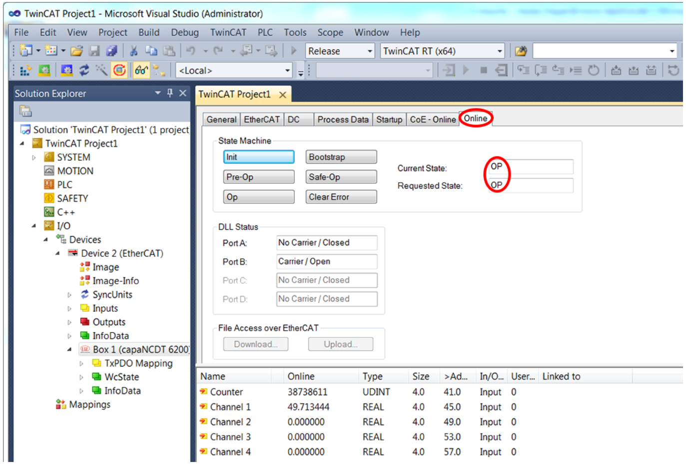
Confirm with `Ja`.

The capaNCDT 62xx is now listed in the `Solution explorer`.

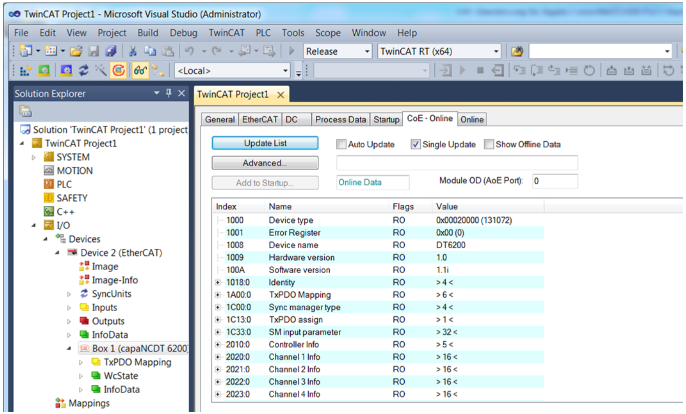
Now confirm the window `Activate Free Run` with `Ja`.



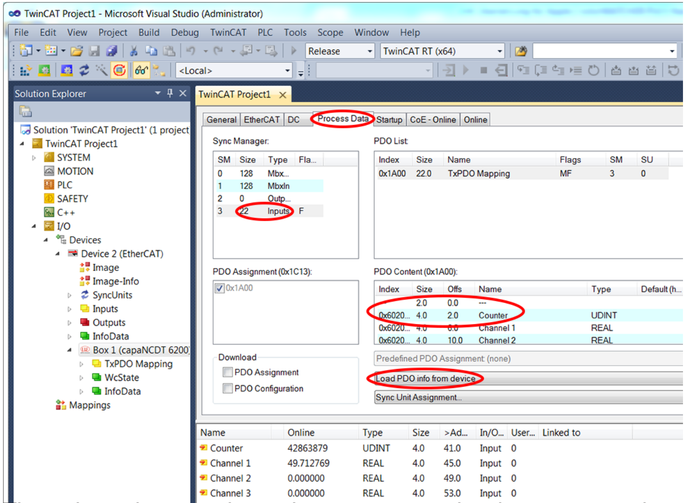
The current status should be at least `PREOP`, `SAFEOP` or `OP` on the `Online` side.



Example for a complete object directory (subject to change without prior notice).



On the `Process data` side the PDO allocations can be read from the device.



The selected measuring values are transmitted as process data in the status `SAFEOP` and `OP`.

Name	Online	Type	Size	>Ad...	In/O...	User...	Linked to
Counter	25512719	UDINT	4.0	41.0	Input	0	
Channel 1	49.716839	REAL	4.0	45.0	Input	0	
Channel 2	0.000000	REAL	4.0	49.0	Input	0	
Channel 3	0.000000	REAL	4.0	53.0	Input	0	
Channel 4	0.000000	REAL	4.0	57.0	Input	0	

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