MICRO-EPSILON

Operating Instructions

capaNCDT 6114/6124

CSHA2FL-CRa5
CSHA2FL-CRa15

Active capacitive measuring system
for long signal transmission paths

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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.
`Measurement`	Indicates hardware or a software button/menu.

1.2 Warnings

⚠ CAUTION

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 sensors and/or the controller

Disconnect the power supply before touching the sensor surface.

> Risk of injury
> Static discharge

NOTICE

The supply voltage must not exceed the specified limits.
> Damage to or destruction of the sensors and/or the controller

Avoid shocks and impacts to the sensor and the controller.
> Damage to or destruction of the sensors and/or the controller

Protect the sensor cable against damage.

> Destruction of the sensor
> Failure of the measuring system

1.3 Notes on CE Marking

The following apply to the capaNCDT CST61x4:
- EU Directive 2014/30/EU
- EU Directive 2011/65/EU

Products which carry the CE mark satisfy the requirements of the EU directives and the harmonized European standards (EN) listed therein. The system is designed for use in industrial and laboratory environments and meets the requirements. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, Article 10.

1.4 Intended Use

- The capaNCDT 61x4 is designed for use in an industrial environment. It is used for
  - displacement, distance and movement measurement, thickness measurement,
  - measuring the position of parts or machine components
- The measuring system must only be operated within the limits specified in the technical data, see Chap. 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, sensor cable: -40 ... +80 °C
  - Controller: +10 ... +60 °C
- Temperature range (storage)
  - Sensor, sensor cable: -10 ... +75 °C
  - Controller: -10 ... +75 °C
- Humidity: 5 - 95% (non-condensing)
- Ambient pressure: Atmospheric pressure

2. Functional Principle, Technical Data

2.1 Measuring Principle

The capacitive distance measuring principle of the capaNCDT system is based on the functioning of an ideal plate capacitor. In the case of conductive targets, the sensor and the target located opposite form the two plate electrodes.

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

The capaNCDT system evaluates the reactance X_C of the plate capacitor, which varies in strict proportion with the distance:

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

i A target that is too small and measured surfaces that are curved (uneven) also produce a non-linear characteristic curve.

This theoretical correlation is reproduced almost perfectly in practice if the sensors are designed as guard ring capacitors.

A linear characteristic curve can be obtained without additional electronic linearization for the measurement signal if targets consisting of electrically conductive materials (metals) are measured. Minor changes in the conductivity or magnetic properties do not affect the sensitivity or linearity.

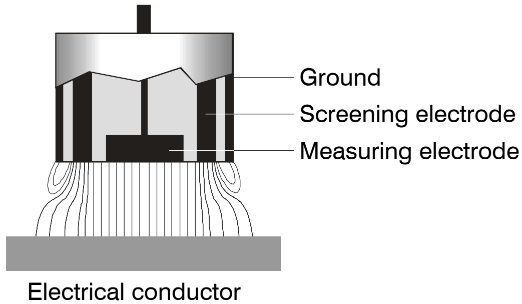


Fig. 1 Structure of a capacitive sensor

2.2 Structure

The non-contact single-channel measuring system of the capaNCDT 61x4 is accommodated in an aluminum housing and consists of the following components:

- Controller
- Sensor
- Sensor cable
- Power supply and signal cable

The signal processing electronics with the oscillator and demodulator can be found in the controller [1].

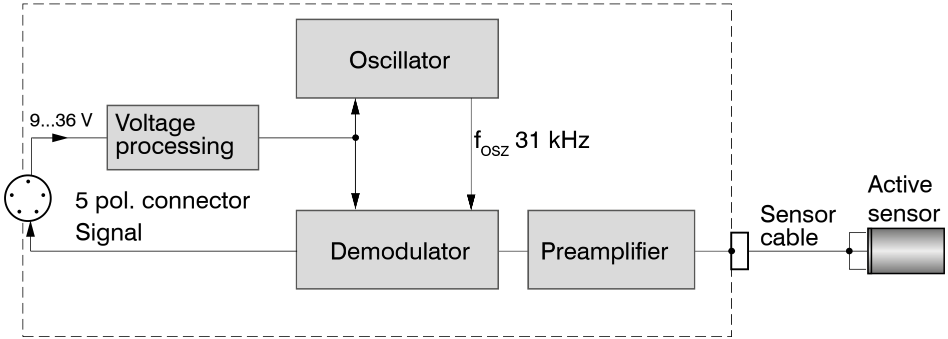


Fig. 2 Block diagram of capaNCDT 6114

1) DT6124 controller: Additionally includes an AD converter for conversion to an RS485 interface.

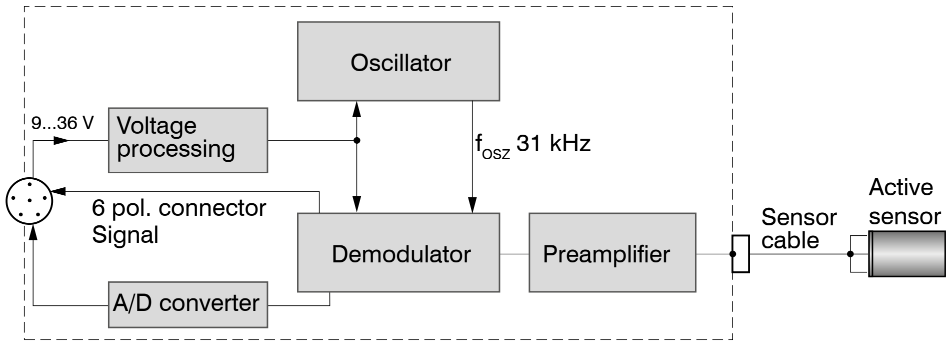


Fig. 3 Block diagram of capaNCDT 6124

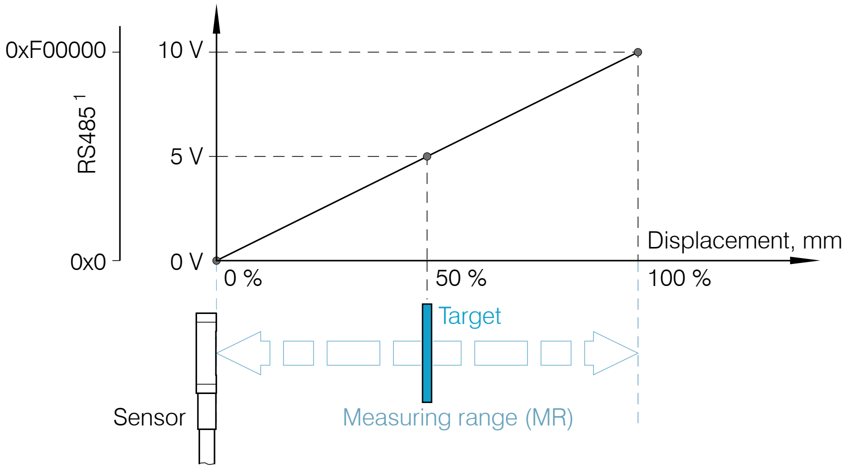


Fig. 4 Term definition, signal output

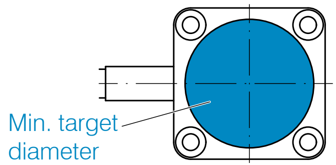
1) Only in connection with DT6124 controller

2.2.1 Sensors

Sensors with an integrated preamplifier can be used in the measuring system.

➡ For accurate measurement results, keep the front of the sensor clean and avoid damaging it.

The capacitive measuring method is area-based. A minimum area is required depending on the sensor model and measuring range, see Fig. 5.



Sensor model	Measuring range, nominal	Min. target diameter
CSHA2FL	2 mm	17 mm

Fig. 5 Sensors for electrically conductive targets (metals)

The preamplifier integrated in the sensor generates and amplifies the distance-dependent measurement signal.

2.2.2 Sensor Cable

The 5-pin sensor cable is firmly connected to the sensor. The robust sensor cable connects the sensor to the controller. It is suitable for use in drag chains and robots, for example.

NOTICE

Switch off the controller when disconnecting or altering the cable connection.
Do nut crush the sensor cable. Do not make any changes to the sensor cable.
Loss of functionality!

2.2.3 Controller

The DT61x4 controller contains a voltage processor, oscillator, demodulator and an output stage.

The voltage processor generates all required internal voltages from the supply voltage. The oscillator supplies the sensor with an alternating voltage that has a constant frequency and amplitude. The frequency is 31 kHz. The demodulator and output stage transform the measurement signal into a standardized voltage signal. The DT6124 controller also includes an analog-digital converter. This converts the measurement signal and outputs it on the RS485 interface.

HINWEIS

The output voltage can reach a maximum value of 13 VDC if the sensor is unplugged or if the measuring range is exceeded.

> Damage to downstream devices

Fig. 6 DT6114 controller

2.3 Technical Data for Controllers

Model		**DT6114/5**	**DT6114/15**	**DT6124/5**	**DT6124/15**
Resolution	Static (2 Hz)	0.01% FSO			
	Dynamic (1 kHz)	0.015% FSO			
Frequency response (-3dB)		1 kHz			
Measuring rate		-	-	Selectable: max. 2 kSa/s	Selectable: max. 2 kSa/s
Linearity [1]		< ±0.1% FSO	< ±0.25% FSO	< ±0.1% FSO	< ±0.25% FSO
Temperature stability		< 100 ppm FSO/K			
Sensitivity		< ±0.2% FSO			
Long-term stability		< ±0.05% FSO/month			
Synchronization		no			
Supply voltage		9 ... 36 V DC			
Power consumption		1.32 W (24 V DC)		1.44 W (24 V DC)	
Digital interface		-	-	RS485; 24 bit; 230400 baud (adjustable)	
Analog output		0 ... 10 V (short-circuit proof); optional: ± 5 V; 10 ... 0 V			
Connection		Sensor: 5-pin connector; Supply/signal: 5-pin connector, SCAC3/5 connection cable included in delivery		Sensor: 5-pin connector; Supply/signal: 6-pin connector, SCAC3/6 connection cable included in delivery	
Mounting		2 x through-bores for M4 screw			
Temperature range	Storage	-10 ... +75 °C			
	Operation	+10 ... +60 °C			
Shock (DIN EN 60068-2-27)		20 g/5 ms, 6 axes, 1000 shocks each, criterion B			
Vibration (DIN EN 60068-2-6)		10 Hz ... 49.8 Hz: 1 mm, 49.8 Hz ... 2000 Hz: 10 g, 3 axes 10 cycles each, criterion B			
Protection class (DIN EN 60529)		IP40			
Weight		Approx. 165 g			
Compatibility		Compatible with active CSHA sensors			

FSO = Full Scale Output

1) Applies only to controller. The overall linearity of the measuring channel is given by adding up the values for the controller and the sensor.

2.4 Technical Data for Sensors

Model		**CSHA2FL-CRa5**	**CSHA2FL-CRa15**
Measuring range	Reduced	1 mm	1 mm
	Nominal	2 mm	2 mm
	Extended	4 mm	4 mm
Resolution [1]	Industrial	300 nm	300 nm
Linearity [2]		< ±2 µm	< ±5 µm
Temperature stability [3]		< 0.2 µm/K	< 0.2 µm/K
Min. target size (flat)		Ø 17 mm	Ø 17 mm
Connection		Integrated cable, for use with drag chain; length 5 m, minimum bending radius: dynamic 60 mm (15 x Ø 4.0 mm)	Integrated cable, for use with drag chain; length 15 m, minimum bending radius: dynamic 60 mm (15 x Ø 4.0 mm)
Mounting		4 x through-bores for M2 screw	
Temperature range	Storage	-40 ... +80 °C	
	Operation	-40 ... +80 °C	
Humidity [4]		0 … 95 % r.H.	
Shock (DIN EN 60068-2-27)		50 g/5 ms, 6 axes 1000 shocks each	
Vibration (DIN EN 60068-2-6)		10 Hz ... 46.15 Hz: 3.5 mm, 46.15 Hz ... 2000 Hz: 30 g, 3 axes 10 sweeps each, criterion B	
Protection class (DIN EN 60529)		IP40	
Material		1.4104 (magn.)	
Weight		approx. 130 g (incl. cable)	approx. 360 g (incl. cable)
Compatibility		Compatible with capacitive controllers of DT61x4 series by Micro-Epsilon	

1) Based on the nominal measuring range
2) Sensor linearity must be added to the controller linearity
3) In recommended mounting position
4) Non-condensing

3. Delivery

3.1 Unpacking/Included in Delivery

1 Controller

1 Power supply and output cable, SCAC3/5 (DT6114) or SCAC3/6 (DT6124)

1 Quick manual

Optional accessories:

1 Sensor with integrated sensor cable

1 IF1032/ETH interface converter from analog (DT6114) or RS485 Ethernet (DT6124) to Ethernet/EtherCAT

Other optional accessories

➡ 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 supplier.

3.2 Storage

- Storage temperature:
  - Sensor, sensor cable: -10 ... +75 °C
  - Controller: -10 ... +75 °C
- Humidity: 5 - 95 % r.H. (non-condensing)

4. Installation and Assembly

4.1 Precautions

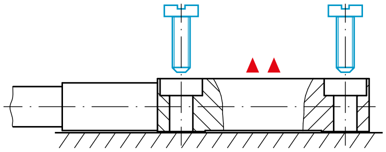
No sharp or heavy objects should be allowed to affect the cable sheath.

- Protect the cable from compressive stress in regions exposed to higher pressure
- Avoid folding the cables.
- Check the plug connections for a tight fit.

4.2 Sensor

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

Screwed connection from top



The flat sensors are mounted using a threaded bore for M2 (for 0.2 and 0.5 mm sensors) or using a through-hole for M2 screws. The sensors can be screwed on from above or below.

Fig. 7 Installing the flat sensors

▲ ▲ Sensor active measuring area

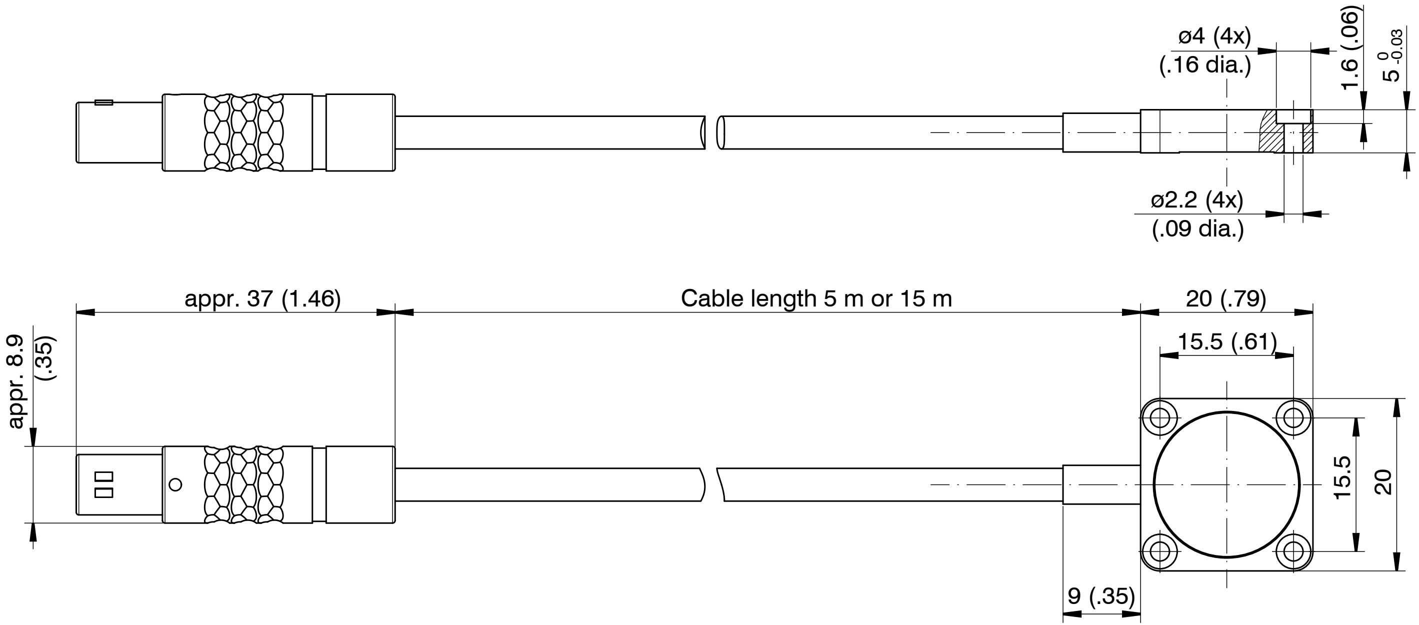


Fig. 8 Dimensional drawing of CSHA2FL-CRAxx flat sensor with integrated cable, measuring range = 2 mm nominal, dimensions in mm

Cable length x = 5 or 15 m

▲▲ Sensor active measuring area

4.3 Sensor Cable

The sensor is connected to the controller via the sensor cable provided.

This is done simply by plugging it in. The plug connection will lock automatically. You can check that the fit is tight by pulling on the connector housing (cable socket). You can unlock and release the plug connection by pulling on the knurled housing sleeve of the cable socket.

4.4 Controller

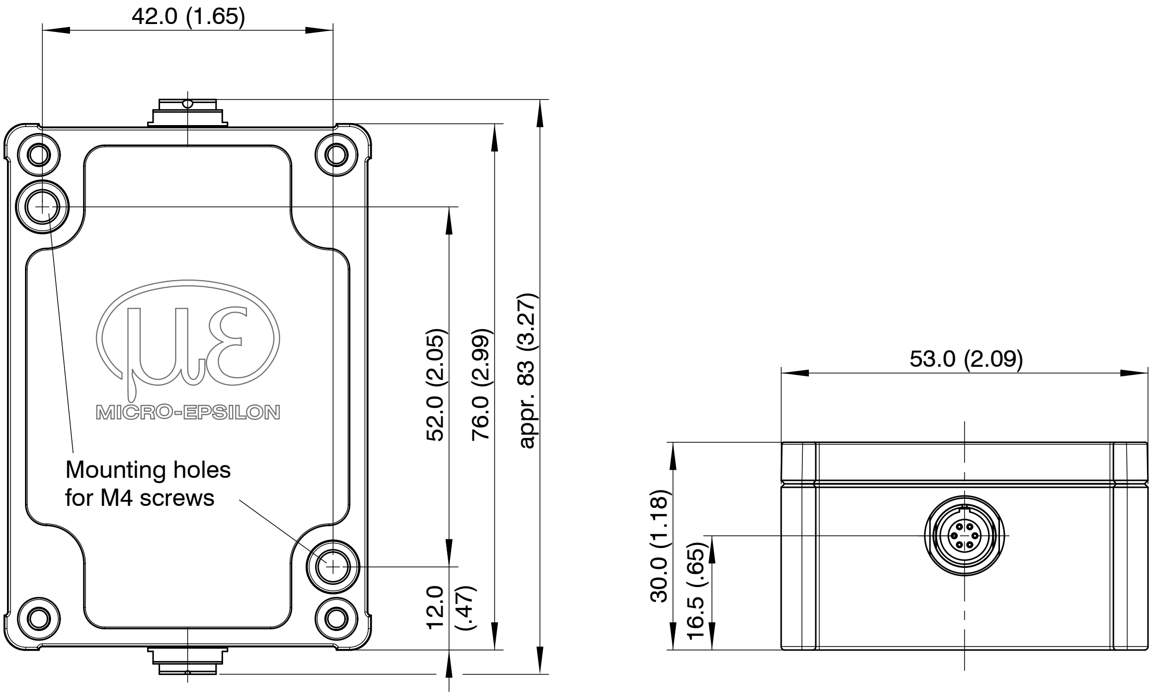


Fig. 9 Dimensional drawing of controller

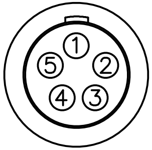
4.5 Ground Connection, Grounding

➡ Ensure sufficient grounding of the target, for example by connecting it to the sensor or the power supply ground.

4.6 Power Supply, DT6114 Display/Output Device

The power supply and signal output are provided via the 5-pin connector on the front of the controller.

Pin	Wire color SCAC3/5	Signal	Description
1	White	+24 V	+24 V supply
2	Gray	GND	Supply ground
3	Yellow	-	Not used
4	green	AGND	Analog ground (for signal output)
5	Brown	U-out	Signal output (load, min. 10 kOhm)
Shield			Cable shield, housing



View: Solder side, 5-pin socket

Fig. 10 Supplyvoltage connection

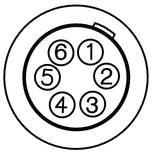
Fig. 11 SCAC3/5 power supply and output cable

The SCAC3/5 is an assembled supply and output cable that is 3 m long.

4.7 Power Supply, DT6124 Display/Output Device

The power supply and signal output are provided via the 6-pin connector on the front of the controller.

Pin	Wire color SCAC3/6	Signal	Description
1	White	+24 V	+24 V supply
2	Gray	GND	Supply ground
3	Pink	RS485 +	RS485 interface
4	Green	AGND	Analog ground (for signal output)
5	Brown	U-out	Signal output (load, min. 10 kOhm)
6	Blue	RS485 -	RS485, negated
Shield			Cable shield, housing



View: Solder side, 6-pin socket

Fig. 12 Supplyvoltage connection

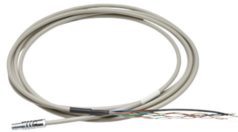


Fig. 13 SCAC3/6 power supply and output cable

The SCAC3/6 is an assembled supply and output cable that is 3 m long.

4.8 Sensor Connection

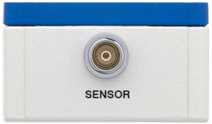


Fig. 14 Sensor cable connection

5. RS485 Interface

The DT6124 series controllers have an RS485 interface.

You can read out the measurements in digital form via the RS485 interface.

MICRO-EPSILON can help you with the MEDAQLib driver, which contains all commands for the capaNCDT 6120. You can download the link directly via the following link:http://www.micro-epsilon.de/link/software/medaqlib .

You can also use the IF1032/ETH interface converter, see Chap. A 1, for configuration and for reading out the measurements via Ethernet.

5.1 Hardware Interface

The interface is a half-duplex RS485 interface (1 common line pair for Rx and Tx).

Baud rate:	230400 (other baud rates can be set)
Data format:	1 start bit, 8 data bits, 1 parity bit (even), 1 stop bit
RS485 address:	126 (can be set between 1 and 126)

There is no RS485 terminating resistor in the controller. In RS485 lines longer than 5 meters, a 120 Ohm terminating resistor is required between the A and B line at both the bus start and end.

5.2 Protocol

The capaNCDT 6120 acts like an RS485 slave. As it is a half-duplex protocol, only the master can initiate a communication. Each device on the RS485 bus requires its own RS485 address. The master sends a request with an address to the bus, and only the slave with this address can answer the request.

5.2.1 Reading Measurements

Master: Request Data						
Byte:	SD	DA	SA	FC	FCS	ED
Value:	0x10	x	x	0x4C	x	0x16
		FCS				

Slave: Response Data										
Byte:	SD	LE	LE rep	SD rep	DA	SA	FC	Data[]	FCS	ED
Value:	0x68	x	x	0x68	x	x	0x08	x	x	0x16
					FCS					

Abbreviations:	
SD	StartDelimiter (0x10: telegram without data; 0x68 telegram with variable length)
LE	Length (number of bytes without SD, LE, LErep, SDrep, FCS, ED)
LErep	LE repeated
SDrep	SD repeated
DA	Destination Address /default 0x7E)
SA	Source Address (e.g. 0x01)
FC	Function Code
FCS	Checksum (sum of all bytes without SD, LE, LErep, SDrep, FCS, ED; without overflow, only 8 bits)
ED	EndDelimiter

Data[] – Measuring data (little endian)

Measuring data consist of a counter, the packet length m and the measurements. The packet length m determines how many measurements are transmitted. The packet length m is the number of measurements that have been queried by the electronic system since the last time measuring data were queried, but is limited to the most recent 20 measurements. The first measurement in the data [] package is the oldest value queried, the last one is the most recently queried value.

Data[0]	Counter [7:0]	unsigned short
Data[1]	Counter [15:8]	
Data[2]	Packet length m [7:0]	unsigned char
Data[3]	Filler byte [7:0]	unsigned char
Data[4]	Measurement 1 [7:0]	signed integer
Data[5]	Measurement 1 [15:8]	
Data[6]	Measurement 1 [23:16]	
Data[7]	Measurement 1 [31:24]	
Data[8]	Measurement 2 [7:0]	signed integer
Data[9]	Measurement 2 [15:8]	
Data[10]	Measurement 2 [23:16]	
Data[11]	Measurement 2 [31:24]	
	. . .	
Data[..]	Measurement m [7:0]	signed integer
Data[..]	Measurement m [15:8]	
Data[..]	Measurement m [23:16]	
Data[..]	Measurement m [31:24]	

5.2.2 Scaling of Measurements

By default, 24-bit measurements are transmitted. The following equivalences therefore apply:

0x0 = 0% of the sensor measuring range

0xF00000 = 100% of the sensor measuring range

If the sensor is outside the measuring range, accordingly larger measurements are output.

5.2.3 Example for Transmitting Measurements

Master: Request Data						
Byte:	SD	DA	SA	FC	FCS	ED
Value:	0x10	x	x	0x4C	x	0x16
		FCS				

DA = Destination address = slave address = 0x7E

SA = Source address = master address = 0x01

FCS = Checksum = 0x7E+0x01+0x43 = 0xC2

Slave: Response Data										
Byte:	SD	LE	LE rep	SD rep	DA	SA	FC	Data	FCS	ED
Value:	0x68	0x13	0x13	0x68	0x01	0x7E	0x08	e.g. 16 bytes	x	0x16
					FCS					

LE = Length = 16 data bytes + 3 bytes (DA, SA, FC) = 19 bytes = 0x13

DA = Destination address = master address = 0x01

SA = Source address = slave address = 0x7E

FCS = Checksum = 0x01 + 0x7E + ….

	Value	**Name**	**Explanation**
Data[0]	0x22	Counter [7:0]	Measurement counter = 0x0122 = 290
Data[1]	0x01	Counter [15:8]	
Data[2]	0x03	Packet length m [7:0]	M = 3 -> 3 measurements
Data[3]	0x00	Filler byte [7:0]	Fillers, can be ignored
Data[4]	0xB1	Measurement 1 [7:0]	Measurements = 0x003244B1 (0xF00000 = 100%) -> 0x003244B1 = 20.945% e.g. 200 μm sensor -> 41.89 μm
Data[5]	0x44	Measurement 1 [15:8]	
Data[6]	0x32	Measurement 1 [23:16]	
Data[7]	0x00	Measurement 1 [31:24]	
Data[8]	0xAC	Measurement 2 [7:0]	Next measurement, see above
Data[9]	0x44	Measurement 2 [15:8]	
Data[10]	0x32	Measurement 2 [23:16]	
Data[11]	0x00	Measurement 2 [31:24]	
Data[12]	0xB9	Measurement 3 [7:0]	Next measurement, see above
Data[13]	0x44	Measurement 3 [15:8]	
Data[14]	0x32	Measurement 3 [23:16]	
Data[15]	0x00	Measurement 3 [31:24]	

In total, 3 measurements (= m) have been recorded and thus transmitted since the last measurement query in the controller.

5.2.4 Setting the RS485 Address

You can change the RS485 address of the controller with this telegram:

Master:														
SD 0x68	LE 0x09	LE rep	SD rep	DA x	SA x	FC 0x43	DSAP 0x37	SSAP 0x3E	new_addr x	ID_Hi 0x0	ID_Lo 0x0	Lock 0x0	FCS x	ED 0x16

DA Destination Address (= old slave address)

SA Source Address = master address (e.g. 0x01)

FCS Checksum (sum of all bytes without SD, LE, LErep, SDrep, FCS, ED; without overflow, only 8 bits)

New_addr New address (in the range of 1 …126)

Slave response (brief acknowledgment),
if successful:

SC
0xE5

No response:

No response means that an error occurred when assigning the address. The controller still has the old address.

The new address will only be valid once the controller has been restarted.

5.3 Commands and Settings

Other settings can be applied via the RS485 interface:

- Filter:
  - Off
  - Moving mean (over 2 to 8 values)
  - Arithmetic mean (over 2 to 8 values)
  - Median (over 2 to 8 values)
  - Dynamic noise suppression
- Data rate at which the measurements can be recorded:
  - 5, 10, 20, 40, 80, 160, 320, 640, 1000 or 2000 samples/s
- Baud rate of RS485 interface:
  - 9600, 115200, 230400, 460800 or 921600 baud
- RS485 address of controller: 1 ... 126
- Controller firmware update

i For these settings, use either our MEDAQLib driver or the IF1032/ETH interface converter to Ethernet with a corresponding configuration option via a web interface.

6. Operation

➡ Connect the display/output devices via the screw terminal connection before connecting the device to the power supply, then switch it on.

The measuring system is calibrated before being shipped. The user does not need to perform a calibration.

i Let the measuring system warm up for approx. 10 minutes after switching on the power supply.

NOTICE The supply voltage must not exceed the specified limits or fall below them for extended periods of time.
> Damage to or destruction of the sensor and/or controller

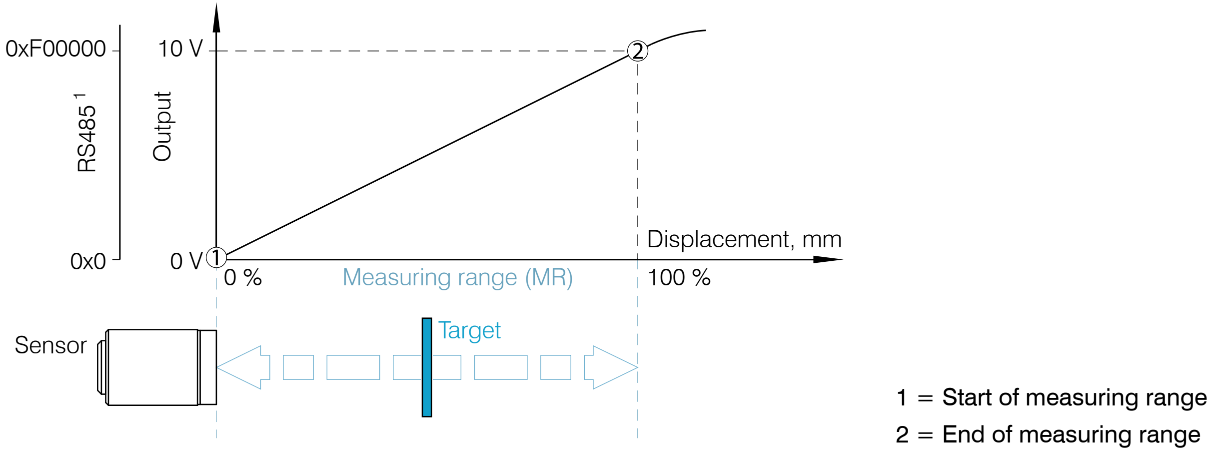


Fig. 15 Output voltage vs measuring range curve

CAUTION Disconnect the power supply before touching the sensor surface.
> Static discharge, risk of injury

1) Digital interface can only be used with DT6124 controller

7. Maintenance

Make sure that the sensor surface is always clean.

- Before cleaning, turn off the supply voltage.
- Use a damp cloth to clean the sensor surface and rub it dry afterwards.

CAUTION Disconnect the power supply before touching the sensor surface.
> Static discharge, risk of injury

In case of a defect in the controller, the sensor or the sensor cable, please send 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
Königbacher Str. 15
94496 Ortenburg / Deutschland

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

Sensors of the same type can be exchanged without the controller having to be recalibrated.

8. 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.

9. Decommissioning, Disposal

➡ Remove the power and output cable from the sensor.

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 Optional Accessories

PS2020		Power supply for top-hat rail installation Input 100 – 240 VAC Output 24 VDC/2.5 A; L/W/H 120 x 120 x 40 mm Installation type; installation on symmetrical standard rail 35 mm x 7.5 mm, DIN 50022
PS2401/100-240/24V/1A		Universal plug-in power supply with open ends; exchangeable inserts; can be used around the world
IF1032/ETH		Ethernet/EtherCAT interface module - For DT6124: RS485 to Ethernet/EtherCAT (24 bit resolution) - For DT6114: Analog output to Ethernet/EtherCAT (only 14 bit resolution)

A 2 Effect of Capacitive Sensor Tilt

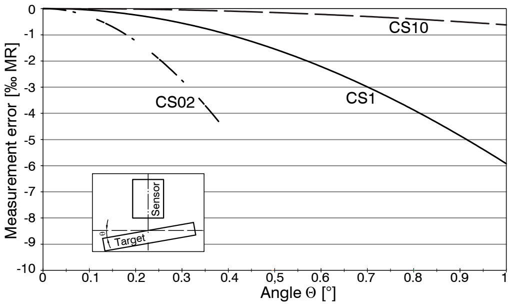


Fig. 16 Example measuring range deviation with a sensor distance of 10% of the measuring range

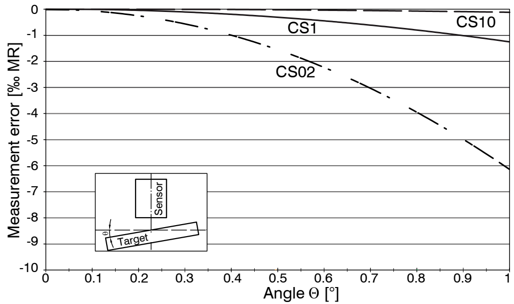


Fig. 17 Example measuring range deviation with a sensor distance of 50% of the measuring range

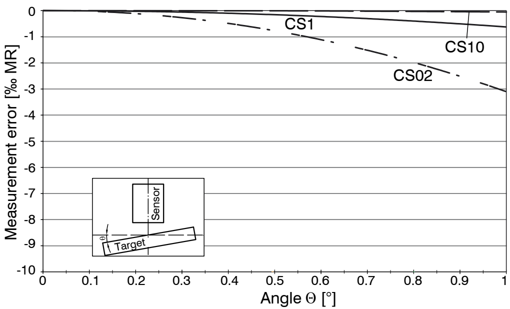


Fig. 18 Example measuring range deviation with a sensor distance of 100% of the measuring range

i The figures show examples of the effect on CS02/CS1 and CS10 sensors at different distances between the sensor and target. The results are based on our own simulations and calculations; please ask if you would like more detailed information.

A 3 Measurement on Narrow Targets

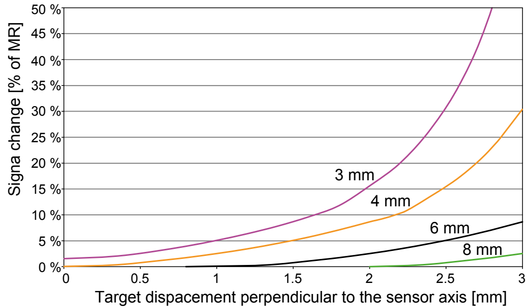


Fig. 19 Example measuring range deviation with a sensor distance of 10% of the measuring range

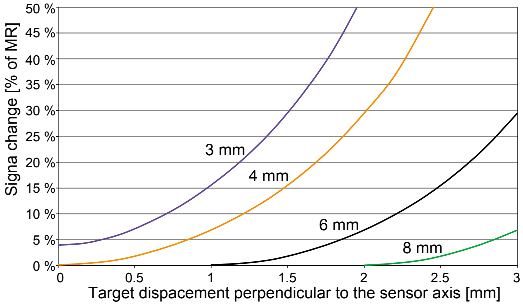


Fig. 20 Example measuring range deviation with a sensor distance of 50% of the measuring range

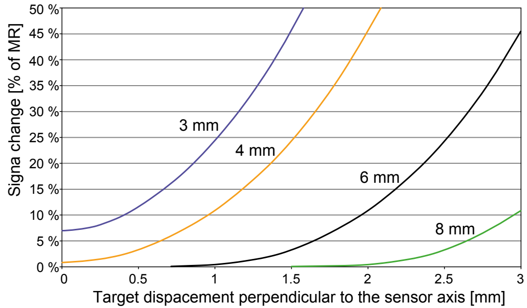


Fig. 21 Example measuring range deviation with a sensor distance of 100% of the measuring range

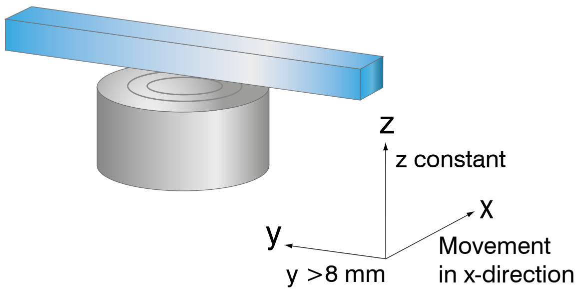


Fig. 22 Signal change when thin targets are shifted transversely to the measurement direction

i The figures show examples of the effect on a CS05 sensor at different distances between the sensor and target and with different target widths. The results are based on our own simulations and calculations; please ask if you would like more detailed information.

A 4 Measurement on Spheres and Shafts

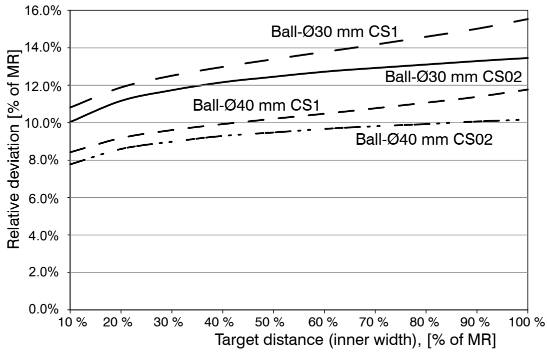


Fig. 23 Measurement deviation when measuring spherical targets

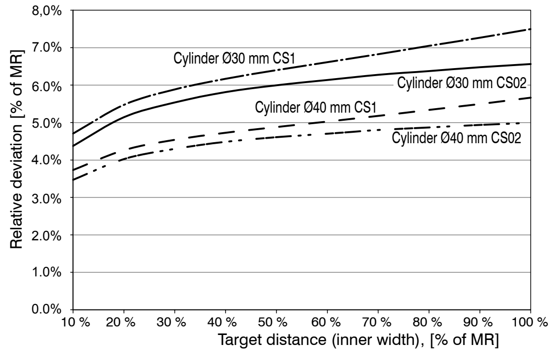


Fig. 24 Measurement deviation when measuring cylindrical targets

i The figures show examples of the effect on CS02 and CS1 sensors at different distances between the sensor and target and with different object diameters. The results are based on our own simulations and calculations; please ask if you would like more detailed information.

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